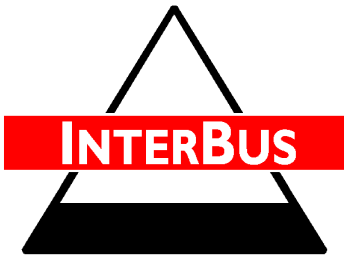
INTERBUS

The International Standard IEC 61158

Technical Guidelines

INTERBUS Data Cable

V2.0
18.12.2002



Supplement to IEC 61158

Contents

1. General

Modern automation concepts use serial networking in the "lowest" level, i.e., in the sensor/actuator area of machines and systems. Compared with conventional parallel cabling, serial networks provide enormous potential savings due to reduced cabling costs, shorter start-up times, and increased flexibility of machines and systems. In automation technology, transmission reliability is particularly vital in a bus system. As sensitive electronics must be used in the process area near the sensors, the transmission reliability depends on the transmission medium, transmission speed, topology, and self-diagnostics of the bus system. Therefore fieldbus devices and their transmission lines must have appropriate protection against electromagnetic inference. Today, copper cables are used in automation technology as a line-based transmission medium, whereas fiber optics are used in environments subject to high levels of electromagnetic interference.

The INTERBUS standard (IEC 61158) refers to the proven RS-485 interface as the physical transmission medium. These technical guidelines for INTERBUS data cable should thus be regarded as a supplement to the INTERBUS standard.

2. Reference Source

The technical guidelines for cable-based transmission technology in the INTERBUS system as well as the guidelines for optical transmission technology and the guidelines for INTERBUS can be ordered from the INTERBUS Club e.V. at the following address:

INTERBUS Club e.V.
Postfach 11 08

32817 Blomberg, Germany

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3. Technical Data

3.1. INTERBUS Remote Bus (2-Wire)

Characteristic Size (20°C [68°F])	Setpoint	Test Method
Number of wires	3 x 2, twisted pair, with common shielding	
Conductor cross section	0.2 mm² (25 AWG), minimum	
DC conductor resistance per 100 m (328.08 ft.)	9.6 Ω, maximum	VDE 0472-501 IEC 189-1 cl. 5-1
Characteristic impedance	120 Ω ±20% at f = 0.064 MHz 100 Ω ±15 Ω at f > 1 MHz	IEC 1156-1 cl. 3.3.6
Dielectric strength - Wire/wire - Wire/shield	 1000 V_{rms}, 1 minute 1000 V_{rms}, 1 minute	VDE 0472-509 test type C or IEC 189-1 cl. 5.2
Insulation resistance (after testing dielectric strength)	150 MΩ, minimum, for 1 km (0.62 mi.) cable	VDE 0472-502 test type B or IEC 189-1 cl. 5.3
Maximum transfer impedance (coupling resistance) - at 30 MHz	 250 mΩ/m	 IEC 96-1
Effective capacitance at 800 Hz	60 nF, maximum, for 1 km (0.62 mi.) cable	VDE 0472-504 test type A IEC 189-1 cl. 5-4
Minimum near-end crosstalk attenuation (NEXT) for 100 m (328.08 ft.) cable - at 0.772 MHz - at 1 MHz - at 2 MHz - at 4 MHz - at 8 MHz - at 10 MHz - at 16 MHz - at 20 MHz	 61 dB 59 dB 55 dB 50 dB 46 dB 44 dB 41 dB 40 dB	VDE 0472-517 or IEC 1156-1 cl. 3.3.4
Maximum wave attenuation for 100 m (328.08 ft.) cable - at 0.256 MHz - at 0.772 MHz - at 1 MHz - at 4 MHz - at 10 MHz - at 16 MHz - at 20 MHz	 1.5 dB 2.4 dB 2.7 dB 5.2 dB 8.4 dB 11.2 dB 11.9 dB	VDE 0472-515 or IEC 1156-1 cl. 3.3.2

3.1.1. Mechanical Requirements

Flexible cable must be used for flexible installation (occasionally moved) and for permanent installation in dry and damp rooms.

