EN Manual

BENDER
The Power in Electrical Safety©

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_Box_D00156_01_M_XXEN/06.2016

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1. Important information

1.1 How to use this operating manual

*This manual is intended for **qualified personnel** working in electrical engineering and electronics!*

Always keep this manual within easy reach for future reference.
To make it easier for you to understand and revisit certain sections of text and instructions in the manual, we have used symbols to identify important instructions and information. The meaning of these symbols is explained below:

*DANGER: The signal word indicates that there is a **high** risk of danger that **will** result in **electrocution** or **serious injury** if not avoided.*

*WARNING: This signal word means that there is a **medium** risk of danger that can lead to **death** or **serious injury,** if not avoided.*

*CAUTION: This signal word indicates a **low level risk** that can result in minor or **moderate injury** or **damage to property** if not avoided.*

*NOTE: This symbol denotes information intended to assist the user to make **optimum use of the product**.*

This manual has been compiled with the utmost care. Nevertheless, errors and mistakes cannot be completely ruled out. Bender accepts absolutely no liability for personnel injury or damage to property arising out of errors or mistakes in this manual.

1.2 Legend

Abbreviation	Description
DCP	**D**irect **C**urrent **P**ulse (continuous measurement method)
PWM	**P**ulse **W**idth **M**odulation
IMD	**I**nsulation **M**onitoring **D**evice
SST	Speed Start Measuring (measurement of system state)
M_{HS}	IR155-3204 IMD **M**easurement output, **H**igh **S**ide (available as a PWM signal)
OK_{HS}	IR155-3204 IMD Status out (**H**igh **S**ide)
R_F	Insulation resistance
t_{an}	Response time
U_n	Device voltage range

2. Safety information

2.1 Work activities on electrical installation

- Only qualified and skilled personnel are permitted to install, commission and run an electrical device or system.
- Compliance with the applicable regulations governing work on electrical installations and with the regulations derived and associated with them is mandatory. EN50110 is of particular importance in this regard. In addition, observe the following 5 safety rules before working on electrical installations:
  - **Disconnect**: First, the voltage must be switched off. This is done, for example, by unscrewing the fuses in households or by switching off the relevant circuit breaker.
  - **Prevent unintentional reconnection**: In order to eliminate any risk, an unintentional reconnection must be reliably prevented. To achieve this, leave fuses unscrewed until the work on the circuit has been completed, for example. Or the switching mechanism in a circuit breaker can be blocked with a piece of wire.
  - **Ensure there is no voltage**: After carrying out the above two tasks, check that there is no voltage present!! A two-pole voltage tester is the best way to determine this. Single-pole voltage testers do not provide reliable results.
  - **Grounding and shortcircuiting**: This rule must only be considered for voltages from 1000 V. Grounding must first take and then the earth must be connected to the short-circuited active parts.
  - **Cover or shield adjacent live parts**: For installations under 1 kV, it is sufficient to cover with insulating cloths, cables or fittings. Above1 kV additional barriers, cables and warning notices are required. In this case, the person must also be protected using, for example, a helmet with a face shield and highly insulated gloves.

General safety instructions for Bender products *are provided on a separate leaflet, which is delivered with the device. Please read these instructions carefully.*

2.2 Warranty and Liability

Warranty and liability claims for damage to personnel and property are excluded if they are caused by one or more of the following:

- Improper use of the Hybrid Vehicle Distribution Box
- Improper installation, commissioning, operation and maintenance of the box
- Non-compliance with the instructions in the user manual regarding transportation, commissioning, operation and maintenance
- Unauthorized modifications to the box
- Failure to observe the technical data. This includes improper repairs and use not recommended by the manufacturer or the use of spare parts and additional equipment not sold or recommended by the manufacturer
- Damage caused by foreign bodies and/or acts of violence
- Assembly and installation using non-recommended equipment

This user manual, and in particular the safety information should be strictly observed by those who work with the box. If the device is being used in a location outside the Federal Republic of Germany, the applicable local standards and regulations must be complied with. European standard EN 50110 can be used as a guide.

2.3 Delivery conditions

Bender sale and delivery conditions apply. For software products the "Softwareklausel zur Überlassung von Standard-Software als Teil von Lieferungen, Ergänzung und Änderung der Allgemeinen Lieferbedingungen für Erzeugnisse und Leistungen der Elektroindustrie" (software clause in respect of the licensing of standard software as part of deliveries, modifications and changes to general delivery conditions for products and services in the electrical industry) set out by the ZVEI (Zentralverband Elektrotechnik- und Elektronikindustrie e. V.) (German Electrical and Electronic Manufacturer's Association) also applies. Sale and delivery conditions can be obtained from Bender in printed or electronic format.

2.4 Handling of the Hybrid Vehicle Distribution Box

The Hybrid Vehicle Distribution Box has been assembled in accordance with the latest state-of-the-art technology and recognized safety rules. Nevertheless, its use may result in injury to the user or a third party respectively, through interference or damage to the box or material property. The Hybrid Vehicle Distribution Box should only be used in perfect condition and for its intended purpose.

Any interference which could jeopardize safety must be eliminated immediately. Unauthorized modifications and the use of spare parts and additional equipment not sold or recommended by the manufacturer of the equipment may cause fire, electric shock and injury. Unauthorized persons may have no access to the Hybrid Vehicle Distribution Box. Warning signs must be legible. Damaged or illegible labels or signs must be replaced immediately.

Danger high voltages!
Because of high voltages, the Hybrid Vehicle distribution Box may ***not*** *be operated without the box cover.*

2.5 Control, transport and storage

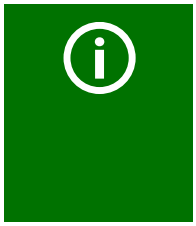
Upon delivery check the packaging of the shipment for damage and compare the package contents against the delivery documents. In the event of damage caused during shipping, please notify Bender GmbH & Co. KG immediately.

As well as damage caused by shipping, a damaged box or a box that has been dropped must not be put into operation and should be immediately returned to the manufacturer.

The devices must only be stored in areas where it is protected from dust, moisture and spray or dripping water, and in which the storage temperatures specified by the manufacturer are complied with.
Information regarding transport and storage temperatures can be found in the Technical data on page 28.

2.6 Precautions

Ensure the correct rated input voltage and supply voltage is applied. For insulation or voltage tests, the Hybrid Vehicle Distribution Box must be separated from the IT system (DC link) for the duration of the test. To check that the device has been properly connected, perform a functional test before commissioning the system. It is necessary to examine whether the initial settings meet the requirements of the IT system.



When using ISOMETER®s in IT systems, make sure that only one active ISOMETER® is connected in each interconnected system. If IT systems are interconnected via coupling switches, make sure that ISOMETER®s not currently used are disconnected from the IT system and deactivated. If IT systems are coupled via capacitances or diodes, this may influence insulation monitoring and so central control of the various ISOMETER®s must be employed.

