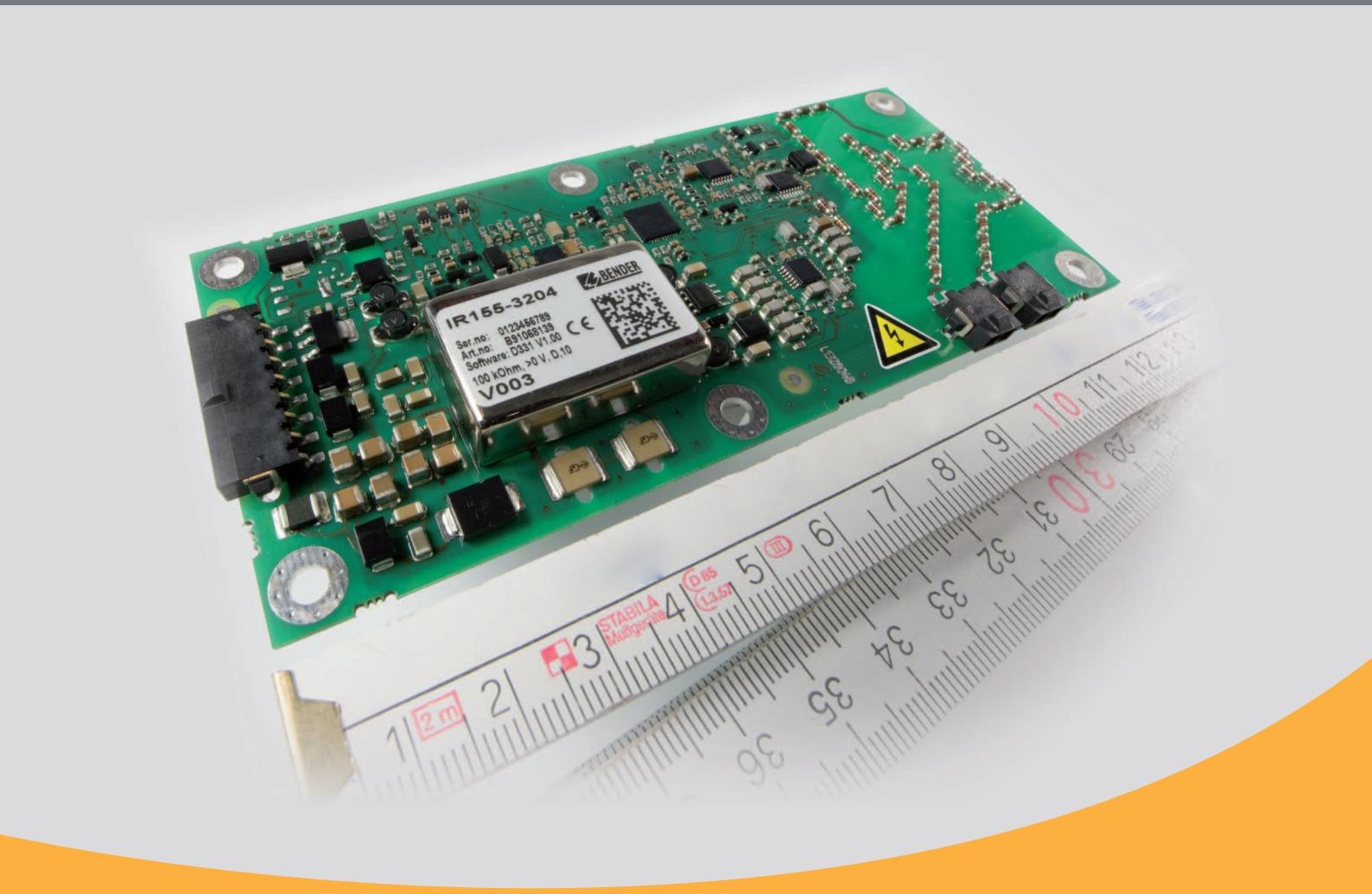
BENDER
The Power in Electrical Safety©

ISOMETER® IR155-3203 / IR155-3204

Insulation monitoring device (IMD) for unearthed DC drive systems (IT systems) in electric vehicles

Version V003



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Insulation monitoring device (IMD) for unearthed DC drive systems (IT systems) in electric vehicles

ISOMETER® IR155-3204

Device features

- Suitable for 12 V and 24 V systems
- Automatic device self test
- Continous 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 unearthed 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 (M_{HS} / M_{LS} output)
- Conformal coating (SL1301ECO-FLZ)

ATTENTION

Observe precautions for handling electrostatic sensitive devices.