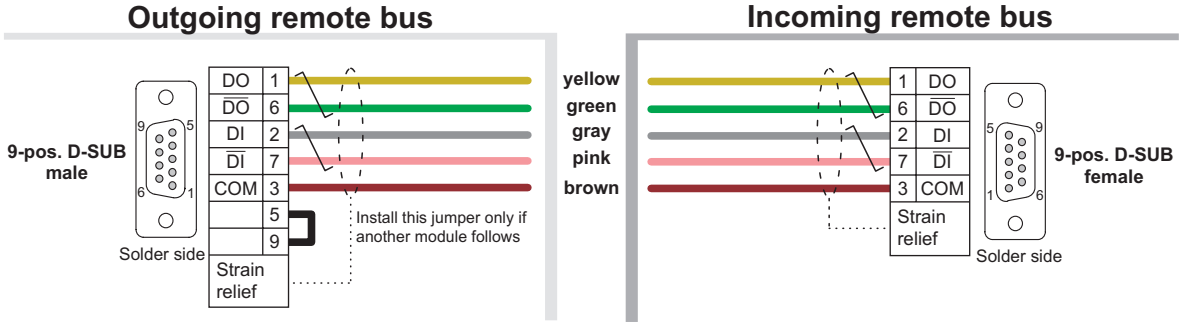
Size	Setpoint
Temperature range	-20°C to +70°C (-4°F to +158°F)
Color coding of the wires	According to DIN 47100
Sheath color	May green RAL 6017
Maximum outside diameter	8 mm (0.315 in.)
Minimum bending radius	64 mm (2.520 in.)
Connection method	Suitable for: - 9-pos. D-SUB connectors (DIN 41652) - 9-pos. IP 65 circular connectors (Coninvers) - 5-pos. M12 (only for devices with automatic interface recognition [IBS SUPI 3 OPC]) - Terminal blocks

Deviations from the mechanical specifications are permitted for special applications if the electrical features of the cable correspond to the data specified above (in the event of deviations, please refer to the data sheet). A cable connection method should be selected, which will not cause a marked deterioration in the specified electrical data. Particular attention must be paid when selecting the connection method for the shielding. The shielding must be connected in such a way that the conductor cross section is not reduced and the wires are covered with as much of the shielding as possible. The shielding must be led concentrically through the threaded joint as far as possible. The wire pairs must be twisted up to the connection contacts. Two cables should not be connected with each other as losses can be caused by reflections at the connection point and the effectiveness of the shielding could also deteriorate. This is especially relevant if different cable types are connected with one another.

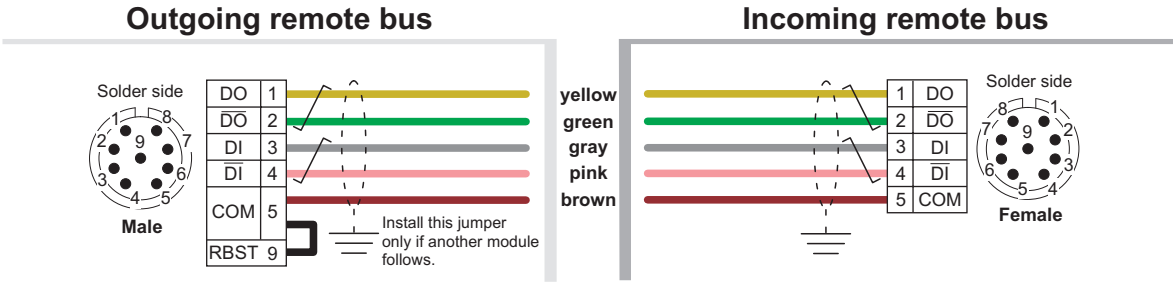
If it is not possible to avoid connection points or the electrical data cannot be achieved for a special cable, an individual test should be carried out to determine whether, for example, the cable can still be used by reducing the permissible transmission distance.