2.7 Intended use

The Hybrid Vehicle Distribution Box monitors the high-voltage (HV) insulation resistance, R_F, between the insulated and 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) in an IT system.
The 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 reliably signalised even under high system interferences, which can be caused by motor control processes, accelerating and energy recovery for example.
The Hybrid Vehicle Distribution Box is optimised for use in hybrid or fully electric vehicles and meets the increased automotive requirements with regard to environmental conditions such as temperatures, vibration and EMC.

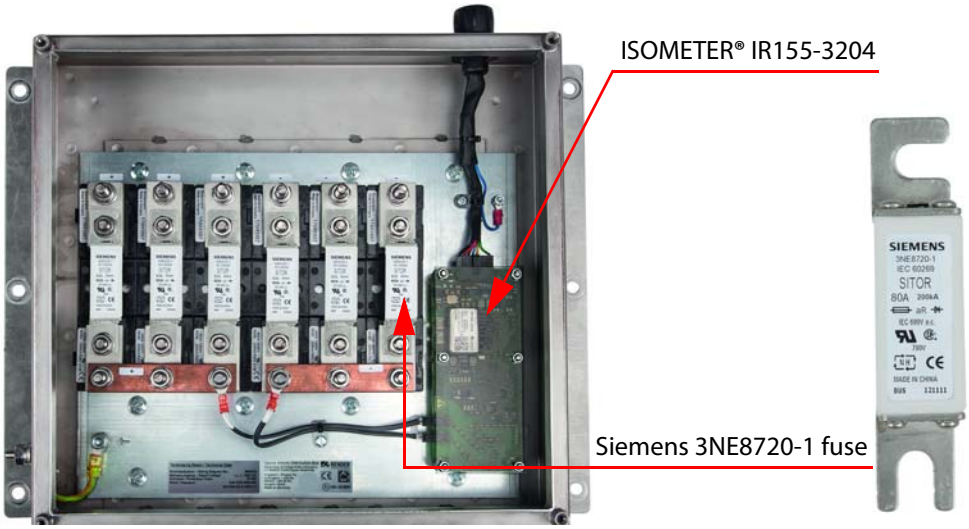
3. Function

3.1 Device features

- Insulation monitoring of AC and DC insulation faults for unearthed systems (IT systems) from DC 0 V…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 (≤1 µF)
- 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 Hz…50 Hz) at high-side driver (M_{HS} output)
- Protective coating (SL 1301ECO-FLZ) on the insulation monitoring device

3.2 Product description

The Hybrid Vehicle Distribution Box is optimised for use in hybrid or fully electric vehicles and monitors the HV insulation resistance between the insulated and 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.



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.
See technical data for further information.

*The **fuses** are not delivered with the Hybrid Vehicle Distribution Box. Instead they must be ordered separately from Siemens. See ordering data in chapter "7.1.1 Spare parts"*

*When a **fuse** needs to be **replaced**, its partner in the "+" or "-" path, depending on which fuse has blown, must also be changed. The same fuse type must be used and both must come from the same manufacturing batch.*

3.3 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 ≤1 µF, 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.

CAUTION

Ensuring the Hybrid Vehicle Distribution Box is properly grounded
To continuously monitor the connection between the terminals E/KE and the chassis ground, it is necessary to install two separate conductors from terminals E/KE to chassis ground. Terminal E is connected to the chassis via the Souriau plug while terminal KE is connected to the chassis via the earth point on the box housing. The earth point is labelled "7" on the housing (external view) shown in the illustration on Page 18.

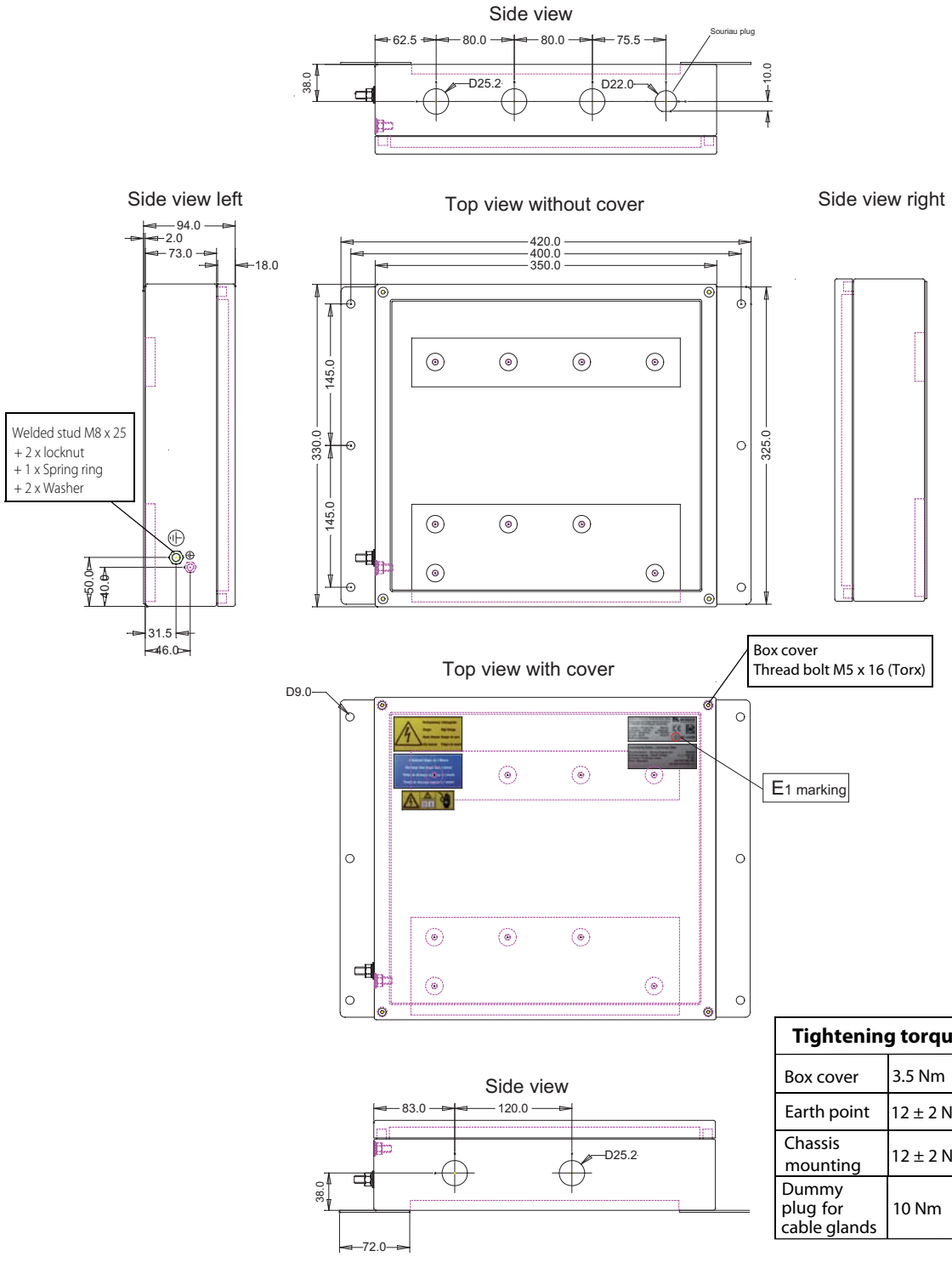
The measured insulation condition is available as a Pulse Width Modulated (PWM) signal at the terminal M_{HS}, which is located on an integrated and galvanically isolated interface (high-side driver). Fault information in the connecting wires to E/KE or functional faults is automatically recognised and signalled through this interface, which consists of the status output OK_{HS}. These fault messages indicate a HV system insulation fault, an ISOMETER® connection or device error.

