Technical informations

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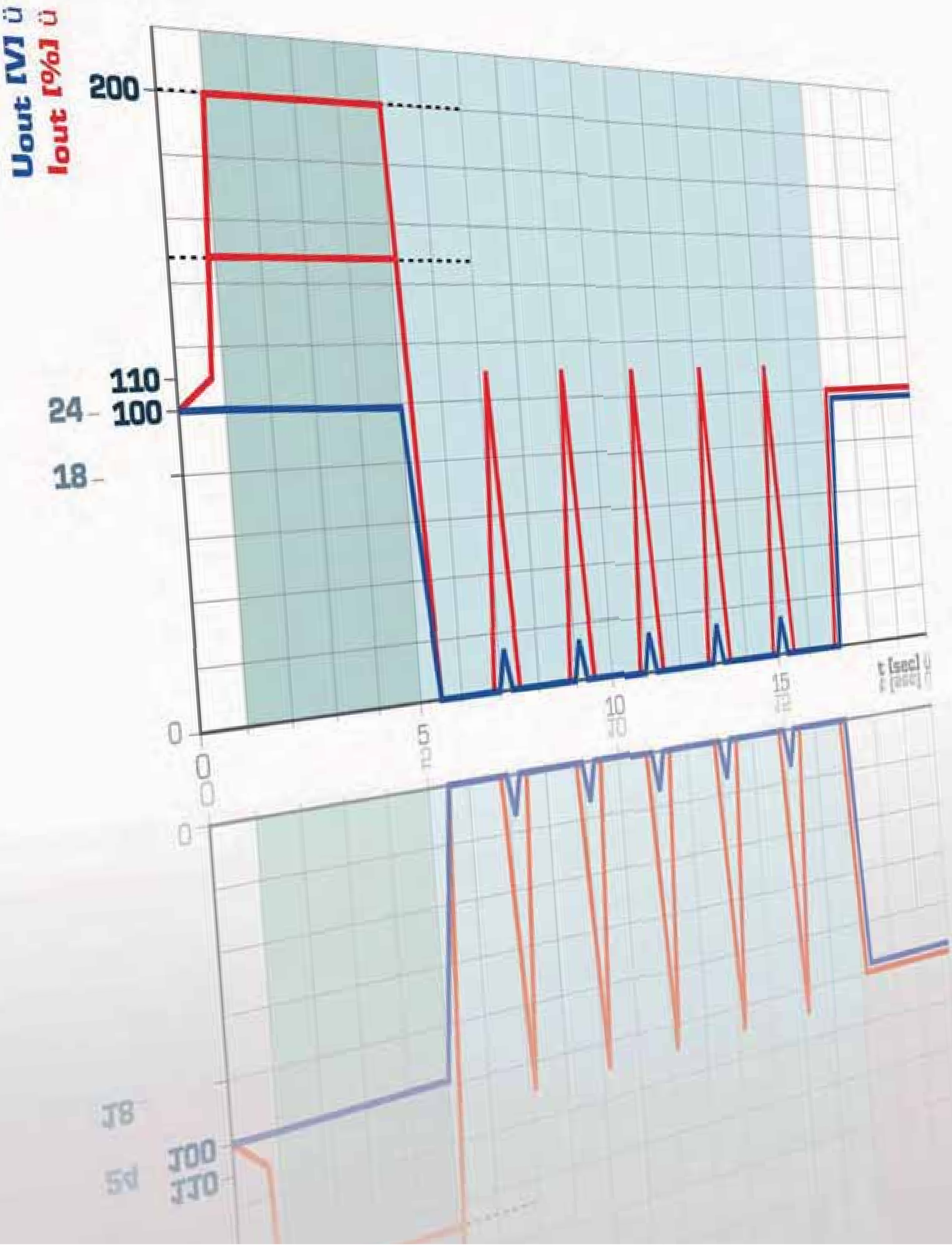


Technical informations Transformers

General informations

Transformers

General technical informations

A transformer is a static device with two or more coils which transforms a system of alternating voltage and alternating current through electromagnetic induction, usually with different values but the same frequency, for the purpose of transmitting electrical energy (Ref: VDE 0570, IEV 421-01-01).

Requirements

The design-related differences between transformers are generally determined by their intended utilisation. Respective requirements are established in the installation and device standards
(e.g. VDE 0100, VDE 0113/EN 60204/
IEC 60204, VDE 0700/EN 60335/
VDE 0805/EN 60950/
IEC 60950) and in the transformer standards (e.g. VDE 0570/DIN EN 61558/
EN 61558/IEC 61558).

An important selection criterion is the insulation construction between input and output electrical circuits:

Transformers with double or enhanced insulation

- Safety transformers (for the safety measure of safety extra-low voltage)
- Safety isolating transformers (for the safety measure of protective separation)

Transformes with basic insulation

- Control transformers (for the safety measure of protective earthing)
- Mains transformers with separated coils, general

Transformers without insulation (no metallic isolation) between input and output circuits

- Autotransformers

Standards

Unless otherwise agreed upon with the ordering party, we manufacture in accordance with the latest "State of Technology" and with the following standards:

VDE 0570: Safety of transformers, power units and similar
EN 61558, IEC 61558: Safety of power transformers, power supply units and similar.

Rated input voltage

The rated input voltage (Ref.: VDE 0570, EN 61558, IEC 61558) is the distribution voltage (or the voltage between the external conductors in the cases of multiphase systems), which the manufacturer has assigned to the transformer for the established operating conditions.

Rated input voltage range

The rated input voltage range (Ref.: VDE 0570, EN 61558, IEC 61558) is the input voltage range assigned to the transformer, as expressed in its upper and lower limits. Unless other arrangements have been made, the upper limit is equivalent to 1.10 times the value of the rated input voltage with which the transformer can be continuously operated without suffering any damage. The lower limit is non-critical. It is nevertheless to be noted that the internal resistance (U_K) of the transformer can increase as a result of the reduced magnetic flux through the core. The prerequisite for a description of the limit values is the transformer load at rated (output) power, expressed as the ohmic or active resistance load.

Rated frequency

The rated frequency (Ref.: VDE 0570, EN 61558, IEC 61558) is the frequency allocated to the transformer for the established operating conditions.

Unless other arrangements have been made, transformers will be designed for 50 to 60 Hz.

Open-circuit current

Open-circuit current is the (apparen) input current of the non-loaded transformer at the rated input voltage and the rated frequency.

Because of non sinusoidal shape of the curve, measurements are to be carried out using "true effect" testing equipment. The size of the open-circuit current can also vary within a production lot, mainly because of non-constant core sheet characteristics. The open-circuit current should, however, be lower than the input current at rated (output) power in order to avoid any possible overloading of the input (primary) coil of the transformer during open-circuit operation.

Open-circuit output

Open-circuit output is the (effective) input power of the non-loaded transformer at the rated input voltage and the rated frequency. This power leads to a heating-up of the transformer which is not under a load because of the magnetisation of the core.