Handle only at safe work stations.

ATTENTION

The device is monitoring HIGH VOLTAGE.

Be aware of HIGH VOLTAGE near to the device.

Product description

The ISOMETER® iso-F1 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 insulations faults will be signalised 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 (OK_{HS} output) and a measurement output (M_{HS} / M_{LS} 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 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 M_{HS} resp. M_{LS}. 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 fife minutes. The interfaces will not be influenced by these self tests.

Standards

Corresponding norms and regulations*

IEC 61557-8	2007-01
IEC 61010-1	2010-06
IEC 60664-1	2004-04
ISO 6469-3	2001-11
ISO 23273-3	2006-11
ISO 16750-1	2006-08
ISO 16750-2	2010-03
ISO 16750-4	2010-04
e1 acc. 72/245/EWG/EEC	2009/19/EG/EC
DIN EN 60068-2-38	Z/AD:2010
DIN EN 60068-2-30	Db:2006
DIN EN 60068-2-14	Nb:2010
DIN EN 60068-2-64	Fh:2009
DIN EN 60068-2-27	Ea:2010

*** Normative exclusion**

The device went through an automotive test procedure in combination of multi customer requirements reg. ISO16750-x.

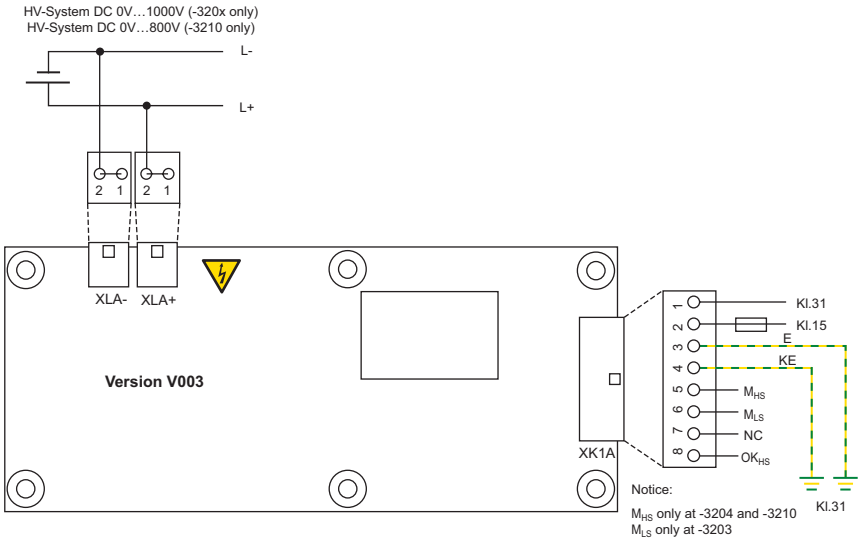
The norm IEC61557-8 will be fulfilled by creating the function for LED warning and test button at the customer site if necessary.

The device includes no surge and load dump protection above 40 V. An additional central protection is necessary.