3.4 ISOMETER® self test

An ISOMETER® IR155-3204 self test is not executed at power on. Instead a self test is automatically carried out every five minutes during operation and lasts about 10 seconds. The interface is not affected by these self tests.

4. Dimensions and mounting

4.1 External Distribution Box dimensions



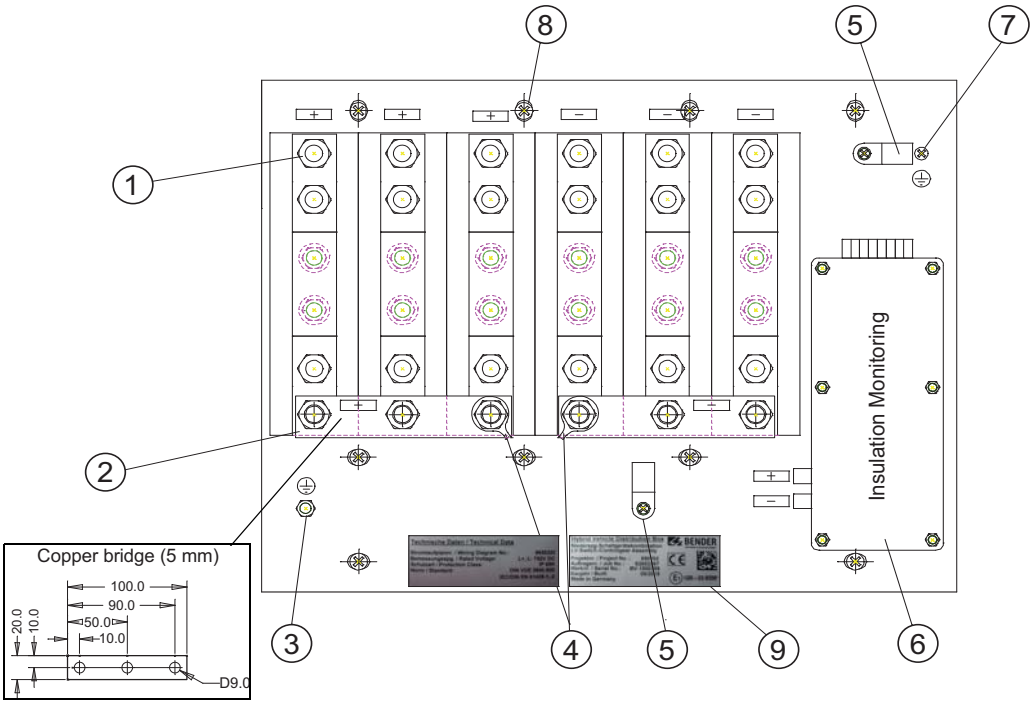
Tightening torques	
Box cover	3.5 Nm
Earth point	12 ± 2 Nm
Chassis mounting	12 ± 2 Nm
Dummy plug for cable glands	10 Nm

4.2 Chassis mounting

*The Hybrid Vehicle Distribution Box can be **mounted** vertically or horizontally.*

4.3 Overview of internal Hybrid Vehicle Distribution Box plate

Internally there is room for an ISOMETER® IR155-3204 IMD and a maximum of six Siemens series 3NE8720-1 fuses:



Number	Components
1	(12 x) Thread bolt M8 x 35 + (1 x locknut*) + (1 x spring washer) + (1 x washer)
2	Copper bridge (100 mm^2)
3	Screw M6 x 20 + (2 x locknut) + (2 x spring washer) + (3 x washer)
4	Ring terminal lug (Recommended: M8 - 1.5 mm^2)
5	Cable clamp - Screw M4 x 10 + (1 x toothed washer)
6	**IR155-3204 IMD** - Bottom: isoplate; Top: plexiglass (anti-static) (12 x) spacers M4 x 15, (6 x) screw M4 x 10, (6x) locknut M4
7	Screw M4 x 16 + (2 x locknut) + (2 x spring washer) + (3 x washer)
8	(9 x) Hexagon socket head cap screw M6 x 10 (RIPP LOCK locking screw)
9	Nameplate with E1 marking (also included on the distribution box cover)

* Recommended tightening torque of 12 ±2 Nm

4.3.1 ISOMETER® IR155-3204

*The ISOMETER® IR155-3204 is covered with an **anti-static plexiglass** to prevent the buildup of static and protection against touching. This covering should only be removed when replacing the ISOMETER®.*

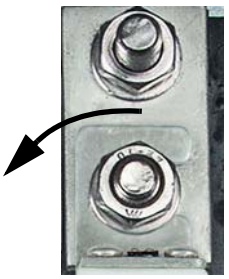
The ESD protection data for the ISOMETER® IR155-3204 is given in “ESD protection (ISOMETER® IR155-3204)” on page 27.

4.3.2 Installing/replacing fuses

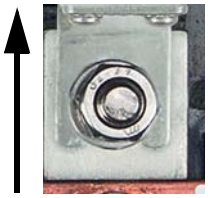
*When a **fuse** needs to be **replaced**, its partner in the "+" or "-" path, depending on which fuse has blown, must also be changed. The same fuse type must be used and both must come from the same manufacturing batch.*

To replace a fuse that is damaged or has blown:

- Turn off the supply voltage.
- Discharge the system and ensure that it is COMPLETELY de-energised. The discharge time is specified as > 1 minute.
- Loosen the M8 hex locknuts, spring ring and washers at both ends of the affected fuse **AND** of its partner fuse.
- To remove the fuse, simply slide the fuse in an anticlockwise direction as showm in figure **A** below. Then at the other end, slide the fuse upwards (as shown in figure **B**) to release.