Input (primary) coil

The input coil is the coil established for the connection with the electrical supply circuit.

There can be several coils for series and parallel connections, taps can also be present. Depending on number, amount of insulation required and percentile deviation of the taps in relation to rated input voltage, an increase in core power (structural size) may become required for the transformer.

An increase of core power is absolutely mandatory when several different input voltages are to be set up as alternatives. If for example 230 V and 400 V are called for in conjunction with unchanging rated (output) power, then the coil space required is increased by about 21 % (coil former with a single chamber). This comes about since one coil needs to be on hand for the full power of the 230 V input voltage, another one needs to be there for 230 V to 400 V. The core power of the transformer is thus to be set at a level circa 21 % higher than the rated (output) power.

Rated input voltage		**Rated (output) power** x factor = core power
	I-Kammer	**II-Kammer**
115 + 230 Vac	1.25	1.50
230 + 400 Vac	1.21	1.43
230 + 500 Vac	1.27	1.54
230 + 400 + 500 Vac	1.31	1.63
230 + 400 + 440 + 500 Vac	1.32	1.64
400 + 440 Vac	1.05	1.09
400 + 440 + 500 Vac	1.11	1.21

Rated output voltage

In cases where the transformer is connected to rated input voltage, in the presence of rated frequency and loading with an impedance (which, in connection with rated output voltage and by using the rated power factor for alternating current, results in rated power) the output voltage may not deviate from its rated value by more than the following:

- 10 % for the output voltage of unconditionally short circuit-proof transformers with a rated output voltage,
- 10 % for the highest output voltage of unconditionally short circuit-proof transformers with more than one rated output voltage,
- 15 % for the other output voltages of unconditionally short circuit-proof transformers with more than one rated output voltage,
- 5 % for the output voltages of other transformers.

The percentage values listed above are increased by 5 for transformers with rectifiers.

Measurement is carried out after warmed-up operating temperature has been reached (equilibrium state) and (unless other arrangements have been made) at rated ambient temperature and rated (output) impedance for which the rated power factor = 1.

For transformers with several output coils, each coil group will be simultaneously loaded, unless some other arrangement has been established.

For transformers with attached rectifiers, the output voltage will be measured at the terminations of the direct current circuit with a voltage measuring device as an arithmetic mean value, insofar as the voltage is not expressly specified as an effective value..

Open-circuit operation output voltage

The open-circuit operation output voltage (Ref.: VDE 0570, EN 61558, IEC 61558) is the output voltage of the non-loaded transformer with rated input voltage and rated frequency. For safety, isolating and control transformers, the highest permissible values for deviation in terms of rated output voltage are to be observed to some extent. The respective determinations are specified in Part 2 of the Standard named above for the various transformer types.

$$\text{deviation} = \frac{\text{open-circuit operation output voltage} - \text{nominal output voltage} \times 100\ \%}{\text{nominal output voltage}}$$

Example: Isolating transformer with 230 V rated output voltage and 238 V open-circuit operation output voltage

$$\text{deviation} = \frac{238\text{ V} - 230\text{ V} \times 100\ \%}{230\text{ V}} = 3.48\ \%$$

Common presentations are also, e.g.:

$$\text{open-circuit operation output voltage} = \text{nominal output voltage} \times \text{Factor}$$

Example: Control transformer with 24 V rated output voltage

$$\text{open-circuit operation output voltage} = 24\text{ V} \times 1.10 = 26.4\text{ V}$$

Note: In accordance with VDE 0113, IEC 60204 and VDE 0570, EN 61558, IEC 61558, the open-circuit operation output voltage for control transformers may not increase by more than a maximum of 10 %!

or

$$\text{Regulation} = \frac{\text{open-circuit operation output voltage} - \text{nominal output voltage} \times 100\ \%}{\text{open-circuit operation output voltage}}$$

Example: Safety transformer with 11.5 V rated output voltage and 14 V open-circuit operation output voltage

$$\text{Regulation} = \frac{14\text{ V} - 11.5\text{ V} \times 100\ \%}{14\text{ V}} = 17.9\ \%$$

In cases of rated (output) power levels of over 1 kVA, the short circuit voltage (as a percentage of rated input voltage) will be specified. Short circuit voltage (%), deviation (%), regulation (%) and open-circuit voltage factor (factor – 1.00 = %) can be roughly compared with one another.

Output (secondary) coil

The output coil is a coil designated for connection with a distributing network, a device, a piece of equipment or another installation.

There may be several coils and taps present. Depending on number and on the amount of insulation required, an increase of the core power (structural size) of the transformer could become necessary. Unless other arrangements have been made, this is the way that taps are designed for the intensity of the current at the highest voltage level and they can carry loads only in alternation.
If the full rated (output) power is to be available from every tap and/or if several output coils are desired which are not simultaneously able to carry loads or to carry changeable loads, then the need for winding space increases. The core power of the transformer is thus to be set at a level higher than the rated (output) power.

Rated power

The rated power (Ref.: VDE 0570, EN 61558, IEC 61558) is the product arising from rated output voltage and rated output current or, in cases of multiphase transformers, the product times $\sqrt{n}$, where n is the total number of the phases.

Note: When single-phase transformers (e.g. control transformers) are being connected to two external conductors of a three-phase network, the number of phases is to be set to 1 for the rated power of the transformer.

In cases where the transformer has more than one output coil or an output coil with taps, the rated power is the sum of the products of rated output voltage and rated output current of all circuits which can be loaded simultaneously.

Installation altitude

The calculation of the transformers is at an altitude of max. 1000 m above sea level. A higher installation altitude require a power reduction caused by the lower heat dissipation.

Installation altitude in meters above NN	power x factor
1500	0.98
2000	0.97
2500	0.95
3000	0.93
3500	0.92
4000	0.90
4500	0.88
5000	0.86
5500	0.85
6000	0.83

Ambient temperature and rated power

With rated ambient temperature deviating from 40 °C and with reference to insulation material class E, one can proceed approximately as follows:

Rated ambient temperature	Rated (output) power x factor = core power
25 °C	1.14
40 °C	1.00
45 °C	0.93
50 °C	0.87
55 °C	0.80
60 °C	0.73
65 °C	0.67
70 °C	0.60

Core power (structural size) needs to be adjusted to reflect rated (output) power.

Example: How high must the core power of a transformer of 100 VA (at 40 °C) be increased in order to be able to operate it at 70 °C

$$P_{core} = \frac{100\ VA}{0.60} = 167\ VA$$

Example: What is the maximum power to be had from a 100 VA transformer (in terms of 40 °C) at 55 °C?

$$P_{max} = 100\ VA \times 0.80 = 80\ VA$$

Excess temperature

The excess temperature is the temperature in the transformer which is created in the established operating conditions of the transformer as a result of self-heating. The maximum permitted excess temperature is calculated from the difference arising between a temperature assigned to the insulation material class and the rated ambient temperature of the transformer. Depending on the insulation material class, the possible excess temperature is also to be reduced for hot spots.