3.1.2. Connector Pin Assignment

9-pos. D-SUB connectors (DIN 41652):



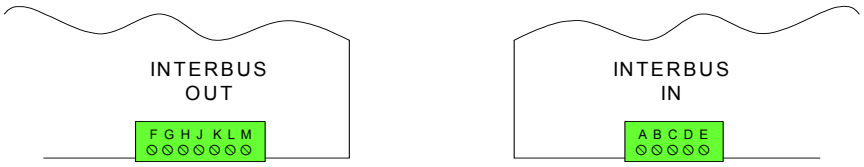
9-pos. IP 65 circular connectors (Coninvers):



5-pos. M12 circular connectors:

Caution: only for devices with automatic interface recognition [IBS SUPI3 OPC]

Terminal blocks:



Outgoing remote bus

Pin	Assignment
F	/DO
G	DO
H	/DI
J	DI
K	GND
L	Jumper
M	Jumper

Green
Yellow
Pink
Gray
Brown

Incoming remote bus

Pin	Assignment
A	/DO
B	DO
C	/DI
D	DI
E	GND

L and M must only be jumpered if they are followed by another module.

3.2. INTERBUS Installation Remote Bus (2-Wire)

The installation remote bus is a special type of 2-wire remote bus, which carries the power supply for the bus logic of subsequent devices in the cable. The cable is mainly used for equipment with IP 65 protection.

The total expansion of an installation remote bus is limited to 50 m (164.04 ft.). Thus the maximum cable length is also 50 m (164.04 ft.). The electrical characteristics of the data lines correspond, to the greatest possible extent, to that of the 2-wire remote bus cable.

Characteristic Size (20°C [68°F])	Setpoint	Test Method
Number of wires	3 x 2 data lines (twisted pair) and 3 power supply lines (common or separate shielding)	
Conductor cross section of data lines	0.2 mm² (25 AWG), minimum	
Conductor cross section of supply lines	1.0 mm² (17 AWG), minimum	
DC conductor resistance per 100 m (328.08 ft.) data line	9.6 Ω, maximum	VDE 0472-501 IEC 189-1 cl. 5-1
DC conductor resistance per 100 m (328.08 ft.) supply line	2.2 Ω, maximum	VDE 0472-501 IEC 189-1 cl. 5-1
Characteristic impedance of the wire pairs (data lines)	120 Ω ±20% at f = 0.064 MHz 100 Ω ±15 Ω at f > 1 MHz	IEC 1156-1 cl. 3.3.6
Dielectric strength - Wire/wire - Wire/shield	 1000 V_{rms}, 1 minute 1000 V_{rms}, 1 minute	VDE 0472-509 test type C or IEC 189-1 cl. 5.2
Insulation resistance (after testing dielectric strength)	150 MΩ, minimum, for 1 km (0.62 mi.) cable	VDE 0472-502 test type B or IEC 189-1 cl. 5.3
Maximum transfer impedance (coupling resistance) - at 30 MHz	 250 mΩ/m	 IEC 96-1
Effective capacitance of data lines at 800 Hz	60 nF, maximum, for 1 km (0.62 mi.) cable	VDE 0472-504 test type A IEC 189-1 cl. 5-4
Minimum near-end crosstalk attenuation (NEXT) for 100 m (328.08 ft.) cable - at 0.772 MHz - at 1 MHz - at 2 MHz - at 4 MHz - at 8 MHz - at 10 MHz - at 16 MHz - at 20 MHz	 61 dB 59 dB 55 dB 50 dB 46 dB 44 dB 41 dB 40 dB	VDE 0472-517 or IEC 1156-1 cl. 3.3.4
Maximum wave attenuation for 100 m (328.08 ft.) cable - at 0.256 MHz - at 0.772 MHz - at 1 MHz - at 4 MHz - at 10 MHz - at 16 MHz - at 20 MHz	 3.0 dB 4.8 dB 5.2 dB 10.4 dB 16.8 dB 22.4 dB 23.8 dB	VDE 0472-515 or IEC 1156-1 cl. 3.3.2

3.2.1. Mechanical Requirements

Flexible cable must be used for flexible installation (occasionally moved) and for permanent installation in dry and damp rooms.