A



B

- Select the same fuse type and ensure both come from the same manufacturing batch.
- In the reverse order as described above, first slot the fuse into position using a downward motion (refer to illustration **B** above). The fuse metal plate should sit directly on the contact plate. Then slide the fuse, in a clockwise direction (see **A**), into position.
- Tighten the M8 hex locknuts according to the recommended tightening torque.

*The maximum permissible **tightening torque** for the M8 hex locknuts used to tighten the fuses into position is 12 Nm ± 2.*
A 13 mm wrench size is required to tighten the M8 hex locknuts.

5. Connection

5.1 Connection conditions

DANGER

Risk of electric shock
The terminals HV+ / HV- may have nominal voltages measuring up to 750 V. Touching live parts of the system carries the risk of electric shock. Therefore, the device should only to be operated with mounted and locked terminal covers.

CAUTION

Function test
*In order to check that the device is properly connected, a **function test** must be carried out before system commissioning by measuring a ground fault using a suitable resistance.*

CAUTION

Connection of terminals E/KE
Terminal E is connected to the chassis via the Souriau plug while terminal KE is connected to the chassis via the earth point on the box housing. The earth point is labelled "7" on the housing (external view) shown in the illustration on Page 18.

CAUTION

Risk of injury
Risk of injury from sharp-edged terminals. Please handle housing and terminals with care.

CAUTION

One ISOMETER® per conductively connected system
In every conductively connected system only one ISOMETER® may be connected. When performing insulation and dielectric tests on the system, the ISOMETER® must be disconnected from the IT system (DC link) for the duration of the test.

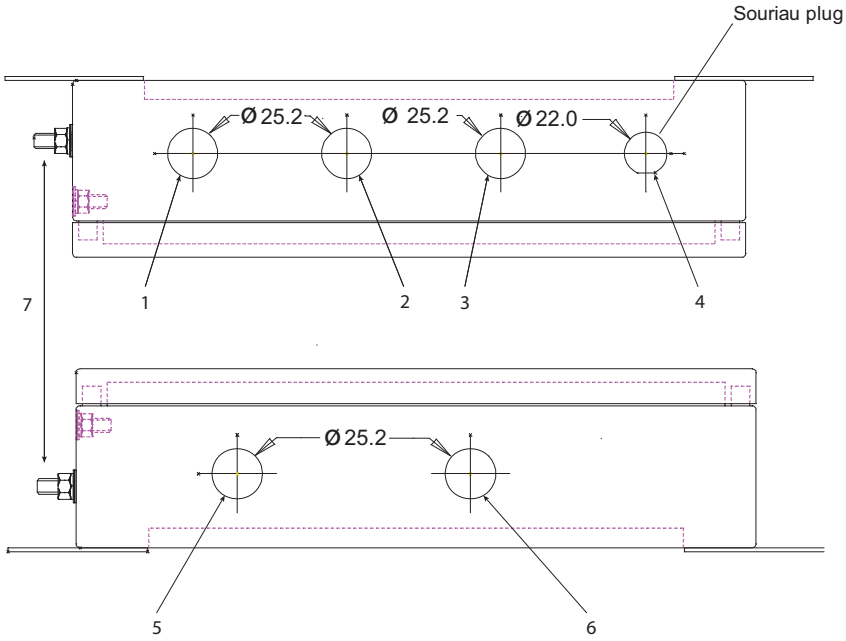
AC system with galvanically coupled DC circuits
When a monitored AC system contains galvanically coupled DC circuits, the following applies: an insulation fault can only be accurately detected if a minimum current of > 10 mA flows through the rectifier valves.

Wiring
The wiring should be carried out in a way that prevents a short circuit from occuring.

Overvoltage category
The test equipment used must be of at least overvoltage category II (300V).

Clearance and creepage distance
Requirements concerning clearance and creepage distance should be carried out in accordance with IEC 60664-1 (2004-04).

5.2 Connection - external



Number	Terminal
1	EMC cable gland with counter nut (M25 x 1.5, IP69K) - for connection to AUX inverter 1
2	EMC cable gland with counter nut (M25 x 1.5, IP69K) - for connection to AUX inverter 2
3	EMC cable gland with counter nut (M25 x 1.5, IP69K) - for connection to AUX inverter 3
4	8-pole Souriau receptacle for Souriau UTS6JC128S, 8-pole male straight cable mount circular connector (see table on following page)
5	EMC cable gland with counter nut (M25 x 1.5, IP69K) - for connection to HV+
6	EMC cable gland with counter nut (M25 x 1.5, IP69K) - for connection to HV-
7	Earth point

Cable glands must be ordered separately - see Page 29 for details. Instead, the Hybrid Vehicle Distribution Box is delivered with dummy plugs, which are tightened with a torque of 10 Nm.
The choice of cable glands (stainless steel recommended) and shielding is dependent on the cable type and cable outer diameter. The cable gland must, however, have a IP69K rating. The cable gland is used to insert a shielded line or cable into the connection space or housing.

Requirements concerning clearance and creepage distance should be carried out in accordance with IEC 60664-1 (2004-04).

5.2.1 8-pole Souriau connector/receptacle

5.2.1.1 Receptacle pin assignment

8-pole Souriau pin receptacle	Description
1 / (A)	0 V permanent (Kl.31)
2 / (B)	Supply voltage - Key on 24 V (Kl.15)
3 / (C)	Chassis ground (E)
---	NC
5 / (E)	Data out (PWM high side - M_{HS})
---	NC
---	NC
8 / (H)	Status out (high side - OK_{HS})

5.2.1.2 Souriau connector

The 8-pole male straight cable mount circular Souriau UTS6JC128S connector has a shell size: 12 (Length - 66.7 mm; Maximum diameter: 29.7 mm):