Example: Insulation material class E (120 °C), hot spot 5 °C, Rated ambient temperature 40 °C

$$\Delta T = 120\ °C - 5\ °C - 40\ °C = 75\ °C$$

Short-circuit-proofness

Transformers are divided up according to their type of short-circuit-proofness (Ref.: VDE 0570, EN 61558, IEC 61558):

A **short circuit-proof transformer** is a transformer for which the temperature does not exceed established limit values when the transformer is overloaded or short-circuited and which continues to fulfil all the requirements of the Standard listed above once the overload or the short circuit has been eliminated.

- An **unconditionally short circuit-proof transformer** is a short circuit-proof transformer without a protective device for which the temperature does not exceed the established temperature limit values in cases of overload or short circuits which can continue to be operated after the overload or the short-circuit has been eliminated.
  Note: Due to physical limitations, this kind of transformer permits only structural designs with low levels of rated power of up to circa 4 VA. The open-circuit voltage factor can thereby take on a value of up to 2.00. The shape of the curve of the output voltage can deviate from the sinusoidal form. It is not mandatory that unconditionally short circuit-proof transformers need be permanently short circuit-proof.
- A **conditionally short circuit-proof transformer** is a short circuit-proof transformer with a built-in protective device, which opens the electrical circuit or limits the electricity in the input or output circuit when the transformer is overloaded or short-circuited.
  Note: Examples of protective devices are fuses, overload releases, temperature fuses, automatic and non-automatic resetting temperature limiters, posistors and automatic mechanically-triggered protective switches.

A **non-short circuit-proof transformer** is a transformer which is intended to be protected against excessive temperatures by means of a protective device which is not built into the transformer.

Note: Unless other arrangements have been made, the ordering party is responsible for taking measures to protect the transformer.

Low-band magnetic leakage fields

Inductive component parts generate low-band magnetic fields, called forth by the leakage fields of the magnetising procedure at the level of the operating frequency. Effects on neighbouring electrical equipment, devices, apparatus or installations cannot to be ruled out entirely. The degree of the influence is essentially dependent upon an EMC-compliant construction (earthing, shielding) of the components and on their spatial clearance from one another. For the purposes of general estimation and as an aid to project design, the following typical values can apply, based on a rated power of circa 200 VA:

Component part* (without shielding)	**Leakage field induction within the clearance**	
	10 mm	**100 mm**
Toroidal transformer	1.2 mT	0.02 mT
EI-sheathed core transformer	2.2 mT	0.04 mT
EI-sheathed reactor with gap	12 mT	1.30 mT
Magnetic voltage stabilizer	5 mT	0.30 mT

*Reference: magnetic core induction ca. 1.2 T (1 Tesla = 1 Vs/m²), at 50 Hz

For non-critical applications, we recommend a clearance of 50 mm to 100 mm between the components and between them and the shielding (e.g. sheet metal housing). For critical applications (e.g. sensitive measuring amplifiers, digital circuits, monitors), additional EMC shielding measures or greater clearances are generally necessary. However, EMC measures to be carried out depend heavily upon the components utilised and upon the operating parameters of the system, which means that it is impossible to make statements of universal validity.

Core power

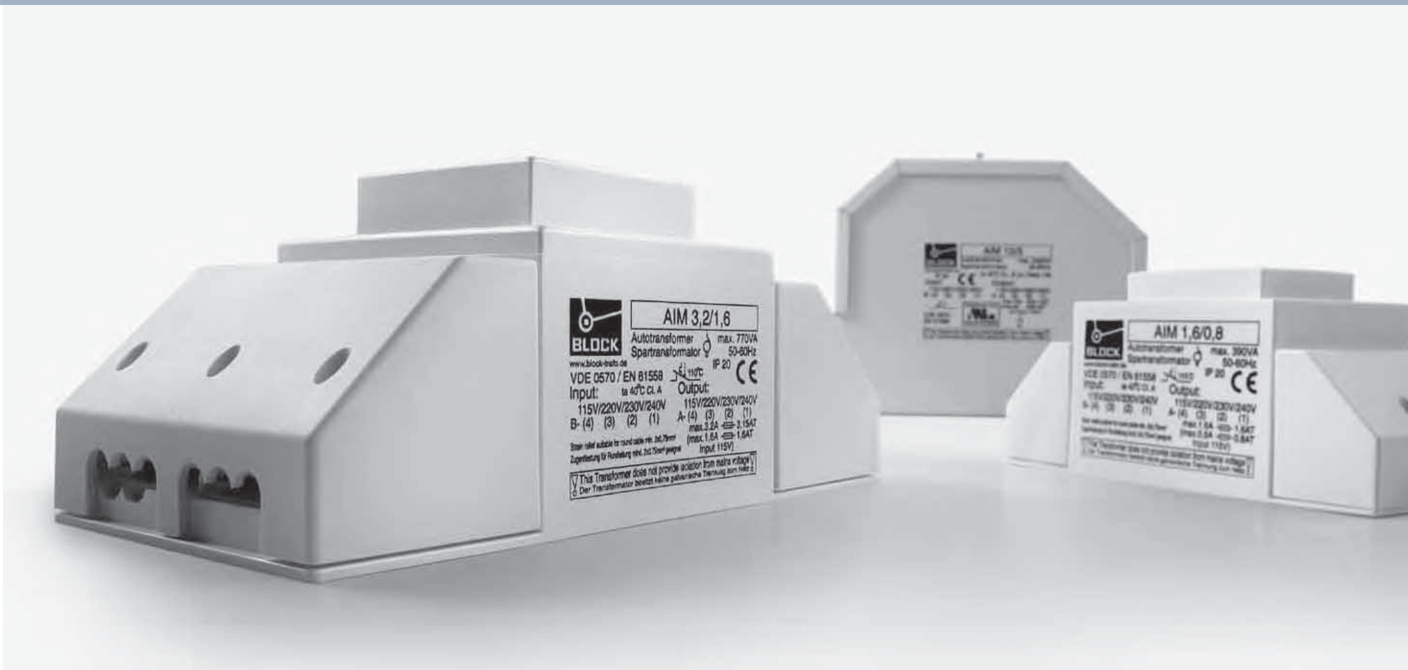
The core power is the power assigned to one particular construction form or structural size, with the specification of particular operating or design characteristics.

Operating characteristics may include, for example, the following:

- Insulation material class E
- Rated ambient temperature 40 °C
- Rated frequency 50 Hz
- Open-circuit operation-output voltage-factor maximum 1.10

Design characteristics may include, for example, the following:

- Type of protection IP 54
- Insulation construction
- Increased need for winding space
- Specification of a particular core type



Autotransformers

Auto transformers are transformers in which input and output coils share common parts (Ref.: VDE 0570 Parts 2–13). For this reason, there is no metallic isolation between the coils.

Requirements

The general statements already made concerning transformers also apply to auto transformers, i.e., such things as protection class, type of protection, insulation material class and rated ambient temperature.

