KNX Hardware Requirements and Tests

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Safety and Environmental Requirements – General

Summary

This document specifies the hardware requirements for KNX products

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

Version 01.02.02 is a KNX Approved Standard.

Document updates

Version	Date	Description
1.0	1999.08	Approved Standard
1.1RfV	2003.10	Restructuring of Volume 4 - Update according modified standards and RF requirements
1.1 FV	2004.06	Integration of comments from RfV – preparation for final voting
1.1 AS	2009.02	Finalisation of Version 1.1 for publication in V2.0 of specifications (a.o. taking into account publication of AN106 and 109)
1.1 AS edup1	2010.03	Editorial update (e.g. missing references)
1.2 AS	2011.10	Update taking into account AN 126
01.02.01 AS	2013.10.21	Editorial updates for the publication of KNX Specifications 2.1.
01.02.02 AS	2013.12.11	Editorial updates.

References

[01] Part 4/3 “Assessment and Test of Electrical Safety”

[02] Volume 5 “KNX Certification of Products”

[03] Volume 9 “Basic and System Components/Devices – Minimum Requirements – Standardised solutions - Tests KNX System Conformance Testing”

[04] Part 9/1 “Cables and Connectors”

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Contents

1 Introduction

This part of the handbook contains all hardware requirements for KNX products, regardless whether they are application products or basic/system components/devices.

For definition of application product, basic and system component respectively devices refer to [02], clause ‘Definitions’.

If no appropriate product standards exist, the EN 50491 series is applicable for KNX products.

For EMC requirements, the following medium-dependent standards are applicable:

Table 1 - Applicable standards according to medium

TP1	PL	RF
EN 50491-5-x	EN 50065-series	ETSI EN 300220-1 ETSI EN 300220-2 ETSI EN 301489-3

KNX Association does not specify additional product requirements but takes recourse to existing product standards for KNX hardware certification of application products. In the case where the relevant product standard covers already products for Home and Building Electronic Systems, compliance to such product standards only is sufficient.

As for many Basic and System components/devices appropriate product standards do not exist, KNX Association has added specific requirements for such devices in [03] of these specifications.

KNX hardware certification is based on CE-marking procedure: the submission of a CE-declaration confirming the compliance to the standards listed in Table 1 suffices for hardware certification. This concept is however completed by appropriate market surveillance (see [02]).

If a product is developed for a national European market, it may be necessary to fulfil in addition some relevant national standards.

Compliance to the underneath requirements will provide Electrical Safety (i.e. protection against electric shock) and Electro Magnetic Compatibility for the KNX product as well as compliance to Functional Safety requirements.

The requirements for withstand climatic stress are dealt with as part of the electrical safety concept.

2 General requirements

2.1 Electrical safety and environmental conditions

2.1.1 Introduction

This clause includes general electrical safety requirements and the requirements for withstanding climate, temperature and mechanical stress.

If not stated otherwise the requirements are specified for 230/400 V mains power networks (including 115/220 V and 277/480 V).

2.1.2 Requirements

- The Twisted Pair bus TP1 shall use Safety Extra Low Voltage (SELV) max. 32 V DC (Protection Measure).
- KNX TP products shall comply with an appropriate product standard selected by the manufacturer as well as the requirements from EN 50491-3. If a KNX product is intended for installation only within a single equipotential earthing system and the rated impulse voltages are reduced (according footnote e of Table 2 of EN 50491-3), then this shall be described in the product documentation. This rule applies to KNX products with connection to earth only.
- Product Standards selected as a basis for testing of electrical safety requirements of KNX products shall be harmonised EN, IEC or national standards.

Table 2 - Examples for product standards for installation products

Standard	Title
EN 60669	Switches for household and similar fixed installations
EN 50178	Electronic equipment for use in power installations
EN 60730	Automatic electrical controls for Household and similar use

NOTE 1 Installation products are e.g. Push Buttons, Binary Inputs and Outputs, Switching/Dimming/Shutter Actuators, Appliance Interface, Sensor, Movement detectors, Displays, Controllers, etc.

- In case product standards are not available, generic or family standards shall be used in combination with the medium relevant standards of Table 1.

  Examples of generic Safety Standards are:

  - HD 625 (EN 60664) and EN 61140 for electrical safety.
  - EN 60068-2 for environmental stresses.
- Protection class of application products

  The protection class according to EN 60529 shall be at least IP 20 for indoor use.

  For outdoor use the protection class may be realised by an appropriate enclosure. The IP Protection Class shall be at least IP 42.

  The test shall be carried out in accordance to EN 60529.
- In the case where a product uses components covered by a dedicated standard, evidence of compliance shall be given e.g. safety transformer covered in EN 61558-1 respectively EN 61558-2-6. Such components should be stated in the data sheet.
- Galvanic connection of external circuits to KNX TP1 bus.
- In order to protect KNX TP1 bus installations against unforeseeable disturbances from external circuits, the following requirements apply for connection of other circuits to KNX TP1 bus:

1. Generally circuits powered by external power feeding shall be galvanically separated from the KNX TP1 bus circuits.
2. Ancillary circuits may be connected galvanically to KNX TP1 bus circuits if the following requirements are met, for which compliance shall be declared in the KNX datasheet (see Figure 1):
   a. Ancillary power feeding shall provide SELV for TP1 according EN 61140 (see NOTE 2)
   b. Galvanic coupling shall be provided on the application side of a device or the PEI (Physical External Interface – if available) only
      i. The bus circuits with power feeding and the power feeding circuits shall be in the same housing of the Application Module or
      ii. The power feeding may be in an individual device that shall be closely mounted to the Application Module. ‘Closely’ in this case means the relation of the power-feeding device to the KNX TP1 bus device shall be evident. A location outside the same room is not allowed for direct coupling.
   c. It shall be assured that the power feeding cannot influence the TP1 bus voltage in normal operation, i.e. cause no breakdown and/or no increase above the specified limits.
   d. The extraction of power from the TP1 bus shall be kept within the specified limits (see 2.5.4).
   e. In case of partial power failure, components of the device circuits shall not be damaged by overvoltage or overload. Verification shall be carried out in accordance with the applicable safety standard.
   f. For EMC the device plus ancillary power-feeding unit (installed as in proper usage) shall comply with the KNX requirements.

NOTE 2 The SELV defined in EN 60950 corresponds to PELV and not to SELV according to EN 61140. Power Feeding transformers for SELV shall comply with EN 61558-1 respectively EN 61558-2-6.

NOTE 3 SELV/PELV: if the TP1 Bus is SELV, then the power supply shall also be SELV. If the bus is PELV, then the power supply shall be PELV or SELV.