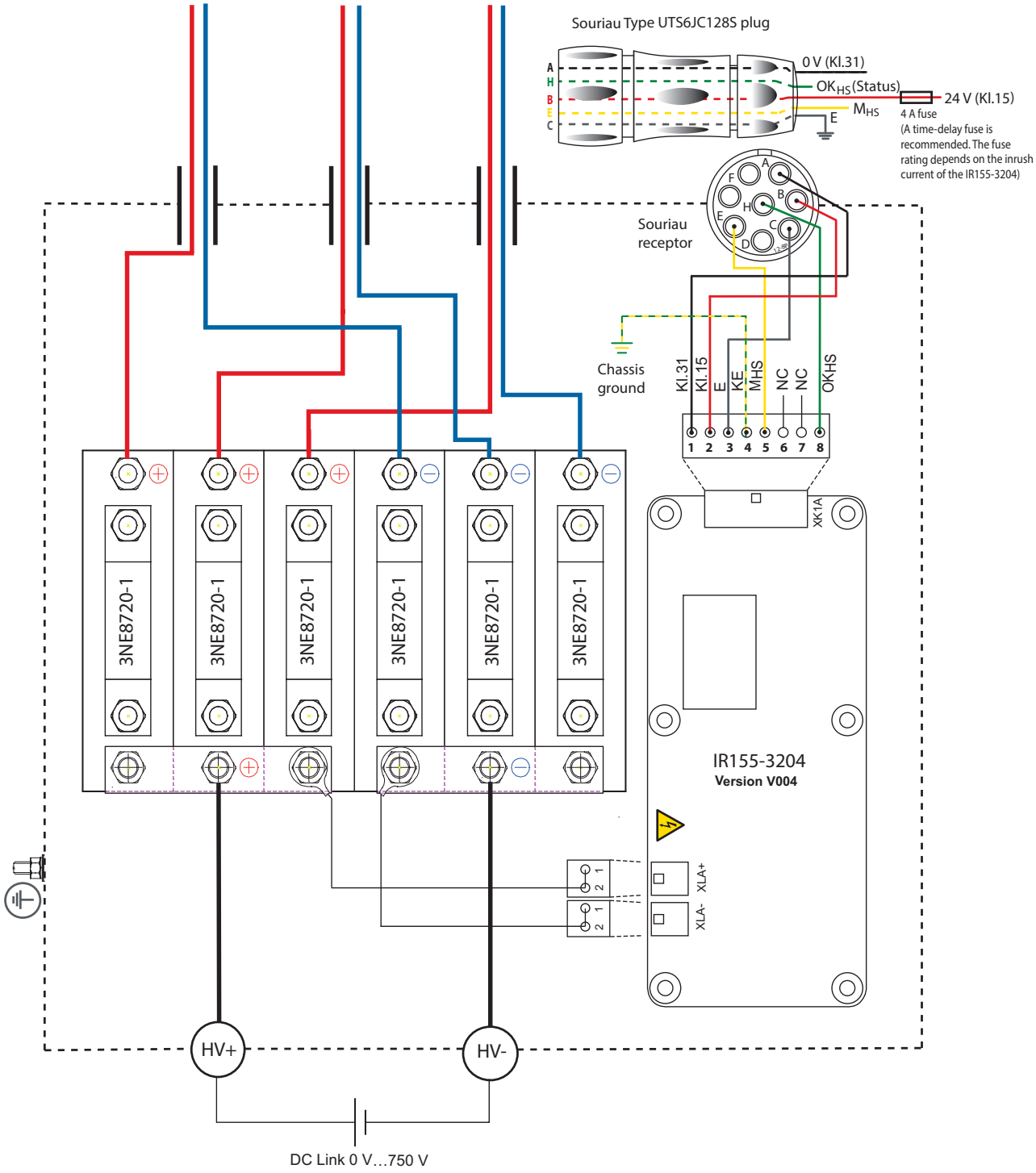
Required cable diameter for the Souriau plug is 3.0 mm to 9.0 mm or 5.0 mm to 12 mm (standard). Each plug is delivered with 2 seals to cover the specified cable range (the standard seal is preassembled).

5.2.1.3 Crimp contact information for Souriou plug

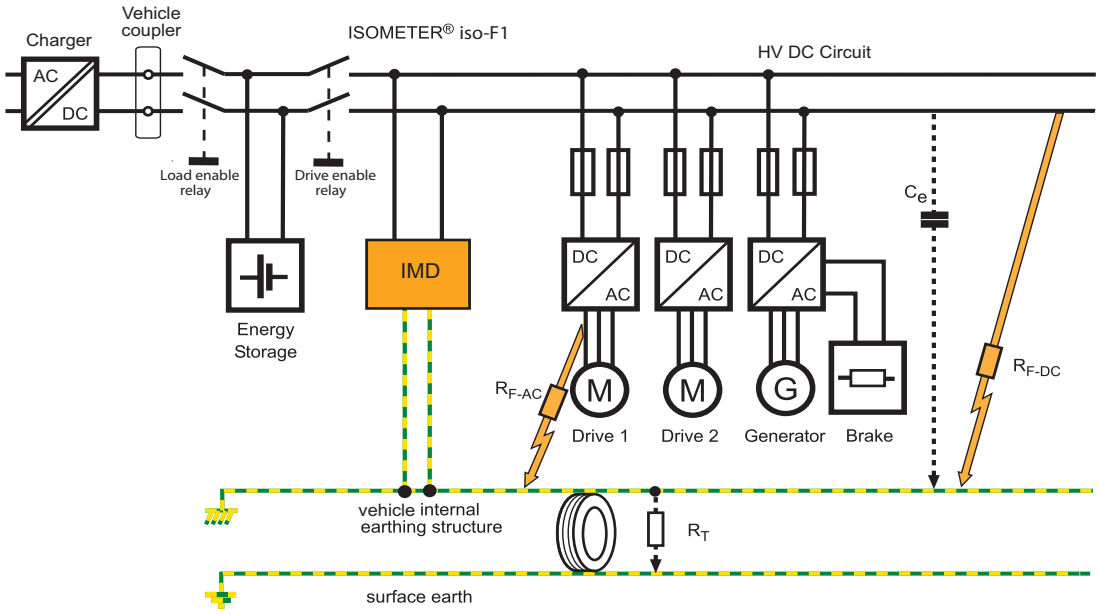
Part number		Wire size		Max. wire diameter	Max.insul-altion diameter	Wire strip length	I.D/O.D
Pin contact	Socket contact	AWG	mm^2				
RM20M12K	RM20M12K	22 - 20	0.32 - 0.52	1.18	2.2	4.8	1.83/2.92

The Souriau UTS6JC128S, 8-pole male straight cable mount circular connector and corresponding crimps are not delivered with the Hybrid Vehicle Distribution Box. Instead it can be ordered separately at Siemens.
See ordering data on Page 29.

