Basic and System Components/Devices – Minimum Requirements – Standardised solutions - Tests KNX System Conformance Testing

Cables and Connectors

9

1

Summary

This document contains minimum requirements for KNX cables and connectors and standardised solutions.

This document is part of the KNX Specifications v2.1.

Version 01.02.01 is a KNX Approved Standard.

Document Updates

Version	Date	Modifications
1.0	2001.10.15	Approved Standard
1.1 RfV	2006.03	Integration of AN's, delete the former requirements indicating use of lead in view of EU regulations prohibiting the use of lead – updating of references to restructured volume 4 – correction of standard references
1.1 FV	2006.09	Resolution of comments from RfV
1.1 AS	2009.06	Finalisation of document in preparation for publication of V2.0 of the KNX Standard
1.2 AS	2012.09	Editorial update following AN 126
01.02.01	2013.10.23	Editorial updates for the publication of KNX Specifications 2.1.

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Contents

1 Preface

In the light of the multi-vendor philosophy within KNX, KNX has opted for a standardization of a number of crucial basic and system components/devices providing Standardised interfaces not only to manufacturers but also installers and users. However, it is still possible to design non-Standardised solutions.

In the following clauses, the underneath connotation is used:

No.	Abbreviation	Meaning
1	M	Minimum requirements for certification – the 'M' requirements are only a subset of the Standardised/optional requirements respectively recommendations – devices not complying to at least these requirements cannot be certified
2	0	Optional requirement - when implemented, the KNX requirements shall be met
3	F	Recommendations (free to implement)
4	S	Feature of Standardised solutions
5	VI	Visual inspection (test guidelines)

If the names of basic and system components/devices have been Standardised respectively exclusively assigned to this type of products (e.g. BCU), non-Standardised versions may not bear this same name. For the example given above, the system device would have to be named BAU or Bus Access Unit.

Note: For commercially available basic and system components/devices, consult the KNX Directory of registered/certified solutions.

2 TP Cable

2.1 TP1 Cable

2.1.1 General

Two types of TP1 cable are distinguished:

- cables complying with the 'S' marked features of the underneath table. This cable will ensure that cable distances as specified in Chapter 3/1/1 "KNX Implementation on Twisted Pair 1" can be met. Moreover, the standardised TP1 cable has amongst others the following additional features: two twisted pairs, overall shield and sheath. This cable is always green RAL 6018 coloured.
- Cables complying only with the 'M' marked features of the underneath table. It is allowed that such cables do not ensure that the distances as specified in Chapter 3/1/1 "KNX Implementation on Twisted Pair 1" can be met (shall be derived from the product instruction sheet). This cable shall however never be green RAL 6018 coloured.

The underneath requirements have to be read in the above light. Further details have to be derived from the Physical Layer specifications.

No.	Features		Requirements	Test	M
1	exclusive designation/ name		TP1 standard cable	-	S
2.1	constructional features, dimensions	Wire diameter	min 0,8 mm, max 1,0 mm (AWG Cu 20 - 18)	Measurement	F/S
2.2		Wire material	Copper, solid and stranded wires	-	F/S
2.3		Wires	Two pair(s)	-	F/S
2.4		Colours of wires	1 pair red/black, 1 pair white/yellow	-	F/S
2.5		Tensile strength	Min 100 N	Measurement	F/S
2.6		Outer shape of cable			
2.7a	constructional features, dimensions	Cable length for Standardised cable	1000 m max.	Measurement	S
2.7b		Cable length for non-Standardised cable	1000 m max. Shorter length specified by the manufacturer[1]	Measurement	M
3.1a	electrical properties for Standardised cable	Loop resistance	min. 20 Ω/km max. 75Ω/km	Measurement	S
3.1b	electrical properties for non-Standardised cable	Loop resistance	min. 20 Ω for the specified length max. 75Ω for the specified length max. 150Ω/km	Measurement	M

[1] For non-standardized cables the manufacturer is obliged to inform on the allowed cable length, e.g. by the instruction sheet. The following warning shall be used in the product instruction documentation: **Warning – the maximum usable cable length per line is maximum xxx m.** The maximum cable length is normally derived from the EMC tests: it is the cable length for which the requirements of item 5.1.2 and 5.1.3 of this table are complied with.

No.	Features		Requirements	Test	M
3.2		Conductance	G_{max} = 1mS/km, $f_{measure}$ = 10 kHz	Measurement	M
4.1	Electrical Safety	Outer sheath	Required	-	M/S
4.2		Insulation resistance core to outer sheath	100 MΩ/km (20°) respectively 0.011 MΩ/km (70°)	Measurement	M/S
4.3		Withstand voltage core/core	800VAC	measurement	M/S
4.4		High voltage withstand	2 kV AC 50Hz 4 kV AC 50Hz[2]	5 minutes 1 minute all cores and screen connected together against outer sheath surface, immersed in water according HD 21.2 S2 and 22.2 S2	M/S
5.1.1	EMC	twist	Min. 5/m	measurement	F/S
5.1.2		Continuous-wave induced differential voltages	U ≤ ± 200 mV peak (50 Hz – 150 kHz)	see 2.1.3	M[3]
5.1.3		Maximum peak bus voltage	U ≤ ± 45 V[4] peak: cable length as specified in Chapter 3/1/1 and transient voltages according industrial level (according EN 61000-6-2) or home level [5](according EN 61000-6-1)	2.1.2	M[3]
5.2		screen	- shall cover entire diameter - drain wire : diameter min. 0,4 mm (AWG Cu 26)	-	F/S
6.1	temperature and climate		According EN 50288 (-1, -2 [screened], -3 [unscreened])[6], alternatively EN 50290 series[7]	according EN 50288 (-1, -2 [screened], -3 [unscreened]), alternatively EN 50290 series	M/S

[2] in some countries this 4 kV test is required

[3] EMC test only necessary for cables without twist or twists < 5.

[4] This implies that for a maximum operating bus DC voltage of 31V, the positive peak may not exceed 14V.

[5] Use restricted to home environment level only shall be clearly stated in the instruction sheet.

[6] For halogen free cable, IEC 60189-2 shall be used as far as applicable. In addition EN 50265-1 and EN 50267-2-2 shall be complied with.

[7] For special applications for which dedicated standards exist (e.g. supply tracks), these may be used alternatively.

No.	Features		Requirements		Test	M
7.1	mechanical stress		According EN 50288 (-1, -2 [screened], -3 [unscreened])[8], alternatively EN 50290 series[è]		according EN 50288 (-1, -2 [screened], -3 [unscreened]), alternatively EN 50290 series	M/S
8	software requirements	-	-			
9.1	Communication for standard cable	capacity wire/wire	min. 10 nF/km max. 100 nF/km (10 kHz)		measurement	S
9.2		inductance	min. 450 µH/km max. 850 µH/km (10 kHz)		measurement	S
9.3		maximum signal attenuation	≤ 50 kHz	15 dB/km	measurement	S
			50-500 kHz	15-35 dB/km[9]		S
			0,5-5 MHz	35-95 dB/km[9]		S
			5-25MHz	95-200 dB/km[9]		S
10	Connection	-	-			
11	Marking	-	See underneath table		VI	M/S

	Logo	Colour
TP1 standard cable	EIB/KNX logo	Green RAL 6018
TP1 non-Standardised cable		Different from green RAL 6018

Figure 1: Marking of TP1 cable

2.1.2 Test set-up for transient induced differential voltages

- Devices connected to the bus require a limitation of induced differential voltages to 45V. The objective of this test is to ensure that the maximum peak bus voltages does not exceed this limit.
- The cable under test shall be laid in parallel with a second one (“primary loop”), into which the test voltages shall be fed into. Select this cable from a range of practical possible cable types, in such a way that the highest possible interferences will occur[10].
- Test shall be carried out with a length of 50 m for each cable (primary loop and test cable).
- Both cables shall be laid in such a way that the inductivity is low (straight or with meanders of approximately 20 cm, not rolled up). A distance of at least 10 cm to each metal plane shall be ensured.
- The cable causing interference (primary loop: single wire or cable with go and return wire, short-circuited) shall be laid parallel to the bus cable to be tested over its entire length.

8 For halogen free cable, IEC 60189-2 shall be used as far as applicable. In addition EN 50265-1 and EN 50267-2-2 shall be complied with.

9 Increasing linearly with the logarithm of the frequency.

10 In case of special applications, the intended use shall be considered, e.g. in case of solutions combining bus and mains lines, the latter ones shall be used for building the primary loop.

- The distance between the interfering cable and the bus cable shall be chosen in such a way, that the highest possible coupling (that can arise in the field) is reached.
- The source of the transient voltages shall be connected to the primary loop with respectively 2 Ω/12 Ω and the corresponding coupling capacitor. A combination wave generator according EN 61000-4-5 with 1,2/50 µs impulse shall generate the transient voltages. The generator shall be coupled to the primary loop as for mains connections according EN 61000-4-5. In order to avoid errors, the generator and the measuring equipment shall be positioned at either side of the test set-up, i.e. the generator and the measuring device shall be separated locally as far as possible.
- On one side the bus cable wires shall be connected to ground with 50 Ω each. On the other side the bus cable shall be short-circuited (this side shall never be connected to ground). The ground plane serves as measuring ground and is not specified.
- Values for transient voltages for industry level according EN61000-6-2 or for home level according EN 61000-6-1

  Home Level

  - peak voltage : 1 kV with Ri = 2 Ω
  - peak voltage : 2 kV with Ri = 12 Ω

  Industry Level

  - peak voltage : 2 kV with Ri = 2 Ω
  - peak voltage : 4 kV with Ri = 12 Ω
- The induced voltage on the bus cable shall be measured as differential voltage.
  - The maximum cable length, for which the defined limit of the induced voltages is not exceeded, shall be measured.

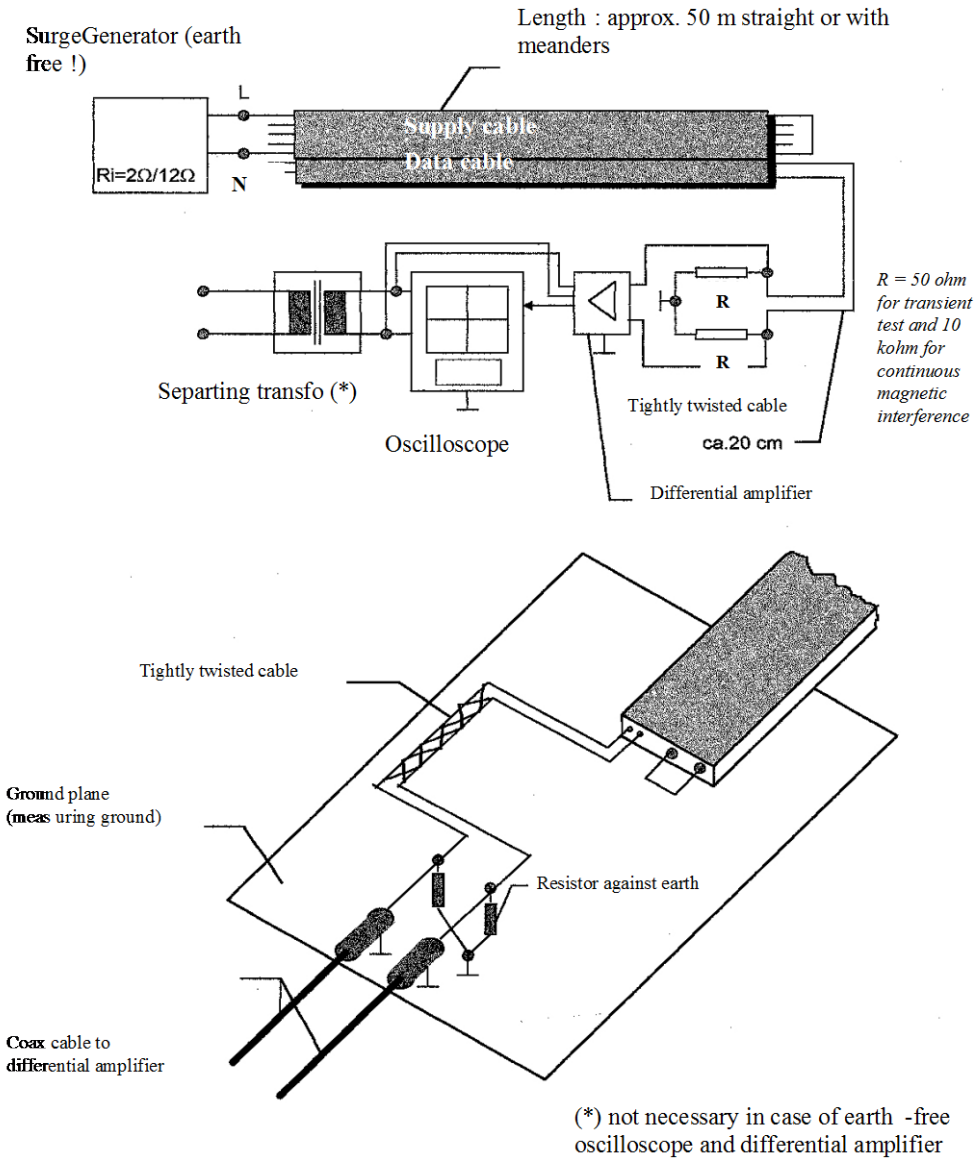

Figure 2: Test set-up for measurement of continuous and transient magnetic interference (example)

2.1.3 Test for measurement of continuous-wave induced differential voltages

The Physical Layer specifications define the telegram signal voltage as an AC voltage ± 200 mV peak, which is modulated onto the analogue bus voltage. The purpose of these tests is to safeguard bus communication by limiting the influence of continuous-wave noise to this value.