Usually, and unless other arrangements have been made with the ordering party, auto transformers will be manufactured with basic insulation between voltage-bearing parts and the core. Existing taps cannot be subjected to loads simultaneously, unless the dimensioning was especially designed for it.

Standards

Unless otherwise agreed with the buyer, we finished state-of-the-art technology and the following standards:

VDE 0570: Safety of power transformers, power supply units and similar,
Teil 1: General requirements and tests,
Teil 2–13: Particular requirements for auto transformers.

EN 61558, IEC 61558: Safety of power transformers, power supply units and similar,
Part 1: General requirements and tests,
Part 2–13: Particular requirements for auto transformers.

Magnet core power

Magnet core power is the power which would be transmitted to the magnet core as a transformer with separated (spaced apart) coils. In everyday speech, the term “core power” is frequently used for “magnet core power” and “throughput power” for “rated power” in reference to auto transformers.

Auto transformers possess shared input and output coils. For this reason, there is no metallic isolation between the coils. Depending on voltage turns ratio, there is to some extent a considerable reduction of the core power in comparison with a design with separated coils.

$$P_{core} = \frac{U_H - U_N \times P_{nominal}}{U_H}$$

P_{core} = required core power (VA)
P_{rated} = rated power (VA) (throughput power)
U_H = higher voltage (V)
U_N = lower voltage (V)

Example: A load of 400 V/5 kVA is to be modified to suit a network with 460 V.

$$P_{core} = \frac{460\ V - 400\ V}{460\ V} \times 5000\ VA = 652\ VA$$

The required core power of the auto transformer therefore amounts to only 652 VA.

Notes for the low-voltage lightning installation

General requirement

The mounting of low-voltage lighting installations must be carried out in such a way that any danger to persons or property caused by dangerous fault or leakage currents or thermal influences is averted.

Transformers

Use only short circuit-proof transformers in accordance with VDE 0570/ EN 61558/ IEC 61558.

Note: even conditionally short circuit-proof safety transformers are short circuit-proof.

Take care to note temperature of the air surrounding the transformer.
Note:

- Do not operate transformers without a ta-specification with ambient temperatures above 25 °C.
- Transformers with a ta-specification are to be operated at rated ambient temperatures up to the specified value.

Mount transformers with a minimum clearance of about 30 cm from one another in order to avoid heat buildup and the influence of magnetic leakage fields.

Only use transformers with MM designation when the behaviour in fire of the surrounding construction materials (wood, furniture, intermediate ceilings) is unknown.

Charge the transformers to in order to 100 % capacity as much as possible, in order to achieve an optimal voltage adjustment to the halogen lamps.

Install transformers with a rated output voltage of preferably 11.5 V for supplying 12 V halogen lamps in order to extend the service life of the halogen lamps and/or in order not to shorten it when exposed to mains overvoltage.

If the transformer is also to take on the line safety of connected secondary power lines, then the transformer must be an appropriate one for this purpose.

If the transformer is to supply a line system with two directly touchable lines (rope cable systems, conductor rails), then wiring must be carried out with safety device (e.g. electronic automatic current controller).
Safety goal:

- The lamp output is monitored at ±25 W.
- In cases where this is exceeded or where it is not achieved, a switch-off takes place within 0.3 s.

Please observe the regulation for preventing damage “Low-voltage illumination installations and systems” VDS 2324 from the Verband der Sachversicherer e. V. (Association of Property Insurers), Cologne.

The transformer should be placed near to the illumination equipment, since there are relatively high currents flow in low-voltage installations, thus meaning that the conductor length, the conductor cross-section and the voltage drop connected with them must all be considered.
Note:

- Maintain a minimum clearance to the transformer of approx. 40 cm to 50 cm, in order to keep away from heat build-up and heat radiation.
- In order to avoid overheating caused by heat radiation, never direct the light of the halogen lamp at the transformer.
- Cold light reflector lamps radiate a high amount of infrared heat radiation, also towards the back through the reflector.
- Only heat-resistant connection lines are to be used for direct hook-up to.

Mount the transformers in such a way that no oscillations can be transmitted in order to avoid unwanted humming noises. Thin-walled mounting plates (such as a loudspeaker diaphragm) can even increase the mechanical 100 Hz vibration of the transformer!

Mount the transformer in such a way that blown fuses can be replaced without difficulty.

Note: Transformers with integrated semiconductors and resetting temperature limiters are once again ready for operation after elimination of the error, mains interruption and cooling.

Switch on transformers or transformer groups with switch-on current limiters, so that it will not be able to lead to the triggering of safety cutouts connected in series.

When using dimmer operation for brightness setting of the halogen lamps, use only those transformers which are suitable for this.
Note:

- use only special transformer dimmers.
- take into account the efficiency of the transformer.
- note base load as specified by the dimmer manufacturer.
- if the supplying of several transformers is handled by a single dimmer, then the transformers utilised should all be of the same type, in order to minimise compensating currents or any oscillation behaviour.
- Fine-tune the arrangement of the wiring and the cross-section of the wires to meet the requirements of the phase control in order to minimise electromagnetic interference fields and oscillation behaviour.

BLOCK

Halogen lamps

Note: The heat resistance R of the halogen lamp is of slightly lesser low impedance with undervoltage and of slightly greater high impedance with overvoltage.

The power consumption of a halogen lamp can deviate from the rated power by as much as approx. 10 %.

Some kinds of dimmer operation used for adjusting the illumination intensity of halogen lamp types can lead to corrosion of the helical parts and blackening of the quartz bulb in connection with low levels of dimmer voltage. The halogen lamp should be periodically operated at maximum dimmer voltage to ensure that the halogen circuit process is able to take place.

Typical operating conditions			
Operating voltage	**12.5 V**	**12.0 V**	**11.5 V**
Service life	50 %	100 %	180 %
Lightning current	120 %	100 %	80 %
Lamp current	102 %	100 %	98 %
Lamp current in the example	4.26 A	4.17 A	4.07 A

Halogen lamp 12 V/50 W (R = 2.88 Ω)

Loading capacity of cables and power lines

Note:

- based upon VDE 0100 Part 559
- based upon DIN VDE 0298
- in terms of copper wires
- in terms of two loaded PVC-insulated lines and cable
- in terms of 25 C ambient temperature
- in terms of wire placement method B2, placement in electric installation tube or channel (wire lines or multi-wire lines on or in walls or concealed or on the floor)

Electric current loading capacity I_Z (A)	10.5	16.5	22.0	30.0	39.0	53.0
Rated cross-section (mm²)	*1.0	1.5	2.5	4.0	6.0	10.0

*The CU wire cross-section diameter must be at least 1.5 mm². It may be reduced to 1 mm², if:

flexible lines are used,

- no overloading is possible,
- and a line length of 3 m is not exceeded.