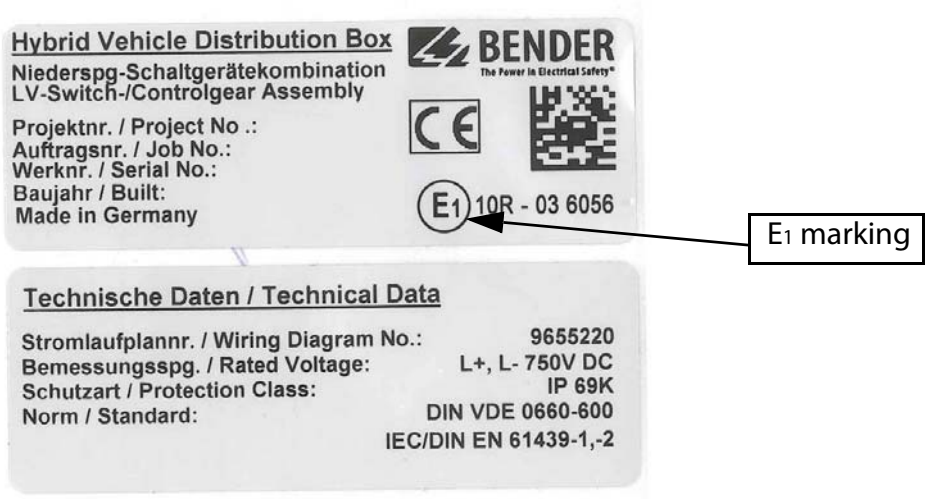
5.2.2 Connection - Internal



5.3 Typical application



5.4 Nameplate



The above two nameplates are glued onto the Hybrid Vehicle Distribution Box cover and the internal box plate

6. ISOMETER® Operation

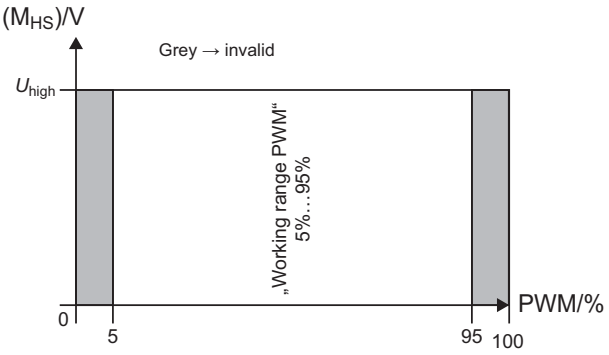
6.1 Operating principle of the PWM driver

6.1.1 Under normal conditions and under voltage detection

Under normal conditions and by under voltage detection (10 Hz; 20 Hz), the insulation resistance, R_F, is available as a PWM signal with maximum 80 mA output current at the output terminal M_{HS}. If the insulation resistance falls below the response value R_{an}, an alarm will be signalled.

The duty cycle as a percentage in relation to the measured value is available at the measured value output M_{HS}:

Duty cycle (dc) %	R_F
5	≥ 50 MΩ
50	1200 kΩ
95	0 kΩ



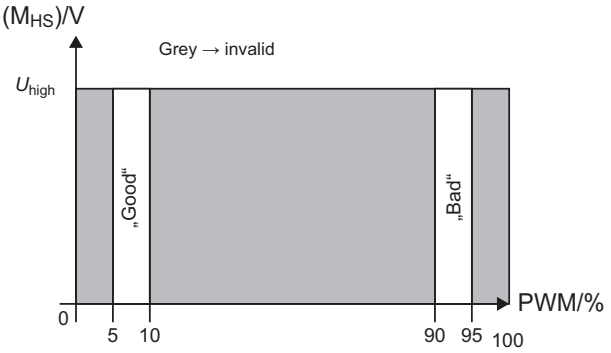
Calculation of the insulation resistance:

$$R_F = \left[\frac{90\% \times 1200\ \text{k}\Omega}{dc_{meas} - 5\%}\right] - 1200\ \text{k}\Omega$$

where dc_{meas} is the measured duty cycle (5 %…95 %)

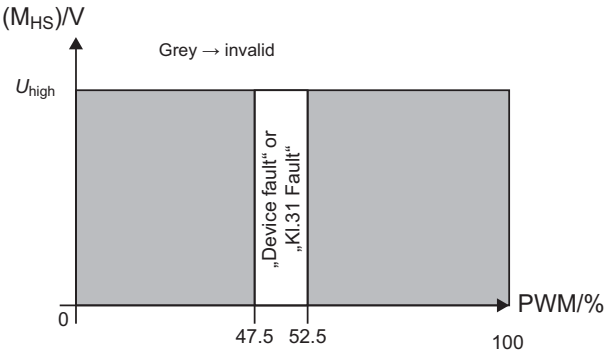
6.1.2 Under SST conditions

Under SST conditions (30 Hz), a duty cycle between 5 % and 10 % is considered "Good", while between 90 % and 95 % it is considered "Bad".



6.1.3 Under the " Device error" and "Kl.31 fault" conditions

Under the "Device error" and "Kl.31 fault" conditions (40 Hz; 50 Hz), the duty cycle lies between 47.5 % and 52.5 %.



7. Technical Data

Supervised IT system

Rated voltage range (U_n) ..... AC 0 V . . . 750 V peak
..... 0 V . . . 660 V rms (10 Hz . . . 1 kHz)
..... DC 0 V . . . 750 V
Protective separation (reinforced insulation) ..... between (HV+ / HV-) – (KI.31, KI.15, E, KE, M_{HS}, OK_{HS})
Voltage test ..... AC 3500 V / 1 min
Load dump protection ..... < 60 V
Undervoltage detection ..... 100 V
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 @ changeover R_F 1 MΩ > R_{an}/2)

Supply voltage (ISOMETER® IR155-3204)

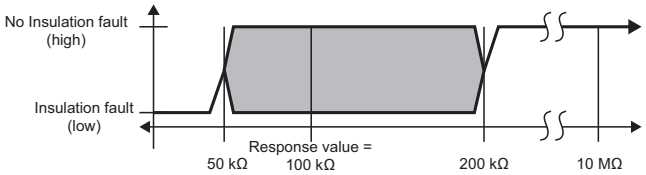
Supply voltage U_S ..... DC 10 V . . . 36 V
Nominal supply voltage ..... DC 12 V/24 V
Max operational current I_S ..... 150 mA
Max current I_K ..... 2 A
..... 6A/2 ms inrush current
High-voltage range ..... DC 0 V . . . 750 V
Power dissipation P_S ..... < 2 W

Measuring circuit (ISOMETER® IR155-3204)

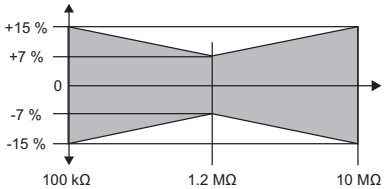
Measurement method ..... Bender DCP technology
Measuring voltage U_m ..... ± 40 V
Measuring current I_m at R_F = 0 ..... ± 33 µA
Factor averaging F_{ave} ..... 1 . . . 10 (default:10)

Measuring ranges (ISOMETER® IR155-3204)