Test set-up is identical to the one specified in clause 2.1.2. However, the short-circuit in the primary loop shall be replaced by a load causing the nominal cable current and voltage. The generator shall moreover be replaced with Power Low Frequency Generator from 50 Hz to 150 kHz, inducing on the primary loop additionally to the nominal rated voltage, current and frequency (e.g. 230 V/16A/50 Hz) a low frequency AC voltage of

- 10Veff in the frequency range to 3 kHz and
- 3Veff in the frequency range from 3 kHz up to 150 kHz.

The connection to the primary loop shall be done in such a way that the highest possible to be expected interference on the secondary loop is ensured.

The induced voltage on the cable under test shall not exceed ± 200 mVpeak for the maximum specified cable length.

The maximum cable length, for which the defined limit of the induced voltages is not exceeded, shall be measured.

2.1.4 Installation requirements

- See Volume 4 Part 4
- If additional protection measures are needed (e.g. overvoltage protection) for a distinct cable type, this shall be explicitly stated in the manufacturer's cable specifications.
- In applications where higher interference voltages (than defined in the tests before) in the range up to 150 kHz are expected (e.g. luminaries with electronic ballasts, switch mode power supplies, …) the Standardised TP1 cable shall be used. Manufacturers of non-Standardised cables shall give an appropriate hint to the installer in the product documentation.
- If a non-Standardised TP1 cable is used in an installation for KNX, then it shall be used for KNX only (and not additionally for e.g. intercom systems, telephone, …).

3 Connectors

3.1 Overview

The underneath table gives an overview of the Standardised connectors.

The type numbering (x.y) consists of the following information:

- the first digit (x) denotes the general type
- the second digit (y) denotes in case of 1 that the connector connects TP bus circuits only whereas in case of 2 that the connector connects mains and TP bus circuits in parallel.

		x.1	x.2
	General connector type and description	**TP Bus only**	**230 V or 230/400 V + TP Bus**
	A. Connection to Equipment		
1.y	Plug & socket outlets with gateway for movable devices (e.g. appliance interface connector)	6 way Western Plug RJ12	Standard Connectors according to IEC 60309-2 (Industry) as well as according to CEE 7 (Home)
2.y	Data-interface to PC/device - wire connections (e.g. RS232 connector)	Sub D9 according to IEC 60807-2 and IEC 60807-3.	—
3.y	Type 1.1 with optical fibre connection	To be defined	—
	B. Connection between Application Module and BCU		
4.y	PEI connector	KNX standard using IEC 60603-8	—
	C. Connection between BCU, Devices and Bus		
5.y	Bus connection interface for connection of system devices and for bus wires	TP1 only	—
6.y	Data rail connector	TP1only	—
7.y	plug, socket outlets & couplers without gateway for connection of fixed equipment and connection of bus wires	TP standard	KNX-Standard
8.y	Plug and socket outlets without gateway for consumer access design parts	To be defined	—

The following picture shows the location of the various above connector types on the combination Application Mode - Bus Access Unit/Bus Coupling Unit.

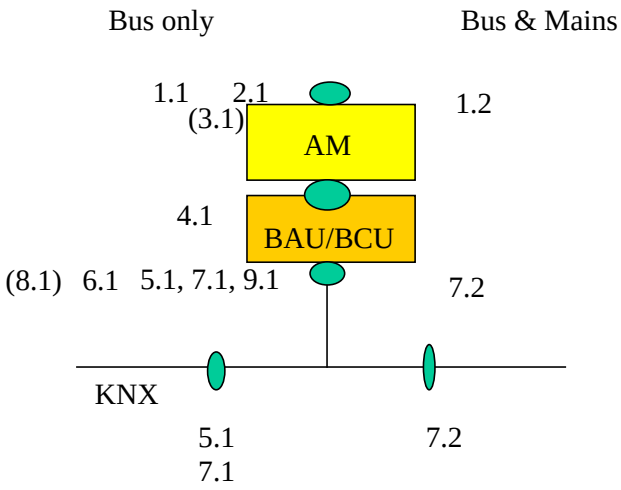

Figure 3: Location of Connector Types

3.2 KNX Connector Type 1.1

The connector is intended for connection of movable devices to wall-outlets containing a gateway to the TP1 bus, i.e. the appliance interface. It consists of a plug and a socket: the socket is included in the wall-outlet, whereas the plug is connected to the cable.

No	Requirements	Type 1.1	M	Test
0	exclusive designation/name	none		
1	Standard	FCC 68 Title 47[11]	F/S	---
2	number of contacts/ways	6	F/S	VI
4	non-interchangeable with all other Standardised connectors	compliant[12]	M	VI
5	coding measure	to be defined	F/S	VI
6	connection of screen	optional		
7	clamping unit/ terminals	--		
8	double contact	--		
9	wire cross section, wire type	0,09 - 0,14 mm² (AWG Cu 28 - 26), stranded	F/S	See 11
10	Nr. of wires connectable per pole	1 stranded	F/S	See 11
11	wire pull out force in latched condition	≥ 40 N	M/S	IEC 60512-8 Test 15e
12	contact force	--		
13	plug extraction force	< strain relief	M/S	IEC 60512-7 Test 13b, alternatively IEC 60512-8

[11] FCC = Federal Communication Committee

[12] When this connector type is used in devices or outlets, the female socket shall be clearly marked with the word 'TP1 Bus' (or equivalent) to avoid connection to other networks.

No	Requirements	Type 1.1	M	Test
				15d
14	strain relief	≥ 50 N	M/S	see 11
14a	plug insertion force	measured value shall be used as reference value in item 4	M/S	IEC 60512-13-1 test 13a standard conditions (24 hours, 24°C, 50%) speed 5mm/sec
15	mating cycles with load at rated voltage and current	--		
16	mating cycles without load	750	M/S	IEC 60512-5 Test 9d
17	Increase of contact resistance after item 16	< 1.5 times of the originally measured contact resistance value	M/S	IEC 60512-2 Test 2a
18	mechanical strength	EN50491-2	M/S	EN50491-2
19	vibration/shock	EN50491-2	M/S	EN50491-2
20	operation environment, temperature range	3k5	M/S	---
21	climatic withstand	EN50491-2	M/S	EN50491-2
22	temperature rise	< 45K with rated current and with cross section	M/S	IEC 60512-5-1 Test 5a
23	rated insulation voltage for bus	50 V	M/S	---
24	test voltage between live parts bus-bus (Usage class B - basic insulation)	0,8 kV impulse 0,6 kV AC	M/S	---
25	Clearance and creepage distances between bus contacts and outer surface when mated (Usage class B - basic insulation)	clearance : 3 mm creepage : 3mm	M/S	test voltage : 2,8 kV AC - 4 kV impulse HB Volume 4/3
26	Clearance and creepage distances between bus contacts and mains live parts when mated (Usage class B - basic insulation)	---		
27	Clearance and creepage distances between mains contacts and outer surface when mated (Usage class B - basic insulation)	---		
28	insulation resistance between terminals	≥ 500 MΩ	M/S	100VDC IEC 60512-3-1 Test 3a standard conditions
29	nominal voltage	5 V	M/S	---
30	nominal current	0,4 A	M/S	---

31	pollution degree (or Micro Environmental Class)	2	M/S	---
32	contact resistance	≤ 20mΩ	M	IEC 60512-2 Test 2a test conditions wire to wire
33	IP degree (not mated) (outlets, connectors) mated	IP 20 IP 20	M/S	---
34	marking	company markings - KNX Logo opt.		
35	installation aspects	on site installation possible	F/S	test installation

3.3 KNX Connector Type 1.2

The connector is intended for connection of movable devices to wall-outlets containing a gateway to the bus and mains. It consists of a Standardised mains plug with integrated plastic optical fibre (POF) and a socket: the socket is included in the wall-outlet, whereas the plug is connected to the cable.

Requirements and tests: to be defined.

3.4 KNX Connector Type 2.1

This type of connector is intended for integration into RS232 interfaces, to ensure connection between the bus and a PC.

The connector is a SUBD9 plug and socket complying with IEC 60807-2 and IEC 60807-3.

3.5 KNX Connector Type 3.1

This connector is intended for integration into appliance interfaces also providing a connection to the POF medium.

The requirements for this type of connector are under consideration.

3.6 KNX Connector Type 4.1

This connector is intended for connection of application modules to the various BCU types.

If the KNX Connector Type 4.1 is accessible, it shall support the full PEI specification, including communication.

The PEI connector consists of a male connector without housing and a female connector with housing, both for mounting on printed boards. The male connector is used on application modules, while the female on BCU's. Two types are defined: 10 respectively 12 pin.

This chapter merely describes the hardware requirements for this KNX connector: the communication aspects are dealt with in Part 3/6/2.

3.6.1 General Requirements

No	Requirements	Type 4.1	M	Test[13]
0	exclusive designation/name	PEI-Connector	S	---
1	Standard	IEC 60603-8	F/S	VI
2	number of contacts/ways	10 or 12[14]	F/S	VI
4	non-interchangeable with all other non-Standardised connectors	compliant[15]	F/S	VI
5	coding measure	keying (collar) restricted to 10 pin PEI used in BCU UP (see Volume 9 Part 4 chapter 1)	F/S	VI
6	connection of screen	---		
7	clamping unit/ terminals	---		
8	double contact	---		
9	wire cross section, wire type	---		
10	No of wires connectable per pole	(PEI use restricted to PCB mounting)		
10a	test probe access	----		
11	pull out force	---		
12	contact force	---		
12a	contact security	3.6.2	M/S	see 3.6.2
13	extraction force for entire PEI	5-30 N for 10 pin connector 6-30 N for 12 pin connector	M/S	IEC 60512-7 Test 13b
14	strain relief	---		
14a	insertion force for entire PEI	max. 30 N for 10 pin connector max. 36 N for 12 pin connector	M/S	IEC 60512-7 Test 13b
15	mating cycles with load at rated voltage and current	---		
16	mating cycles without load	≥ 50	M/S	IEC 60512-5 Test 9a (speed 100 mm per minute max. and rest 30 seconds (unmated))
17	Increase of contact resistance after item 16	< 1,5 times of the originally measured contact resistance	M/S	IEC 60512 part 2 test 2a

[13] As the PEI connector is an integrated part of either BCU or Application Module, testing of the PEI shall be carried out during testing of either BCU or application module

[14] Extensions of the standardized 10 pin PEI connector are allowed : however, e.g. a non-standardized two pin extension shall then not be denominated as 12 pin but 10 + 2 pin.

[15] By the integration of the PEI connector into the BCU, non-interchangeability is normally guaranteed. In case of doubts, the connector shall be clearly marked with the word 'PEI'.

No	Requirements	Type 4.1	M	Test[13]
18	mechanical strength	EN50491-2	M/S	EN50491-2
19	vibration/ shock	EN50491-2	M/S	EN50491-2
20	operation environment, temperature range	3K5	M/S	---
21	climatic withstand	EN50491-2	M/S	EN50491-2
22	temperature rise	< 45 K with rated current and with cross section	M/S	IEC 60512-5-1 Test 5a
23	rated insulation voltage for bus	50V	M/S	---
24	test voltage between live parts bus-bus (Usage class B - basic insulation)	0,8 kV impulse 0,6 kV AC	M/S	---
25	Clearance and creepage distances between bus contacts and outer surface when mated (Usage class B - basic insulation)	for unmated female 10 pin connector clearance : 3 mm creepage : 3 mm between front and contact pins	M/S	Test voltage : 2,8 kV AC, 4kV impulse for other types, electrical safety shall be provided by the product design
26	Clearance and creepage distances between bus contacts and mains live parts when mated (Usage class B - basic insulation)	provided by the product design		
27	Clearance and creepage distances between mains contacts and outer surface when mated (Usage class B - basic insulation)	---		
28	insulation resistance between pins	$> 10^{11}\ \Omega$	M/S	100V DC IEC 60512-3-1 Test 3a standard conditions
29	nominal voltage	32V	M/S	---
30	nominal current	25 mA	M/S	---
31	pollution degree (or Micro Environmental Class)	2	M/S	---
32	Contact resistance one pin	≤ 20 mΩ in new condition	M	IEC 60512-2-1 Test 2a test conditions
32a	damage to the contact surface (sliding)	---		
33	IP degree (outlets, connectors) mated or not mated	(IP20 provided by product)	M/S	Test-finger
34	marking	KNX Logo opt.		
35	installation aspects	---		

3.6.2 Additional Requirements for Contact Security

1. The contact security shall be provided for a 10 years lifetime.
2. The contact pins shall be lubricated

Lubricant: Min.20 Vol.% Fomblin Y25 thinned with 80 Vol.% Galden SV 70 or with other non-resinous grease or oil.