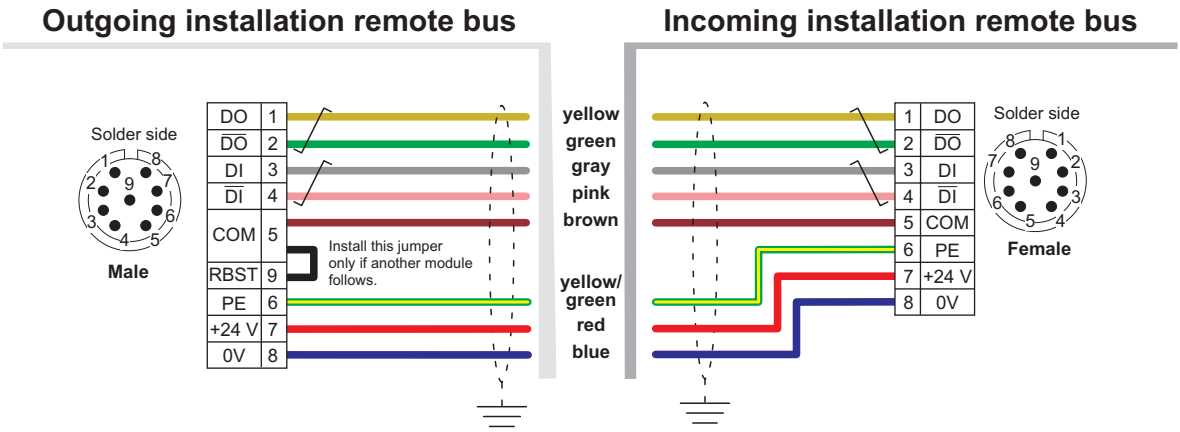
Size	Setpoint
Temperature range	-20°C to +70°C (-4°F to +158°F)
Color coding of the data lines	According to DIN 47100
Color coding of the supply lines	Red, blue, and yellow/green
Sheath color	May green RAL 6017
Maximum outside diameter	8 mm (0.315 in.)
Minimum inside diameter of the sheath	5 mm (0.197 in.)
Minimum bending radius	80 mm (3.150 in.)
Connection method	Suitable for: - 9-pos. IP 65 circular connectors (Coninvers) - Terminal blocks

Deviations from the mechanical specifications are permitted for special applications if the electrical features of the cable correspond to the data specified above (in the event of deviations, please refer to the data sheet). A cable connection method should be selected, which will not cause a marked deterioration in the specified electrical data. Particular attention must be paid when selecting the connection method for the shielding. The shielding must be connected in such a way that the conductor cross section is not reduced and the wires are covered with as much of the shielding as possible. The shielding must be led concentrically through the threaded joint as far as possible. The wire pairs must be twisted up to the connection contacts. Two cables should not be connected with each other as losses can be caused by reflections at the connection point and the effectiveness of the shielding could also deteriorate. This is especially relevant if different cable types are connected with one another.

If it is not possible to avoid connection points or the electrical data cannot be achieved for a special cable, an individual test should be carried out to determine whether, for example, the cable can still be used by reducing the permissible transmission distance.

3.2.2. Connector Pin Assignment

9-pos. IP 65 circular connectors (Coninvers):



Terminal blocks:

Outgoing remote bus

Pin	Assignment
F	/DO
G	DO
H	/DI
J	DI
K	GND
L	Jumper
M	Jumper

Incoming remote bus

Pin	Assignment
A	/DO
B	DO
C	/DI
D	DI
E	GND

Green
Yellow
Pink
Gray
Brown

PE	PE
+24 V	+24 V
0 V	0 V

Yellow/green
Red
Blue

L and M must only be jumpered if they are followed by another module.

3.3. INTERBUS Loop 2

Cable for data transmission/sensor supply 2 x 1.5 mm² (16 AWG)

INTERBUS Loop 2 is a version of the INTERBUS local bus whereby data and power can be transmitted via a single cable. The cable is mainly used to network devices with IP 65 protection.