Conversion factors for deviating ambient temperatures:

Ambient temperature (°C)	25	30	35	40	45	50
Electrical current conversion factor	1.0	0.94	0.88	0.82	0.75	0.67

Conversion factors for the accumulation of cables and power lines in the electrical installation pipe or channel:

Number of simultaneously loaded electrical circuits	1	2	3	4	5	6
Electrical current conversion factor	1.00	0.80	0.70	0.65	0.60	0.57

Note: The loading capacity of cables and lines offers information regarding the thermal current carrying capacity, but not about voltage drop, and therefore not about length.

Allocation of the overvoltage protection organs for protection in case of overload

The loading capacity of cables and lines presumes that there is a correct allocation of the overvoltage protection organs (protective devices), such as line protection switches and fuses.

Note: If the transformer is also to assume the line safety of connected secondary power lines, then the transformer must be an appropriate one for this purpose.

Generally speaking, the allocation rules apply (Ref.: VDE 0100 Part 430):

- $I_B \leq I_N \leq I_Z$
- $I_2 \leq 1.48\ I_Z$

with

I_B = operating current of the electrical circuit
I_Z = current load capacity of the line or the cable
I_N = rated electrical current of the protective device
I_2 = conventional tripping current of the protective device (conventional fusing current)

Example: A CU line of 1 mm² is to be shielded against overload with a protective device with a rated electrical current of 10 A and a triggering characteristic B or C.

I_B = 10 A
I_Z = 10.5 A (for 1 mm2 CU with PVC insulation at 25 °C ambient temperature, based upon VDE 0298)
I_N = 10 A
I_2 = 14.5 A (multiplied by 1.45 with B or C, in accordance with VDE 0641)

- $I_B \leq I_N \leq I_Z$
  10 A ≤ 10 A ≤ 10.5 A
  is fulfilled
- $I_2 \leq 1.48\ I_Z$
  14.4 A ≤ 1.45 A ≤ 10.5 A
  is fulfilled

Result: The line is protected against overload.

Voltage drop on cables and power lines

In addition to thermal loading capacity, voltage drop also plays an essential role in cables and power lines. A voltage drop of
2.5 % to 3 % has established itself as a practice-oriented compromise between the material costs for wiring and a still-bearable brightness loss for lighting equipment.

The length of the cables and power lines can be calculated with sufficient precision in accordance with:

$$L = \frac{A \times U_B \times U_B \times æ \times dU}{2 \times P \times 100}$$

L = 2-wire cable or length between transformer and halogen lamp (m)
U_B = rated voltage of the transformer (V)
dU = voltage drop (%)
A = cross section of a cable or a conductor (mm^2)
P = rated power of the lamp(s) (W)
æ = electrical conductivity (CU= 56 m/Ω mm^2)

Given a voltage drop of 3 % and a rated transformer voltage of 11.5 V, the following power line lengths emerge. It must be remembered in this connection that the same voltage drop is to be found on all cable and power line lengths, in order to avoid brightness differences in conjunction with the use of the same lighting equipment.

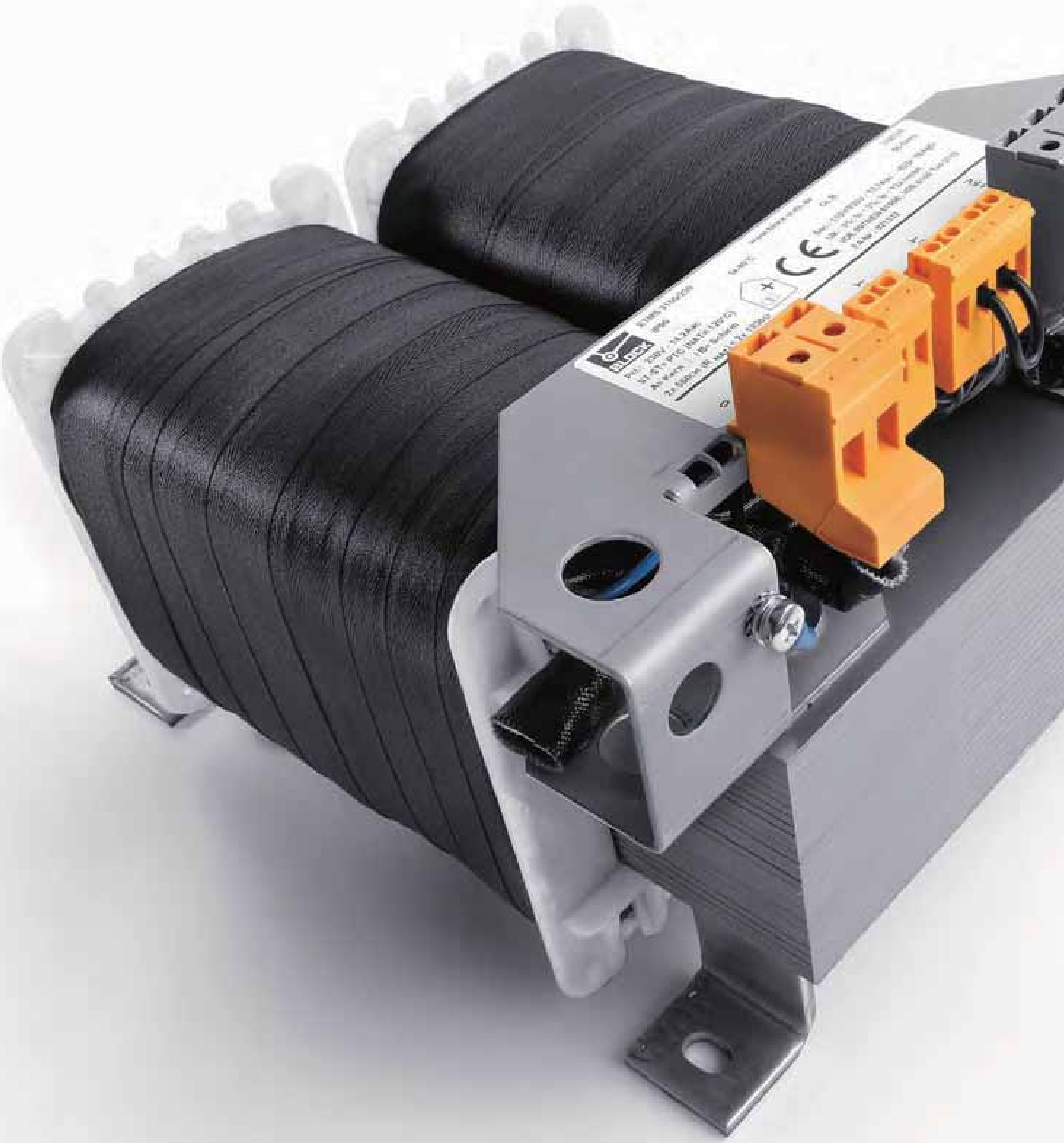
Note: Take into account loading capacity of cables and power lines, as well as the allocation of the overvoltage protection features.