At least one of the contact partners shall be sufficiently lubricated.

Test of lubrication by visual inspection or chemical methods.

3.6.3 Contact material:

Au - the Gold plating shall comply with: Au ≥ 0,7 µm; Hardness > 140 HV,

Ni-intermediate-Layer: > 1,2 µm

In case of introduction of new contact material the manufacturer shall verify that the new material fulfils the above requirements in all combinations with existing contact material.

3.6.4 Constructional Features

3.6.4.1 10 pin Physical External Interface

Application pin size: 0,63 x 0,63 mm

BCU Type	L1 min	L2 max	reference 1
BCU N	6,5 mm	10 mm	screen surface
BCU UP	4, 1 mm	7,6 mm	BCU surface

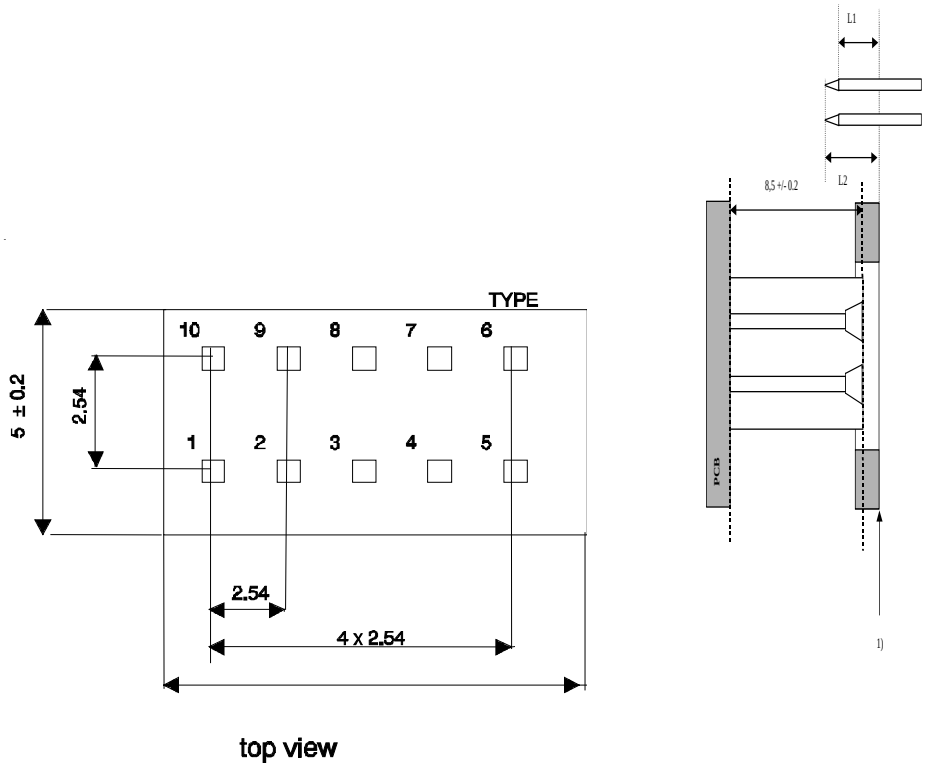

Figure 4: 10 pin Physical External Interface

3.6.4.2 12-Pin Physical External Interface

Application male pin size: 0,63 x 0,63 mm

Application male pin length: L1 = 5,5 mm min.

L2 = 12,8 mm min.

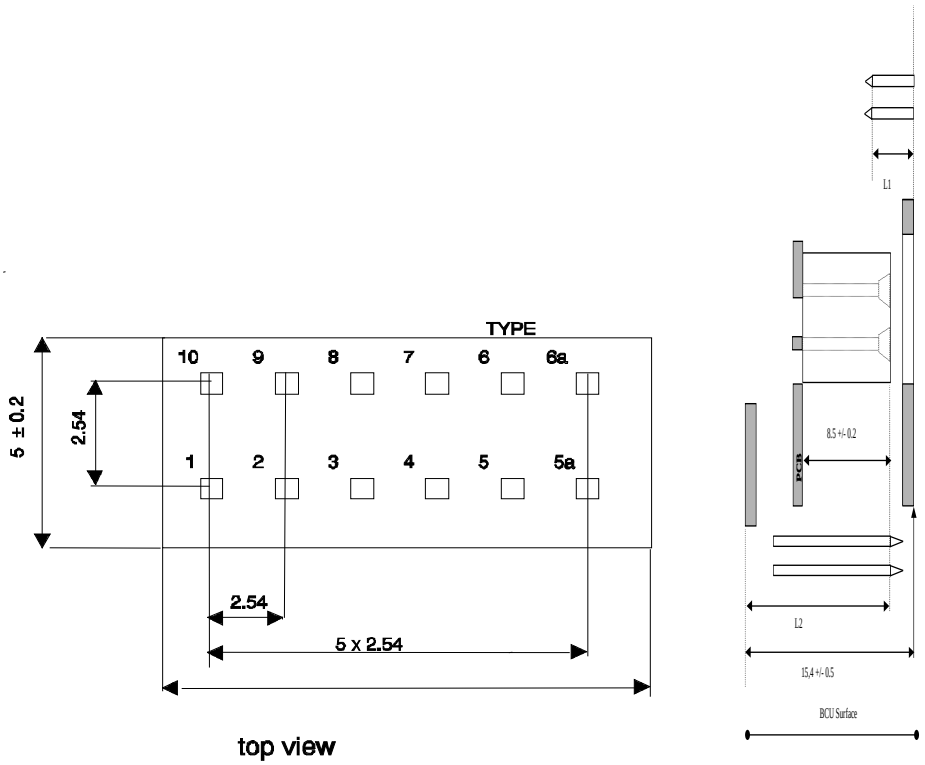

Figure 5: 12-pin Physical External Interface

3.7 KNX Connector Type 5.1

The Standardised KNX connector Type 5.1 shall exclusively be used for KNX TP1 networks.

The connector is intended for connection of BCU's or products with integrated BAU to the bus, preferably used within box mounting. It consists only of the female plug; the corresponding socket or male part is described for the BCU types.

3.7.1 Requirements for KNX Connector Type 5.1

No	Requirements	Type 5.1	M	Test
0	exclusive designation/name	none		
1	Standard for screw-less connector standard for connector with screw	EN 60998-2-2 EN 60998-2-1	M	---
2	number of contacts/ways	2	F/S	VI
3	bus interruption	connector shall allow disconnecting device without interrupting bus	M/S	VI

4	non-interchangeable with all other non-Standardised connectors	Compliant by design or colour for standardised solution Additional marking shall clearly indicate the bus connection in case of non-standardised solution	M/S	VI
5	coding measure	KNX coding : see Figure 7	F/S	VI
6	connection of screen	---		
7	clamping unit/ terminals	screw-less or with screw	F/S	---
8	double contact	---		
9	wire cross section, wire type	0,8 mm-1,00 mm dia solid (AWG Cu 20-18) 0,5 mm^2 (AWG Cu 20) stranded	F/S	clamping test
10	Nr. of wires connectable per pole with identical diameter	≥ 3 x 0,8 mm dia (AWG Cu 20) or ≥ 3 x 1,0 mm (AWG Cu 18)	F/S	VI (clamping test)
10a	test probe access	min. 1 mm x 1 mm – shall be accessible in mounted condition	F/S	VI
10b	male contact pins	1 mm ∅ (± 0,05 mm), 6 to 8 mm long - tin coated	F/S	VI
11	wire pull out force per conductor	> 30 N	M/S	see clause 3.7.3.1
12	contact force	---		
12a	contact security	---		
13	plug extraction force per pole	> 3 N	M/S	see clause 3.7.3.1
14	strain relief	---		
14a	plug insertion force	< 10 N	M/S	see clause 3.7.3.1
15	mating cycles with load at rated voltage and current	50	M/S	IEC 60512-2 Test 9d
16	mating cycles without load	---		
17	Increase of contact resistance after item number 15	< 1,5 times of the originally measured contact resistance	M/S	IEC 60512-2 Test 2a
18	mechanical strength	EN50491-2	M/S	EN50491-2
19	vibration/ shock	EN50491-2	M/S	EN50491-2
20	environmental class	3k6 or GPE DIN 40040 (-10/+85°C, light condensation)	M/S	---
21	climatic withstand	EN50491-2	M/S	EN50491-2

				DIN 40040
22	temperature rise	< 45 K with rated current and with cross section	M/S	IEC60512-5-1 Test 5a
23	rated insulation voltage for bus	50 V	M/S	----
24	test voltage between live parts bus-bus (Usage class B - basic insulation)	0,8 kV impulse 0,6 kV AC	M/S	---
25	Clearance and creepage distances between bus contacts and outer surface when mated (Usage class B – basic insulation)	clearance : 3 mm creepage : 3 mm[16]	M	Test voltage : 2,8 kV AC, 4kV impulse HB Volume 4/3
26	Clearance and creepage distances between bus contacts and mains live parts when mated (Usage class B - basic insulation)	---		
27	Clearance and creepage distances between mains contacts and outer surface when mated (Usage class B - basic insulation)	---		
28	insulation resistance between poles (100 V DC)	$> 10^{11}\ \Omega$	M/S	100VDC IEC 60512-3-1 Test 3a standard conditions
29	nominal voltage	32V	M/S	---
30	nominal current	3A	M/S	---
31	pollution degree (or Micro Environmental Class)	2	M/S	---
32	contact resistance R_D(one connection) - for R_c1 and R_c2 see Figure 6	conductor-conductor $R_c1 < 10\ m\Omega$	M/S	see clause 3.7.3.4
		conductor-contact pin $R_c2 < 10\ m\Omega$	M/S	see clause 3.7.3.4
32a	damage to the contact surface (sliding)	---		
33	IP degree (outlets, connectors) mated or not mated	IP20 in both cases	M/S	test finger
34	marking	KNX Logo opt.		
35	installation aspects	on site installation possible	M/S	test installation
36	terminal-conductor material	E-Cu	M/S	---

[16]These creepage distances can if necessary be provided via an additional cover over the connector surface, if the connector itself does not provide these required creepage distances.