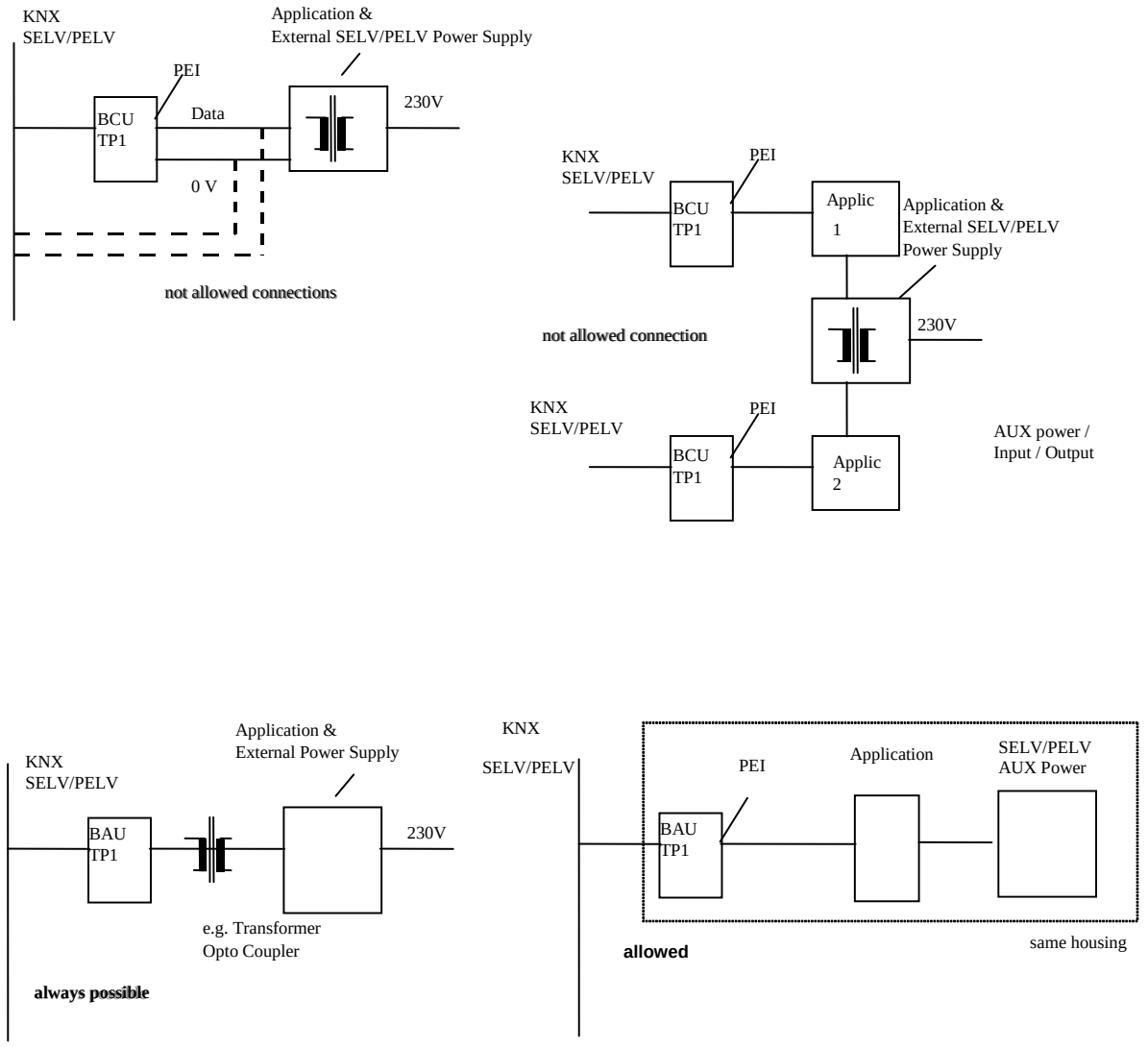

Figure 1 - Examples of galvanic connection of external circuits to KNX bus

- Use of protective impedances in TP1 circuits:
  1. If for functional reasons connections between bus and other circuits or ground are required, protective impedances shall be used that comply with EN 61140.
  2. If more than one protective impedance is used for one bus circuit, all impedances together shall comply with EN 61140 requirements (current limitation in particular!).
  3. The use of protective impedances (type, connection between which parts/circuits, etc.) shall be declared in the KNX datasheet.

2.2 Functional Safety

KNX Devices shall comply with the Functional safety requirements of EN 50491-4-1.

2.3 EMC Requirements

2.3.1 General

- The requirements and the tests for KNX application products are in compliance with the goals of the today's valid EEC EMC directives (today 2004/108/EC).
- A product comprising of a KNX system component and an application module (or a product with integrated bus access unit (BAU)) shall be regarded as a single device. As a consequence, the entire device shall comply with the EMC requirements.
- General test and performance requirements:

  When degradation of performance according the performance criterion of the relevant product standard for certain functions of the device is permitted, the device shall not disturb other devices/equipment connected to the KNX bus. For instance, each telegram is answered by the device with a NACK (not acknowledge) or the device sends BUSY telegrams, etc.

2.3.2 EMC Requirements for media Twisted Pair

- The products shall comply with the relevant (EMC) product standards, if published in the official journal of the European Community as a harmonised standard. If this standard includes HBES requirements, testing according this standard suffices. If the product standard does not contain HBES requirements, KNX application products for TP1 shall moreover fulfil the requirements of EN 50491-5-2. If an appropriate product standard is not available, generic standards shall be applied according to Figure 2.
- KNX TP1 application products exclusively designed for industrial application shall not exceed limits stipulated in EN 55022 Class A on the bus cable. The limits of the EN 61000-6-4 shall not be exceeded.
- If the 2nd pair of the KNX TP1 cable is used for other purposes, the limit values stipulated in CISPR 22 shall not be exceeded (see Table 3).

Table 3 - EN 55022 Class B, Limits for Radio Interference Voltage on symmetrical Lines

Frequency Range MHz	**Voltage Limits** dB(µV)		**Current Limits** dB(µA)	
	Quasi-Peak	**Average**	**Quasi-Peak**	**Average**
0,15 to 0,5	84 to 74	74 to 64	40 to 30	30 to 20
0,5 to 30	74	64	30	20
The limits decrease linearly with the logarithm of the frequency in the range 0,15 MHz to 0,5 MHz. The current and voltage disturbance limits are derived for use with an impedance stabilisation network (ISN) which presents a common mode (asymmetric mode) impedance of 150 ohms to the telecommunication port under test (conversion factor is 20log10 150 / l =44 dB).Provisionally, a relaxation of 10 dB over the frequency range of 6 MHz to 30 MHz is allowed for high-speed services having significant spectral density in this band. However, this relaxation is restricted to the common mode disturbance converted by the cable from the wanted signal.				