Cable and lead lengths in relation to 3% voltage drop::

Lamps rated power	**Electrical current 11.5 V**	**Length of the 2-wire CU power line with cross-section**		
		2x 1.0 mm²	2x 1.5 mm²	2x 2.5 mm²
10 W	0.8 A	11.11 m	16.66 m	27.77 m
20 W	1.6 A	5.56 m	8.33 m	13.89 m
35 W	2.8 A	3.17 m	4.76 m	7.94 m
50 W	4 A	2.22 m	3.33 m	5.56 m
75 W	6 A	1.48 m	2.22 m	3.70 m
100 W	8 A	1.11 m	1.67 m	2.78 m
150 W	12 A	*0.74 m	1.11 m	1.85 m
200 W	16 A	*0.56 m	0.83 m	1.39 m
250 W	20 A	*0.44 m	*0.67 m	1.11 m
300 W	24 A	*0.37 m	*0.56 m	*0.93 m
350 W	28 A	*0.32 m	*0.48 m	*0.79 m
400 W	32 A	*0.28 m	*0.42 m	*0.69 m
450 W	36 A	*0.25 m	*0.37 m	*0.62 m
500 W	40 A	*0.22 m	*0.33 m	*0.56 m
550 W	44 A	*0.20 m	*0.30 m	*0.51 m
600 W	48 A	*0.19 m	*0.28 m	*0.46 m

Lamps rated power	**Length of the 2-wire CU power line with cross-section**			
	2x 4.0 mm²	2x 6.0 mm²	2x 10 mm²	2x 16 mm²
10 W	44.45 m	66.65 m	111.1 m	177.7 m
20 W	22.22 m	33.33 m	55.55 m	88.87 m
35 W	12.70 m	19.04 m	31.74 m	50.78 m
50 W	8.89 m	13.33 m	22.22 m	35.55 m
75 W	5.93 m	8.89 m	14.81 m	23.70 m
100 W	4.44 m	6.67 m	11.11 m	17.78 m
150 W	2.96 m	4.44 m	7.41 m	11.85 m
200 W	2.22 m	3.33 m	5.55 m	8.89 m
250 W	1.78 m	2.67 m	4.44 m	7.11 m
300 W	1.48 m	2.22 m	3.70 m	5.93 m
350 W	1.27 m	1.90 m	3.17 m	5.08 m
400 W	*1.11 m	1.67 m	2.78 m	4.44 m
450 W	*0.99 m	1.48 m	2.47 m	3.95 m
500 W	*0.89 m	*1.33 m	2.22 m	3.56 m
550 W	*0.81 m	*1.21 m	2.02 m	3.23 m
600 W	*0.74 m	*1.11 m	1.85 m	2.96 m

*Do not use, because the demand of current carrying capacity I_z of cables and wires is not fulfilled!



Transformers used for medical purposes

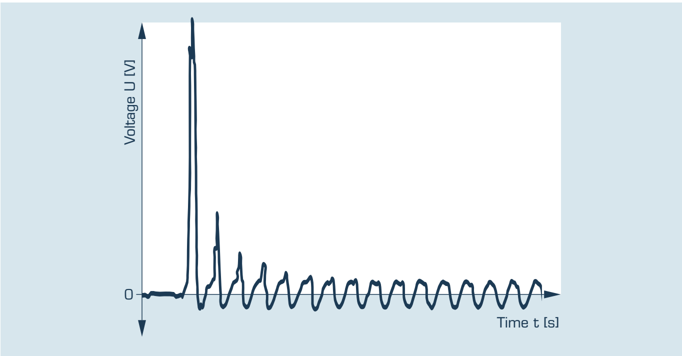
The requirement

For isolating transformers, the following requirements apply, in accordance with VDE 0570 part 2–15, EN 61558-2-15:

- Part 13.3: The switch-on current is not permitted to be in excess of twelve times of the curve summit value of the rated input current.

The switch-on

The oscillogram shows the typical curve progression of the primary switch-on current of a transformer:



The switch-on current is reduced in accordance with an e-function, in order to die off after about 100 ms. The current peaks reach their maximum in unfavourable switch-on moments: in the mains voltage zero crossing, in open-circuit operation (without load) and with high remanence of the iron core.

The rated electrical current

The rated primary current of a transformer comes into force with rated primary voltage, rated frequency and orderly operation with rated power load. If the rated primary current is not known or cannot be determined using measurement technology, then an approximate determination can take place as follows:

$$I_B \approx \frac{P_B}{\eta \times U_B} \text{ (A)}$$

P_B = rated (secondary) power (VA) divided by 3 in the case of alternating current
U_B = rated primary voltage (V) with alternating current combined voltage L – N
η = efficiency of the transformer
typically 0.94 with 3,150 VA
typically 0.95 with 5,000 VA
typically 0.96 with 8,000 VA

Calculation of the peak value of the rated primary current yields:

$$I_S = I_B \times \sqrt{2} \text{ (AS)}$$

The switch-on current factor

Based on the previous models, the switch-on current factor can be defined as the ratio of the maximum switch-on current of the unloaded transformer to the peak value of the rated primary current of the loaded transformer.

The measuring

Determination of switch-on currents using measurement techniques previously proved itself to be expensive and hardly possible to carry out on location in the context of a construction site. The switch-on current is determined by means of a storage oscillograph using a low-impedance shunt (connected in series to the primary coil of the transformer to be tested). Frequent repetition of the switch-on process raises the probability of measuring the maximum value of the switch-on current at the least favourable switch-on moment.

Computation of the switch-on current factor

Starting from the measurement of the switch-on current and of the rated electrical current, the switch-on current factor can be computed as follows:

$$F = \frac{I_{on\,max}}{I_B \times \sqrt{2}}$$

For isolating transformers used for medical purposes with VDE 0100 part 710, VDE 0570 part 2–15, EN 61558-2-15, the switch-on current factor F must be less than 12.

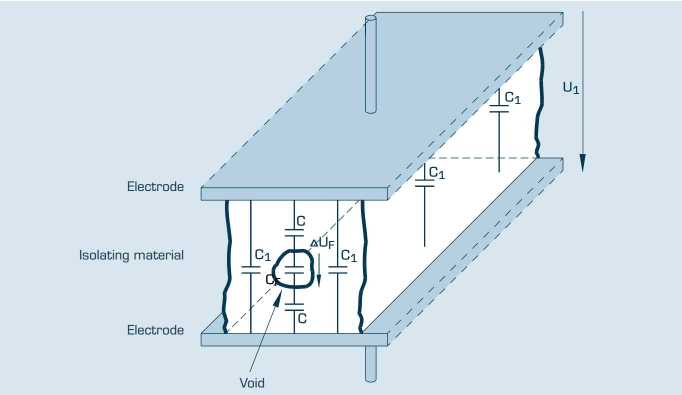
Partial discharge measurement on transformers

In the published standards for devices, partial discharge ability is also required, in addition double or reinforced insulation, to ensure electrical separation in component parts and other electrical modules. An example of this the standard norm, "Outfitting of high-voltage installations with electronic equipment", VDE 0160/ EN 61800/IEC 61800. This standard norm contains a partial discharge test on the insulation system of the winding materials used. The correctly-applied partial discharge measurement offers a non-destruction testing procedure which can be applied for the qualitative evaluation of an insulation system.

