Automatic Passenger Counting

IRMA – Infrared Motion Analyzer
5th generation

IRMA-Gateway-4-RS485.2
Data sheet

Sensor versions

- IRMA MATRIX

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Short	Product name	Type designation
IRMA-Gateway-4	IRMA-Gateway-4-RS485.2	C8-4-R2-141.2.2.-16.261300.211215

Content

1 General

1.1 Trade names

Unless otherwise indicated, all brand and product names in this document are the registered trade names of their respective owners.

1.2 Disclaimer

The information contained in this document is based on product data resulting from the development and approval phases as well as the production of initial samples. These specifications do not claim to be error-free and will need to be updated or corrected. Such modifications may be made without notice. Characteristic or typical values given are based on our experience and are approximate values to be expected; they are by no means guaranteed.

1.3 Symbols / abbreviations used

"Please note"	"Worth knowing"
"Caution!" Failure to observe the guidelines can result in damage to the sensor."	"Information"
"Download"	"See document"

link Text shown in blue and underlined indicates the possibility of going directly to another part of the text, i.e. navigating within the document (in addition to 'normal' text references).

1.4 Preliminary

The following data sheet describes the analyzer variant 'Gateway' for IRMA MATRIX and the communication protocol RS485 (.2). Gateways in this context are evaluation units of the IRMA people counting system. Gateway and IRMA-Gateway-4-RS485.2 are synonymous. This data sheet does not describe the function or installation of the gateway in its entirety (sensors, cables, data interface, etc.), but reproduces the technical data.

The analyzer and gateway are identical in hardware, only the software is different for both devices. To distinguish the functionality, the analyzer has been renamed gateway. Electrical and mechanical properties have remained the same. Documents for type testing are therefore only available for the analyzer. (Table 2 “Standard compliance”)

1.5 Position of the gateway within the analyzer family

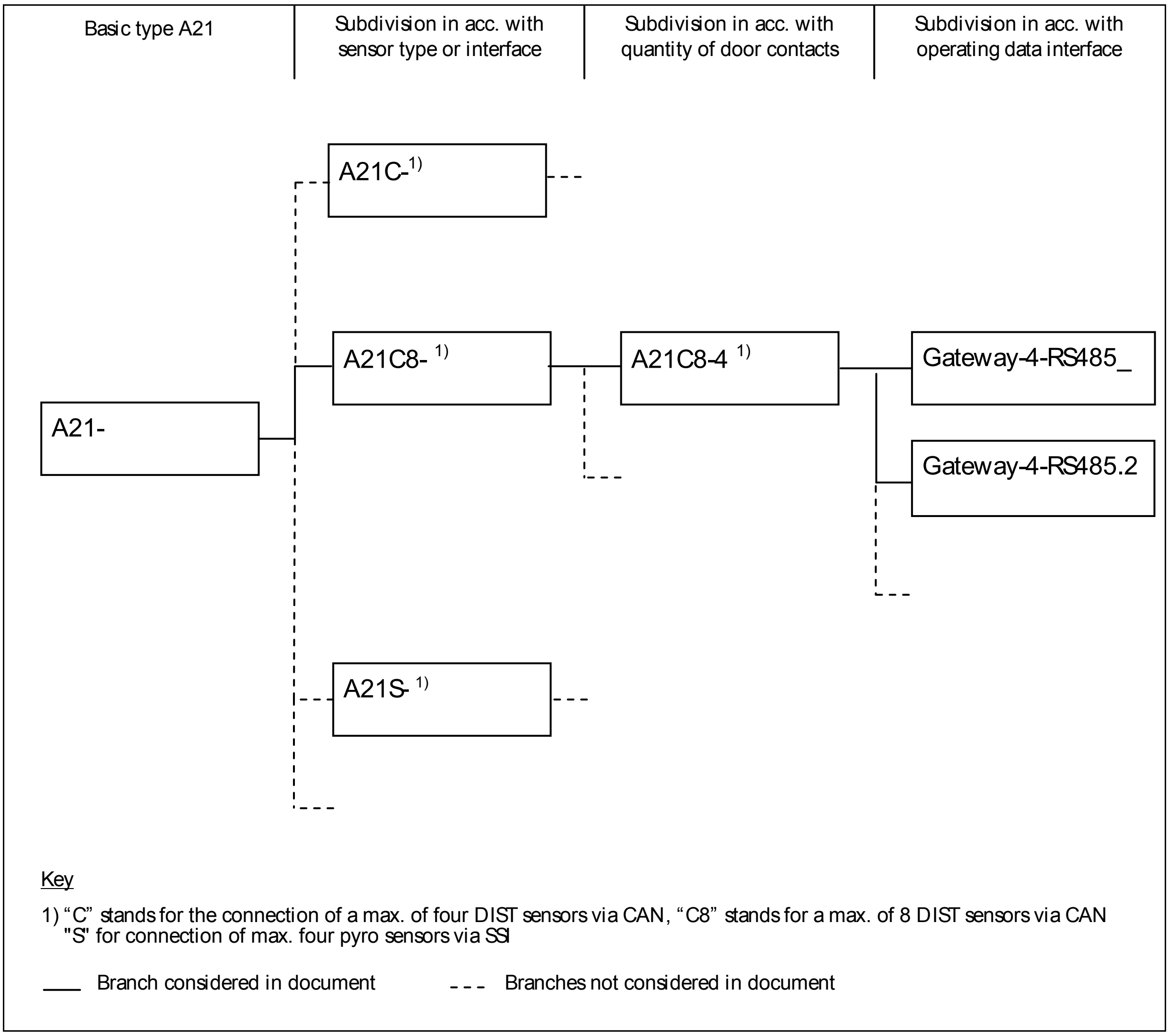

Fig. 1: Position within the analyzer family

1.6 Views on the device, photographs (examples)

Fig. 2: View of IRMA-Gateway-4-RS485.2: operating interfaces and name plate

Fig. 3: View of IRMA-Gateway-4-RS485.2: sensor connection

1.7 Name plate (example)

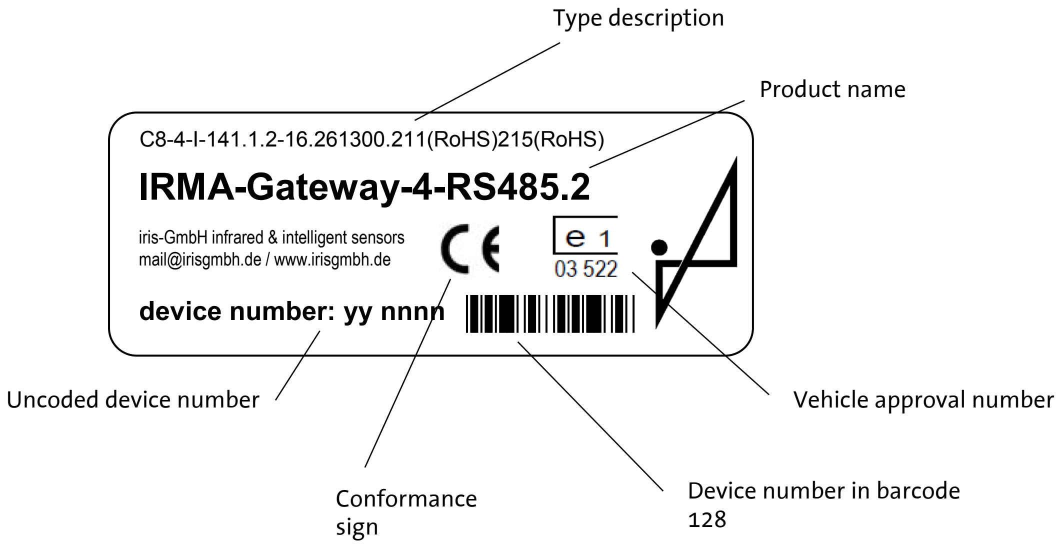

Fig. 4: **Name plate (example**

1.8 Type designation structure (excerpt)

a(a)-4-i-ccc.y.2-16.2613rr.bbbttt

a(a)	= C:	A21C for a maximum of 4 sensors
	= C8:	A21C8 for a maximum of 8 sensors
4	=	4 door signal inputs
i	= R:	RS485, 4-wire
	= R2:	RS485, 2-wire
ccc	= 141:	Housing version 1.41, four-part, IP30, PCB V1.41
y	= 1:	No routing capability of the operating data interface
	= 2:	Routing capability of the operating data interface
rr	= 00:	No logger memory, no real time clock
	= 13:	128kbyte logger memory, real time clock
bbb	= 211	PCB „LPBG-A21C211“
ttt	= 214:	Interface module „LPBG-A21-R214“
	= 215:	Interface module „LPBG-A21-R215“

e. g. C8-4-R-141.1.2-16.261300.211214

2 Brief description

The interface IRMA-4-Gateway-RS485 (.2) is the RS485 interface of the IRMA person counting system which is mainly used in public transport - buses and trains. The connected IRMA MATRIX sensors record the persons passing through the doors at each stop (boarding the vehicle and alighting from it) and record the numbers for each door/passage. The counting data is sent via CAN from IRMA MATRIX to the gateway. The gateway translates the counting results according to the VDV 300 specification into the RS485 communication protocol and communicates with the on-board computer via IBIS (VDV 300).

Up to eight IRMA MATRIX sensors can be connected, which are arranged individually or in pairs above narrow or wide doors. All IRMA MATRIX sensors are connected to the gateway via a common, shielded cable. Communication is based on the CAN standard (Controller Area Network). The wiring is linear, the branches to the IRMA MATRIX sensors are realized via distributors and short stubs.

Cabling is the subject of project planning. Connection to the gateway itself is via the "CAN" connector. (Sensor 6.4interface “CAN”, p. 25)

Detection of door states (counting start/stop) is achieved with four galvanically separated switching inputs (sensor interface “V”) - refer also to Fig. 1. These may be connected to external sources of control voltage, specific to the onboard power supply, or to potential-free switches – in such cases making use of auxiliary voltage provided by the device (the so-called door voltage). Connection is made using unshielded single wires.

Electrically isolated full or half duplex data interfaces (depending on the type of interface) are available for transmission of counting data to an on-board computer. Connection is usually made using unshielded cables with individual wires stranded in pairs. Shielded wires may also be used if appropriate (in any case when used in residential areas / buildings). (Operating interface, connector „V“, p. 16)

The separate “P” connector serves as connection to the on-board network. An intern DC-DC-transformer with galvanic separation from the on-board supply provides the complete system with the electric power required. It generates internal signal voltage as well as sensor supply voltage.

In addition, a RS232 service interface “C”, which is not galvanically separated, is also available. It is not active in normal operations and is used for configuration and software download as required. (Service interface, “C” connector, p. 23)

A two-color light emitting diode (LED) is used to signal the various operating states. LED state indication (LED state indication, p. 28)

The gateway and its components are of modular design. Each gateway has a certain PCB and an interface module (SSM) specific to its type. All components are mounted in stainless-steel housing. The PCB contains the central power supply, a processing kernel, consisting of a micro controller and memory, the CAN line driver and the RS232 service interface.The interface module contains the RS485 operating data interface to the on-board computer and 4 potential-free signal inputs. It moreover generates the door voltage.