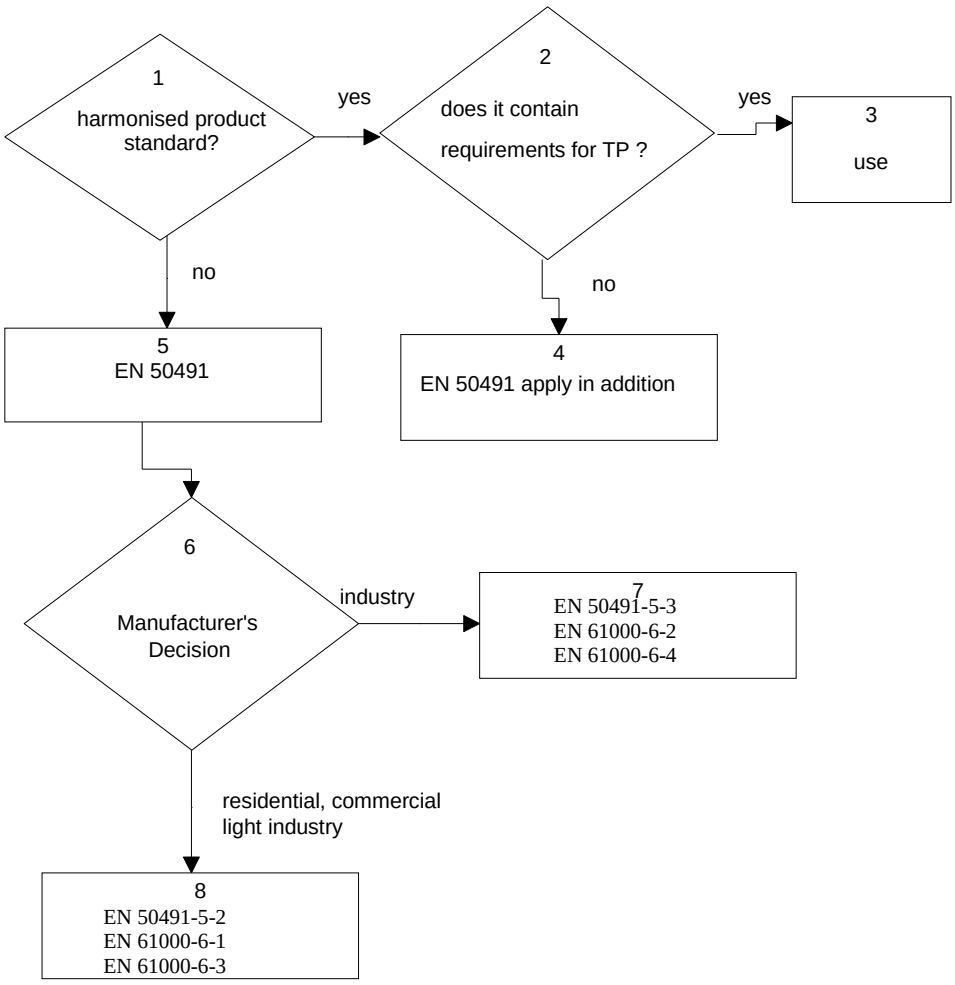

Figure 2 - Selection of EMC Standards for TP1

2.3.3 EMC Requirements for media Powerline

- The products shall comply with the relevant (EMC) product standards, if published in the official journal of the European Community as a harmonised standard. If this standard includes HBES requirements, testing according this standard suffices. If the product standard does not contain HBES requirements, KNX application products for PL shall moreover fulfil the requirements of the Powerline standards:
  - for industry environment : EN 50065-1 Cl 134 and EN 50065-2-2
  - for residential, commercial, light industry environment: EN 50065-1 Cl 122 and EN 50065-2-1

2.3.4 EMC Requirements for RF medium

KNX RF products shall fulfil the following requirements:

2.3.4.1 RF-specific requirements

The requirements of EN 300220-1 and EN 300220-2 apply.

2.3.4.2 EMC – Requirements for RF

2.3.4.2.1 Requirements for RF

The requirements of EN 301489-3 apply.

2.3.4.2.2 Immunity Requirements

If a product standard exists, this standard shall be used instead of the above-mentioned generic EMC – standards.

If no product standard exists, the following requirements apply:

- EN 61000-6-1: For KNX RF products used in residential, commercial and light –industrial environment.
- EN 61000-6-2: For KNX RF products used in industrial environment.

2.4 Assignment of KNX bus devices to relevant Product Standards

The manufacturer is responsible for the selection of the appropriate product standard for his KNX bus product.

However the scope of the chosen product standard and/or the assignment of the product to the product standard shall cover the KNX bus product type.

In case of an evident mismatch of the chosen product standard to the product type, the KNX Association is entitled to refuse KNX certification of the product, until the product has been tested on the basis of an appropriate product standard.

2.5 Further KNX Specific Requirements

2.5.1 General Overview

All terms and definitions in this part are derived from ISO 8402 and IEC 60050 (IEV chapter 191).

This chapter lays down requirements and recommendations for the following aspects:

- Quality

One of the major goals of the KNX certification is to achieve a high quality level of the entire bus system, regardless of the origin of the products the system consists of:

A high quality ensures that

- the functionality of the product is guaranteed under the environmental conditions specified by the manufacturer;
- a high **reliability level** (2.5.8) of the individual products and the system as a whole is reached.

Quality is a factor to be considered at the early stages of development. It will not be possible to reach higher quality levels by final tests only: appropriate quality surveillance during production is therefore essential. This can be achieved via the implementation of an adequate **Quality Management System** (2.5.2).

In addition, this handbook part stipulates requirements and/or recommendations for:

- Failure Rates (2.5.8) (recommendation)
- Life Time (2.5.8) (certification relevant)

- TP1 Power Consumption (2.5.5)

Each TP1 device shall not consume more power from the bus than the limited level specified.

- Material Recycling (2.5.9)

KNX Association recommends its manufacturers to design products in such a way (as regards application, used materials and their recycling) to avoid environmental pollution.

Material Recycling Guidelines are provided in this handbook part, which are however not certification relevant.

