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 standardized TP1 cable has amongst others the following additional features: two twisted pairs, overall shield and sheath. This cable is always green RAL 6018 colored.
- 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 colored.

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		Colors 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 standardized cable	1000 m max.	Measurement	S
2.7b		Cable length for non-standardized cable	1000 m max. Shorter length specified by the manufacturer[1]	Measurement	M
3.1a	electrical properties for standardized cable	Loop resistance	min. 20 Ω/km max. 75Ω/km	Measurement	S
3.1b	electrical properties for non-standardized cable	Loop resistance	min. 20 Ω for the specified length max. 75Ω for the specified length max. 150Ω/km	Measurement	M
3.2		Conductance	G_{max} = 1mS/km, $f_{measure}$ = 10 kHz	Measurement	M
4.1	Electrical Safety	Outer sheath	Required	-	M/S

[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 s 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
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	Color
TP1 standard cable	EIB/KNX logo	Green RAL 6018
TP1 non-standardized 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.

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[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.

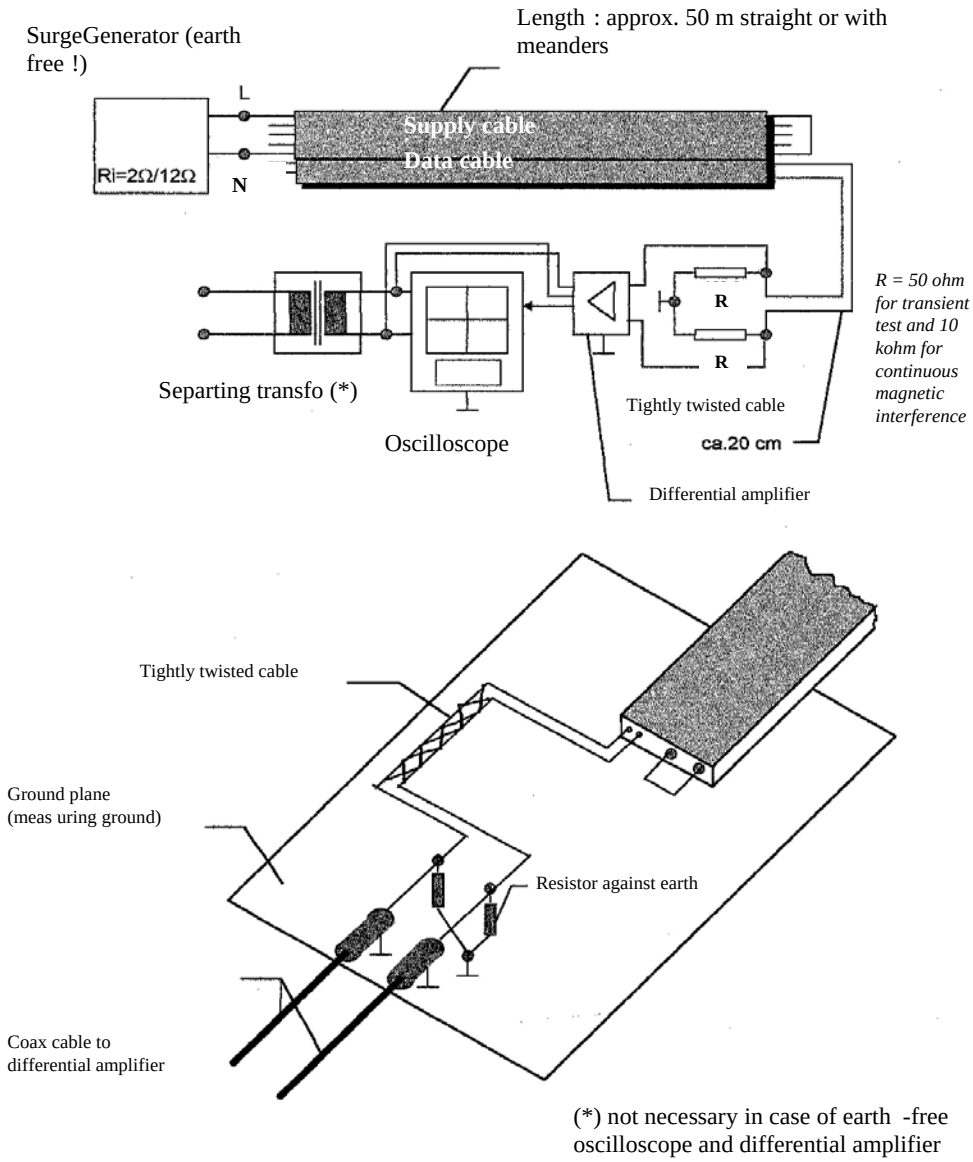

Figure 2: Test set-up for measurement of continuous and transient magnetic interference (example)

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 standardized TP1 cable shall be used. Manufacturers of non-standardized cables shall give an appropriate hint to the installer in the product documentation.
- If a non-standardized 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, …).