A firmware device controls the interplay between the individual components. For software download, configuration and visualization, software tools for the Windows PC is provided. (Firmware, software, p. 28)

3 Block Diagrams

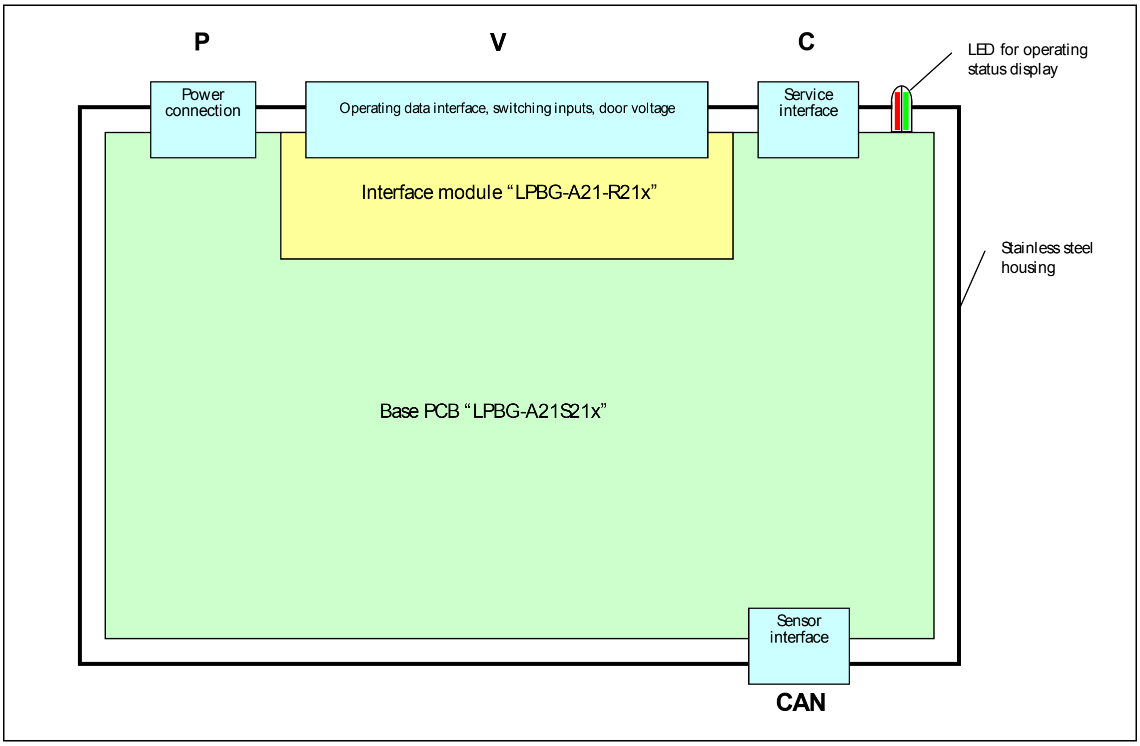

Fig. 5: Overview of interfaces

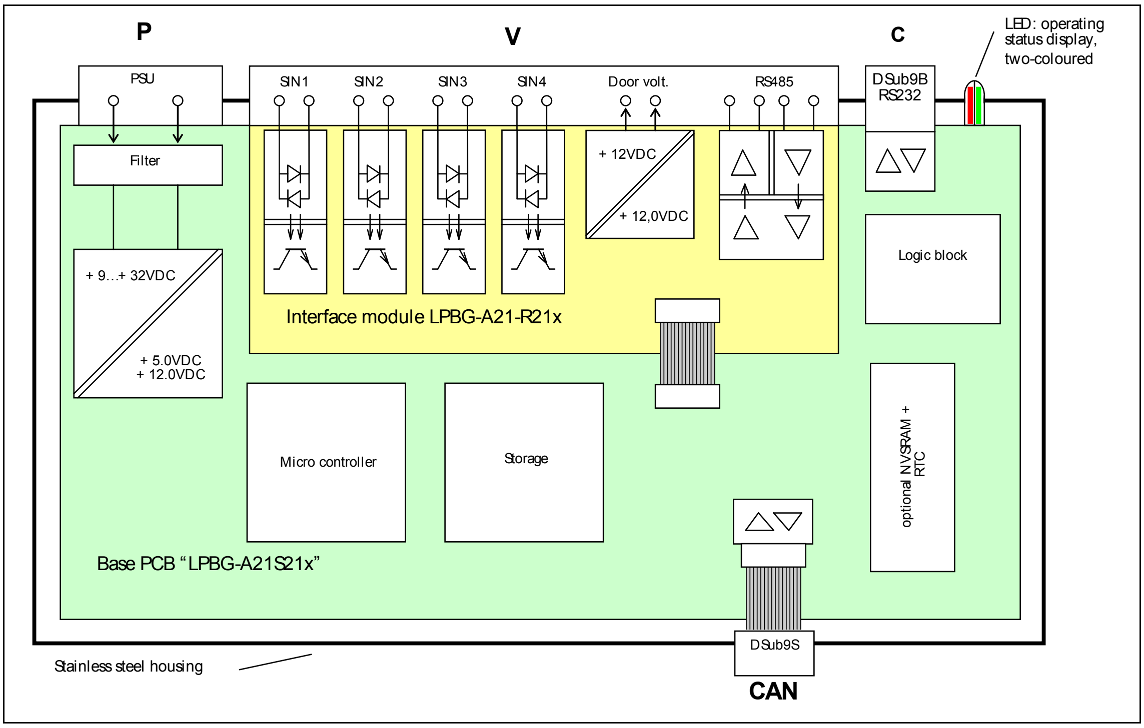

Fig. 6: **Internal components**

4 General Technical Data, Operational Parameters

Table 1: **General technical data, operational parameters**

Parameter	**Symbol**	**Value**	**Notes**
Operational conditions			
Power supply voltage	U_{VP} in V DC	9...32	12 V or 24 V motor vehicle on-board network; electrical isolation - permissible voltage fluctuation in acc. with EN 50155 (cl. S2) and ISO7637-2.3 Level_3 - load dump protection in acc. with SAE J1455 Aug. 94 and ISO7637-2.3, Impulse_5 Level_3
Isolation voltage strength	V_{iso} in kV DC	1.0	Valid for all electrical isolation
Operating temperature range	T_A in °C	-25 ... +70 0 ... +60 °C	for devices with logger and real-time clock
Relative humidity	RH in %	≤ 95	Non condensing
Protection class		IP30	With housing of version 1.41
MTBF	h	≥ 300.000	At 25° ambient temperature

Storage, transport			
Temperature range	T_A in °C	-40 ... +85	
Relative humidity	RH in %	≤ 95	Non condensing
General information			
Weight	in g	950...1000	depends on equipment
Dimensions over all	LxWxH in mm	198 x 125 x 62	over all
Housing material		Stainless steel 1.4301	Casing 1 mm sheet steel, base plate 2 mm sheet steel

5 Standard compliance

Table 2: Standard compliance

Compliance with standards, device tests			
Field	**Standard, classification**	**Application**	**Test report[1)]**
Rail	DIN EN 50121-3-2	EMC	ProEMV PL090507
	DIN EN 50155	Heat, cold	Aucoteam 4965/05
	DIN EN 50155	Voltage fluctuations and interruptions	ProEMV PL090507
	DIN EN 61373:2011-04, category 1, class A	Vibration, shock loads	Aucoteam 4965/05
Road	EC directive for vehicles 2006/28/EC	EMC	ProEMV PL090508
	J1455	Load dump transient protection on power line	ProEMV PL071207A PL071207A_supplementation[3)]
	EN 60721-3-5, class 5M2	Vibration, shock loads (without external shock loads)	Aucoteam 4965/05
1) If a test report is not specified, references to technical standards are considered to be design objectives, for which verification is still to be made by an independent test centre. 2) Applies in connection with "Zert_Konformitaet-A21-Impuls5a-PL071207A_07-2009.pdf" 3) For similar test, see PL071207A and "PL071207A_Ergänzung"			

Table 3: **Certification marks**

Mark	Approval No.
e 1 03 5221	e1*72/245*2006/28*5221*00

6 Interfaces

6.1 Power supply, “P” connector

The IRMA-Gateway-4-RS485.2 device will be used for operating in a 12 V or 24 V on-board network for rail or road transport as well as for operation with a power supply unit for use in buildings. The on-board (power supply unit) voltage is supplied via a surge filter, inverse-polarity protection and a short-term outage bridge. A DC-DC converter supplies the electrically isolated voltage required for operating the device. The DC-DC converter itself has an input current limiter and thermal surge protection. A delayed fuse ensures input in the case of a converter defect.

The on-board voltage is connected via a 4 pole "P" (power) male multipoint connector. By means of the internal bridge with two contacts in each case it is possible to pass on the current.

6.1.1 Connector

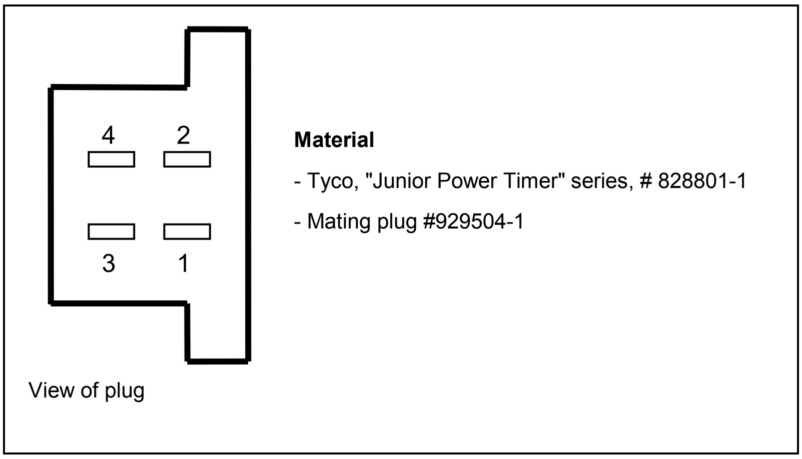

Fig. 7: **"P" connector**

Table 4: **Connector assignment, power connector "P"**

Pin	Signal name	Type	Application	Comments
1, 3	VP	Input	Power supply, pos. pole	Electrical isolation of housing and electronics
2, 4	GNDVP	Input	Power supply, neg. pole	

6.1.2 Pin description, signal names

Power supply input "VP, GNDVP"

The power supply to be applied at the input "VP" with respect to "GNDVP" (**V**oltage**P**ower or **G**rou**nd**V**oltage**P**ower) feeds an electronically isolated DC-DC converter.
Transient protection is realized by means of a varistor and an electronic surge protection switch.
The input is protected against inverse polarity.