2.5.2 Quality Management (certification relevant)

In order to achieve a high quality level, each manufacturer submitting products [1)] for KNX certification, shall implement a **Quality Management System (QMS)** in accordance with the valid ISO 9001 standard.

Once the QMS has been duly implemented, it shall be certified by a certification body, which has been nationally accredited according EN 45012. If at the time of registration of a first product, the implemented ISO 9000 QMS has not yet been certified by an accredited certification body, the applicant will be submitted to a quality audit as carried out by the audit team of the KNX Association.

2.5.3 Useful Life/Life Cycles (certification relevant)

Useful life of a product shall also be considered as a quality parameter during the planning and design phase of a product. A declaration on the useful life shall be made in the KNX datasheet.

The useful life of a product is the time period in which the failure rate is approximately constant; it is represented by the bottom period of the 'bathtub curve', which is shown in Figure 3. For KNX bus products, the useful life shall be at least 10 years.

If the lifetime of a product is mainly determined by its switching cycles (e.g. load switch), these cycles shall be additionally stated in the KNX data sheet. The life cycles shall be determined under nominal conditions (current, voltage, power factor, ambient temperature, etc.). The life cycle shall be stated as $t_{10\text{-value}}$ (i.e. number of live cycles after which 10% of the tested devices are defective).

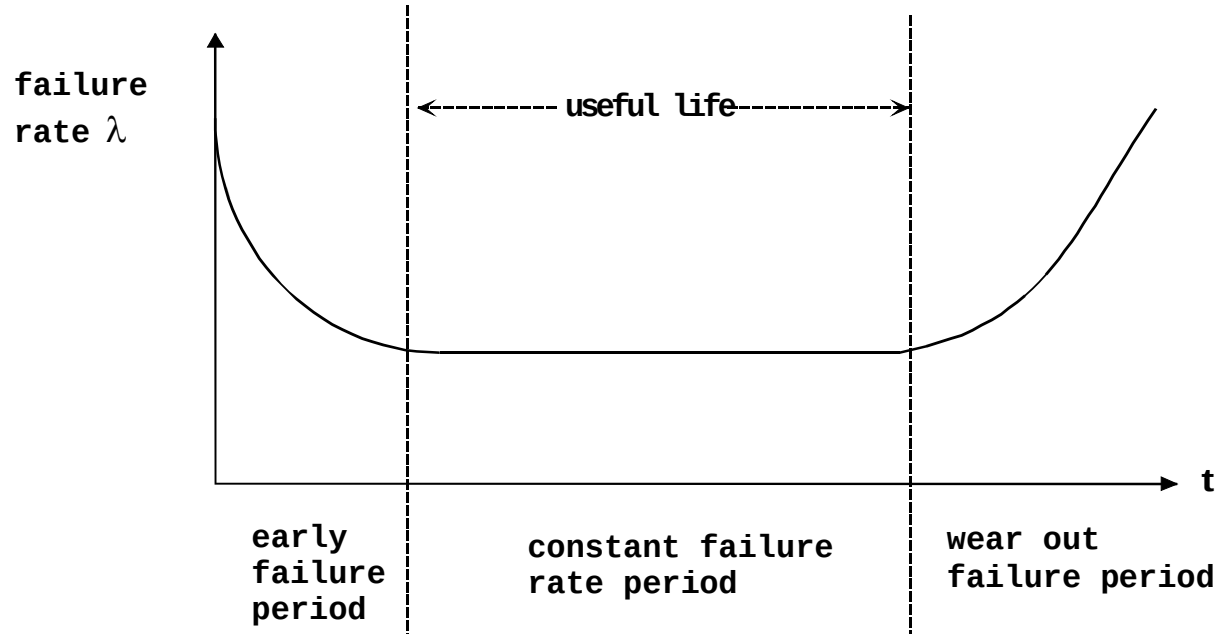

Figure 3 - Time dependence of failure rate

[1)] Only applicable for products developed by the manufacturer applying for certification (main certificate).

2.5.4 TP1 Bus Power Consumption of Application Products /Fan-in-model for TP1 (certification relevant)

It is recommended that the power consumption from the bus for devices is limited to the real needs. The power consumption and the transmission characteristics of the device shall be documented in the product datasheet and shall be provided in the KNX database according to the following Fan-in-Model.

The Fan-in-Model describes the relevant 'combination' characteristics: How many devices can be connected to one physical segment as regards transmission characteristic and the (nominal) output current of the Power Supply Unit(s)

a) The transmission characteristic fan-in W_t

- $W_t = 1$ for TP1 256 products
- $W_t = 4$ for TP1 64 products

If not otherwise specified, a $W_t = 4$ is taken per default. If necessary, this model may be extended in future.

b) The current consumption **I**

The maximum current consumption (e.g. with LEDs switched on) of a device (BAU + application module) shall be tested at the nominal bus voltage of

- $U_N = 24$ V and classified according to the classes below.
- The next higher value of the following table shall be taken, which is the relevant current class of the device.

Table 4 - Classes

2,5 [mA]	5 [mA]	7,5 [mA]	10 [mA]	12.5 [mA]	15 [mA]
17,5 [mA]	20 [mA]	25 [mA]	30 [mA]	35 [mA]	

(continue in steps of 5 mA)

For a given TP1 physical segment (bus line), the two following conditions shall be met at the same time:

1. Requirement for max. current consumption:

   The total current consumption shall not be higher than the nominal output current of the power supply:

   $$\sum_{n=1}^{N} I_{C(n)} < I_N$$

   N = Number of connected devices to bus line.

   I_C = Current class of the device (e.g. 5 mA).

   I_N = nominal output current of used power supply.

2. Requirement for transmission characteristics:

   The maximum transmission fan-in (W_t) of all devices of one bus line shall not exceed 256:

   $$\sum_{n=1}^{N} W_{t(n)} < 257$$

   N = Number of connected devices to bus line.

   W_t = Transmission characteristics.

2.5.5 TP1 Drawing of Current from the outer Tracks of the KNX Data Rail (certification relevant)

Feeding a bus device from the unfiltered voltage is not allowed as parts of the transmission circuit of the bus coupling unit can possibly be short-circuited. It can moreover not be excluded that such devices have a negative influence on the EMC behaviour of an entire KNX bus installation.

2.5.6 Connection of Bus Wires and 2nd Pair

For connection of TP1 devices, connector types 5.1 – 7.1 – 7.2 shall preferably be used (see [04]). If the above connectors are not used, the characteristics of the used connector shall at least comply with the requirements as marked with 'M' in the appropriate sections of [04].

The 2nd pair (yellow & white) shall be connected by yellow and white connectors (similar but not compatible with the TP1 bus connector) or other appropriate connectors that are non-interchangeable with the TP1 bus connectors (also not in the colour).