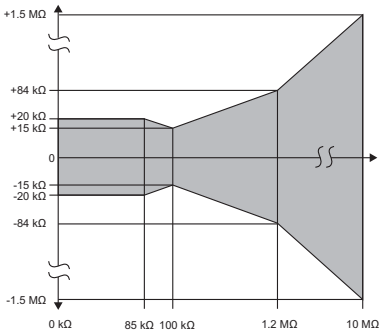
Insulation resistance range[1)] for 1 µF ..... 0 Ω . . . 10 MΩ
Insulation resistance range[1)] for 3 µF ..... 0 Ω . . . 1 MΩ
Insulation resistance range[1)] for 5 µF ..... 0 Ω . . . 750 kΩ
Insulation resistance range[1)] for 6 µF ..... 0 Ω . . . 550 kΩ
Impedance Z_i at 50 Hz ..... ≥ 1.2 MΩ
Internal DC resistance R_i ..... ≥ 1.2 MΩ
Relative uncertainty SST (≤ 2 s) ..... Good > 2 x R_{an}; Bad < 0.5 x R_{an}



Relative uncertainty (DCP) for 1 µF ..... 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 %



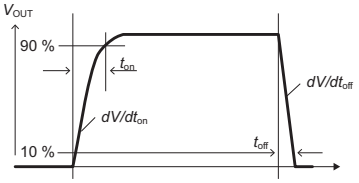
Absolute error (DCP) ..... 0 Ω . . . 85 kΩ, ±20 kΩ



Relative error output - M (base frequencies) ..... ± 5 % at each frequency
..... (10 Hz; 20 Hz; 30 Hz; 40 Hz; 50 Hz)
Relative error undervoltage detection ..... $U_n \geq$ 100 V, ± 10 %
..... $U_n \geq$ 300 V, ± 5 %

Response values (ISOMETER® IR155-3204)

Response uncertainty (according to IEC 61557-8) ..... ± 15 %
Hysteresis ..... + 25 %
Response value R_{an} ..... 400 kΩ
Response time after power on t_{an} (OK_{HS}; SST) ..... $t_{an} \leq$ 2 s (typ. < 1 s at U_n > 100 V)
Response time under normal operating conditions t_{an} (OK_{HS}; DCP)
(Changeover R_F: 10 MΩ - R_{an}/2; at C_e = 1 µF; U_n = 750 V DC)
..... $t_{an} \leq$ 20 s (at F_{ave} = 10)
..... during self test t_{an} + 10 s
(Changeover R_F: 1 MΩ - R_{an}/2; at C_e = 3 µF; U_n = 750 V DC)
..... $t_{an} \leq$ 68 s[2)] (at F_{ave} = 10)
..... during self test t_{an} + 10 s
(Changeover R_F: 750 kΩ - R_{an}/2; at C_e = 5 µF; U_n = 750 V DC)
..... $t_{an} \leq$ 68 s[2)] (at F_{ave} = 10)
..... during self test t_{an} + 10 s
(Changeover R_F: 550 kΩ - R_{an}/2; at C_e = 6 µF; U_n = 750 V DC)
..... $t_{an} \leq$ 68 s[2)] (at F_{ave} = 10)
..... during self test t_{an} + 10 s
Switch-off time t_{ab} (OK_{HS}; DCP)
(Changeover R_F:R_{an}/2 - 10 MΩ; at C_e = 1 µF; U_n = 750 V DC)
..... $t_{ab} \leq$ 40 s (at F_{ave} = 10)
..... during self test t_{ab} + 10 s
Self test time ..... 10 s
..... every 5 minutes; has to be added to t_{an}/t_{ab}
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 from 10 to 30 % V_{OUT} ..... Max. 6 V/µs
Slew rate off from 70 to 40 % V_{OUT} ..... Max. 8 V/µs
Timing:



Measurement Output (ISOMETER® IR155-3204)

M_{HS} switches to U_S - 2 V ..... external pull-down resistor of ≤ 2.2 kΩ required[3)]
Status Output (OK_{HS})
OK_{HS} switches to U_S - 2 V ..... external pull-down resistor of ≤ 2.2 kΩ required[3)]
..... High - No fault; R_F > response value
..... Low - Insulation resistance ≤ response value detected or
..... IMD error or ground error or
..... undervoltage detected or IMD off

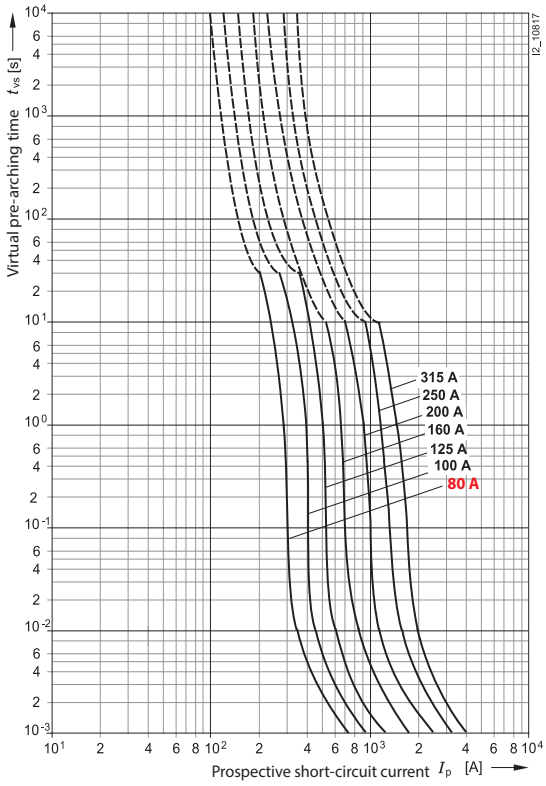
ESD protection (ISOMETER® IR155-3204)

Contact discharge - directly to terminals ..... ≤ 10 kV
Contact discharge - indirectly to environment ..... ≤ 25 kV
Air discharge - handling of the PCB ..... ≤ 6 kV

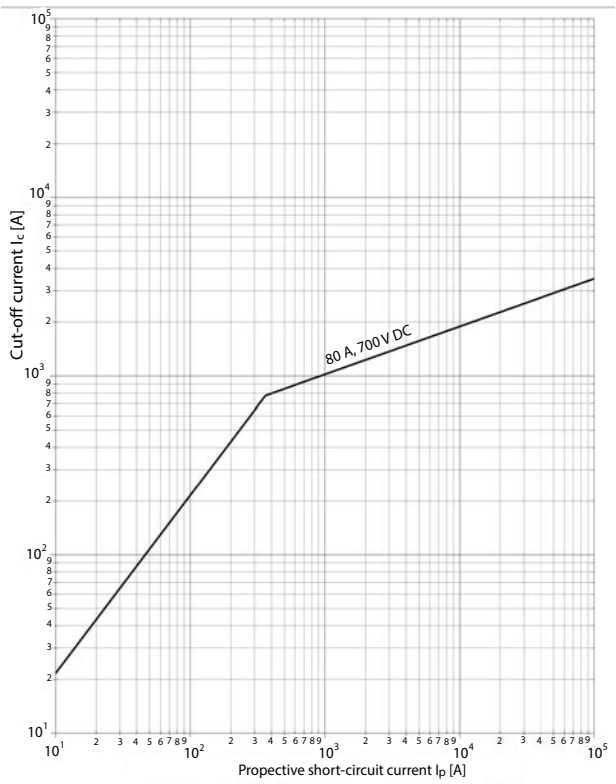
Fuses[4)]