6.1.3 Electrical parameters

Table 5: **Power supply "P", limiting values / power rating**

Boundary values / maximum loads (T_A = 25 °C unless otherwise specified)				
Parameter	**Symbol**	**min.**	**max.**	**Conditions / Comments**
Power supply voltage	V_{VP} in V DC	-36	+36	t ≤1 min, R_{source} = 0 Ω
		-50	+50	t ≤ 10 s, R_{source} = 0 Ω
		-150	+150	Impulse, τ = 0.4 s, R_{source} = 0.8 Ω [1)]
Transient absorption capacity	W_{max} in J		20	Varistor in DC supply voltage input capped at 200 V at 50 A, 2 ms
Isolation voltage strength	V_{iso} in kV AC		1,0	Per design, all potentials with respect to other potentials
Burst, all contacts	V_s in kV	-2,0	+2,0	5/50 ns, 5 kHz, wire-wire, wire-chassis
Surge, all contacts	V_s in kV	-2,0	+2,0	5/50 µs, 100 Ω, wire-wire, wire-chassis
ESD, all contacts	V_s in kV	-4/-8	+4/+8	Contact/air, 150 pf, 330 Ω, cycle time ≥ 1 s
1) Load dump impulse in accordance with SAE-J1455				

Table 6: **Power supply "P", electrical operating values**

Specification / operating values (T_A = 25 °C unless otherwise specified)					
Parameter	**Symbol**	**min.**	**Type**	**max.**	**Conditions / Comments**
Insulation resistance	in MΩ	100			Test voltage 1 kV DC, all potentials/individual wires with respect to chassis
Insulation capacity	in nF		4.7		Wire with respect to chassis
Power supply voltage					
Full load range	V_{VP} in V	9.0		32.0	$P_{out,DCDC,min}$ ≥ 9 W [1], $T_{gatewayhousing}$ ≤70 °C
Peak load range		18.0		32.0	$P_{out,DCDC,max}$ ≥ 14 W [2], without heat dissipation from PCB floor plate limited over time
Power-up range		8.5		33.0	When switching on power
Idling range		7.0			At part load 4 sensors, input current limiter cuts in
				50.0	Limited over time through thermal cut-off according to load
Outage bridging time	tü in ms	20			$P_{out,DCDC}$ = 9 W [3], VVP = 24 V
Power take-up	I_{VP} in A		0.5		V_{VP} = 12 V, 4 sensors at 1 W,
			0.25		V_{VP} = 24 V, 4 sensors at 1 W,
			1.4		$P_{out,DCDC}$ = 9 W, V_{VP} = 9 V
			1.0		$P_{out,DCDC}$ = 10 W, V_{VP} = 12 V
			0.5		$P_{out,DCDC}$ = 10 W, V_{VP} = 24 V
Continual defective current				5.0	in case of a defect for $t \rightarrow \infty$, internal delayed-action fuse
Switch-on surge current			8.0	10.0	t < 10 ms, current limiter cuts in
Undervoltage detection	$V_{low\ bat}$ in V	17.0		18.0	for internal signalisation

The energy supplied by the DC-DC converter is divided between the microcontroller core (about 1 W), the interface module (about 1 W) and the sensors. At the same time we differentiate between the following cases:

1) $P_{out,DCDC,min}$ is the guaranteed total output performance of the DC-DC converter at the lowest limit of the on-board voltage
2) $P_{out,DCDC,max}$ is the guaranteed total peak output performance (thermal activation) limited over time, of the DC-DC converter.
3) $P_{out,DCDC}$ is the required total long-term output performance (concrete load) of the DC-DC converter.

6.2 Operating interface, „V“ connector

The signals for detecting the door position are transmitted via the "V" (vehicle) connector and connection is made to the on-board computer. The connection is made predominantly via unshielded leads (details in section "Installation", p. 31).

6.2.1 Connector

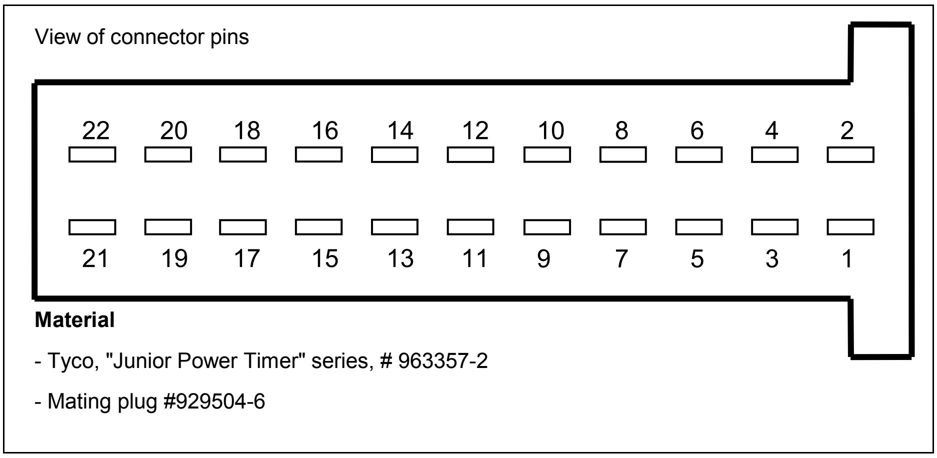

Fig. 8: **"V" connector**

6.2.2 Pin description, signal names

Table 7: **Operating interface "V", signals and names**

Pin	Author	Type	Application	Comments
RS485 data interface, full duplex, 4 wires, R214				
1	RXD+	In	Data input +	electrically isolated
2	RXD-	In	Data input -	
3	TXD+	Out	Data output +	
4	TXD-	Out	Data output -	
5	GNDISO		Data ground	
6				
RS485 data interface, half duplex, 2 wires, R215				
1	A	In	Data input/output +	electrically isolated
3		Out		

2	B	In Out	Data input/output -	
4				
5	GNDISO (C)		Data ground	
6				
Door voltage				
7, 11, 15, 19	GNDVD	Out	Door voltage, neg. pole	Galvanically isolated ancillary voltage output 12 V, R_i = 100 Ω proof against short circuits
9, 13, 17, 21	VD	Out	Door voltage, pos. pole	
Door signal inputs				
8	SIN1b	In	Switching input_1, contact "b"	Galvanically isolated, polarity-independent, $U_{in,max}$ = 36 V, U_{trip} = 6...9 V, R_i = 22 kΩ plus constant current sink 5 mA
10	SIN1a	In	Switching input_1, contact "a"	
12	SIN2b	In	Switching input_2, contact "b"	Galvanically isolated, polarity-independent, $U_{in,max}$ = 36 V, U_{trip} = 6...9 V, R_i = 22 kΩ plus constant current sink 5 mA
14	SIN2a	In	Switching input_2, contact "a"	
16	SIN3b	In	Switching input_3, contact "b"	Galvanically isolated, polarity-independent, $U_{in,max}$ = 36 V, U_{trip} = 6...9 V, R_i = 22 kΩ plus constant current sink 5 mA
18	SIN3a	In	Switching input_3, contact "a"	
20	SIN4b	In	Switching input_4, contact "b"	Galvanically isolated, polarity-independent, $U_{in,max}$ = 36 V, U_{trip} = 6...9 V, R_i = 22 kΩplus constant current sink 5 mA
22	SIN4a	In	Switching input_4, contact "a"	

Door voltage "VD, GNDVD"

An ancillary galvanically isolated voltage, proof against short circuits, is supplied by the device for controlling the switching inputs when potential free contacts are used. It is proof against accidental loading with the on-board voltage.

Care must be taken that when using the door voltage for several switching inputs the potential isolation between these inputs is eliminated.

Switching inputs "SINx"

The "SINx" switching inputs (**S**SM-**In**put) are potential free and optically isolated control inputs. In the standard operation they are used as door signal inputs. Any polarity of the control voltage can be used, i.e. the input works independently of the direction of current. The additional identification with "a" or "b" is only made for organizational reasons.

The input resistance arises from the parallel switching of a 22 kΩ resistor and the current sink. At zero values of voltages the electrical resistance serves the purpose of a base load (for "checking out" the lines). The current sink functions as a resistor dependent on voltage. With an increasing control voltage value, the input resistance increases too. Hence increasing losses are avoided at high control voltage values. On the other hand a certain minimum current flows at low values of control voltage in order for example to ensure the function of the line break monitoring ($R \le 1.7$ kΩ at 4.6 V).

RS485 data lines "RXD+, RXD-, TXD+, TXD-" or "A, B"

A full duplex 4-wire port is available for serial communication with the on-board computer, i.e. the transmitter and receiver lines are brought out separately (R214). For alternative use as a two-wire port, "RXD+" and "TXD+" or "RXD-" and "TXD-" can be bridged. On the SSM of type "R215" this bridge is installed by the manufacturing works. Hardware arrangement - levels, timing, etc. conform to the RS485 standard (now also referred to as TIA/EIA-485 standard, identical with RS-485). The use of real push-pull drivers typical for RS485 in combination with difference signal receivers enables high bit rates in combination with long line lengths in combination with good resistance to fault signals.

The interface in the gateway is electrically isolated. This type of circuit engineering avoids mass currents in combination with increased common mode rejection. Transient voltage suppressors (TVS) are inserted to suppress differential interference. Accidental, short-term loading with the on-board voltage is tolerated. In the event of a defective BUS line (open or short-circuited) the receiver will remain passive. The data lines must be terminated on the receiver side in accordance with the specifications of RS485 - 2 x resistor 120 Ω must be added at the cable ends.

"GNDISO" potential

The "GNDISO" potential is the data port reference ground. The interconnection of the reference grounds of all BUS devices ensures equipotential bonding and keeps the common-mode voltage applied within the permissible limits.

If long cables are used and high-frequency currents are applied, the reference grounds of the BUS devices may nevertheless take differential potentials at the moment of a disturbance. This would result in equipotential bonding currents. Such equipotential bonding currents are avoided by designing the data port as an electrically isolated interface; a current limiting resistor, which would otherwise be necessary, may be dispensed with, at least from the gateway point of view. The interface as a whole can to a certain extent take the potential of the common-mode interference; the communicating ability at the moment of a disturbance remains as it is.

In case of very short BUS lengths the connection of the reference grounds may be dispensed with, if applicable, as it is not required for data transmission as such (see also section “Installation”, p. 31).

Potential "CHGND"

When shielded lines are used the shield of the data line may be connected to the flat-cable plug with potential "CHGND" (beside "V" connector).
In order to prevent ground loops it is recommended to provide only single-sided connection of the shield. In order to achieve a good shielding effect also from the HF point of view, the other end is best connected to frame potential via a capacitor. The concrete layout and realization depends on the individual project.

Please refer to section “Installation”, p. 31 for notes on actual wiring and termination designs.

6.2.3 Electrical parameters

Table 8: Operating interface "V", boundary values / maximum loads

Boundary values / maximum loads (T_A = 25 °C unless otherwise specified)				
Parameter	**Symbol**	**min.**	**max.**	**Conditions / Comments**
"SINxa, b" switching inputs				
Burst	V_s in kV	-2.0	+2.0	5/50 ns, 5 kHz, wire-wire, wire-chassis
Surge	V_s in kV	-2.0	+2.0	5/50 µs, 100Ω, wire-wire, wire-chassis
ESD	V_s in kV	-4/-8	+4/+8	Contact/air, 150 pf, 330Ω, cycle time ≥ 1 s
Isolation voltage strength	V_{iso} in kV AC		1.0	Per design, all potentials with respect to other potentials
Overvoltage resistance	$V_{max,SIN}$ in V DC	-48	+48	t→∞R_{source} = 0Ω
		-54	+54	t ≤1 min, R_{source} = 0Ω
		Tested with SINa with respect to SINb		
Transient absorption capacity	W_{max} in J		1.2	48 V transguard, 1210
Door voltage "VD-GNDVD"				
Burst	V_s in kV	-2.0	+2.0	5/50 ns, 5 kHz, wire-wire, wire-chassis
Surge	V_s in kV	-2.0	+2.0	5/50 µs, 100 Ω, wire-wire, wire-chassis
ESD	V_s in kV	-4/-8	+4/+8	Contact/air, 150 pf, 330Ω, cycle time ≥ 1 s
Isolation voltage strength	V_{iso} in kV AC		1.0	Per design, all potentials with respect to other potentials
Overvoltage resistance	$V_{max,VD}$ in V DC	-32	+48	t→∞, R_{source} = 0Ω
		-32	+54	t ≤1 min, R_{source} = 0Ω
		Tested with VD with respect to GNDVD		
Transient absorption capacity	W_{max} in J		1.2	48 V transguard, 1210

RS485 data interface "RXD+, RXD-, TXD+, TXD-, GNDISO" or "A, B"				
Burst	V_s in kV	-2.0	+2.0	5/50 ns, 5 kHz, wire-chassis
Surge	V_s in kV	-2.0	+2.0	5/50 µs, 100 Ω, wire-chassis
ESD	V_s in kV	-2/-4	+2/+4	Contact/air, 150 pf, 330 Ω, cycle time ≥ 1 s
Isolation voltage strength	V_{iso} in kV AC		1.0	Per design, all potentials with respect to other potentials
Overvoltage resistance	V_{max} in V DC	-32	+32	t ≤5 s, R_{source} = 0 Ω
		Tested with RXD or TXD with respect to GNDISO		
Transient absorption energy	W_{max} in J		0.3	26 V transguard, 0805
Note: These values have been fixed as shown for the design, but have not been tested in each case as these are not necessarily part of the tests for the relevant standard.				