2.5.7 Length of PEI

When connecting an application module via a flat cable to the PEI of a bus coupling unit, the length of this 'extended PEI' shall be limited to 100 mm (a.o. to limit EMC susceptibility).

2.5.8 Reliability/Failure Rates (recommendation)

Reliability is one of the keys to reach market acceptance (but also to increase environmentally friendliness products). Too many failures of the KNX system will decrease its market acceptance.

The reliability of components and products is a further quality parameter, which has to be taken into account during the earliest planning stages of a product.

However, the reliability of the entire installed system depends directly on the reliability of every single installed device. As the end user will focus on the reliability of the whole installation, it might be necessary that the manufacturer additionally provides appropriate installation guidelines along with the product (e.g. in instruction sheets).

In order to ensure minimum product reliability, KNX Association recommends that manufacturers calculate the failure rates of their delivered products. KNX Association however does not lay down limits for failure rates.

The dimension of failure rates is *one over time* (1/T). Low values are often stated in 'fit'. One fit equals one failure per 10^9 component operational hours. Failure rates of developed products shall be checked and possibly improved at appropriate intervals (e.g. at least every three years).

The failure rate values may be:

- calculated by theoretical prediction methods,
- derived from field data (per year) or,
- found by comparing the product under consideration with a product of similar use and structure for which a failure rate exists.

In order to ensure comparability of failure rates of KNX products, KNX Association recommends using only field data as the basis for failure rate assessment. Instead, theoretical prediction method may be used. It is recommended not to use MIL data bases, as its data are mainly not obtained from the field.

If FIT calculation is carried out, the selected method, database and result shall be stated in the KNX data sheet, thereby also specifying the conditions (e.g. product temperature range) for FIT calculation.

2.5.9 Material recycling (recommendation)

2.5.9.1 General

This clause describes guidelines for recycling of housing and terminal material, which shall be taken into account during the product design of all KNX bus products. If a product complies with underneath material recycling guidelines, this shall be stated in the KNX datasheet.

The relevant valid European directives shall be taken into account (e.g. REACh, RoHS, WEEE, EuP, etc.).

2.5.9.2 Dismantling of KNX bus devices

The design of KNX bus devices shall be such that they can easily be dismantled into the three components:

- Plastic housing material.
- Terminal and other metal parts for mounting.
- Printed Circuit Boards (PCB). The PCB shall not be damaged during dismantling.

2.5.9.3 Plastic Housing Material

- The plastic material shall be free of add-ons containing cadmium, chrome, beryllium, phosphor or arsenic.
- The plastic material shall be free of halogen as well as of flame retards containing halogen (halogen free according to IEC 60754 parts 1+2).
- The plastic material shall be of controlled composition. Plastic parts with a weight greater 5g shall be marked in accordance with ISO 11469 whenever possible.

Evidence of compliance shall be given in the product documentation file.

2.5.9.4 Metal Parts for terminals

The coating of terminals shall be free of chrome (VI) and cadmium.

Evidence of compliance shall be given in the product documentation file.

2.5.9.5 Recycling of Batteries

For batteries, the relevant valid European directives shall be taken into account.

3 Informative Annex – Electrical Safety

3.1 Introduction

This clause shall be regarded as a further elucidation of EN 50491-3 when using this standard as a basis when testing compliance of KNX devices to electrical safety conditions.

3.2 Definitions

3.2.1 Device Group

The Device Group indicates where in the device protective separation is required and in which electrical environment the device is used.

Table 5 – Device groups and their protective separation

Group	Device contains the following circuit types	Electrical environment, combination of devices
1	Bus (KNX SELV/PELV bus) + mains power or derived circuits [2].	Mains 230V environment [3] - Combinations with mains devices.
2	Bus (KNX SELV/PELV bus) only.	
3	Bus (KNX SELV/PELV bus) only.	Bus SELV/PELV environment - Combinations with SELV/PELV devices only.
4a	Bus (KNX SELV/PELV bus) + other SELV or PELV circuits or similar.	Mains 230V environment [3]- Combinations with mains devices.
4b		Bus SELV/PELV environment - Combinations with SELV/PELV devices only.

3.2.2 Combinations

Combination of devices denotes that KNX SELV/PELV bus devices are mounted in close contact with mains devices or with devices connected to other networks, e.g. in distribution boards or in wall boxes.

3.3 General Conditions

3.3.1 Protective Separation

1. The KNX SELV/PELV bus devices shall provide the required protective separation for the rated insulation voltage U_R
   - to the outer surface.
   - between all internal non-KNX bus circuits and the KNX SELV/PELV bus circuits.
   - to conductive parts according to Table 6.

[2] A Powerline device normally complies with Group 1 characteristics. In this case the application module and its corresponding supply circuit shall be regarded as KNX TP bus.

[3] For 230/400V, respectively 320V for 277/480V or 400V for 230V/400V IT supply system networks.

2. The device Group of the device shall be stated in the datasheet.
3. Galvanic Separation of circuits for ancillary SELV/PELV power supply from KNX SELV/PELV bus: the requirements as stipulated under 'Use of protective impedances in TP1 circuits' in clause 2.1.2 apply.

Table 6 – Separation

	Parts not connected to PE		Parts connected to PE
No	**Already provided separation of conductive parts from mains**	**Additional required separation for KNX SELV/PELV bus TP1 circuits**	**Basic separation is required (see Table 9; 5A)**
1	Protective separation (U_R ≥ 250V [4)])	no safety insulation required	
2	Basic separation (U_R ≥ 250V [4)]	Basic separation (U_R ≥ 250V [4)]	
3	less than Basic separation (U_R ≥ 250V [4)]	Protective separation (U_R ≥ 250V [4)]	

3.3.2 Terminals

Terminals for KNX SELV/PELV bus devices and equipment shall comply with the following requirements:

- Terminals for all circuits shall be protected against direct contact, unless they are for SELV or PELV circuits with voltages below 25 V AC and 60 V DC.
- All terminals shall be clearly marked.
- Terminals for connection of Protection Earth (PE) shall comply with IEC 60364 5 54 or with the harmonised European or national standard respectively.

3.4 Group 1 KNX devices

The requirements shall be met in accordance with the parameters defined/selected from Table 8.

4) For 230/400V, respectively 320V for 277/480V or 400V for 230V/400V IT supply system networks.