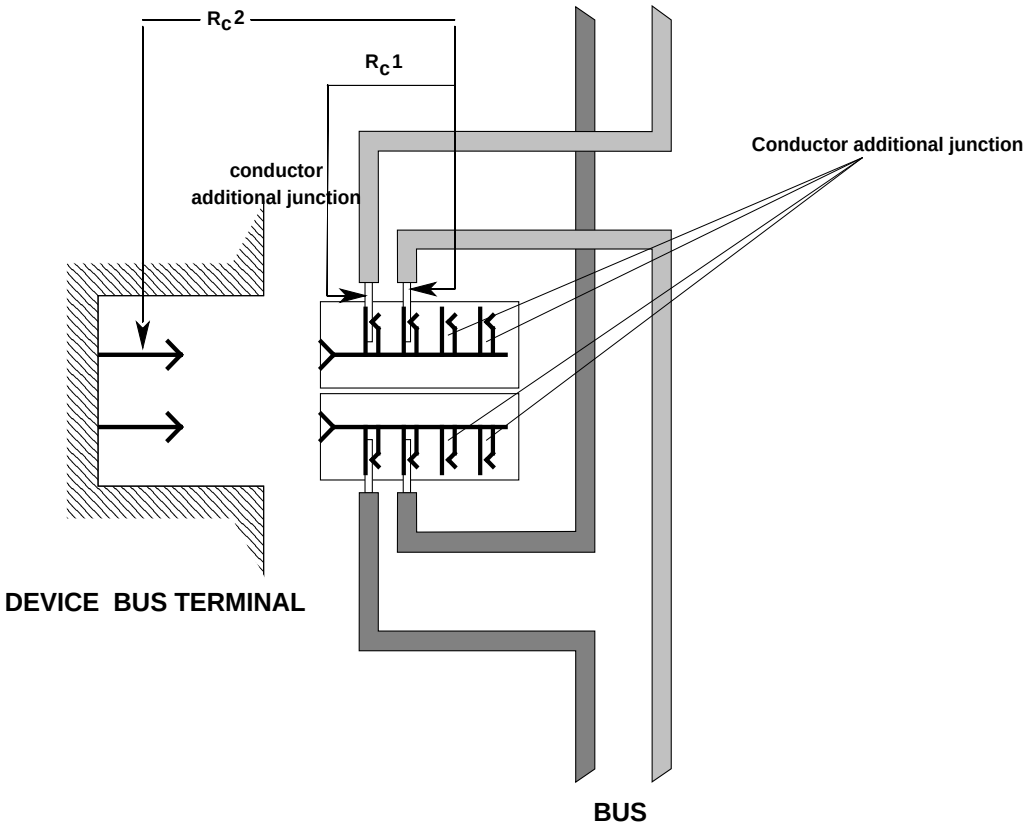

Figure 6: KNX-Connector Type 5.1 - Principal Diagram

3.7.2 Constructional Features for Standardised Solution

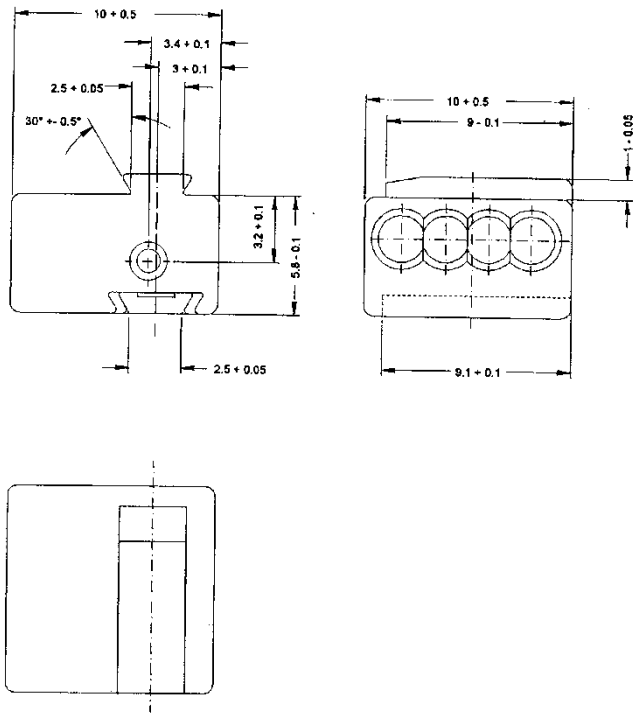

Figure 7: Cable Connector

Male socket: Pin diameter: 1 +/- 0,05 mm - Pin length: 6…8 mm

Cable: Core diameter: 0,8…1,0 mm (no mix of different diameters allowed at same time)

Strip length: 5…6 mm

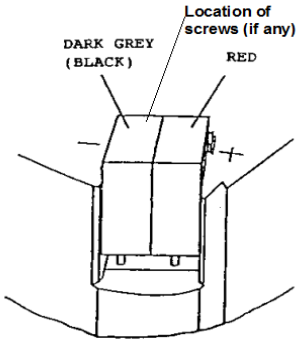

Figure 8: Colour coding of cable connector[17]

A bus connection block can either consist of two separate parts notched together or of one single unseparable block. When consisting of one single unseparable block, the colours indicating bus polarity (dark grey-red) shall be clearly visible to the user and ensure proper and safe connection.

3.7.3 Test Guidelines

3.7.3.1 Pull-out Test

Pull out test according to EN 60 998-2-2, 1993, clause 14.102 for screw-less type clamping units and according to EN 60998-2-1, 1993, clause 10.105 for screw type clamping units

Specified values of the conductor retention forces according to EN 60 998-2-2, 1993, table 103 or to EN 60998-2-1, 1993, table 108 for conductor

0,5 mm² corresponding to 0,8 mm diameter (AWG Cu 20): 30 N

0,75 mm² corresponding to 1,0 mm diameter (AWG Cu 18): 30 N

The pull is applied on each conductor without jerks (1 min in the direction of the axis of the connector.

[17] In case of white/yellow variation, white corresponds to minus where yellow to plus.

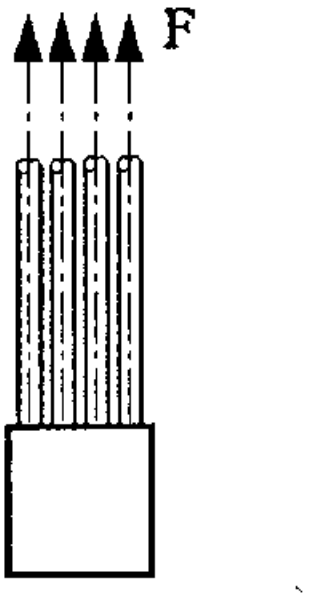

Figure 9: Pull out Test

During the test the conductor shall not come out of the terminal.

3.7.3.2 Testing of the Insertion and Extraction Forces at one Pole Socket Connector

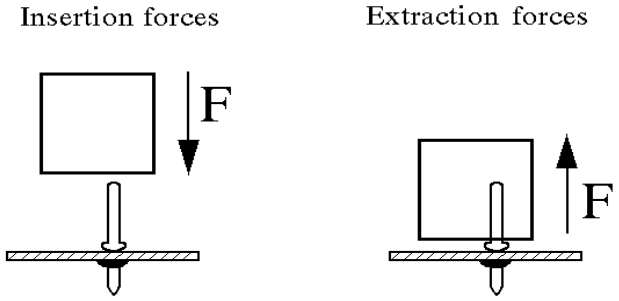

Figure 10: Insertion and Extraction Forces

Contact pin: 1 mm ± 0,05 mm

This test verifies the insertion and extraction forces of the contact pin and the pole of socket connector

Specified values per pole:	- Insertion force	< 10 N
	- Extraction force	> 3 N

3.7.3.3 Testing of the Insertion Frequency of the Contact Pin

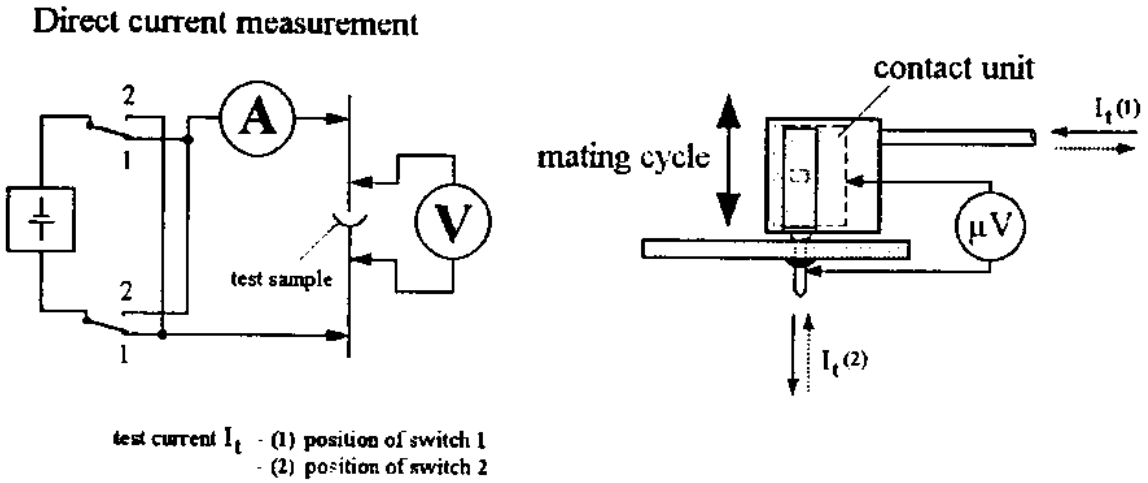

Figure 11: Test Arrangement for Insertion Frequency of the Contact Pin

Contact pin: 1 mm ± 0,05 mm

Conductor diameter: 0,8 mm (AWG Cu 20)

Test current I_t: 100 mA DC

Test voltage: 1 V (open-circuit voltage)

Before and after 50 mating cycles the through resistance according to IEC 60512-2-85, of the contact unit and contact pin is measured.

The through resistance is inferred from the voltage drop. When measuring the through resistance with DC, the arithmetic average from both readings in two directions of current flow is the result of one measuring cycle.

After 50 mating cycles the through resistance shall not exceed 5 mΩ.

3.7.3.4 Test Arrangement for Contact Resistance

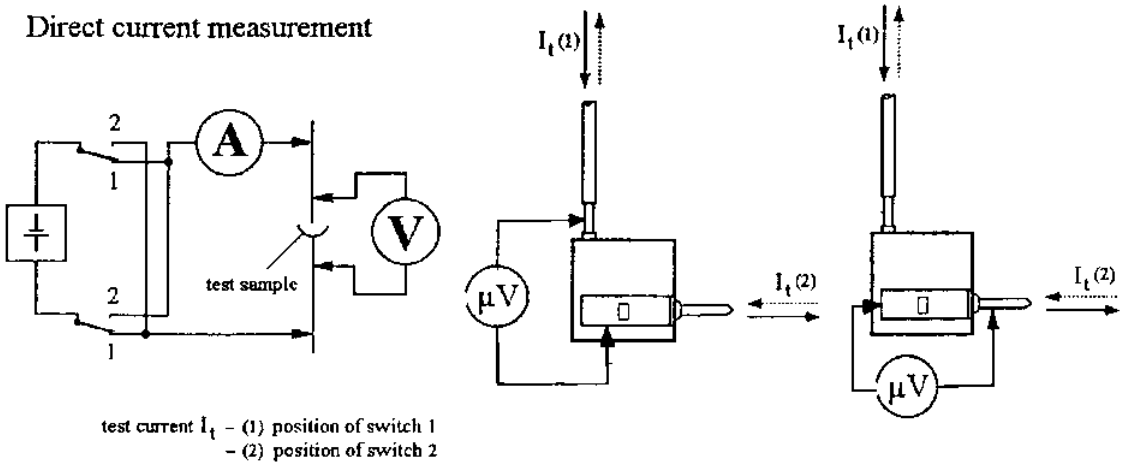

Figure 12: Test Arrangement for Measuring of Contact Resistance of Cable Connector

3.8 KNX Data Rail Connectors - Type 6.1

This KNX connector is intended for the automatic connection of TP1 DIN rail devices to the TP1 bus only when snapped onto the DIN-rail. It consists of a data rail and a contact block, the latter consisting of a housing and a set of spring contacts.

For ensuring connection between data rail and cable, requirements for a (non-KNX Standardised data) rail to wire connector are specified.

This clause also contains KNX specific test guidelines for this connector type.

3.8.1 KNX Connector Type 6.1 - Contact Block/Data Rail

This connector type consists of two elements: a contact block and a data rail. Compliance to the underneath requirements shall be verified by either

- integrating the developed contact block into a product and testing it with all at that time existing data rail types except when the standard coating and shape is used. In this case, execution of the tests is only required with the standard data rail type;

and/or

- testing the developed data rail with all already certified contact block types except when the standard coating is used. In this case, execution of the tests is only required with the standard contact block type.