Abbreviations

DCP	Direct Current Pulse
SST	Speed Start Measuring

Wiring diagrams



Connector XLA+

Pin 1+2	L+	Line voltage

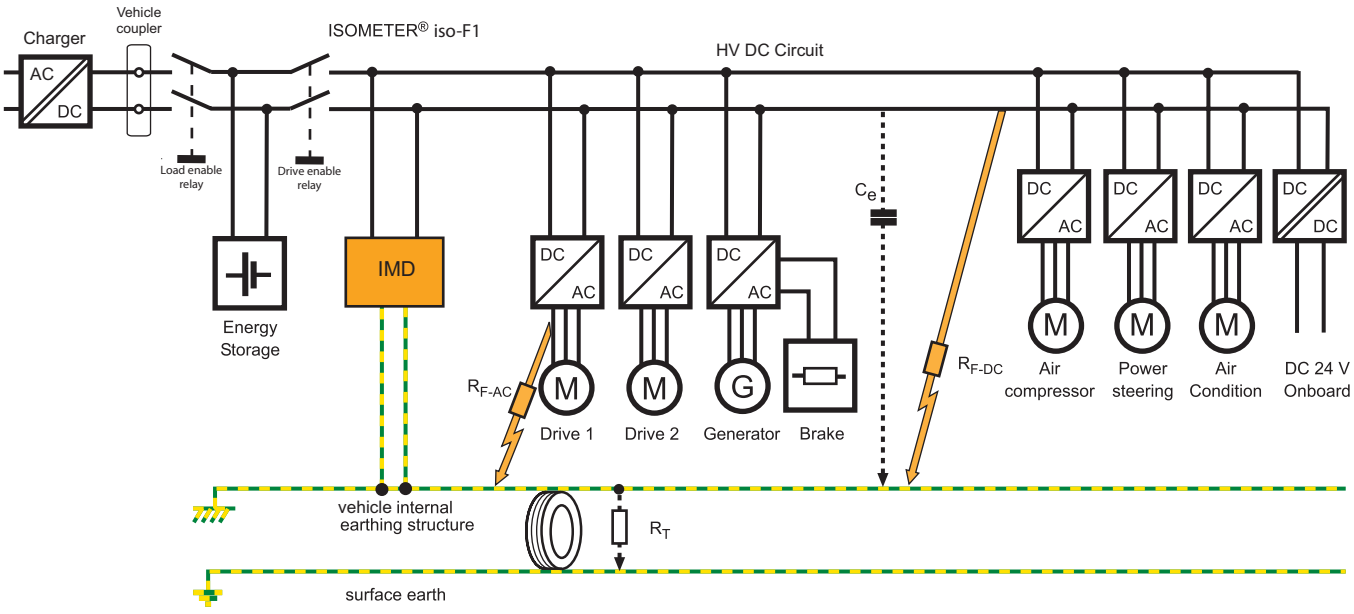
Connector XLA-

Pin 1+2	L-	Line voltage

Connector XK1A

Pin 1	Kl. 31	Chassis 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

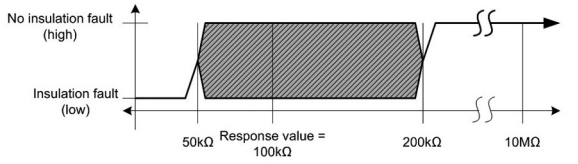


Technical data

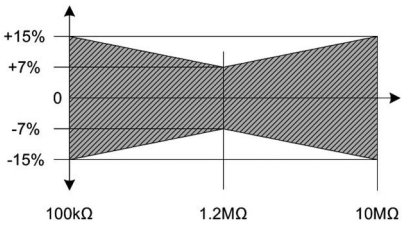
Supply voltage U_S	DC 10…36 V
Nominal supply voltage	DC 12 V / 24 V
Voltage range	10 V…36 V
Max. operational current I_S	150 mA
Max. current I_k	2 A
	6 A / 2 ms Rush-In current
Power dissipation P_S	< 2 W
Line L+ / L- Voltage U_n	AC 0 V…1000 V peak;
	0 V…660 V rms (10 Hz…1 kHz)
	DC 0 V…1000 V
Protective separation (reinforced insulation) between	
	(L+ / L-) – (KI.31, KI.15, E, KE, M_{HS}, M_{LS}, OK_{HS})
Voltage test	AC 3500 V / 1 min
Load dump protection	< 40 V
Under voltage detection	0 V…500 V; Default: 0 V (inactive)
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 @ change over R_F 1 MΩ > R_{an}/2)	
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 technologie
Factor averaging	
F_{ave} (Output M)	1…10 (default: 10; EOL Bender)
Relative error at SST (≤ 2s)	Good > 2 * R_{an}; Bad < 0.5 * R_{an}
Relative error at DCP	0…85 kΩ ▸ +/-20 kΩ
	100 kΩ…10 MΩ ▸ +/-15 %
Relative error Output – M (base frequencies)	+/- 5 % at each frequency
	(10 Hz; 20 Hz; 30 Hz; 40 Hz; 50 Hz)
Relative error under voltage detection	U_n ≥100 V ▸ +/-10 %;
	at U_n ≥300 V ▸ +/-5 %
Response value hysteresis (DCP)	25 %
Response value R_{an}	100 kΩ…1 MΩ
	▸ higher tolerances at R_{an} < 85 kΩ; (Default: 100 kΩ)
Response time t_{an} (OK_{HS}; SST)	t_{an} ≤ 2 s (typ. < 1 s at U_n > 100 V)
Response time t_{an} (OK_{HS}; DCP)	
(Changeover R_F: 10 MΩ ▸ R_{an}/2; at C_e = 1 µF; U_n = 1000 V DC)	
	t_{an} ≤ 20 s (at F_{ave} = 10*)
	t_{an} ≤ 17.5 s (at F_{ave} = 9)
	t_{an} ≤ 17.5 s (at F_{ave} = 8)
	t_{an} ≤ 15 s (at F_{ave} = 7)
	t_{an} ≤ 12.5 s (at F_{ave} = 6)
	t_{an} ≤ 12.5 s (at F_{ave} = 5)
	t_{an} ≤ 10 s (at F_{ave} = 4)
	t_{an} ≤ 7.5 s (at F_{ave} = 3)
	t_{an} ≤ 7.5 s (at F_{ave} = 2)
	t_{an} ≤ 5 s (at F_{ave} = 1)
	during self test ▸ t_{an} + 10 s