Characteristic Size (20°C [68°F])	Setpoint	Test Method
Number of wires	2, twisted	
Distance per twist	<= 52 mm (2.05 in.)	
Conductor cross section	1.5 mm² (16 AWG)	
Litz wire structure	Finely stranded	VDE 0295, Class 5
Litz wire structure/maximum wire diameter	0.26 mm (0.010 in.)	VDE 0295, Class 5
Litz wire structure/minimum wire diameter	0.2 mm (0.008 in.)	
DC conductor resistance per 1000 m (3280.84 ft.)	13.3 Ω, maximum for plain single wires 13.7 Ω, maximum for metal-clad single wires	VDE 0295, Class 5
Characteristic impedance	75 Ω ±15% at f = 250 kHz to 10 MHz	
Dielectric strength wire/wire	1000 V_{rms}, 1 minute	VDE 0472-509 test type C or IEC 189-1 cl. 5.2
Wire insulation material	PVC/PE	
Insulation resistance (after testing dielectric strength)	20 MΩ, minimum, for 1 km (0.62 mi.) cable	VDE 0472-502 test type B or IEC 189-1 cl. 5.3

3.3.1. Mechanical Requirements

Flexible cable must be used for flexible installation (occasionally moved) and for permanent installation in dry and damp rooms.

Size	Setpoint
Temperature range	-5°C to +70°C (+23°F to +158°F)
Color coding of the wires	Brown, blue
Length marking	Meters marked on the cable: 1 m... 2 m...3 m... to 999 m (3.28 ft. …6.56 ft. …9.84 ft. …3277.56 ft.) (no calibration)
Labeling	INTERBUS Loop 2 2 x 1.5 mm² (16 AWG)
Sheath color	May green RAL 6017
Labeling color	Black
Outside cable diameter (VDE 0281-5)	7.2 mm (0.283 in.), typical, (6.8 - 8.2 mm [0.268 - 0.323 in.])
Outside wire diameter (including insulation)	2.5 mm (0.098 in.)
Minimum bending radius	15 x cable diameter
Environmental compatibility	Free from substances which would hinder coating with paint or varnish
Connection method	Suitable for INTERBUS Loop 2 - Insulation displacement connection method - Terminal blocks

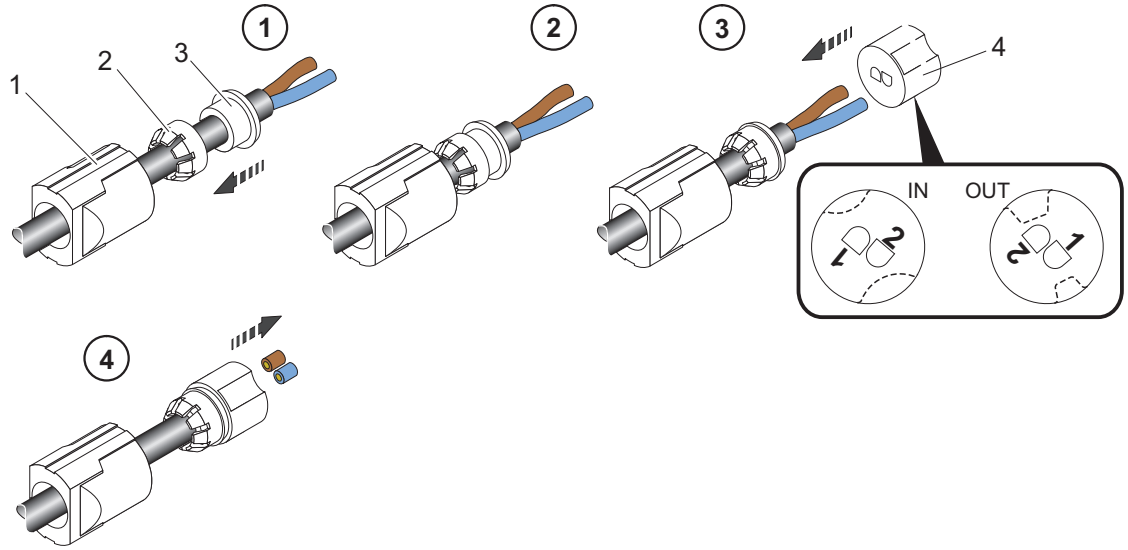
Deviations from the mechanical specifications are permitted for special applications if the electrical features of the cable correspond to the data specified above (in the event of deviations, please refer to the data sheet). A cable connection method should be selected, which will not cause a marked deterioration in the specified electrical data. The wire pairs must be twisted up to the connection contacts. Two cables should not be connected with each other as losses can be caused by reflections at the connection point and the effectiveness of the shielding could also deteriorate. This is especially relevant if different cable types are connected with one another.