No	Requirements	Type 6.1	M	Test
0	exclusive designation/name	---		
1	Standard	---		
2	number of contacts/ways	2 or 4	F/S	VI
4	non-interchangeable with all other non-Standardised connectors	Compliant by design for standardised solution Additional marking shall clearly indicate the bus connection in case of non-standardised solution	M/S	VI
5	coding measure	---		
6	connection of screen	---		
7	clamping unit/ terminals	--		
8	double contact (of contact block)	--		
9	wire cross section, wire type	---		
10	Number of wires connectable per pole	---		
11	wire pull out force in latched condition	---		
12	contact force of contact block on data rail (when using the standard coating as laid down in 12b)	2N<K<8N at any position of contact zone The shape of the contact shall be such that the requirements are met and no damage to the contact surface is inflicted.	M/S	spring force measurement; force-distance characteristic precision ± 0,1 N (including long-term stability according test VIII of test procedure in clause 3.8.5)
12b	standard coating of contact pin and data rail tracks	tin - thickness of data rail tracks coating : 10 – 25 µm - if any anti-diffusion barrier is necessary owing to the choice of the basic material, it shall be provided	F/S	measurement
13	plug extraction force	---		
14	strain relief	---		
14a	plug insertion force	---		
15	mating cycles with load at rated voltage and current	50	M/S	EN 60512-2-1 Test 2a
16	mating cycles without load	---		
17	Increase of contact resistance after item 15	< 1,5 times of the originally measured contact resistance	M/S	EN 60512-2-1 Test 2a
18	mechanical strength	EN50491-2	M/S	EN50491-2
19	vibration/ shock	contact interruption < 1	M/S	see test guidelines 3.8.5 :

No	Requirements	Type 6.1	M	Test
		ms ; R_D < 50 mΩ		test V
20	operation environment, temperature range	3k6	M/S	---
21	climatic withstand	see test guidelines 3.8.5	M/S	see test guidelines 3.8.5
22	Temperature rise temperature rise of hot spots (power rating)	< 45K with rated current < 60K	M/S	see test guidelines 3.8.5 : test VII
23	rated insulation voltage for bus	50V	M/S	----
24	test voltage between live parts bus-bus (Usage class B - basic insulation)	0,8 kV impulse 0,6 kV AC	M/S	---
25	Clearance and creepage distances between bus contacts and outer surface when mated (Usage class B - basic insulation)	clearance : 3 mm creepage : 3 mm	M/S	test voltage 2,8 kV AC - 4 kV impulse HB Volume 4/3
25a	mounting of DIN rail devices in DIN rail without inserted data rail	creepage and clearance between DIN rail and contact block ≥ 3 mm or protection of pins with appropriate insulation (see Figure 13)	M/S	VI and measurement
26	Clearance and creepage distances between bus contacts and mains live parts when mated (Usage class B - basic insulation)	---		
27	Clearance and creepage distances between mains contacts and outer surface when mated (Usage class B - basic insulation)	---		
28	insulation resistance between terminals (100 V DC)	> 10^{11}Ω (built into device)	M/S	100VDC IEC 60512-3-1 Test 3a standard conditions
29	nominal voltage	32V	M/S	---
30	nominal current	3A	M/S	---
31	pollution degree (or Micro Environmental Class)	2	M/S	----
32	contact resistance R_D(one connection)	< 50mΩ for 0,5-0,8 A load	M/S	EN 60512-2-1 Test 2a according to test guidelines clause 3.8.5
32a	damage to the contact surface (sliding)	no damage to the contact surface after sliding	M/S	see test guidelines of clause 3.8.5: test VI combined with Test I to IV
33	IP degree (not mated) (outlets, connectors) mated	---		
34	marking	standard + KNX Logo opt.		

No	Requirements	Type 6.1	M	Test
35	installation aspects	on-site installation possible	F/S	test installation
36	reference DIN-rail	according EN60715-TH35-7,5	F/S	VI

3.8.2 Constructional Requirements for Standardised Contact Block

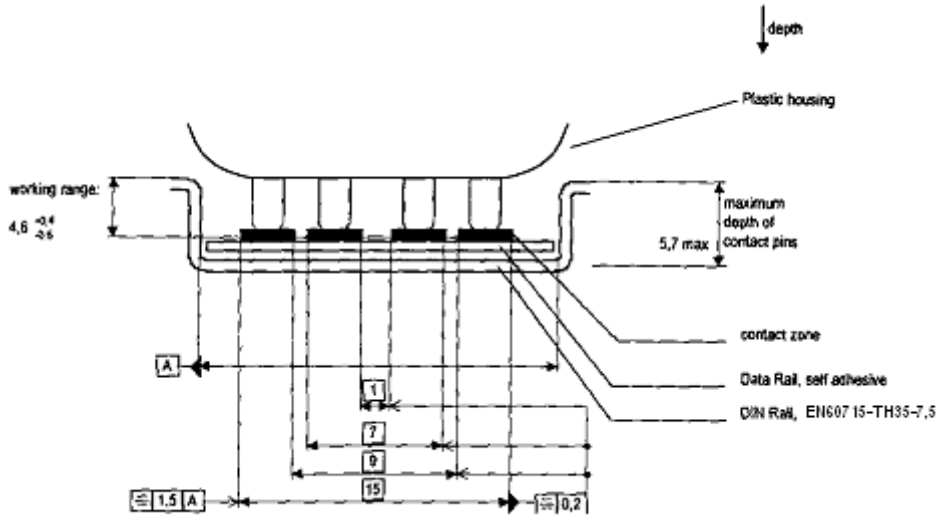

Figure 13: Constructional Requirements

- Moreover, the devices shall be constructed/mounted in such a way, that the polarity of the pin configuration corresponds to the polarity of the data rail as shown in the above figure ("+" upper track, "-" lower track). In case of wrong polarity, the device will not respond to the bus.

3.8.3 Constructional Features of the Data Rail

Data rail is part of the connector type 6.1. The data rail functions like a back plane that is mounted inside the DIN rail. The inner two tracks are used for the data transmission of the analog signal of the physical layer type TP1. The outer tracks may be used for other purposes that shall not disturb the transmission on the inner tracks according to the second pair requirements as laid down in Volume 4 Part 4.

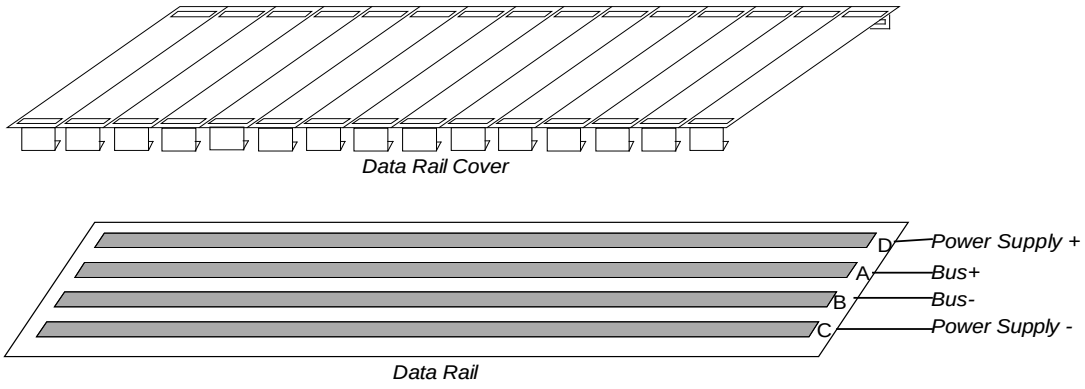

Figure 14: Data Rail and Data Rail Cover

- The contact zones provided by the data rail shall comply with the drawing given in Figure 15. In the X-direction, the tracks shall provide at least the given contact range, in the Y-direction, the tracks may not exceed the working range, nor may any other part exceed the dotted line.
- The recommended surface of the tracks is smooth and flat (as e.g. the surface of a standard PCB).

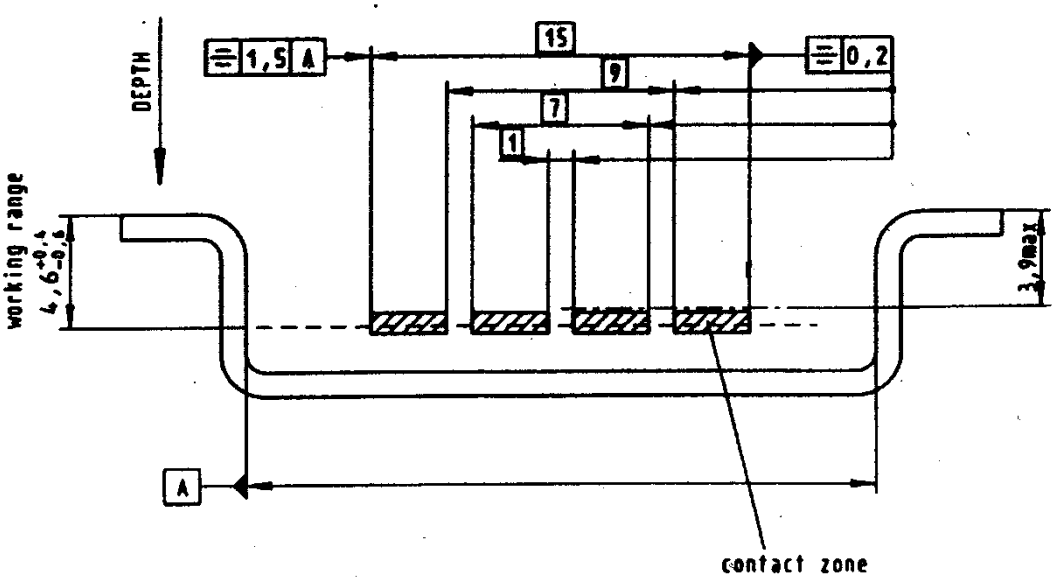

Figure 15: Constructional Features

Note: When the length of the data rail exceeds approximately 200 mm, proper transport and installation guidelines shall ensure that ruptures of the data rail tracks do not occur.

3.8.4 Constructional Features of Data Rail Cover

Parts of the data rail that are not covered by devices, shall be covered with a data rail cover to prevent the data rail from dirt and to ensure the SELV requirement in case of a mixed installation with mains.

The cover shall be made of plastic material which

- is sufficiently flexible to allow permanent fixing of the cover to the DIN rail. To test this, the data rail cover shall be mounted and removed from the DIN rail 30 times;
- withstands a glow wire temperature of 750°C;
- shall allow the easy adaptation of the length according to the module width of DIN 43880 (CLC TC23E Report R023-01).

3.8.5 Test Guidelines for Contact Block and Data Rail

A to be certified data rail or contact block shall be submitted to the underneath tests:

3.8.5.1 Overview of Required Tests

Climatic Test I	Damp Heat, cyclical according to DIN 50017 KFW. If this standard is not available, tests can be carried out on the basis of EN 60068-2-30. However, the in the latter standard quoted climatic cycle (Db, variant 1) shall then be combined with an 8 hour bedewment.
Climatic Test II	Damp Heat, cyclical according to EN 60068-2-30, Db Test, first variant, temporary bedewment, 30 cycles

Climatic Test III	Sulphur dioxide and hydrogen sulphide for electrical contacts and connections according to EN 60068-2-60 Method 1
Climatic Test IV	Dry Heat according to EN 60068-2-2, Bb Test, level of stringency 80°C, 168 to 2688 hours. The stringency of the test is higher than in the above quoted standard.
Vibration Test V	Vibration test according to EN 60068-2-6 Frequency range: 10 to 150 Hz. From 10 to 57 Hz with a stable amplitude of 0,15 mm and from 57 to 150 Hz with stable acceleration of 2,0 g. 1 octave per minute, each time 10 cycles in the three main axes of the devices
Test VI	damage of the contact surface If the snapped-on contact system is shifted twice across the entire data rail length, intentional damage is inflicted on the contact surface. This test shall be carried out on 4 test objects (contact system with at least 16 contact pins) and 4 data rails
Test VII	power-rating Temperature rise test according to EN 60512-5-1 (former IEC 60512-3). Power is serially conducted through all contact pairs amperage : 3 A
Test VIII	Change in the strength of the springs owing to long-term strain

3.8.5.2 Test Procedure

All Rd - measurements shall be carried out according to the principle of the transit resistance measurement according to EN 60512-2-1 Test 2a, millivolt method, measurement principle with 4 wires.

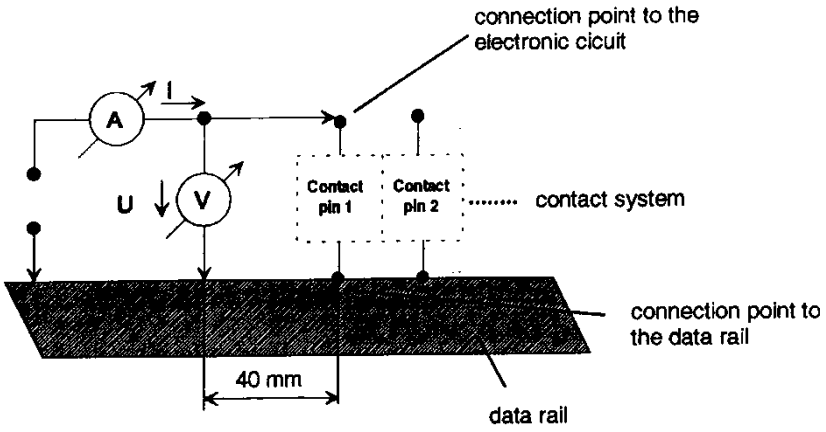

Figure 16: Schematic Representation of R_D-Measurement

R_D = ≤ 50 mΩ per contact pin

The sum of the possible track- and transit resistance of the contact system shall be ≤ 50 mΩ per contact pin.

Climatic Tests (Test I to IV)

Each climatic tests shall be carried out on 4 open (snapped-off) systems [4 test objects with contact systems - at least 16 contacts and 2 data rails] and 4 snapped-on systems [4 test objects with contact systems - at least 16 contacts - mounted on 2 data rails]. Before the start of the tests, each contact pin shall be submitted to a Rd-measurement.