Table 9: Operating interface "V", electrical operating values

Specification / operating values (T_A = 25 °C unless otherwise specified)					
Parameter	**Symbol**	**min.**	**Type**	**max.**	**Conditions / Comments**
"SINxa, b" switching inputs					
Insulation resistance	R_{iso} in MΩ	100			For isolated potentials, test voltage 1 kV DC
Insulation capacity	C_{iso} in nF		4.7		For isolated potentials
Switching voltage	V_{in} in V	-6.5		+6.5	for logical L, for P2.0x ≥ 4.5 V
			±7,5		Switch point, for P2.0x ≈ 2.5 V
		-32.0		-8.5	for logical H, for P2.0x ≤ 0.5 V
		+8.5		+32.0	
		The transition zone between H and L and vice versa is undefined and is considered to be a "forbidden" zone (switching input)			
Max. switching frequency	f_{sw} in kHz			1.0	
Input resistance	R_{in} in kΩ		22		V_{in} = 0 V
			1.2		V_{in} = 4.6 V
				1.7	V_{in} = 4.6 V and T_A = -25...85 °C
			1.1		V_{in} = 6.5 V
			1.3		V_{in} = 8.5 V
			1.8		V_{in} = 12.0 V
			2.9		V_{in} = 24.0 V
			3.3		V_{in} = 32 V
Ancillary voltage output / door voltage "VD-GNDVD"					
Insulation resistance	R_{iso} in MΩ	100			For isolated potentials, test voltage 1 kV DC
Insulation capacity	C_{iso} in nF		4.7		For isolated potentials
Output voltage	V_{VD} in V		24.0	32,0	Idling
			12.0		R_{load} = 4 switching inputs
			9.5		R_{load} = 220 Ω
Short circuit current	$I_{max,VD}$ in mA			150	Sustained, protection by PTC
RS485 port, general, "RXD+, RXD-, TXD+, TXD-, GNDISO" with R214 or "A, B, GNDISO" with R215					
Insulation resistance	R_{iso} in MΩ	100			For isolated potentials, test voltage 1 kV DC
Insulation capacity	C_{iso} in nF		4.7		for each wire with respect to

					isolated potential
Internal BUS load capacitance	C_{in} in nF		1.25		R214: RXD+/- or TXD+/-
			2.5		R215: A-B
Baud rates can be selected	Baud	300		38400	All standard baud rates in the range
RS485 transmitter operation, "TXD+, TXD-" for R214 or "A, B" for R215					
Permissible BUS load capacity	$C_{load, bus}$ in nF		64	100	with a typical value of 50 pF/m and a BUS length of 1200 m for AWG24
Differential output voltage	V_{OD} in V		4.1	5.25	non-loaded
Differential output voltage	V_{OD} in V	2.0	2.7		RL = 50 Ω
Common mode output voltage	V_{OCM} in V	2.0	2.5	3.0	
Output short-circuit current	I_{Omax} in mA	35		250	
RS485 receiver operation , "RXD+, RXD-" for R214 or "A, B" for R215					
Input resistance	R_{in} in kΩ	85	125		corresponds to approx. 0.25 x RS485 equivalent standard load
Differential input switching threshold	V_{TH} in mV	-200		+200	with common-mode voltage -7 V < U_{CM} < +12 V, measured with respect to GNDISO
Switching hysteresis	V_{inHys} in mV		20 mV		with common-mode voltage -7 V < U_{CM} < +12 V, measured with respect to GNDISO

6.3 Service interface, „C“ connector

The service interface is a serial communications interface with the PC in accordance with the RS232 standard. It is instrumental in putting the device into operation, and configuring and servicing it. The interface is not electrically isolated.

An ancillary voltage output (Pin_6) is designed for supplying current for - among other devices - interface converters.

The connection to a PC is made by a shielded 1:1 lead (standard extension, iris ordering number: K-A21-C-RS232-01).

6.3.1 Connector

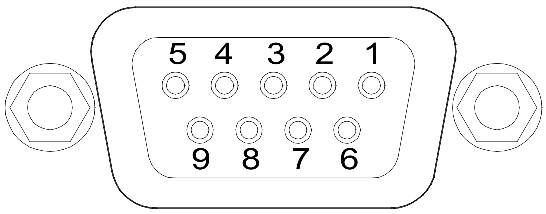

Fig. 9: **DSub9-socket, view on pin out**

Table 10: **Service interface "C", pin out**

Contact	Signal name	Type	Application	Comments
1				Not assigned
2	RD	Output	Read Data Line	
3	TD	Input	Transmit Data Line	
4	DTR	Input	Data Terminal Ready	For switching over to the initial loading mode when powering up
5	GND			
6	+12 V	Output	Ancillary voltage output	max. 100 mA
7	RTS	Input	Request To Send	
8	CTS	Output	Clear To Send	
9				Not assigned

Housing	GND		Chassis	Shielding

6.3.2 Pin description, signal names

Data lines "RD" and "TD"

The minimum requirements for data communication are the lines "RD" (read by PC) and "TD" (transmit by PC).

Handshake lines "RTS" and "CTS"

These two lines signal to the other device in each case the request (RTS) and the readiness (CTS) for transmitting.

Control line "DTR"

For switching over to the initial loading mode (LED yellow) the control input "DTR" is used. For this purpose at the moment of powering this signal is changed to logical H (for level see Table 12).

Table 11: Service interface "C", boundary values / maximum loads

Boundary values / maximum loads (T_A = 25 °C unless otherwise specified)				
Parameter	**Symbol**	**min.**	**max.**	**Conditions / Comments**
Signal lines				
Max. voltage at the RD, CTS outputs	V_{max} in V	-13.2	+13.2	
Max. voltage at the TD, RTS, DTR inputs	V_{max} in V	-25.0	+25.0	
Ancillary voltage output				
Max. voltage	V_{max} in V	-0.4	+30.0	$t \rightarrow \infty$, depending on varistor and inverse polarity protection diode
Shielding				
Burst	V_s in kV	-2.0	+2.0	5/50 ns, 5 kHz
Surge	V_s in kV	-2.0	+2.0	5/50 µs, 100Ω
All pins and shielding				
ESD	V_s in kV	-4/-8	+4/+8	Contact/air, 150 pf, 330 Ω, cycle time ≥ 1 s
N.B. - Further information on the boundary values can be found in Maxim's data sheet "MAX3223E" and in the EIA/TIA-232-F standard.				

- The RS232 signals cannot be sustained or only partly sustained when continuously produced in connection with the 12/24 V on-board network.
- These values have been fixed as shown for the design, but have not been tested in each case as these are not necessarily part of the tests for the relevant standard.

Counting mode (normal operation) U_{DTR} = logical L or open
Initial loading mode U_{DTR} = logical H at the moment of switching on

Ancillary voltage output +12 V

For the power supply for interface converters to be connected directly at the RS232 interface a voltage protected against an overload current will be provided.

6.3.3 Electrical parameters

Table 12: Service interface "C", electrical operating values

Specification / operating values (T_A = 25 °C unless otherwise specified)					
Parameter	**Symbol**	**min.**	**Type**	**max.**	**Conditions / Comments**
Baud rate	Baud	300		34800	All standard baud rates in the range
Data lines					
Transmitter output voltage RD, CTS	V_o in V	5,0	5.4		
Input voltage range for receiver, TD, RTS, DTR	V_{in} in V	-25		+25	
Trigger point for receiver TD, RTS, DTR	V_{in} in V	0.8	1.5		or open for logical L
			1.8	2.4	for logical H
		Typical 300 mV hysteresis for switching over, typical 5 kΩ input resistance			
Ancillary voltage output					
Output voltage	V_{+12V} in V	11.0		12.25	
Output current	I_{+12V} in mA			100	Via Polyswitch 200 mA

6.4 Sensor interface, “CAN”

For connection of 1 to 8 IRMA MATRIX sensors) a four-wire, shielded CAN BUS system is used (2 x signals, 2x power).

The CAN BUS system has a line structure, the sensors are connected via short stubs and distribution connectors. The system must be terminated between CAN_H and CAN_L with 120Ω at the outermost line ends.

6.4.1 Connector

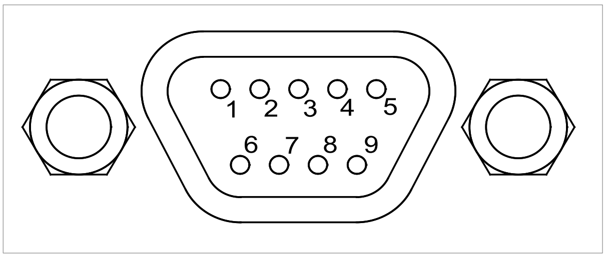

Fig. 10: Sketch of sensor interface "CAN", DSub9 connector

Table 13: Sensor interface “CAN”, pin assignment

Contact	Signal name	Type	Application
1	NC		Not assigned
2	CAN_L	IO	CAN signal L
3	CAN_GND		Ground
4	NC		Not assigned
5	NC		Not assigned
6	CAN_GND		Ground
7	CAN_H	IO	CAN signal H
8	NC		Not assigned
9	CAN_V+	Power	Voltage supply of sensors
10	NC		Not assigned

6.4.2 Electrical parameters

Table 14: Sensor interface “CAN”, boundary values / maximum loads

Boundary values / Maximum loads (T_A = 25 °C unless otherwise specified)				
Parameter	**Symbol**	**min.**	**max.**	**Conditions / Comments**
Data "CAN_H" und "CAN_L"				
Voltage strength	$V_{CAN\_H,}$ $V_{CAN\_L,}$ in VDC	-27	+30	t → ∞, R_{Source} = 0Ω, max. continuous voltage varistor
		-27	+35	t ≤1min, R_{Source} = 0Ω, limitation by varistor
Transient absorption capacity	W_{max} in J		0.1	30V-Transguard, 0805
Shielding				
Burst	V_s in kV	-2.0	+2.0	5/50ns, 5kHz
Surge	V_s in kV	-2.0	+2.0	5/50µs, 100Ω
All contacts and shielding				
ESD	V_s in kV	-4/-8	+4/+8	Contact/ Air, 150pf, 330Ω
Note: These values have been fixed as shown for the design, but have not been tested in each case as these are not necessarily part of the tests for the relevant standard.				