1. Group 1 devices shall comply with clause 3.3.
2. Group 1 devices shall provide protective separation to the user.
3. In the case of 'combinations' of Group 1 devices with devices connected to other circuits, Protective Separation is considered to be provided if each of the devices provides basic separation for the (same) rated insulation voltage (U_R).
4. The possibility of usage of Group 1 devices in combinations shall explicitly be stated in the instruction/data sheet (see [02]).
5. Group 1 devices shall at least provide Basic Insulation for ≥ 250 V [4)] to the outer surface.
6. For Group 1 devices (including terminals) not providing protective separation themselves protective separation shall be provided by installation measures. Proper instructions for the installation shall be provided in the instruction/datasheet (see [02]).
7. KNX SELV/PELV bus devices not providing protective separation themselves shall not be installed in contact with life parts of any other circuit unless this circuit uses SELV/PELV.
8. Insulation between mains and other non-bus circuits shall not be less than Basic separation for U_R if not otherwise specified in product standards.
9. Between terminals for non-KNX bus circuits and the KNX SELV/PELV bus terminals, protective separation for the rated insulation voltage UR shall be provided.
10. KNX bus terminals of Group 1 devices shall either provide protective separation themselves according to the rated insulation voltage or shall be protected by an additional cover after proper installation.

3.5 Group 2 KNX devices

1. Group 2 devices shall comply with clause 3.3 (clause 3.3.1 is not applicable).
2. In the case of 'combinations' of Group 2 devices with devices connected to other circuits, Protective Separation is considered to be provided if each of the devices provides basic separation for the (same) rated insulation voltage (U_R).
3. The possibility of usage of Group 2 devices in combinations shall be stated explicitly.
4. Group 2 devices shall at least provide Basic Insulation for $U_R \geq 250V$ to the outer surface
5. For Group 2 devices not providing protective separation themselves, protective separation shall be provided by installation measures. Proper instructions for the installation shall be provided.
6. KNX SELV/PELV bus devices not providing protective separation themselves shall not be installed in contact with life parts of any other circuit unless this circuit uses SELV/PELV.
7. KNX SELV/PELV bus terminals of Group 2 devices shall either provide protective separation themselves according to the rated insulation voltage or shall be protected by an additional cover after proper installation.

3.6 Group 3 KNX devices

1. Group 3 devices shall not be used in combinations unless they are combined with devices connected to SELV/PELV only.
2. For Group 3 devices proper instructions for the installation in a non-hazardous electrical environment shall be provided.
3. Group 3 devices shall comply with clause 3.3.1 item 3.

3.7 Group 4 KNX devices

- Group 4a devices

1. Group 4a devices shall comply with 3.5.
2. In case of local (see 2.1.2) SELV/PELV circuits protective separation according to U_R shall be provided between the circuits.
3. In case of circuits not covered by item 2 above (e.g. SELV/PELV networks) protective separation for $U_R \geq 250$ V shall be provided.

- Group 4b devices
  1. Group 4b devices shall comply with clause 3.6.
  2. Group 4b devices shall comply with items 2 and 3 of the clause for Group 4a devices.

3.8 Dimensioning of Insulation

3.8.1 Realization of protective Separation for SELV/PELV Protection Measures

- Insulation

The required protective separation to meet the SELV/PELV requirements can be achieved by the following types of insulation (see EN 60664-1 and EN 61140).

Table 7 – Insulation types

No	Insulation type	Description	Protection for
1	Mechanical separation		
2	Double insulation (DI)	a) Basic +Supplementary Insulation b) 2x Basic Insulation	Insulation specified for the highest occurring voltage between the circuits
3	Reinforced insulation (RI)		
4	Basic Insulation (BI) + screen connected to Protection Earth (PE)		

A survey on the required insulation is given in Figure 4. The rated insulation voltage U_R is given between brackets.

- Realisation of protective separation by coupling components

Such coupling components are e.g. power feeding transformers or optocouplers. If for such coupling components valid harmonized product standards exist (EN or IEC, e) and protective separation for the appropriate rated voltage is specified in these product standards, these components shall comply with and shall be tested according to these components product standards.

Power Feeding transformers for SELV shall comply with in EN 61558-1 respectively EN 61558-2-6.