Each time the measurements shall be carried out according to 4 test steps:

Test I	after 3, 8, 15 and 30 cycles
Test II	after 3, 8, 15 and 30 cycles
Test III	after 1, 4, 10 and 21 cycles
Test IV	after 168, 672, 1176 and 2688 hours

After each test step all snapped-on contact systems shall be submitted to a Rd-measurement. After each test step a test object of the open systems shall be mounted on a data rail and submitted to a Rd-measurement. The test object remains snapped on the data rail for the rest of the test procedure. After completion of the 4 test steps all systems are in a mounted condition.

Vibration test V (Test V)

As previously described, four test objects with contact systems (with at least 16 contacts) shall be mounted on a data rail and submitted to a vibration test.

Before and after each test step a Rd-measurement shall be carried out.

Moreover, during the consecutive tests, it shall be examined if contact between contact pin and data rail is not interrupted. Short time increase of contact resistance in the limits duration $t \leq 1$ ms and contact resistance $R_D \leq 50$ mΩ according to item 19 of clause 3.8.1.

Damage of the contact surface (Test VI)

The damage inflicted of the contact surface shall be carried out in the above-described way.

Subsequently, one test object of the contact system and one data rail shall be used as open systems in the test steps I to IV. After completion of the fourth test phase they shall be mounted and submitted to a Rd-measurement.

Power-rating (Test VII)

The previously described measurements shall be carried out on four test objects of the contact system (with at least 16 contact pins) mounted on a data rail.

Change in the strength of the springs (Test VIII)

After completion of the test phases and after having successfully carried out a Rd-measurement, a spring diagram should be drawn up of the contact pins of all snapped-on test objects of test IV. These spring diagrams shall be compared to those of new test objects (with at least 16 contact pins).

3.8.5.3 Assessment of the Measurement Results

Climatic tests I to IV (Test I to IV)

None of the measured Rd-values may exceed the value indicated in item 32 of clause 3.8.1.

Vibration Test (Test V)

None of the measured Rd-values may exceed the value indicated in item 19 of clause 3.8.1. Moreover, contact may not be interrupted during the tests.

Damage to the Contact Surface (Test VI)

None of the measured Rd-values may exceed the value indicated in item 32 of clause 3.8.1. Moreover, contact may not be interrupted during the tests.

Power Rating (Test VII)

The temperature rise should not exceed the value indicated in item 22 of clause 3.8.1.

Changes in the Spring Strength (Test VIII)

The differences between the compared spring diagrams should not exceed 5%.

3.8.5.4 Number of Test Samples and their Deployment during the various Tests

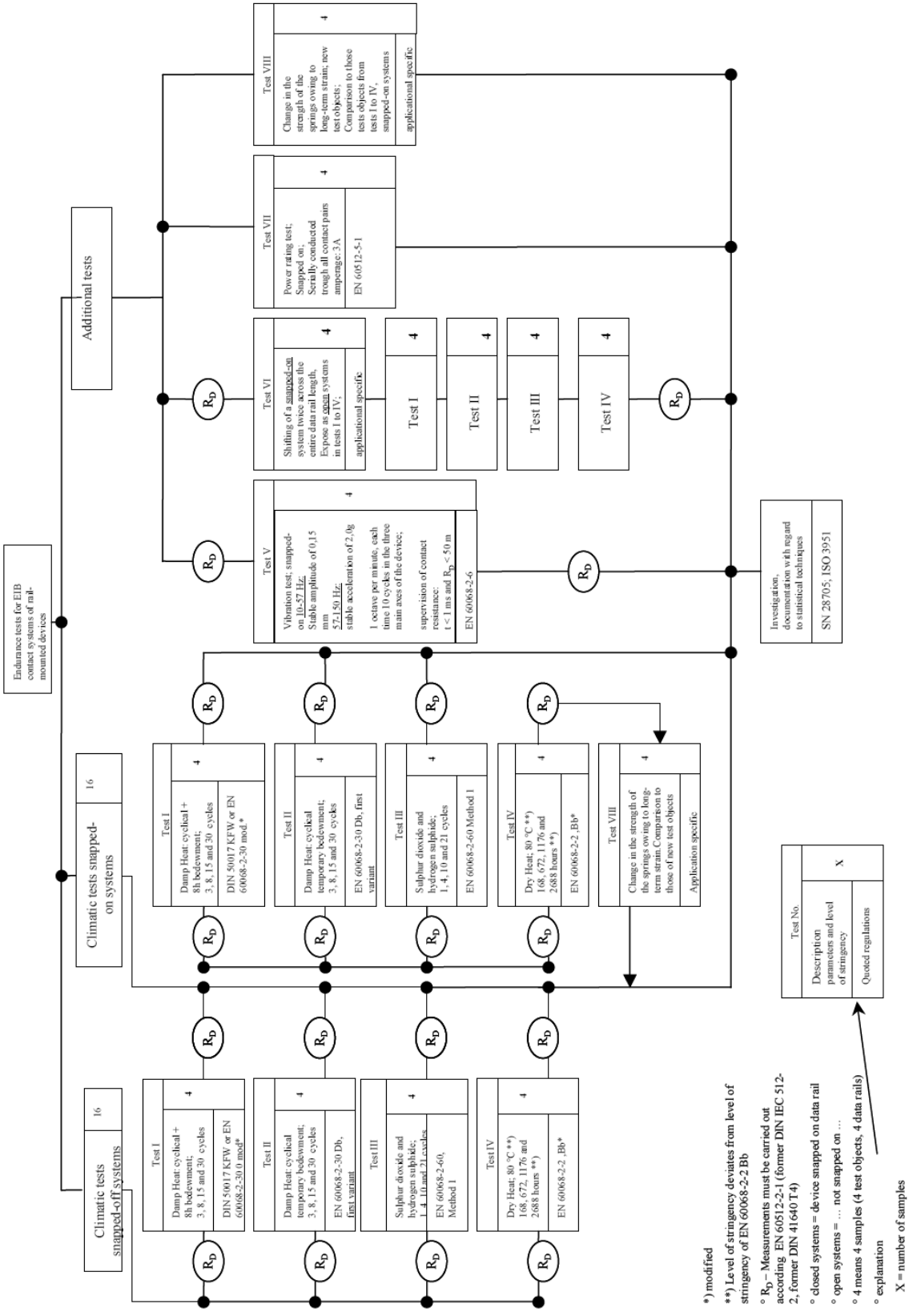

Figure 17: Number of Test Samples and their Deployment during Contact Block/Data Rail Tests

Note 1: For this number of test samples failures or malfunctions are not allowed. When the manufacturer decides to carry out the required tests with a higher number of test samples, statistical techniques shall be used, with the above stated number of test samples as a starting point (e.g. techniques as laid down in ISO 3951). If such statistical techniques are used, they shall be stated in the resulting test report.

3.8.6 Data Rail to Wire Connector

This connector shall be exclusively be used for KNX TP1 networks.

The data rail may be connected to the bus cable with a data rail to wire connector: this product is composed of connector type 5.1 and 6.1. For requirements for this non-Standardised data rail to wire connector, see the requirements of the connector type 5.1 and 6.1.

The entire device shall moreover comply to EN60715-TH35 and to DIN 43880 (CLC TC23E Report R023-01) and the requirements of EN 60669-1.

3.9 KNX Connector Type 7.1

3.9.1 Requirements

This KNX connector is used in cabling systems (e.g. in ceiling, on wall, in ducts, under floor, ...). This KNX connector is especially intended for professional use.

The Standardised KNX connector Type 7.1 shall exclusively be used for KNX TP networks.

This KNX connector consists of a plug and socket. The plug is intended for connection to cables, whereas the socket is intended either for connection of cables, for integration into wall outlets without design parts or for integration into devices.

No	Requirements	Type 7.1	M	Test
0	exclusive designation/name	BST14 connector	---	---
1	Standard	---		
2a	number of contacts/ways	2	F/S	VI
2b	number of contacts/ways	option: 2+1 or 2+2 or 2+2+1 2 denotes 1 twisted pair 1 denotes screen	F	VI
4	non-interchangeable with all other non-Standardised connectors	Compliant by design or colour (in case of doubt additional marking)	M/S	IEC 60512-13-5 test 13e using reference value 14a
5	coding measure	coded connector with KNX keying (see Figure 18, green colour)	F/S	VI
5a	Locking mechanism	see Figure 18	M/S	VI
6	connection of screen	Optional		
7	clamping unit/ terminals	according IEC 60999	M/S	clamping test
8	double contact	---		

No	Requirements	Type 7.1	M	Test
9	wire cross section	screen 0,25 mm^2 – 0,5 mm^2 (AWG Cu 23-25) bus 0,25 mm^2- 0,75 mm^2 (AWG Cu 23-18)	F/S	clamping test
10	No of conductors and type connectable per pole	1 solid or 1 stranded	F/S	clamping test
10a	test probe access	---		
11	pull out force in latched condition	≥ 20N	M/S	IEC 60512-13-1 test 13a standard conditions (24 hours, 24 °C, 50%) speed 5 mm/sec
12	contact force	---		
12a	contact security	---		
14	strain relief	≥ 40N (higher than latching)	M/S	IEC 60512-17-3 test 17c mounting as specified by the manufacturer
14a	plug insertion force	measured value shall be reference value in item 4	M/S	IEC 60512-13-1 test 13a standard conditions (24 hours, 24 °C, 50%) speed 5 mm/sec
15	mating cycles with load at rated voltage and current	---		
16	mating cycles without load	≥ 50	M/S	IEC 60512-9-1 test 9a speed 5mm per sec max and rest 5 seconds min (unmated)
17	Increase of contact resistance after item 16	< 1,5 times of the originally measured contact resistance	M/S	IEC 60512-2-1 Test 2a
18	mechanical strength	EN50491-2 + tumbling barrel	M/S	EN50491-2 + IEC 61535
19	vibration/ shock	EN50491-2, IEC 61535	M/S	EN50491-2
20	operation environment, temperature range	3K6	M/S	---
21	climatic withstand	EN50491-2 with rated current	M/S	EN50491-2
22	temperature rise	< 45 K with rated current and with cross section	M/S	IEC60512-5-1 Test 5a
23	rated insulation voltage for bus	50V	M/S	---

No	Requirements	Type 7.1	M	Test
24	test voltage between live parts bus-bus (Usage class B – basic insulation)	0,8 kV impulse 0,6 kV AC	M/S	---
25	Clearance and creepage distances between bus contacts and outer surface when mated (Usage class B – basic insulation)	clearance : 3 mm creepage : 3 mm	M/S	test voltage 2,8 kV AC – 4 kV impulse HB Volume 4/3
26	Clearance and creepage distances between bus contacts and mains live parts when mated (Usage class B – basic insulation)	---		
27	Clearance and creepage distances between mains contacts and outer surface when mated (Usage class B – basic insulation)	---		
28	insulation resistance between pins	$> 10^{11}$ Ω	M/S	100VDC IEC 60512-3-1 Test 3a standard conditions
29	nominal voltage	32V	M/S	---
30	nominal current	3A	M/S	---
31	pollution degree (or Micro Environmental Class)	2	M/S	---
32	contact resistance	≤ 15 mΩ in new condition	M/S	IEC 60512-2-1 Test 2a test conditions wire to wire mated
32a	damage to the contact surface (sliding)	---		
33	IP degree (outlets, connectors) mated or not mated	IP20 not-mated IP20C mated	M	Test-Finger IEC 60529 Tab 6-2b
34	marking	standard + KNX Logo opt.		
35	installation aspects	field installation possible	F/S	test installation

3.9.2 Constructional Features

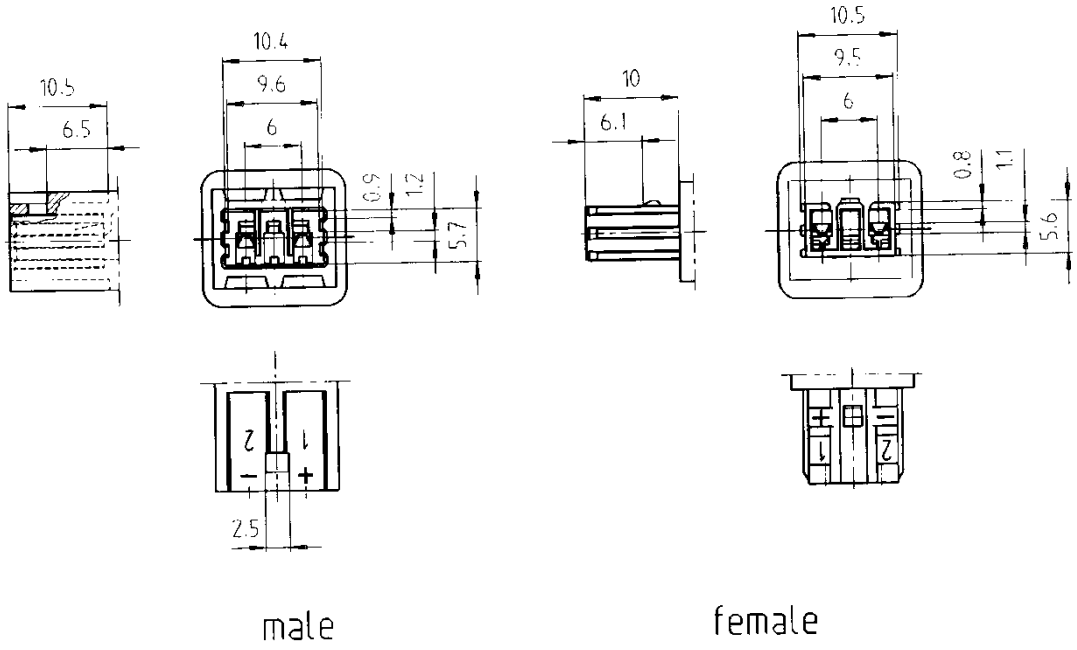

Figure 18: Constructional Features of KNX Connector 7.1 Male and Female

3.10 KNX Connector Type 7.2

3.10.1 Requirements

The Standardised KNX connector Type 7.2 shall exclusively be used for KNX TP networks.