Table 15: Sensor interface “CAN”, electrical operating values

Specifications / Operating values (T_A = 25 °C unless otherwise specified)					
Parameter	**Symbol**	**min.**	**Type**	**max.**	**Conditions / Comments**
Data "CAN_H" und "CAN_L"					
Capacity CAN_L, CAN_H vs. CAN_GND	C in pF		100		is formed by transguards
Line termination CAN_L against CAN_H	Z in kΩ		3.0		T-network 2x 1.5kΩ in series, center with 100nF against CAN_GND
Signal voltages	Vo in V	0		5.25	see data sheet TJA1040 from Philips
Baudrate	in kBaud			1000	

7 LED State Indication

Various LED colours reveal the following operating states:

Table 16: LED indication, colors and states

Colour	Operating status
Off	Out of operation
Red	Reset during power-up, initialisation
Yellow	Initial loading mode
Green	Counting mode ready

8 Firmware, Software

The firmware (software on the gateway) controls the interaction of the individual components. Here, aspects such as communication protocols, data preparation and adaptation of routines to vehicle-specific features are taken into account.

The IRMA MATRIX sensor generates the passenger count data itself (it has a firmware and all necessary configurations). IRMA MATRIX transmits these counting results via CAN to the gateway, which converts the counting results into another protocol (IBIS) and sends them to the on-board computer via the RS485 interface. Here the count data can be processed further.

This firmware is already loaded on the IRMA MATRIX sensor on delivery, but can be reloaded or overwritten at any time via the "C" interface.

Firmware example:

- GDIST500_AA21C_CI-6.00-20130528.HEX

For software loading and configuration service software for the PC is provided - IRMA-Setup_Release_5.1.9- downloadable via https://www.irisgmbh.de/en/technical-documents/service-software/.

The framework program IRMA-Setup_Release_5.1.9 for putting the system in operation and for data visualization includes additional components like:

- "A21_Boot" for firmware download and update

The IRMA gateways support multiple baud rates. IRMA-Gateway-4-RS485 works by default with **1200 or 9600 baud**. Before changing the gateway baud rate, please consult the responsible project engineer of iris-GmbH.

IRMA-Gateway-RS485.2 is also available with other protocols, e.g. INEO.

9 Device sketches

Note: The drawings are not to scale; all specified dimensions are in millimetres.

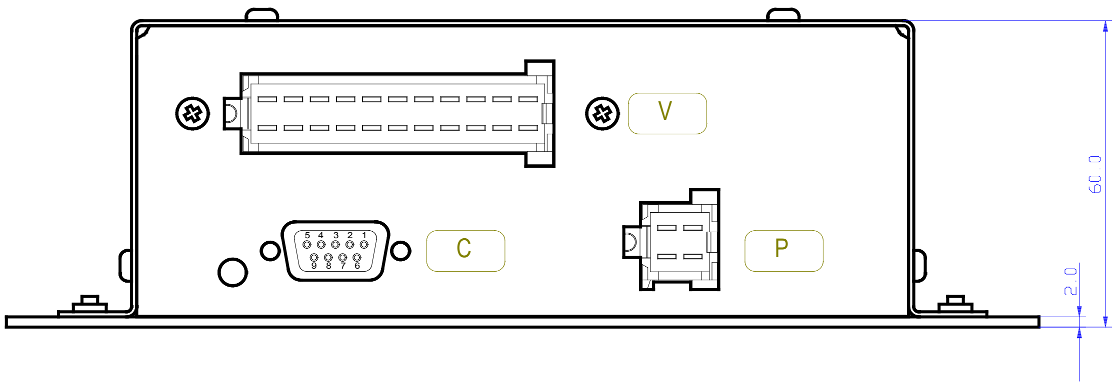

Fig. 11: View of connector for the IRMA-Gateway-4-RS485.2 operating interfaces

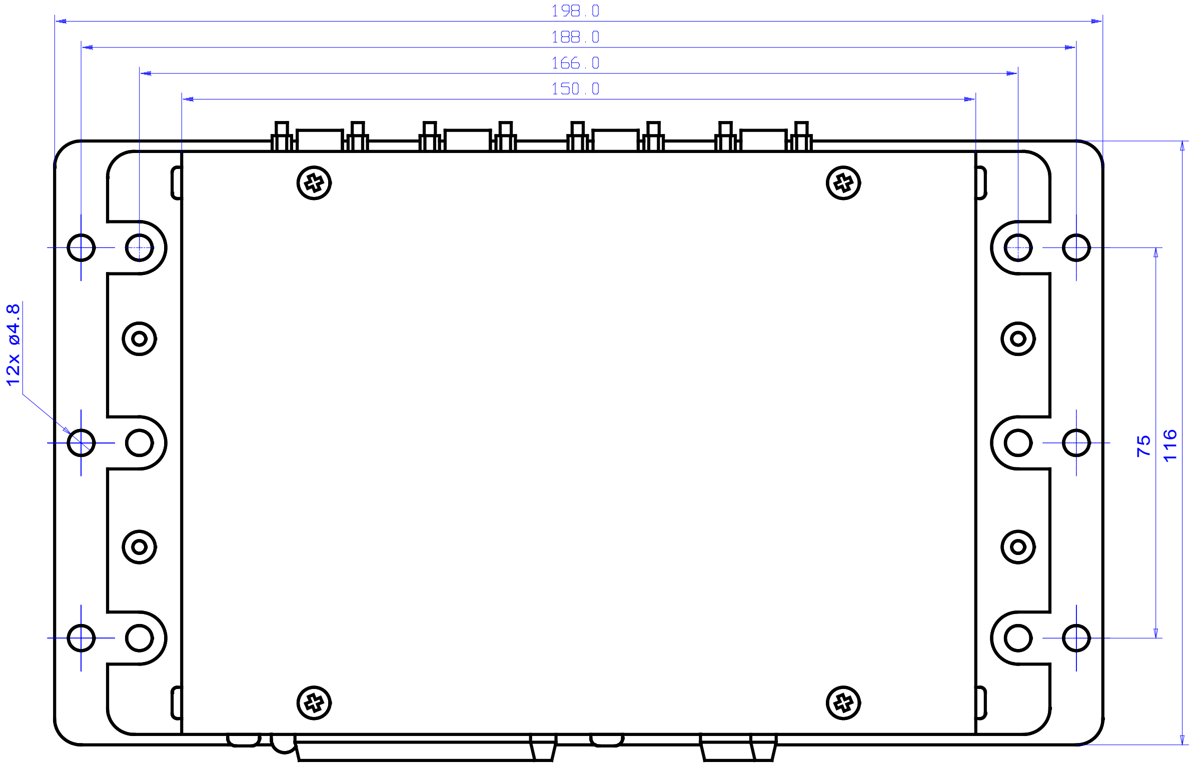

Fig. 12: **View from above of IRMA-Gateway-4-RS485.2, attachment holes**

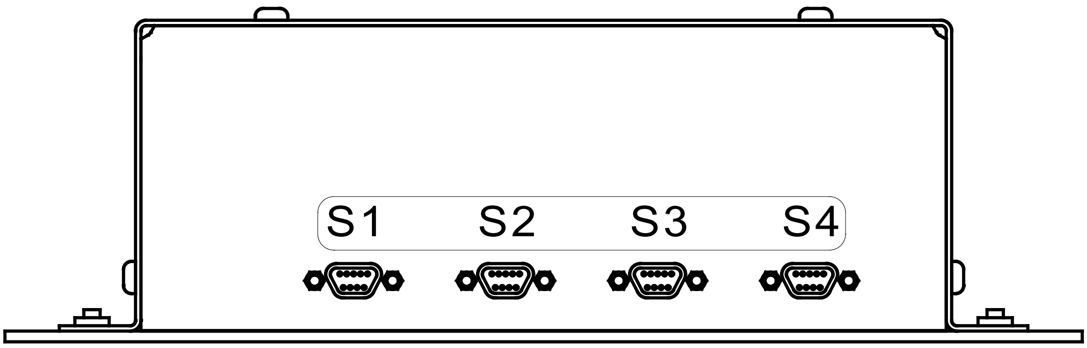

Fig. 13: **Rear view of IRMA-Gateway-4-RS485.2**

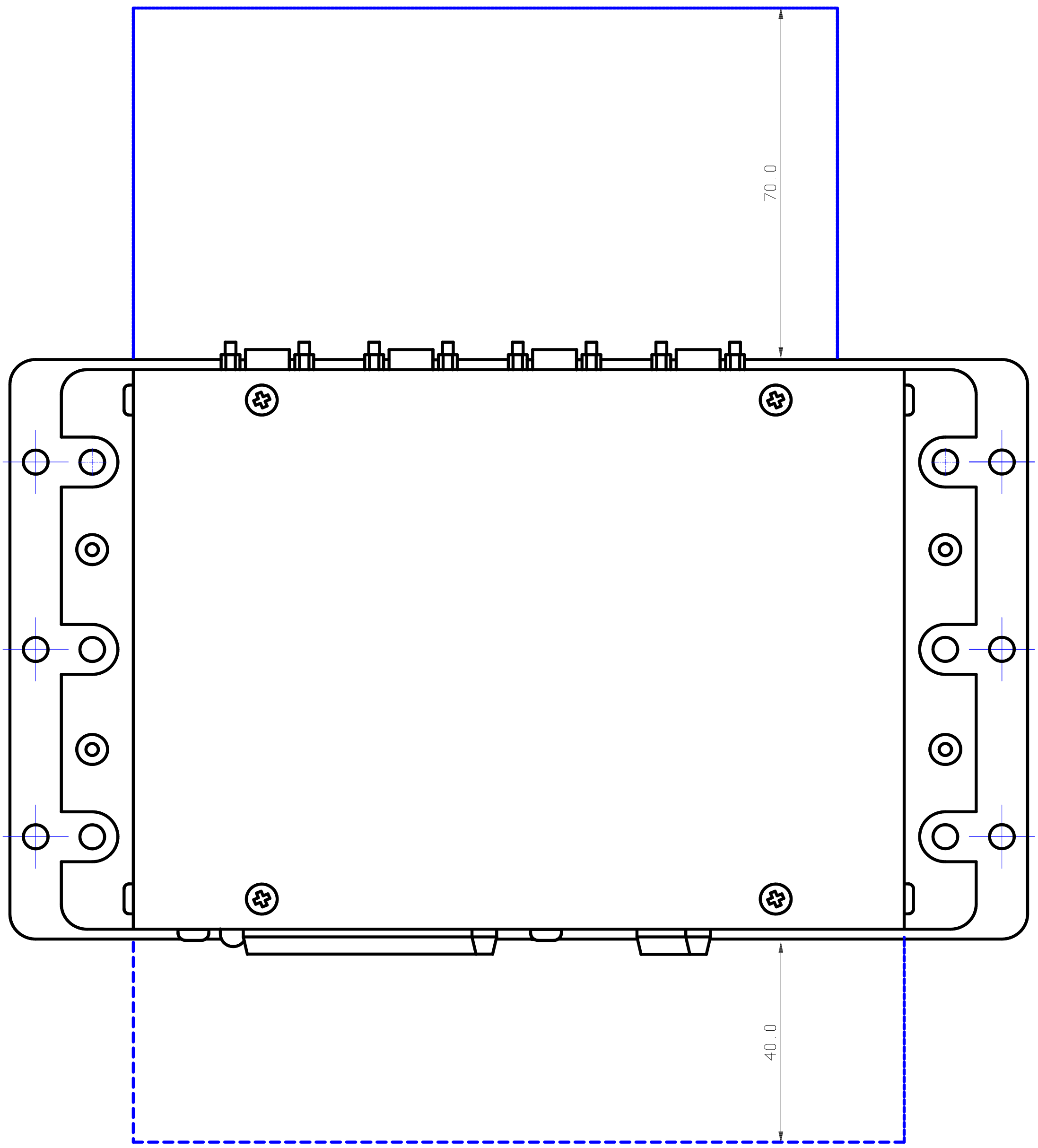

Fig. 14: **Space required for installation**

10 Installation

The explications in this section do not apply to installations in living quarters, professional operations and small businesses. Here shielded cables are to be used for the data line and common mode inductors in the door contact lines. More detailed information will be supplied on request.