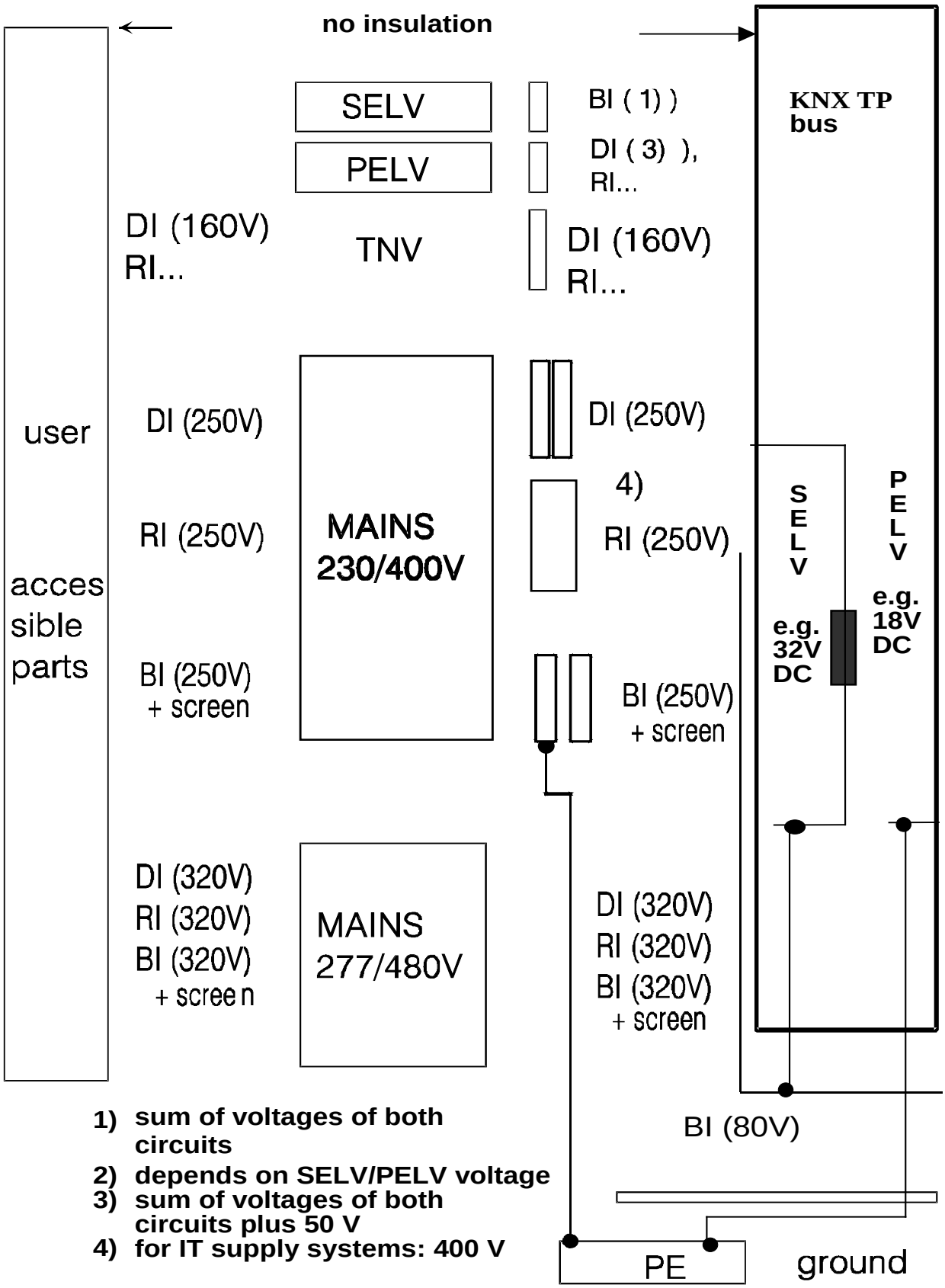

Figure 4 - Overview of insulation scheme

3.8.2 Dimensioning Parameters

The design of protective separation of KNX SELV/PELV bus circuits from hazardous other circuits inside and outside KNX SELV/PELV bus devices shall take into account the Safety Parameters and general selection criteria as stated in Table 8.

Table 8 - Safety parameters and general selection criteria

No	Parameter	Definition/purpose	Selection criteria /KNX requirements
1	Overvoltage category	Indicates the 'availability' (life time) of electrical insulation under specified stress by overvoltage impulses or by AC high voltages.	1) Overvoltage category III (general) or 2) Overvoltage category II + appropriate Overvoltage protection of the installation (see usage class)
2	Rated Impulse Voltage	Withstand voltage (peak) for impulse over-voltages (1,2/µs).	The rated impulse voltage of the device shall not be less than the impulse voltage specified for the overvoltage category.
3	Pollution degree	Indicates macro environment pollution.	Pollution degree 2 for indoor use. Pollution degree 3 for outdoor use. (see usage class)
4	Rated Insulation Voltage (U_R)	Withstand voltage for long-term voltage stress.	See Figure 4 and Table 9.
5	Usage class for the relevant U_R	Combination of pollution degree and overvoltage category.	Minimum requirements for use in environmental conditions:

Usage Class	Overvoltage category	Pollution degree	Indoor use	Outdoor use In enclosure	Outdoor use, bathrooms [5])	Overvoltage protection
A	III	3	O	O	M	O
B	III	2	M	M	---	O
			O = optional M = mandatory/minimum requirement			

- Determination of Rated Insulation Voltage U_R

Examples for the Rated Insulation Voltage (U_R) are given in Table 9 (see also Figure 4) together with the overvoltage category and the required quality of separation.

KNX SELV TP1 has a maximum value of 32 V.

NOTE 4 The KNX SELV TP1 SELV is a mixed voltage of 32 V DC and an approximate 10 kHz AC voltage (signalling voltage) with max. 12 V peak.

a) KNX SELV is within the SELV frame according to sub-clause 5.2.13 of EN 50178 - see also EN 60950.

b) The signalling voltage is disregarded in the following specification of insulation.

5) Protected area in bathrooms.

Table 9 - Examples for the Rated Insulation Voltage (U_R)

'Other circuit' and related	Separation	Over-voltage	Rated Insulation Voltage	Remarks/Examples U_R		
'Supply System'		**Category**	**U_R (r.m.s)=**	**other bus**	**SELV 50V**	**PELV 50V**
1. SELV a) ≤ 50 V b) ≤ 100 V c) ≤ 150 V	Basic separation		max KNX bus voltage + max voltage of "other circuit"	SELV 32 V (TP1) 18 V (TP0)	 80 V 125 V	 125 V 125 V
2. PELV a) ≤ 50 V b) ≤ 100 V c) ≤ 150 V			max KNX bus voltage + max voltage "other circuit" + 50 V max PE Voltage	PELV 18 V (TP0)	125 V	63 V
3. TNV supply systems ≤ 135 V	Protective Separation		≥ 160 V			
4. Mains		III				
230/400 V			≥ 250 V	TN,TT supply systems		
127/220 V			≥ 250 V	"		
240/415 V			≥ 250 V	"		
277/480 V			≥ 320 V	"		
IT supply system 230/400 V			≥ 400 V			
5A. Protection Earth ≤ 50 V	Basic Separation		≥ 50 V + max KNX SELV-Voltage 32 V	32 V 18 V	PE = 50 V	80 V 63 V
5B. Non specified Earth (Ground) The relevant	≥ 50 V Protective Separation		≥ 250 V			
Voltage has to be specified from the local conditions.	≤ 50 V Basic Separation		≥ 50 V + max KNX SELV/PELV bus voltage	32 V 18 V	PE = 50 V	80 V 63 V
6. FELV Type with protective separation from mains.	Basic Separation		max KNX bus voltage + max voltage of FELV circuit	Supply system: see SELV / PELV		
7. FELV Type with basic separation from mains.			≥ 250 V Respectively for 320 V or 400 V	Supply system = mains		
8. FELV Type with < basic separation from mains.	Protective Separation		≥ 250 V Respectively for 320 V or 400 V	Supply system = mains		

3.8.3 Basic and Protective Separation realized by means of Clearances and Creepage Distances

For the usage classes specified in 3.8, in the following figures Basic and Protective Separation as realised by means of clearances and creepage distances is specified for material class III (III a) on the basis of EN 60664-1.

Usage classes	Reference
usage class A	Table 10
usage class B	Table 11

Further values for clearances and creepage distances can be obtained directly from EN 60664-1 for the desired usage class (overvoltage category and pollution degree), the Rated insulation voltage and for material class III a. The rule shall thereby be taken into account that the creepage is always equal or greater than the clearance distance.