This combined mains and KNX connector consists of a plug and socket. The plug is intended for connection to mains + bus cables, whereas the socket is intended either for connection of mains + bus cables or for integration into wall outlets without design parts and for integration into devices.

This mains + TP bus connector is used in cabling systems (e.g. in ceiling, on wall, in ducts, under floor, etc.). This mains + TP bus connector is especially intended for professional use.

Cables used with this connector may be constructed as follows:

a) One cable with bus and mains under a common sheath

b) Twin cable with bus and mains

c) Separate cables for bus and mains

No	Requirements	Type 7.2	M	Test
0	exclusive designation /name	Combined connector EST 2I3, EST 2I5	S	---
1	Standard	IEC 61535 (mains part)	F/S	---
2	number of contacts/ways	mains + Type 7.1	F/S	VI
4	non-interchangeable with all other non-Standardised connectors	Compliant by design or colour (in case of doubt additional marking)	M/S	IEC 60512-13-5 test 13e using reference value 14a

No	Requirements	Type 7.2	M	Test
5	coding measure	coded connector with KNX keying (see Figure 19 to Figure 22), green colour	F/S	VI
5a	Locking mechanism	see Figure 19 to Figure 22	M/S	VI
6	connection of screen	optional		
7	clamping unit/ terminals	according IEC 60999	M/S	clamping test
8	double contact	---		
9	wire cross section	screen 0,25 mm^2 – 0,5 mm^2,(AWG Cu 23-20) bus 0,25 mm^2- 0,75 mm^2 (AWG Cu 23 - 18) mains 0,75 mm^2- 2,5 mm^2 (AWG Cu 18 - 13)	F/S	clamping test
10	number of conductors and type connectable per pole	1 solid or 1 stranded	F/S	clamping test
10a	test probe access	---		
11	pull out force in latched condition	≥ 20N bus mains : IEC 61535	M/S	IEC 60512-13-1 test 13a standard conditions (24 hours, 24°C, 50%) speed 5mm/sec
12	contact force	---		
12a	contact security	---		
14	strain relief	cable a) ≥ 80N cable b) ≥ 80N cable c) ≥ 40N for bus and ≥ 80N for mains	M/S	IEC 60512-17-3 test 17c mounting as specified by the manufacturer
14a	plug insertion force	measured value shall be used as reference value in item 4	M/S	IEC 60512-13-1 test 13a standard conditions (24 hours, 24°C, 50%) speed 5mm/sec
15	mating cycles with load at rated voltage and current	---		
16	mating cycles without load	≥ 50	M/S	IEC 60512-9-1 test 9a speed 5 mm per sec max. and rest 5 seconds min.
17	Increase of contact resistance after item 16	< 1,5 times of the originally measured contact resistance	M/S	IEC60512-2-1 test2a

No	Requirements	Type 7.2	M	Test
18	mechanical strength	EN50491-2 + tumbling barrel	M/S	EN50491-2 + IEC 61535
19	vibration/ shock	EN50491-2	M/S	EN50491-2
20	operation environment, temperature range	3k6	M	---
21	climatic withstand	EN50491-2	M/S	EN50491-2
22	temperature rise	< 45K with rated current and rated cross section	M/S	IEC60512-5-1 test 5a
23	rated insulation voltage for bus	250V	M/S	---
24	test voltage between live parts bus-bus (Usage class B - basic insulation)	0,8 kV impulse 0,6 kV AC	M/S	---
25	Clearance and creepage distances between bus contacts and outer surface when mated (Usage class B - basic insulation)	clearance : 3 mm creepage : 3 mm	M/S	test voltage 2,8 kV Ac - 4 kV impulse HB Volume 4/3
26	Clearance and creepage distances between bus contacts and mains live parts when mated (Usage class B - double insulation)	clearance : 5,5 mm creepage : 5,5 mm	M/S	Test voltage : 4,8 kV AC, 6kV impulse see Vol 4/3
27	Clearance and creepage distances between mains contacts and outer surface when mated (Usage class B - basic insulation)	clearance : 3 mm creepage : 3 mm	M/S	Test voltage : 2,8 kV AC, 4kV impulse see Vol 4/3
28	insulation resistance between pins	$> 10^{11}$ Ω	M/S	100V DC IEC 60512-3-1 test 3a Standard Conditions
29	nominal voltage	32V bus, mains see standard	M/S	---
30	nominal current	3A bus, 16 A	M/S	---
31	pollution degree (or Micro Environmental Class)	2	M/S	---
32	contact resistance	≤ 15 mΩ in new condition bus	M/S	IEC 60512-2-1 test 2a test conditions : wire to wire mated
32a	damage to the contact surface (sliding)	---		
33	IP degree (outlets, connectors) mated or not mated	IP20 not-mated IP40 mated	M	IEC 60529 Test finger Tab 6-2b
34	marking	standard + KNX Logo opt.		

No	Requirements	Type 7.2	M	Test
35	installation aspects	field installation possible	F	test Installation