10.1 Selection of mounting place

The device must be located in the vehicle interior so that the following conditions are observed:

- It must be ensured that the permissible operating temperature range is observed, i.e.:
  - do not install the device on an outside vehicle wall where it is exposed to solar radiation
  - do not install the device in locations where there is a risk of heat build-up

- The device must not be installed in locations exposed to dust or wear particles such as near rods, belt drives or in exhaust air ducts.

- The device must not be installed in locations exposed to air currents that favour condensation because of their temperature or moisture content.

- The device must not be installed on vibrating structural components or those exposed to impact loads.

Furthermore, when installing the device, care should be taken that a reliable earthed connection is made with the vehicle chassis that has a low electrical resistance and is protected against corrosion. This means that, where applicable, paint should be removed from at least one attachment hole on the chassis side and a tooth-lock washer used. For an insulated installation, an additional earthing cable, strip or stranded wire with a cross section of at least 10 mm² and a maximum length of 30 cm should be used.

10.2 Power connection diagrams, overviews, leads

For connecting the operating voltage and the door contacts unshielded leads can be used in the form of individual insulated strands or in the form of a cable.

Generally, connection of the data interface is made using twisted core pairs as part of unshielded or shielded cables. Shielded cables are specified only for use in living quarters, professional operations and small businesses.

Pre-assembled cables are recommended. These are available in various qualities (flame protection class, halogen free yes/no) and lengths. The lengths are to be specified when ordering the cables (the variables X, Y, Z, A, B are for lengths in metres).

N.B. The EMC tests effected by the supplier are made on the recommended cable types.

Table 17: **Recommended cable types (examples)**

Power connection	Cable type, identification for orders	Comments
Potential free contacts + RS485 interface	K-A21-V-RS485- 12-X-Y-Z-A-Bm[1]	LiY 1,0 mm² + LiYY TP 3 x 2 x 0,75 mm²
External control voltage + RS485 interface	K-A21-V-RS485-11-X-Y-Z-A-Bm	LiY, 1,0 mm² + LiYY TP 3 x 2 x 0,75 mm²
Power	K-A21-P-01-xm	LiY, 1 mm²
	K-A21-P-02-xm	Sabix A 146 FRNC, 1 mm²
	K-A21-P-03-xm	Helutherm 145, 1 mm²
1) To be defined		

10.3 Door contact installation

Connecting the door signals can be carried out in two ways:

- Application of potential free contacts using the ancillary voltage supplied by the device (door voltage)
- Application of external control voltages

Door signal detection functions independently of polarity. The control voltage polarity can be set one way or another.

❗ The door signal detection works polarity independent, the polarity of the control voltage is arbitrary. The transmission of the door signals is in general via 2-wire pairs. This means that both poles of the door signal input should be connected to the source. If individual wiring strands are used, these should be close together - and ideally twisted. This wiring method ensures lasting electromagnetic compatibility.

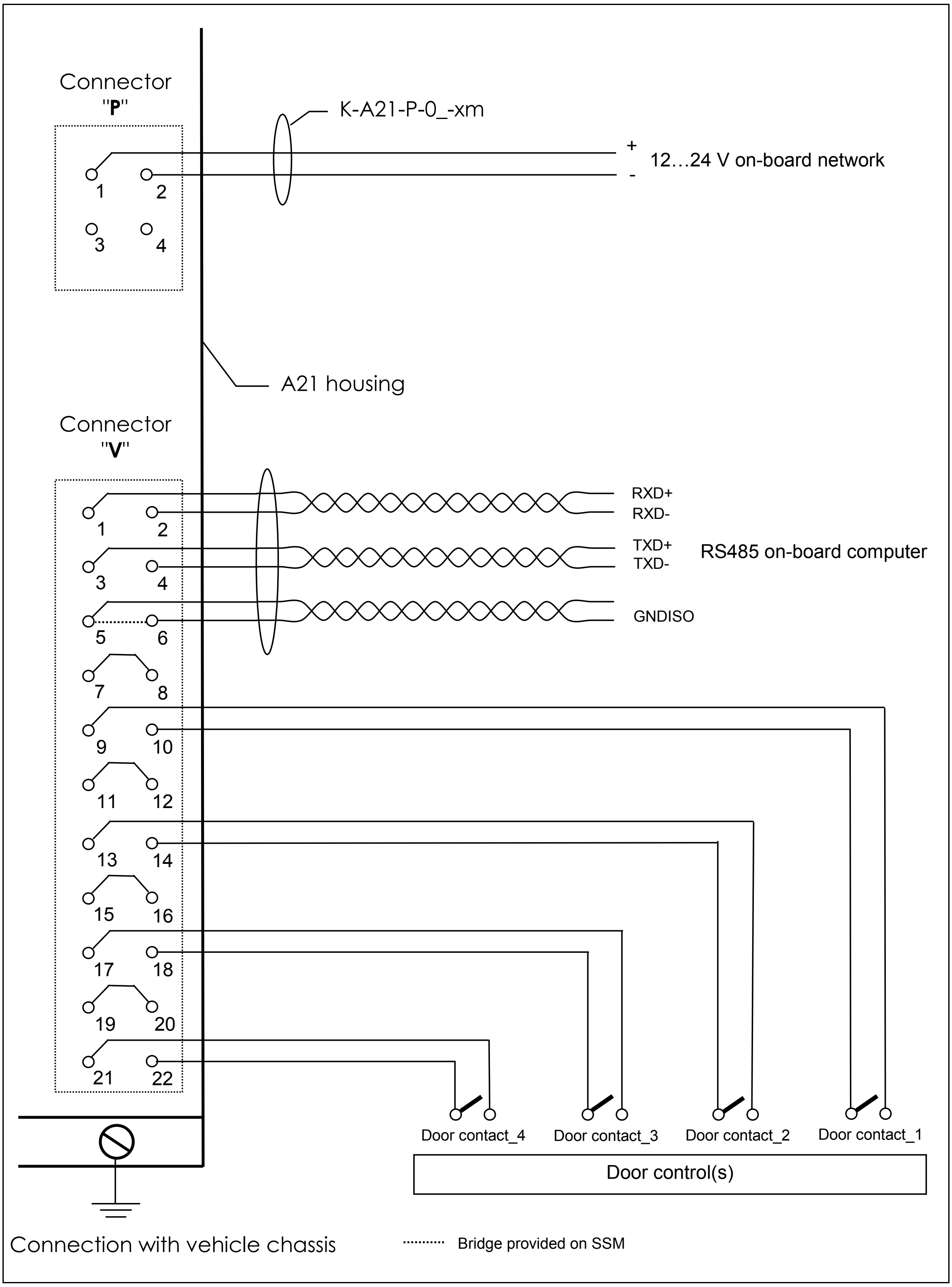

Fig. 15: **Overview of door signals by means of potential free contacts, IRMA-Gateway-4-RS485.2, 4 wires, unshielded**

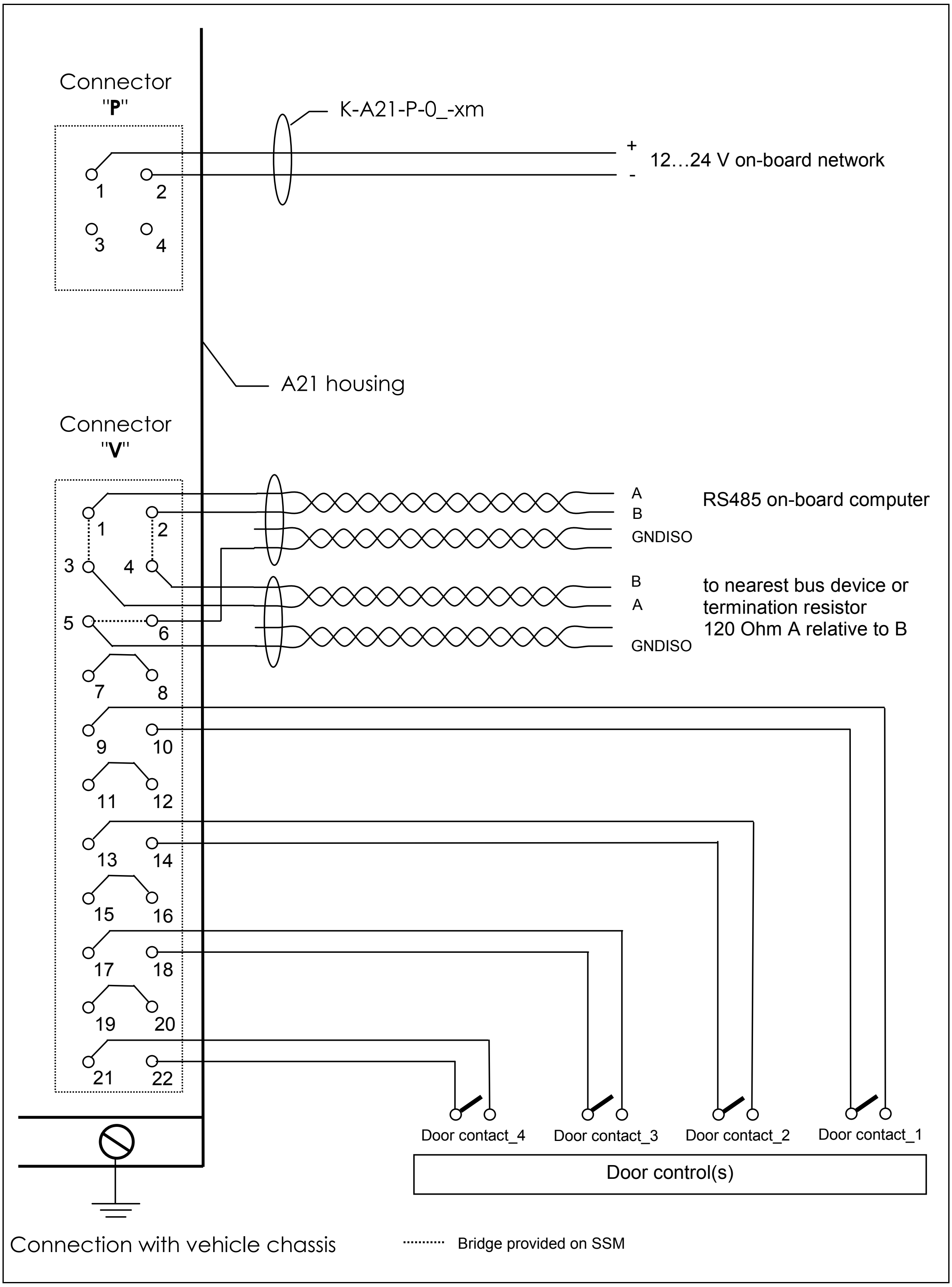

Fig. 16: **Overview of door signals by means of potential free contacts, IRMA-Gateway-4-RS485.2, wires unshielded**