If it is not possible to avoid connection points or the electrical data cannot be achieved for a special cable, an individual test should be carried out to determine whether, for example, the cable can still be used by reducing the permissible transmission distance.

3.3.2. Connector Pin Assignment

INTERBUS Loop 2 has a special feature, which enables installation to be carried out without the signal polarity having to be observed. Therefore, the pin assignment does not have to be determined.

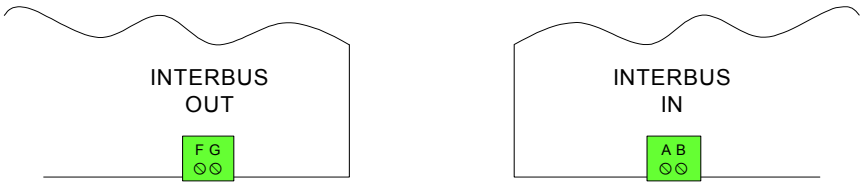
Insulation displacement connection method:



Outgoing Loop 2 Incoming Loop 2

Pin	Assignment		Pin	Assignment
1	Any	Brown	1	Any
2	Any	Blue	2	Any

Terminal blocks:



Outgoing Loop 2 Incoming Loop 2

Pin	Assignment		Pin	Assignment
F	Any	Brown	A	Any
G	Any	Blue	B	Any

3.4. INTERBUS S-Line

Cable for data transmission/sensor supply 2 x 2 x 0.5 mm² (20 AWG)

INTERBUS S-Line is a version of the INTERBUS local bus whereby data and power can be transmitted via a single cable. In contrast to INTERBUS Loop 2, forward and return lines are fed in one cable. The cable is mainly used to network devices with IP 65 protection.

Characteristic Size (20°C [68°F])	Setpoint	Test Method
Number of wires	2 x 2 twisted pair	
Distance per twist	<= 52 mm (2.05 in.)	
Conductor cross section	> 0.5 mm² (20 AWG)	
Litz wire structure	Finely stranded	VDE 0295, Class 5
Litz wire structure/maximum wire diameter	0.26 mm (0.010 in.)	VDE 0295, Class 5
Litz wire structure/minimum wire diameter	0.2 mm (0.008 in.)	
DC conductor resistance per 1000 m (3280.84 ft.)	39.2 Ω, maximum	VDE 0472-501 IEC 189-1 cl. 5-1
Characteristic impedance	79 Ω ±5 Ω at f = 250 kHz to 10 MHz	IEC1156-1 cl. 3.3.6
Dielectric strength wire/wire	1000 V_{rms}, 1 minute	VDE 0472-509 test type C or IEC 189-1 cl. 5.2
Wire insulation material	PVC/PE	
Insulation resistance (after testing dielectric strength)	5 GΩ, minimum, for 1 km (0.62 mi.) cable	VDE 0472-502 test type B or IEC 189-1 cl. 5.3
Maximum transfer impedance (coupling resistance) - at 30 MHz	 250 mΩ/m	 IEC 96-1
Effective capacitance of data lines at 800 Hz	110 nF, maximum, for 1 km (0.62 mi.) cable	VDE 0472-504 test type A IEC 189-1 cl. 5-4
Minimum near-end crosstalk attenuation (NEXT) for 100 m (328.08 ft.) cable - at 0.772 MHz - at 1 MHz - at 2 MHz - at 4 MHz - at 8 MHz - at 10 MHz - at 16 MHz - at 20 MHz	 84 dB 72 dB 67 dB 64 dB 62 dB 61 dB 59 dB 54 dB	VDE 0472-517 or IEC 1156-1 cl. 3.3.4
Maximum wave attenuation for 100 m (328.08 ft.) cable - at 0.256 MHz - at 0.772 MHz - at 1 MHz - at 4 MHz - at 10 MHz - at 16 MHz - at 20 MHz	 0.8 dB 2 dB 2.5 dB 7.5 dB 13.5 dB 17.5 dB 22 dB	VDE 0472-515 or IEC 1156-1 cl. 3.3.2

3.4.1. Mechanical Requirements

Flexible cable must be used for flexible installation (occasionally moved) and for permanent installation in dry and damp rooms.