What are partial discharges?

This has to do with a stochastic or random discharge between two voltage-bearing electrodes which bridge over only a partial distance of the clearance between the electrodes. They appear first at the contact surface or also sometimes physically displaced within an insulation configuration. If this occurs in a solid insulation material, then it is referred to as an internal partial discharge (PD), the causes of which are to be found either in defective manufacturing technology or in the use of unsuitable materials. Numbered among the latter for actual insulation materials are hollow spaces, voids and non-homogeneities which cannot be ruled out to 100 %.

A simplified insulation configuration between two electrodes is provided in the illustration in order to better clarify the processes which contribute to the formation of a partial discharge. The individual capacitors illustrate the course of the lines of electric flux. C_F indicates the concentration of the lines of electric flux in the flaw position, C symbolises the course of the lines of electric flux from the surface of the insulating material to the walls surrounding the hollow space. If the initial voltage in this configuration crosses over the flaw position which is to be considered a voltage- dependent radio link (C_F), then a voltage drop U_F occurs there, which causes a change in the charge q_F. The voltage leap at the electrodes caused by this can be used for an analysis of the PD activity of the insulating material.

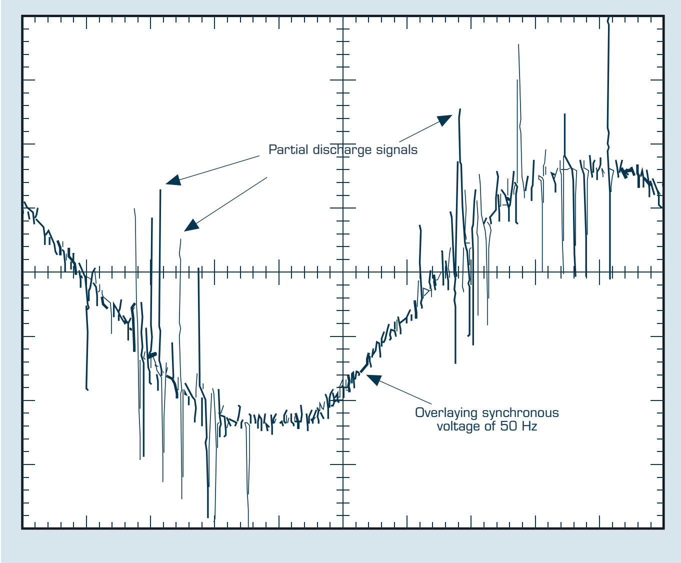


What is the effect of partial discharges?

Every discharge caused by a PD causes a weakening of the material surrounding it. Continuous PD leads to a permanent destruction processes in the insulator. When the damage reaches an advanced state it results in the loss of insulation capability. Therefore, in order to ensure a permanently reliable insulation system configuration, it must be a requirement that:

- no PD shall occur in the insulation system in connection with the maximum allowable operating voltage plus a safety margin
- PD caused by transients shall terminate automatically after cessation of the overvoltage
- PD freedom shall be designed for the maximum peak value plus a safety margin for amplitude stresses with continuously repeating voltage impulses

The previously won research results show a new way for evaluating insulation systems the low-voltage technology transformers. It is becoming possible to make more than just a vague Good/Bad statement about safe electrical separation inside a transformer – now one can also evaluate its quality, which also means a statement predicting its service life.



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Instructions for interference protection transformers

Mains interruption and their causes

Mains interruption cause systems failures and impair the functioning of installations, computers and highly sensitive electronic consumers and equipment. Investigations in Central Europe have shown that 3/4 of all sporadically-occuring errors and faulty functioning among highly-sensitive consumers are based on defective quality of the power supply.

The most common occurrences are:

- long-term network overvoltage
- long-term network undervoltage
- interference impulses and transients
- voltage drops and voltage surges
- electrical disturbance
- short-term mains interruption
- long-term mains interruption

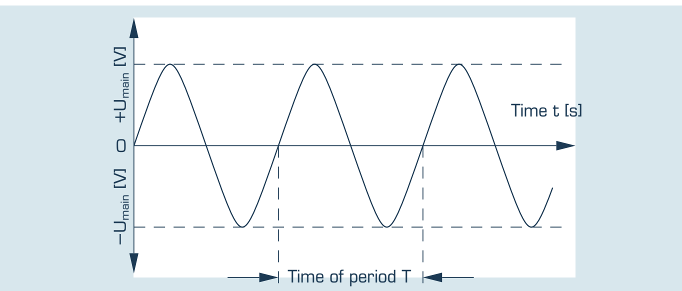
Mains interruptions can result from a wide variety of causes, e.g.:

- switching procedures in the mains
- long cable paths in the mains
- environmental influences, such as storms
- mains overloading

Typical causes for mains interruptions generated in-house include, for example:

- thyristor-controlled operating mechanisms
- elevators, air conditioning systems, copy machines
- motors, compensation installations
- electrical welders, large machines
- switching illumination devices

Types and description of mains interruptions

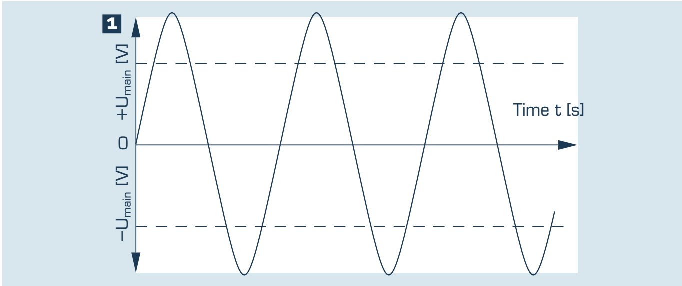


Oszillogramm einer Netzsinusspannung ohne Störungen

1. Mains overvoltage

Mains voltage in excess over a long period by more than +6 % (VDE 0175/HD 472 S1/ IEC 60038).

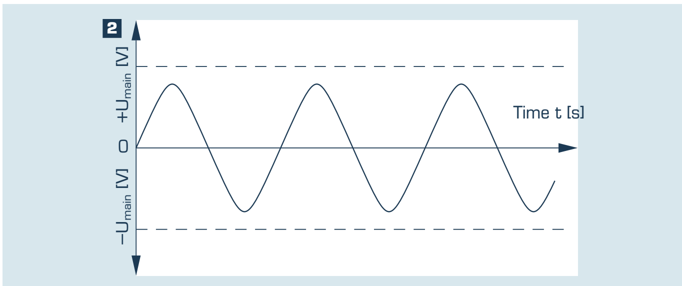
Circa 15–20 % involvement in mains interruptions. Leads to overheating and thermal destruction of components. Causes total failure.



2. Mains undervoltage

Mains voltage fails to achieve minimum levels over a long period by more than –10 % (VDE 0175/HD 472 S1/IEC 60038).