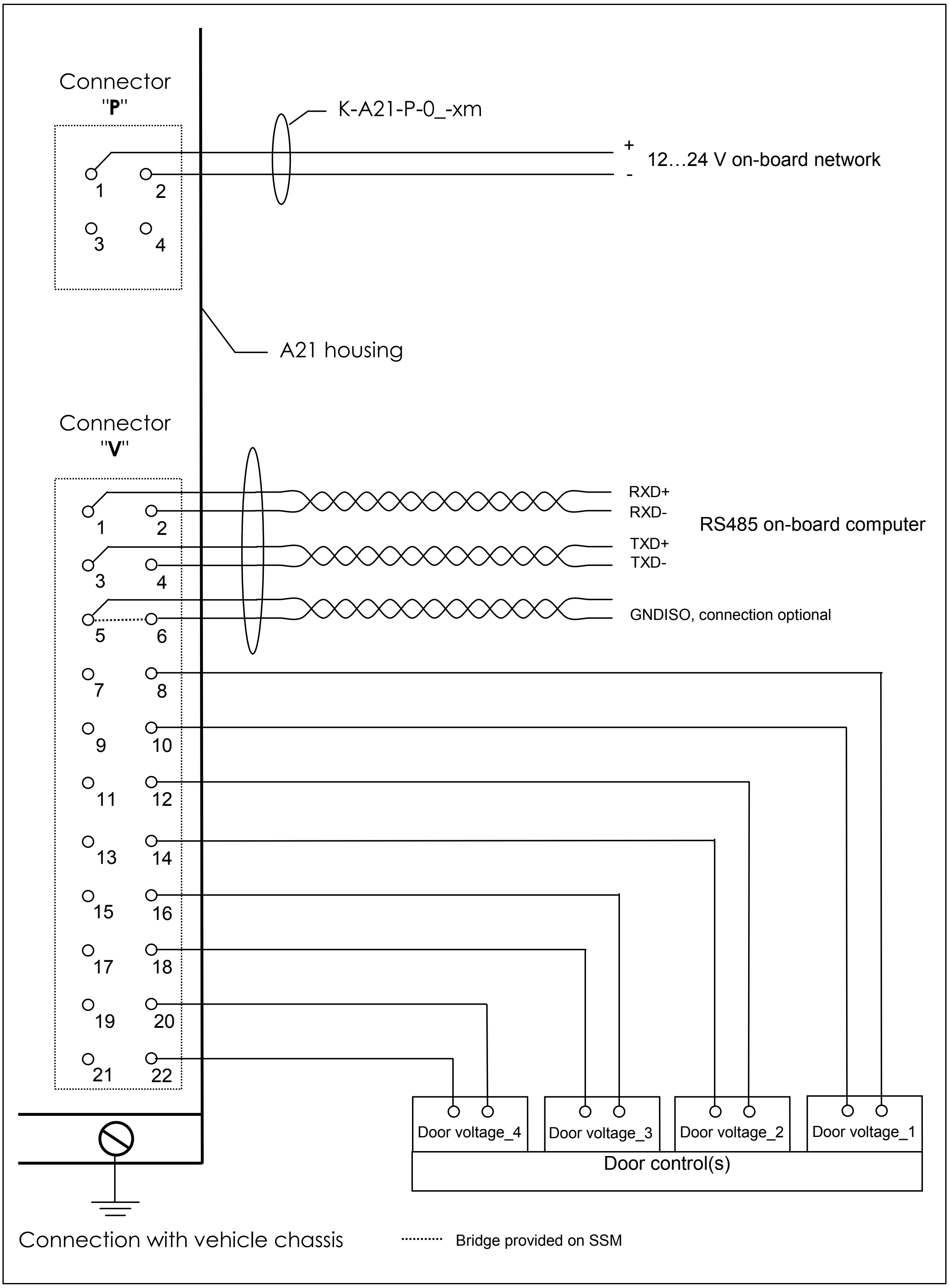

Fig. 17: **Overview of door signals by means of external control voltage (any polarity), IRMA-Gateway-4-RS485.2, 4 wires unshielded**

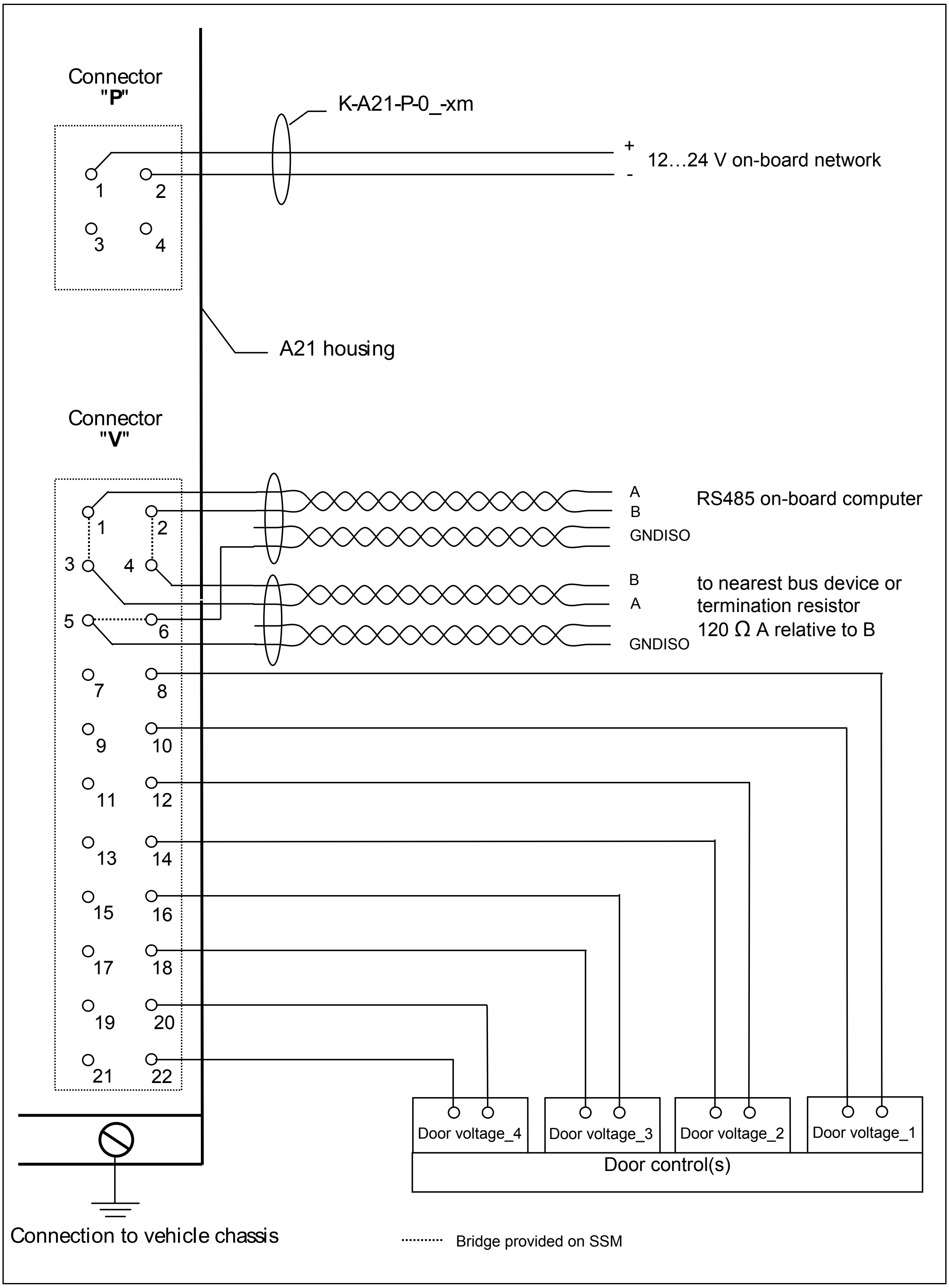

Fig. 18: **Overview of door signals by means of external control voltage (any polarity), IRMA-Gateway-4-RS485.2, 2 wires unshielded**

10.4 RS485 BUS installation, examples

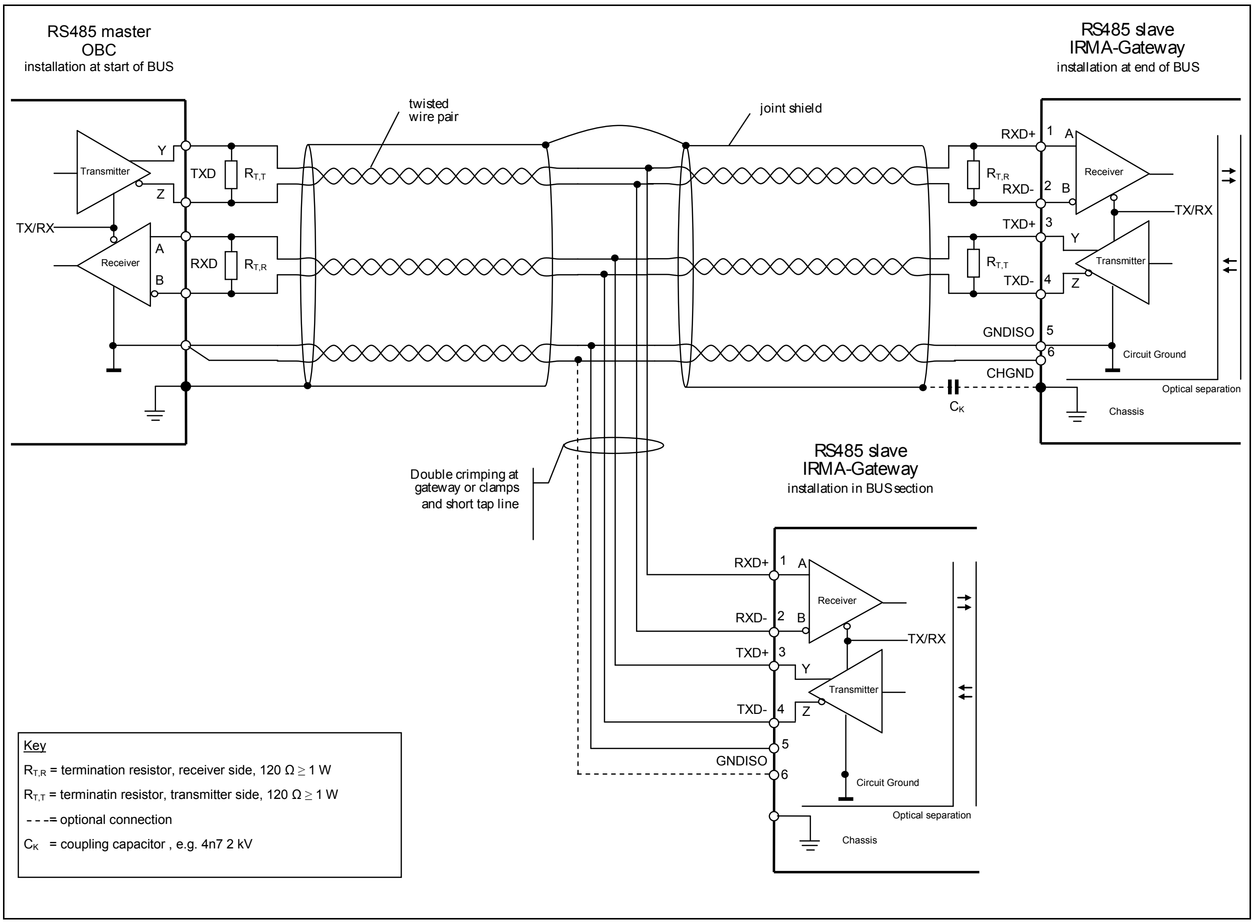

Fig. 19: **IRMA-Gateway-4-RS485.2, 4 wire BUS plan (full version)**

Here shown with shield, termination on both ends, with GNDISO wiring (data reference ground).