Type ..... Siemens series 3NE8720-1 (x 6)
Rated voltage U_n ..... AC 690 V
..... DC 700 V[5)]
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-arcing value (t_{vs} = 1 ms) ..... 380 A^2s
Total operating energy at U_n ..... 2700 A^2s

Time/current characteristic curve



Cut-off current characteristic



Temperature rise (midsection) at I_n ..... 80 K
Power dissipation at I_n ..... 18 W
Mounting position ..... Vertical and horizantal
Varying load factor 0.9
Ambient temperature ..... -40°C . . . +70°C
Operating class (IEC 60269) ..... aR

Connectors (Electric Distribution Box)

Souriau plug[6] UTS6JC128S (8-pole)
Cable diameter for Souriau plug[7] ..... 3 mm . . . 9 mm
..... 5mm . . . 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 ..... ≤ 10 kV
Contact discharge - indirectly to environment ..... ≤ 25 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 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).

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 short-circuit currents. This applies to short-circuit currents, which lead to a maximum fuse melting time of 10ms. At the minimum short-circuit current of 350 A, the fuse is - according to the time/current characteristic (graph) - significantly quicker than 10ms, 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 resid-ual 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 5mm…12 mm is pre-assembled.*
The second seal, for cables with a diameter of 3mm…9 mm, is supplied as a loose part together with the plug.

7. 1 Ordering data

Type	Response value	Nominal voltage	Supply voltage	Undervoltage detection	Ordering number
Hybrid Vehicle Distribution Box	400 kΩ	DC 0…750 V	12 V- 24 V	<100 V	B91068520
Fuse 3NE8720 -1	Order directly from Siemens				A5E00866833
Souriou UTS6JC128S 8-pole male straight cable mount circular connector	Order directly from manufacturer or Siemens				190863
Pflitsch cable gland M25 14…18 mm	Order directly from manufacturer				225281808
Pflitsch cable gland M25 16…18 mm	Order directly from manufacturer				225322010
Locknut M25x1.5	Order directly from manufacturer				225/5

7.1.1 Spare parts

Type	Response value	Nominal voltage	Supply voltage	Undervoltage detection	Art. No.
Isometer® IR155-3204	400 kΩ	DC 0…750 V	12 V- 24 V	100 V	IR155-3204-400kΩ-100V + B 9106 8139CV4

7.1.2 Approvals/certifications

CE E 1 **10R - 03 6056**

7.2 Technical support

For questions related to the Hybrid Vehicle Distribution Box or if you cannot clear the fault related to the Hybrid Vehicle Distribution Box after thorough reading of the technical manual and intensive fault location in your installation, please contact our Technical Service department.

7.2.1 First level support

Technical support by phone or e-mail for all Bender products
Questions concerning specific customer applications, commissioning and troubleshooting:

Tel.:+49 6401 807-760 or 0700BENDERHELP (in Germany only)
Fax:+49 6401 807-259
E-mail: support@bender-service.com

7.2.2 Repair service

Repair, calibration, update and replacement service for Bender products:

- Repairing, calibrating, testing and analysing Bender products
- Hardware and software update for Bender devices
- Delivery of replacement devices in the event of faulty or incorrectly delivered Bender devices
- Extended guarantee for Bender devices, which includes an in-house repair service or replacement devices at no extra cost

Telephone:+49 6401 807-780 (technical); +49 6401 807-784**, -785** (Sales)**
Fax:+49 6401 807-789
E-Mail:repair@bender-service.de

7.3 Disposal

Abide by the national regulations and laws governing the disposal of this device. Ask your supplier if you are not sure how to dispose of the old equipment.
The directive on waste electrical and electronic equipment (WEEE directive) and the directive on the restriction of certain hazardous substances in electrical and electronic equipment (RoHS directive) apply in the European Community. In Germany, these policies are implemented through the "Electrical and Electronic Equipment Act" (ElektroG). According to this, the following applies:

- Electrical and electronic equipment are not part of household waste.
- Batteries and accumulators are not part of household waste and must be disposed of in accordance with the regulations.
- Old electrical and electronic equipment from users other than private households which was introduced to the market after 13 August 2005 must be taken back by the manufacturer and disposed of properly.

For more information on the disposal of Bender devices, refer to our homepage at www.bender-de.com -> Service & support.

7.4 Standards - corresponding norms and regulations

7.4.1 General

Standard	Description
IEC 61557-8 (2007-01)	Electrical safety in low voltage distribution systems up to 750 V a.c. and 1500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - Part 8: Insulation monitoring devices for IT systems
IEC 60664-1 (2004-04)	Insulation coordination for equipment within low-voltage systems - Part 1: Principles, requirements and tests.
IEC 61010-1 (2010)	Safety requirements for electrical equipment for measurement, control and laboratory use. Part 1: General requirements.
ISO 6469-3 (2001-11)	Electrically propelled road vehicles -- Safety specifications -- Part 3: Protection of persons against electric shock.
ISO 23273-3 (2006-11)	Fuel cell road vehicles - Safety specifications - Part 3: Protection of persons against electric shock.
E1 acc. 72/245/ EWG/EEC	2009/19/EG/EC

7.4.2 EMC

Standard	Description
IEC 61326-2-4 (2006)	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-4: Particular requirements - Test configurations, operational conditions and performance criteria for insulation monitoring devices according to IEC 61557-8 and for equipment for insulation fault location according to IEC 61557-9.

7.4.3 Environmental

Standard	Description
ISO 16750-1 (2006-08)	Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 1: General.
ISO 16750-2 (2010-03)	Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 2: Electrical loads.
ISO 16750-4 (2010-04)	Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 4: Climatic loads.
IEC 60068-2-14	Environmental testing - Part 2-14: Tests - Test N: Change of temperature.
IEC 60068-2-27	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock.
IEC 60068-2-30	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic.
IEC 60068-2-38	Environmental testing - Part 2-38: Tests - Test Z/AD: Composite temperature/hunidity cyclic test.
IEC 60068-2-60	Environmental testing - Part 2-60: Tests - Test Ke: Flowing mixed gas corrosion test.

Normative exclusion
The Hybrid Vehicle Distribution Box has gone through an automotive test procedure in accordance with multi-customer requirements as outlined by reg. ISO16750-x. The norm IEC61557-8 will be fulfilled by creating an LED warning function and test button at the customer site if necessary. The device includes no surge and load dump protection above 60 V. Additional central protection is necessary.

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BENDER
The Power in Electrical Safety©

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Photos: Bender archives.

BENDER Group