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

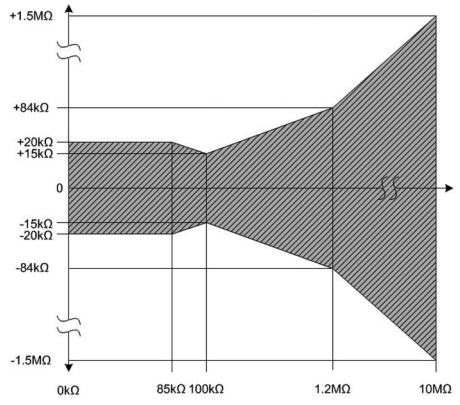
Switch-off time t_{ab} (OK_{HS}; DCP)	
(Changeover R_F: $R_{an/2}$ ▸ 10 MΩ; at C_e =1 µF; U_n = 1000V DC)	
	t_{ab} ≤ 40 s (at F_{ave} = 10)
	t_{ab} ≤ 40 s (at F_{ave} = 9)
	t_{ab} ≤ 33 s (at F_{ave} = 8)
	t_{ab} ≤ 33 s (at F_{ave} = 7)
	t_{ab} ≤ 33 s (at F_{ave} = 6)
	t_{ab} ≤ 26 s (at F_{ave} = 5)
	t_{ab} ≤ 26 s (at F_{ave} = 4)
	t_{ab} ≤ 26 s (at F_{ave} = 3)
	t_{ab} ≤ 20 s (at F_{ave} = 2)
	t_{ab} ≤ 20 s (at F_{ave} = 1)
	during self test ▸ t_{ab} + 10 s
Self test time	10 s
	(every 5 minutes; has to be added to t_{an} / t_{ab})
Relative error (SST)	"Good-Value" ≥ 2 * R_{an}
	"Bad-Value" ≤ 0.5 * R_{an}



Relative error (DCP)	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



Measurement Output (M)

M_{HS} switches to U_S – 2 V (3204)
(external load to ground necessary ➞ 2.2 kΩ)

M_{LS} switches to KI.31 +2 V (3203)
(external load to U_b necessary ➞ 2.2 kΩ)

0 Hz ▶ Hi > short to U_b+ (KI.15); Low > IMD off or short to KI.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; response time ≤ 2 s;
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 (KI. 31) detected
PWM 47.5%…52.5%

Status Output (OK_{HS})

OK_{HS} switches to U_S – 2 V
(external load to ground necessary ➞ 2.2 kΩ)

High ▶ No fault; R_F > response value
Low ▶ Insulation resistance ≤ response value detected; IMD error; ground error, under voltage detected or IMD off (ext. pull-down resistor required)

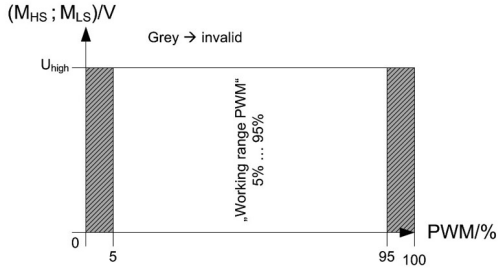
Operating principle PWM- driver

- Condition "Normal" and "Under voltage detected" (10Hz; 20Hz)

Duty cycle ▶ 5 % = >50 MΩ (∞)
Duty cycle ▶ 50 % = 1200 kΩ
Duty cycle ▶ 95 % = 0 kΩ

$$R_F = \frac{90\% \times 1200\ k\Omega}{dc_{meas} - 5\%} - 1200\ k\Omega$$

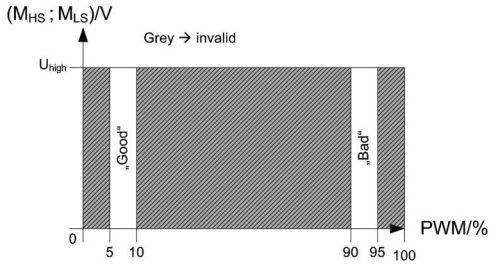
dc_{meas} = measured duty cycle (5 %…95 %)