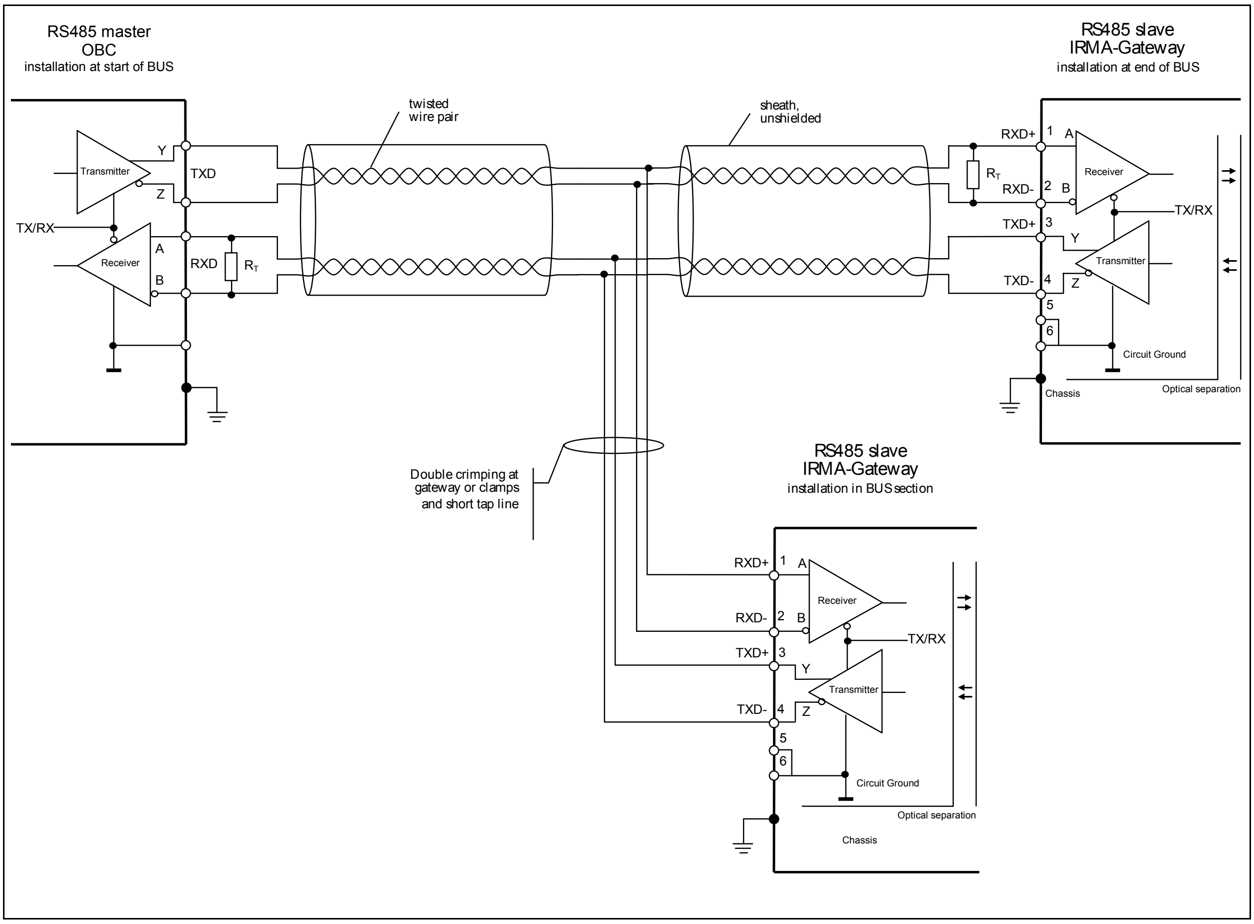

Fig. 20: **Simplified IRMA-Gateway-4-RS485.2, 4-wire BUS plan**

To be used if the bus devices are not separated physically and if short bus lengths are used (typically < 15 m), unshielded, without GNDISO wiring (data reference ground), minimum requirement: termination resistors at the receivers.

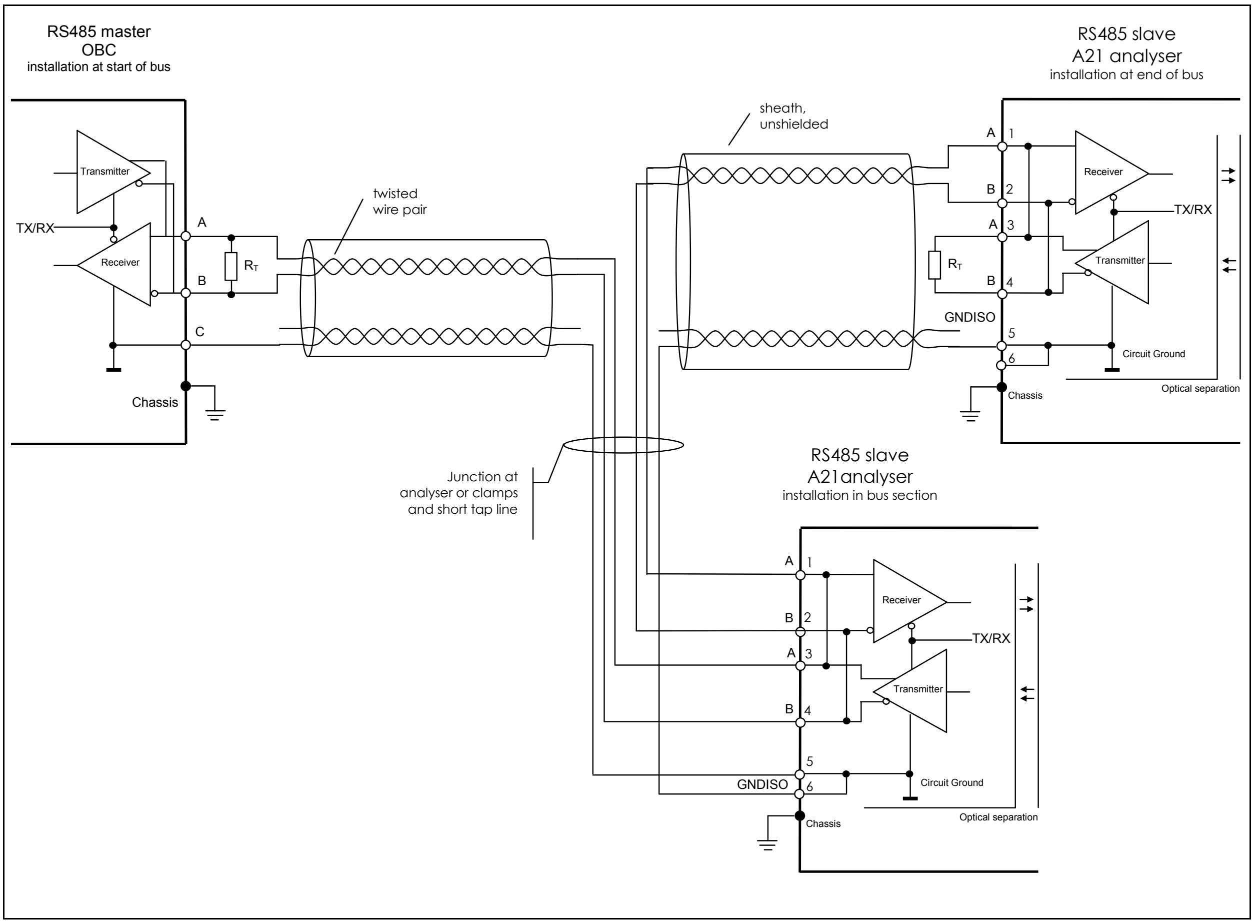

Fig. 21: **IRMA-Gateway-4-RS485.2, 2-wire BUS plan**

10.4.1 Termination yes/no?

A line terminating resistor to the greatest possible extent reduces signal reflections at the line ends, thus improving signal quality by minimising overshooting at the flanks. Furthermore, its application positively influences the resistance to fault signals, as otherwise an open cable end (the receivers are of the high-resistance design) acts more or less as an aerial. What is disadvantageous is the increased technical complexity and expenses as well as the additional length of line required.

Where must the resistors be located?

As already mentioned, open/high-resistance line ends should be avoided. Therefore terminating resistors should be installed at least on the receiver side. If, due to the BUS topology selected, the transmitter can be switched to the high-resistance mode, a terminating resistor should equally be provided on the transmitter side.

The resistor(s) are installed at the end of each cable, even if no bus devices are connected in these positions.
BUS devices which are connected to inner sections of the data BUS via short branch lines, will not be terminated.

Which resistor values shall be selected?

The resistor values shall be selected in such a way that the aggregate of the parallel connection (2 x terminating resistor parallel of all receiver input resistors) does not fall short of 50 Ω. 120Ω is the standard value for a terminating resistor. This value is optimal also in terms of the line surge impedance of commercial data cables.

The resistor's performance value depends on the maximum permissible signal differential voltage (6 V) and should therefore not fall short of 300 mW. A necessary upward performance reserve results from an overvoltage resistance required for the entire project taking into account economic considerations. The use of a positive temperature coefficient (PTC) resistor may be advantageous.

N.B. All EMC tests were carried out with 4 wire cabling and termination on the receiver side.

10.4.2 Wiring of data reference ground "GNDISO" yes/no?

The "GNDISO" (or "C") signal is the reference ground of the electrically isolated RS485 driver circuit. Strictly speaking, this signal is not required for data transmission, as RS485 is a differential signal data transmission standard. This means that the H or L levels are generated by calculating the difference between "TXD+" and "TXD-", "RXD+" and "RXD-" and "A" and "B" As the data stream, which consists of a varying number of 0 and 1 bits, comprises DC components and coupled-in interference (surge, burst, etc.) may shift the common-mode voltage applied beyond limits, the connection of the reference grounds between master and slave(s) ensures equipotential bonding, improving the resistance to fault signals.

Especially for cable lengths of more than 15 m or in an environment characterised by severe interference, connection of the "GNDISO" signal should therefore be provided (depending on the project).

N.B. "GNDISO" was NOT connected for the EMC tests.

10.4.3 Shielded lines yes/no?

The advantage of shielded lines over unshielded ones is the fact that they do not only suppress undesired HF emissions, but also remove interference effects from the environment to earth. All in all, signal transmission becomes less sensitive to disturbance and more reliable. Depending on the application and the EMC limits applicable, the decision to use shielded lines or not can be based on economic considerations. For installations in living quarters, professional operations and small businesses the use of shielded lines for the RS485 data line is mandatory.

When connecting the shield, care should be taken that it is connected electrically on one side only in order to prevent currents in the earthing system passing through the shield. For long lines it may be useful to connect to earth also the other end of the shield in terms of HF engineering. In this case a capacitor is used for the connection of the shield to the earthing potential.

Additional information on cable lengths, cross sections and attenuation can be seen in the RS485 standard or pertinent application documentation.

11 Abbreviations, terms

APC	Automatic Passenger Counter
CAN	Controller Area Network
DC	Direct current
ESD	Electro Static Discharge
EMC	Electromagnetic Compatibility
IRMA	Infrared Motion Analyzer
NVSRAM	Non Volatile Static Random Access Memory
OBC	On-board computer
potential free	Same meaning as "electrically isolated" or "galvanically isolated"
SPI	Serial Peripheral Interconnection
SSI	Serial Synchronous Interconnection
SSM	Schnittstellenmodul - Interface module
SV	Stromversorgung - Power supply
TIA	Telecommunication Industry Association
EIA	Electronic Industries Association