3.10.2 Constructional Features

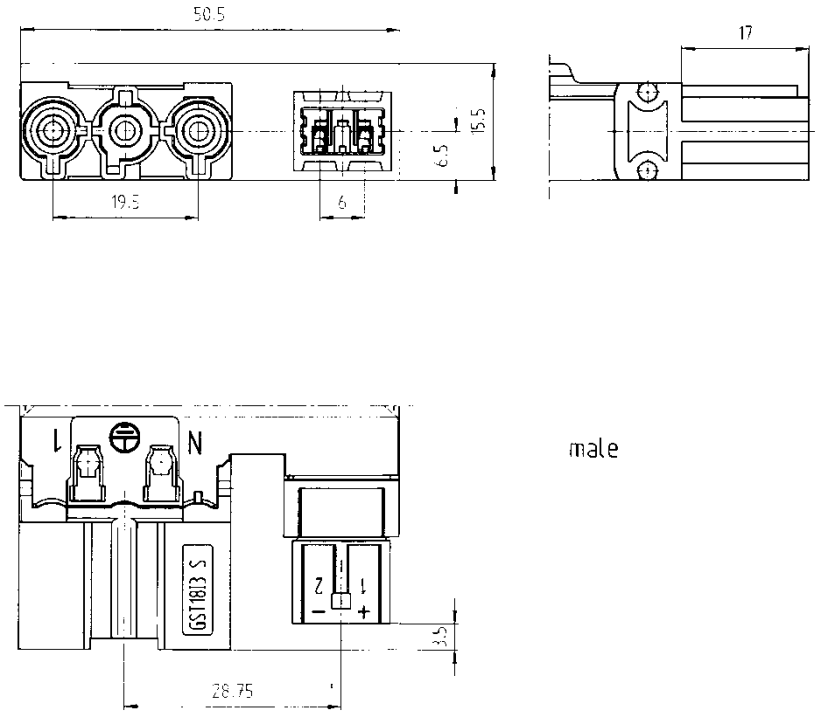

Figure 19: Constructional Features Connector Type 7.2 Male Single Phase

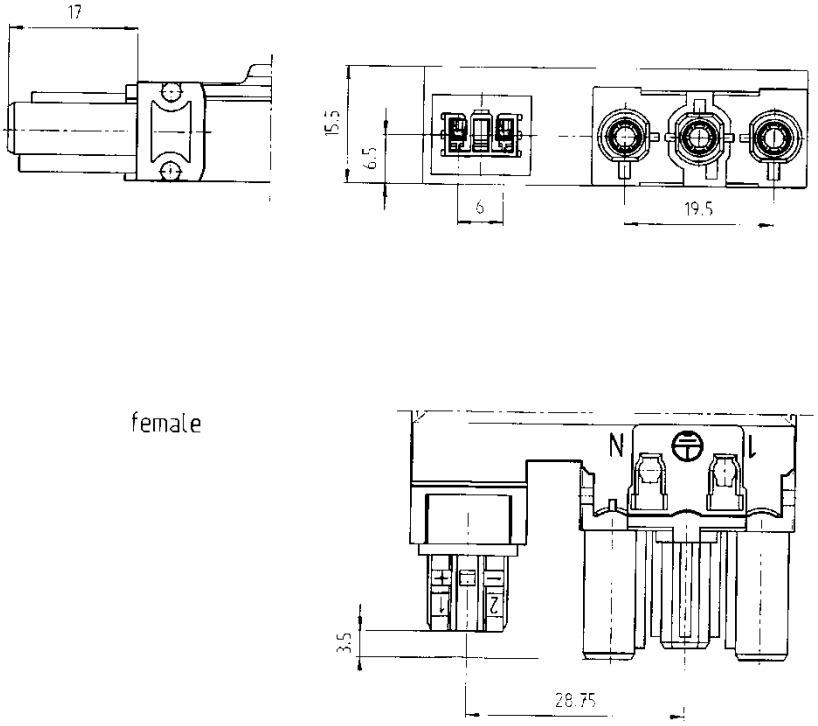

Figure 20: Constructional Features Connector Type 7.2 Female Single Phase

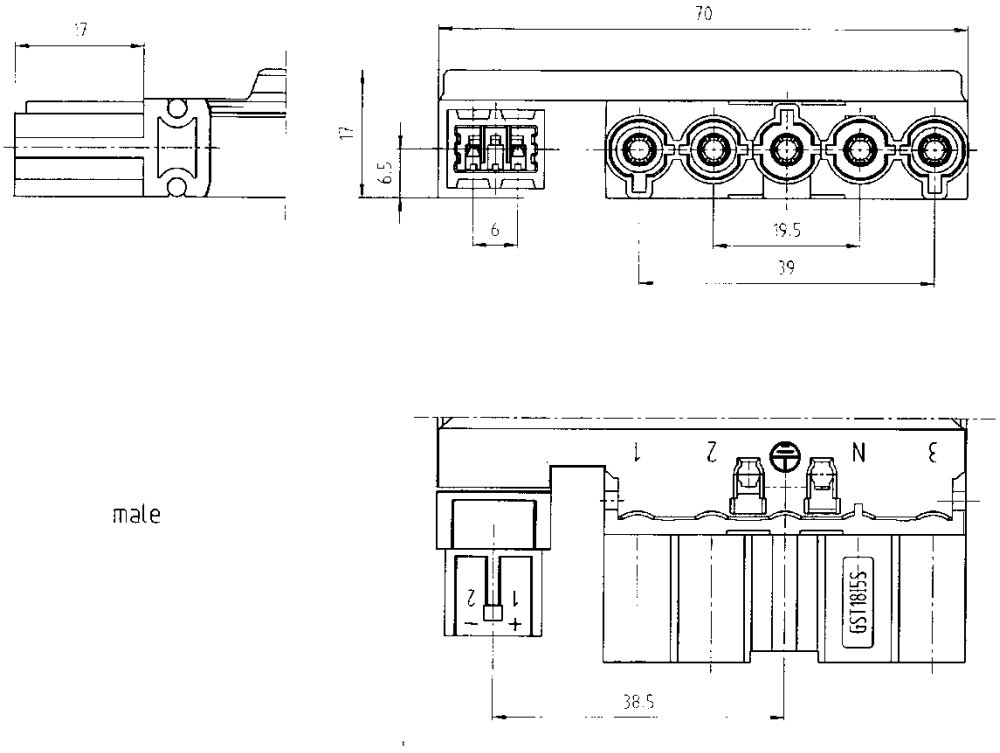

Figure 21: Constructional Features Connector Type 7.2 Male Three Phase

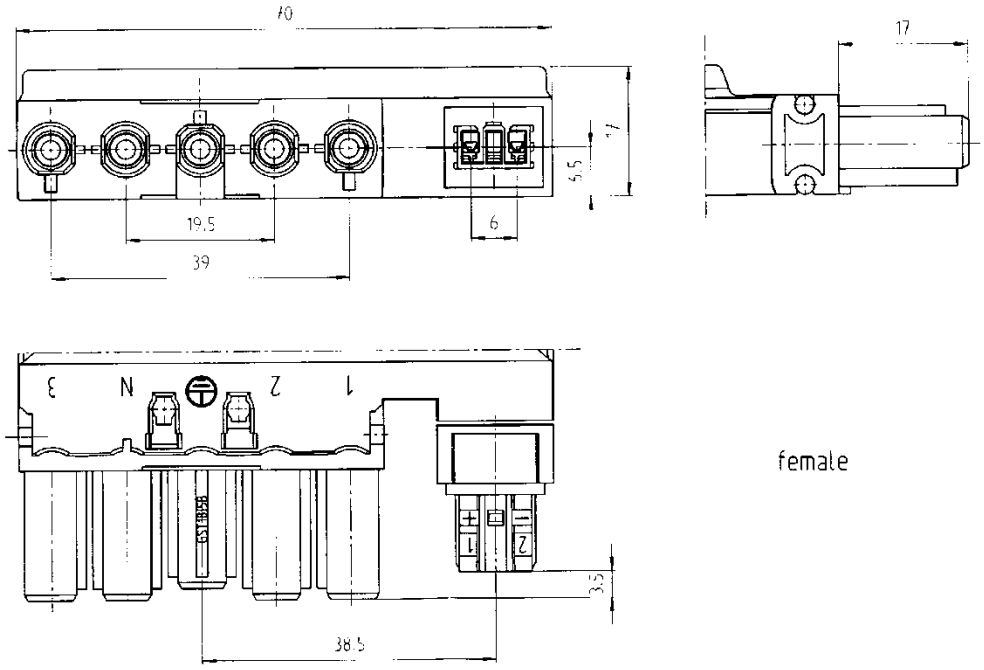

Figure 22: Constructional Features Connector Type 7.2 Female Three Phase

3.11 KNX Connector Type 8.1

The connector type 8.1 is intended for direct connection of the Bus in plugs/socket outlets, e.g. for consumer access design parts. Direct connection means, there is no gateway in the socket outlet (as it is in Type 1.1), the bus (TP1 twisted pair only) is accessible directly on the connector.

Connector Type 8.1 is also intended for use on device interfaces with direct access to the bus.

As physical component for Connector Type 8.1, the RJ45 Western Plug is used.

3.11.1 Requirements

3.11.1.1 General Requirements

The requirements in the following table are based on the requirements for Connector Type 1.1, which is also a western plug (RJ12).

No	Requirements	Type 8.1	M	Test
0	exclusive designation/name	RJ45 Connector	S	---
1	Standard	EN 60603-7	F/S	---
2	number of contacts/ways	8	F/S	VI *)
3	Bus interruption	---		
4	non-interchangeable with all other Standardised connectors	See clause 3.11.1.2	M	VI
5	coding measure	none	---	---
6	connection of screen	optional		
7	clamping unit/ terminals	---		

No	Requirements	Type 8.1	M	Test
8	double contact	---		
9	wire cross section, wire type	0,09 - 0,14 mm², AWG Cu 28 -26, stranded	F/S	See 11
10	No. of wires connectable per pole	1 stranded	F/S	See 11
11	wire pull out force in latched condition	≥ 40 N	M/S	IEC 60512-8 Test 15e
12	contact force	---		
13	plug extraction force	< strain relief	M/S	IEC 60512-7 Test 13b, alternatively IEC 60512-8 15d
14	strain relief	≥ 50 N	M/S	see 11
14 a	plug insertion force	measured value shall be used as reference value in item 4	M/S	IEC 60512-13-1 test 13a standard conditions (24hours, 24°C, 50%) speed 5mm/sec
15	mating cycles with load at rated voltage and current	---		
16	mating cycles without load	750	M/S	IEC 60512-5 Test 9d
17	Increase of contact resistance after 16	< 1.5 times	M/S	IEC 60512-2 Test 2a
18	mechanical strength	EN50491-2	M/S	EN50491-2
19	vibration/shock	EN50491-2	M/S	EN50491-2
20	operation environment, temperature range	3k5	M/S	---
21	climatic withstand	EN50491-2	M/S	EN50491-2
22	temperature rise	< 45K with rated current and with cross section	M/S	IEC 60512-5-1 Test 5a
23	rated insulation voltage for bus	50 V	M/S	---
24	test voltage between live parts bus-bus (Usage class B - basic insulation)	0.8 kV impulse 0.6 kV AC	M/S	---
25	Clearance and creepage distances between bus contacts and outer surface when mated (Usage class B - basic insulation)	clearance : 3 mm creepage : 3mm	M/S	test voltage : 2.8kV AC - 4 kV impulse
26	Clearance and creepage distances between bus contacts and mains live parts when mated (Usage class B - basic insulation)	---		

No	Requirements	Type 8.1	M	Test
27	Clearance and creepage distances between mains contacts and outer surface when mated (Usage class B - basic insulation)	---		
28	insulation resistance between terminals	≥ 500 Ω	M/S	100VDC IEC 60512-3-1 Test 3a standard conditions
29	nominal voltage	24 V (bus voltage)	M/S	---
30	Nominal current	According EN 60603-7	M/S	---
31	pollution degree (or Micro Environmental Class)	2	M/S	---
32	contact resistance	≥ 20 mΩ	M	IEC 60512-2 Test 2a test conditions wire to wire
33	• IP degree (not mated) (outlets, connectors) • mated	IP 20 IP 20	M/S	---
34	marking	See clause 3.11.1.2		
35	installation aspects	---		

3.11.1.2 Pin assignment of connector type 8.1

The bus shall be connected to the pins of the RJ45 connector in the following way:

Pin – No	Usage	
1	Bus +	1)
2	Bus -	1)
3	Not connected	
4	Not connected	
5	Not connected	
6	Not connected	
7	Optional use	2)
8	Optional use	2)

1) It is not allowed to also connect the bus+ to pin 8 and bus- to pin 7.

2) Requirements for optional use:

a) The usage shall be within the frame of SELV/PELV (25V AC / 60 V DC)

b) Max current 1 A. Overcurrent protection is required.

c) Polarity: Pin 7 - ; Pin 8 +

The connection of the RJ 45 - socket outlet to the bus is done by the installer. Therefore, the manufacturer of a KNX-device using a connector type 8.1 shall provide in the product instruction sheet clear hints on marking of the RJ 45 – socket outlet by the installer. In case of only using pin 1 and 2 the socket outlet shall be marked with “KNX”. In case of additional use of other pins additional clear marking shall be ensured. In case of using pins 3 to 6, marking with KNX is not allowed.

4 KNX TP Overvoltage Protector (secondary Protector)

4.1 General Requirements

KNX TP Overvoltage protectors shall comply with the requirements of EN 61643 part 21.

4.2 Requirements for Communication

No	Topic	Data and requirements	Test guideline	M
1	Insulation resistance	> 25 MΩ at 25 V	EN 61643 part 21 Clause 6.2.1.2	M/S
2	Insertion loss (Operating frequency range f_g (3dB))	> 100 kHz (Z_0 = 150 Ω)	EN 61643 part 21 Clause 6.2.3.2	M/S
3	Impulse reset	< 150 ms	EN 61643 part 21 Clause 6.2.1.42	M/S

4.3 Electrical Safety Requirements

As regards electrical safety, KNX TP Overvoltage protectors shall meet the relevant requirements of the KNX connector type 5.1 in clause 3.7.

4.4 Environmental Conditions

As regards environmental conditions the relevant requirements of the KNX Connector type 5.1 shall be met (see clause 3.7).

4.5 EMC

As the TP KNX Overvoltage protector is a passive component, emission tests do not apply.

Clause 4.7 item 1 ‘nominal surge current’ covers the immunity of the TP Overvoltage protector.

4.6 Mechanical, Dimensions

The dimensions shall follow the relevant parts of the KNX Connector type 5.1 (see clause 3.7).

Additionally the following requirements apply:

No	Topic	Data and requirements	Test Guidelines	M
1	minimum conductor cross section for earthing	0,75 mm^2 (AWG Cu 19)	clamping test	M/S
2	wire colours and length	connection to the bus : red : + polarity dark grey : - polarity connection to earth : yellow green length : see Figure 23 wires shall be affixed to the TP KNX Overvoltage protector at delivery	VI	F/S
3	nominal conductor cross section	0,8 - 1 mm diameter solid (AWG Cu 18-17) 0,5 mm^2 stranded (AWG Cu 20)	clamping test	F/S

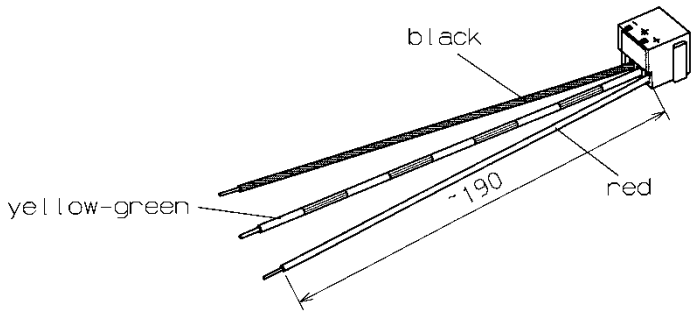

Figure 23: Example of a KNX TP Overvoltage Protector

4.7 Electrical Requirements

No	Topic	Data and requirements	Test guidelines	M
1	Impulse durability (Nominal surge discharge current I_N (8/20) single line)	Category C2 5 kA Line-PG	EN 61643 part 21 Clause 6.2.1.6	M/S
2	Impulse limiting voltage (common mode)	< 2 kV	EN 61643 part 21 Clause 6.2.1.3	M/S
3	rated current I_L	> 1,5 A	EN 61643 part 21 Clause 6.2.2.1	M/S
4	Transverse voltage	≤ 500 V ≤ 200 ns	EN 61643 part 311 Clause 7.6	

4.8 Testing

See relevant requirements above.

4.9 Functional Safety

To be completed.

4.10 Interfaces, Connectors

None.

4.11 Symbols

The following symbol shall be used for KNX installation schematics

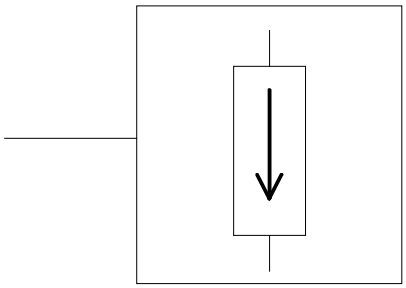

Fig. 9/1- 29: Secondary Protector

4.12 Installation

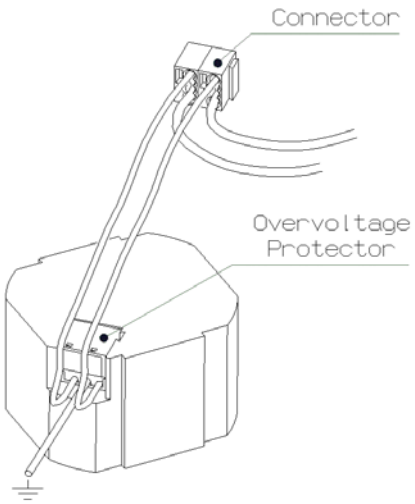

Figure 24: Connecting the Overvoltage Protector directly on a BCU, replacing the Connector by the Overvoltage Protector

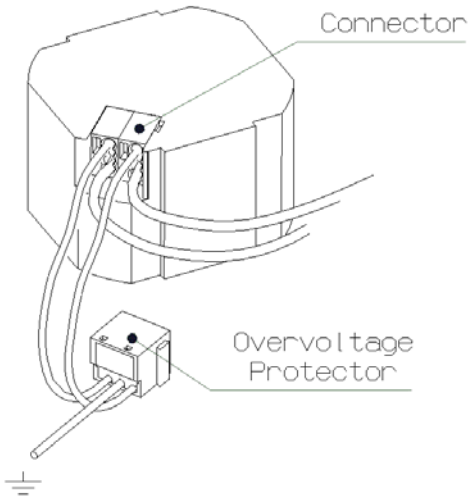

Figure 25: Connecting the Overvoltage Protector at the existing Connector at the BCU

KNX TP Overvoltage protectors shall be installed closely to the to be protected KNX device.

4.13 Marking

KNX Logo optional.