Table 10 - Usage Class A clearances and creepage distances of KNX SELV/PELV bus to other circuits

Clearances	**Supply voltage Voltage to ground --> (other systems)**	**0 ≤ 50 V** ♠[6)]	**> 50 ≤ 100 V** ♥	**> 100 ≤ 150 V** o	**> 150 ≤ 300 230/400V (127/220V) (277/480V)** oo	**> 300 ≤ 600 IT supply system 3P 400V** ♣
Rated Impulse Voltage		0,8kV	1,5 kV	2,5 kV	4 kV	6 kV
Basic Separation	Clearance	**0,8 mm**	**1,0 mm**	**1,5 mm**	**3 mm**	**5,5 mm**
	Test Voltage Impulse	0,8 kV	1,5 kV	2,5 kV	4 kV	6 kV
	AC	0,6 kV	1 kV	1,8 kV	2,8 kV	4 kV
Protective Separation	Clearance	**1,0 mm**	**1,5 mm**	**3 mm**	**5,5 mm**	**8 mm**
	Test Voltage Impulse	1,5 kV	2,5 kV	4 kV	6 kV	8 kV
	AC	1 kV	1,8 kV	2,8 kV	4 kV	6 kV

Creepage Distances														
U_R V	50	63	80	80	100	125	125	160	200	200	250	320	320	400
	♠			♥			o			oo			♣	
Basic Separation mm	1,9	2	2,1	2,1	2,2	2,4	2,4	2,5	3,2	3,2	4	5	5,5	6,3
Protective Separation mm	2,2	2,4	2,5	2,5	3,2	4	4	5	6,3	6,3	8	10	10	12,5

6) The symbols ♠/♥/°/°°/♣ refer to corresponding sections of the above and underneath table.

Table 11 - Usage Class B clearances and creepage distances of KNX SELV/PELV bus to other circuits.

Clearances	**Supply voltage Voltage to ground --> (other systems)**	**0 ≤ 50 V ♠**	**> 50 ≤ 100 V ♥**	**> 100 ≤ 150 V o**	**> 150 ≤ 300 230/400 V (127/220 V) (277/480 V) oo**	**> 300 ≤ 600 IT supply system 3P 400 V ♣**
Rated Impulse Voltage		0,8 kV	1,5 kV	2,5 kV	4 kV	6 kV
Basic Separation	Clearance	**0,8 mm**	**1,0 mm**	**1,5 mm**	**3 mm**	**5.5 mm**
	Test Voltage Impulse	0,8 kV	1,5 kV	2,5 kV	4 kV	6 kV
	AC	0,6 kV	1 kV	1,8 kV	2.8 kV	4 kV
Protective Separation	Clearance	**1,0 mm**	**1,5 mm**	**3 mm**	**5,5 mm**	**8 mm**
	Test Voltage Impulse	1,5 kV	2,5 kV	4 kV	6 kV	8 kV
	AC	1 kV	1,8 kV	2,8 kV	4 kV	6 kV

Creepage Distances														
U_R V	50	63	80	80	100	125	125	160	200	200	250	320	320	400
	♠			♥			o			oo			♣	
Basic Separation mm	1,2	1,25	1,3	1,3	1,4	1,5	1,5	1,6	2	3	3	3,2	5,5	5,5
Protective Separation mm	1,4	1,5	1,6	1,6	2	2,5	3	3,2	4	5,5°	5,5°	6,3	8°	8

° adapted to clearance

3.8.4 Compliance of Clearances and Creepage Distances

The clearances and creepage distances specified are minimum requirements. They shall be kept also under worst case tolerances and in the case of movable parts, in the case of worst case position.

In the case the clearances and/or creepage distances do not comply with the requirements in clause 3.8.3, the following applies:

Table 12 – Clearance and creepage distances

	Clearance	Creepage Distance	Compliance, if
1	< specified	≥ specified	If the HV voltage test as specified in [01] has been passed without failure, the clearance is considered compliant.
2	≥ specified	< specified	In the case the material is class II or I material instead of class III material and the creepage distance under question complies with EN 60664-1 for this material, the creepage distance is considered compliant.
3		< specified creepage distances are on a printed circuit board PCB	In the case the creepage distances comply with the EN 60664-1 requirements for printed circuit boards, the creepage distance is considered compliant.

In all cases not covered by item 1 to 3 the clearances or creepage distances do not comply with the requirements.

3.8.5 Basic and Protective Separation by Solid Insulation

Under consideration.

3.8.6 Basic and Protective Separation by Coating

- General

Coating shall not be used/planned for new devices as a solution to achieve basic or protective separation.

- Coating is used for reducing creepage distances

The following requirements apply:

1. The coating shall comply with the requirements and tests for type B in IEC 60664 3.
2. The CTI value of the coating material shall not be less than that of the carrier and shall be documented in the test report.
3. In the case of achieving reinforced insulation by the coating, the thickness of coating on the live parts shall comply with the requirements in Figure 5.
4. The insulation distance (see Figure 5) shall not be less than specified in Table 4 of EN 60664 1 for the actual CTI value (material group), with all other parameters unchanged.

- Coating is used for protection against pollution.

Type A coating may be applied; clearances and creepage distances shall be the same as required without coating.

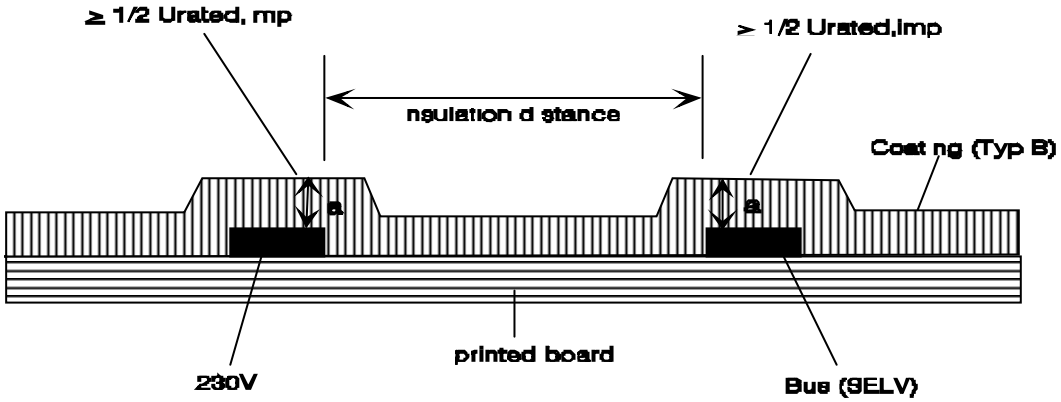

Figure 5 – Insulation distances

1. in the case of basic separation the insulation distance is sufficient.
2. for achieving protective separation the thickness ‘a’ must be such that the withstand voltage is not less than the required rated impulse voltage.
   In the case given U_{rated} impulse = 6 kV: thickness “a” must withstand at least 3 kV impulse.