Size	Setpoint
Temperature range: Flexible Fixed	-5°C to +80°C (+23°F to +176°F) -40°C to +80°C (-40°F to +176°F)
Color coding of the wires	[white, brown], [green, yellow]
Sheath color	May green RAL 6017
Labeling color	Black
Outside cable diameter (VDE 0281-5)	7.2 mm (0.283 in.), typical, (6.8 - 8.2 mm [0.268 - 0.323 in.])
Outside wire diameter (including insulation)	2.5 mm (0.098 in.)
Minimum bending radius	15 x cable diameter
Environmental compatibility	Free from substances which would hinder coating with paint or varnish
Connection method	Suitable for: - M12 connection method - Terminal blocks

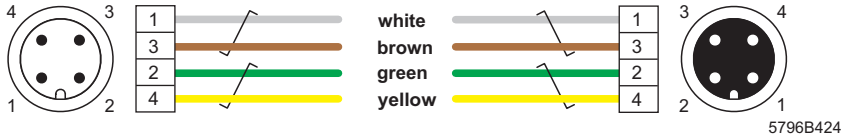
Deviations from the mechanical specifications are permitted for special applications if the electrical features of the cable correspond to the data specified above (in the event of deviations, please refer to the data sheet). A cable connection method should be selected, which will not cause a marked deterioration in the specified electrical data. The wire pairs must be twisted up to the connection contacts. Two cables should not be connected with each other as losses can be caused by reflections at the connection point and the effectiveness of the shielding could also deteriorate. This is especially relevant if different cable types are connected with one another.

If it is not possible to avoid connection points or the electrical data cannot be achieved for a special cable, an individual test should be carried out to determine whether, for example, the cable can still be used by reducing the permissible transmission distance.

3.4.2. Connector Pin Assignment

INTERBUS Loop 2 has a special feature, which enables installation to be carried out without the signal polarity having to be observed. Therefore, the pin assignment does not have to be determined.

M12 connection method:



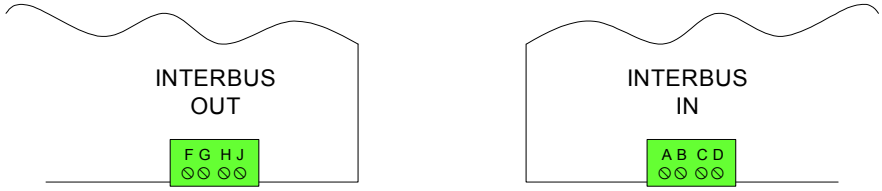
Outgoing S-Line male connector

Pin	Assignment
1	IN
2	OUT
3	IN
4	OUT

Incoming S-Line female connector

Pin	Assignment
1	IN
2	OUT
3	IN
4	OUT

Terminal blocks:

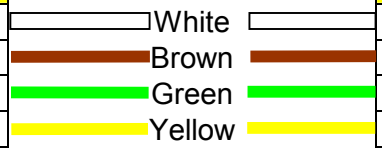


Outgoing S-Line terminal block

Pin	Assignment
F	IN
G	IN
H	OUT
J	OUT

Incoming S-Line terminal block

Pin	Assignment
A	IN
B	IN
C	OUT
D	OUT



4. Certification Procedure

The Certification Board Committee of the INTERBUS Club decides the suitability of a data cable based on the manufacturer declaration and the test reports in the same way that it certifies devices with INTERBUS interfaces. The applicant must submit a manufacturer test report, which contains the results of the specified test criteria. The Certification Board Committee of the INTERBUS Club checks whether the requirements specified in the INTERBUS Club Guidelines for data cable have been met. The Board then issues authorization for the INTERBUS mark of conformity (the certification symbol for data cable) to be used, together with a certification number.

5. Conformance Mark

Every data cable manufacturer is entitled to use the conformance mark for data cable (see below) provided the cable meets the technical specifications of these guidelines and the manufacturer has submitted an "application for a conformance mark certificate" to the INTERBUS Club, which has subsequently been approved.

With the "application for a conformance mark certificate" the manufacturer states that all batches displaying the conformance mark meet the technical specifications of these guidelines.

The conformance mark contains the text "INTERBUS Compatible" in black letters on a May green background (RAL 6017), separated by the "INTERBUS Compatible" symbol.