Operating principle PWM- driver

- Condition "SST" (30Hz)

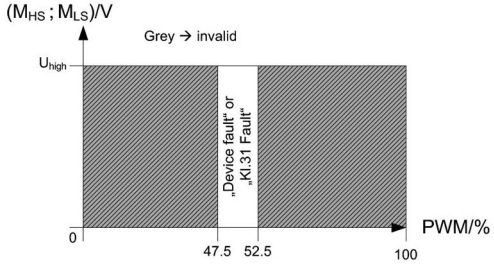
Duty cycle ▶ 5 %…10 % ("Good")
90 % … 95 % ("Bad")



Operating principle PWM- driver

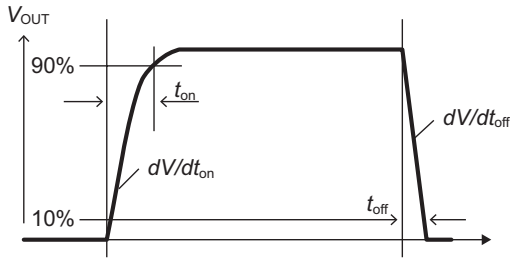
- Condition "Device error" and "KI.31 fault" (40Hz; 50Hz)

Duty cycle ▶ 47.5 % … 52.5 %



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 ▶ 10 to 30 % V_{OUT}	Max. 6 V/µs
Slew rate off ▶ 70 to 40 % V_{OUT}	Max. 8 V/µs

Timing 3204 (inverse of 3203)



Connectors	TYCO-MICRO MATE-N-LOK 1 x 2-1445088-8 (KI.31, KI.15, E, KE, M_{HS}, M_{LS}, OK_{HS}) 2 x 2-1445088-2 (L+, L-)
Crimp contacts	TYCO MICRO MATE-N-LOK Gold 14x 1-794606-1 Wire size: AWG 20…24
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.

Torx, T20 with a max. tightening torque of 4 Nm for the screws. Furthermore max. 10 Nm pressure to the PCB at the mounting points.

Mounting and connector kits are not included in delivery, but are available as accessories. 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-Lacquer
Weight	52 g +/-2 g

Ordering information

Type		Art.No
IR155-3203	Fixed default parameters R_{an}: 100 kΩ Under voltage detection: 300 V F_{ave}: 10 Measurement output low side	B 9106 8138
IR155-3203	Parameters can be customised R_{an}: 100 kΩ…1 MΩ Under voltage detection: 0 V…500 V F_{ave}: 1…10 Measurement output low side	B 9106 8138C
IR155-3204	Fixed default parameters R_{an}: 100 kΩ Under voltage detection: 0 V (inactive) F_{ave}: 10 Measurement output high side	B 9106 8139
IR155-3204	Parameters can be customised R_{an}: 100 kΩ…1 MΩ Under voltage detection: 0 V…500 V F_{ave}: 1…10 Measurement output high side	B 9106 8139C

Accessories

Mounting kit	B 9106 8500
Connecting kit IR155-32xx	B 9106 8501

Example for ordering

IR155-3204-100kΩ-0V + B 9106 8139

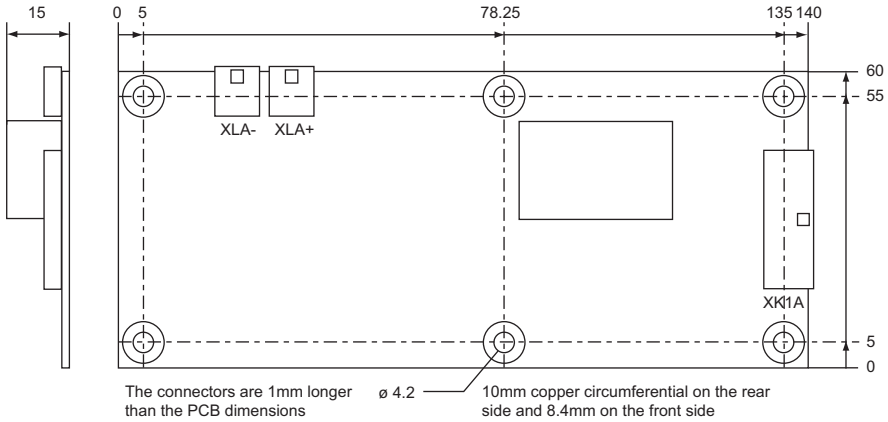
IR155-3204-200kΩ-100V + B 9106 8139C

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

Dimension diagram

Dimensions in mm

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



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