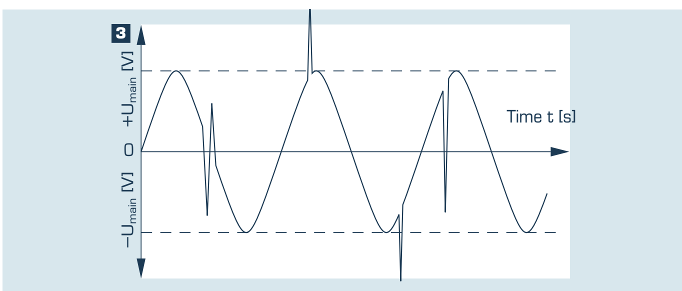
Circa 20–30 % involvement in mains interruptions. Leads to non-defined operating states for the mains units of the components, caused by deficient mains stabilisation. Causes data errors.



3. Interference impulses

Energy-rich impulses (e.g. 700 V/1 ms) and energy-poor transients (e.g. 2500 V/20 μs), by switching processes in the mains.

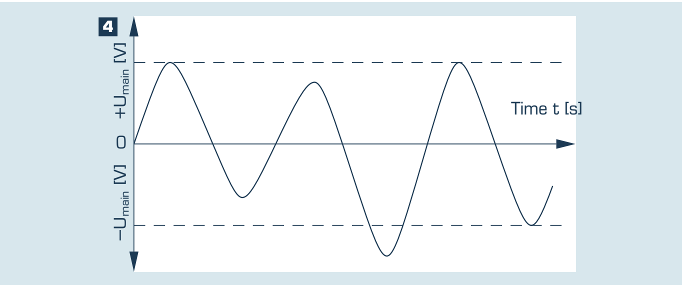
Circa 30–35 % involvement in mains interruptions.



4. Voltage drop and voltage surge

Voltage level changes abruptly and in an uncontrolled manner, e.g. through load changes and long wiring arrangements.

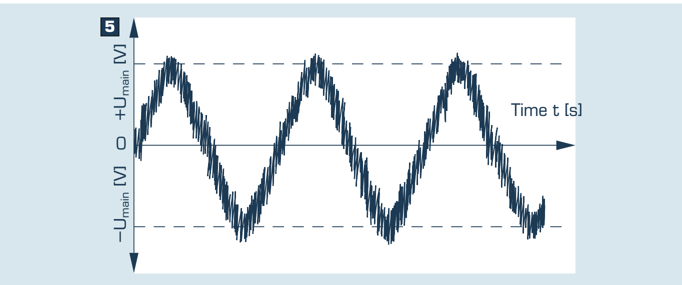
Circa 15–30 % involvement in mains interruptions. Leads to non-defined operating states and can cause the destruction of components. Cause data errors.



5. Electrical noise

The mixture of frequencies superimposed on the mains by poor earthing and/or severe HF disrupters, such as radio stations, storms.

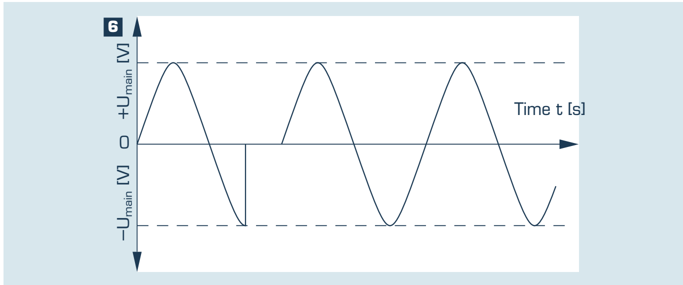
Circa 20–35 % involvement in mains interruptions. Leads to non-defined operating states for the mains units of the components. Causes data errors.



6. Short voltage interruption

Short-term (up to circa 10 ms) interruption of the mains voltage through short-circuit in neighbouring networks or by startup of large electrical machines.

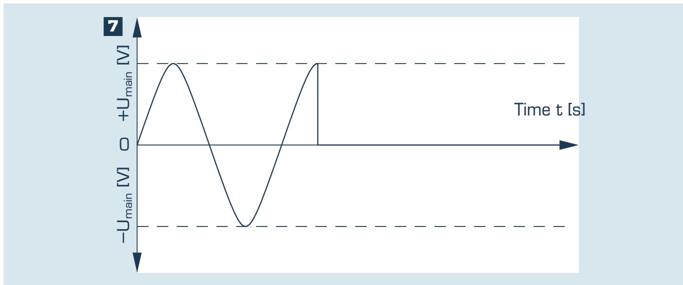
Circa 8–10 % involvement in mains interruptions. Leads to non-defined operating states for the mains units of the components, particularly those with insufficient mains bridging. Causes data errors.



7. Long voltage interruption

Long (more than circa 10 ms) interruption of the mains voltage.

Circa 2–5 % involvement in mains interruptions. Causes data errors.



Countermeasures and their effect

Countermeasure	1	2	3	4	5	6	7
Mains socket	no	no	no	no	no	no	no
Mains socket via seperate power supply lines	no	no	conditionally	conditionally	no	no	no
Isolating Transformator e.g.: BLOCK NTT, ETTK …	no	no	conditionally	no	conditionally	no	no
Interference protection transformer, e.g.: BLOCK STT, SMTT …	no	no	yes	no	yes	no	no
Magnetic voltage stabilizer, e.g.: BLOCK KH, BSV, BSD …	yes	yes	conditionally	yes	conditionally	yes	no
Online UPS	yes	yes	yes	yes	yes	yes	yes

= no
= conditionally
= yes

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Evaluation of the efficiency

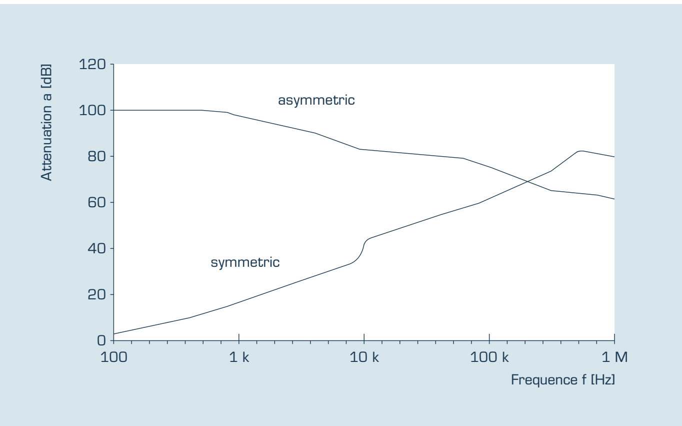
The voltage attenuation a (dB, decibel) describes a logarithmic ratio between two electrical voltage values:

a = 20 x lg (U1 : U2) [dB]

Values often applied for U1 : U2 include:

0 dB = 1 : 1
3 dB = 1 : 1.41
6 dB = 1 : 2
10 dB = 1 : 3.16
20 dB = 1 : 10
40 dB = 1 : 100
60 dB = 1 : 1,000
80 dB = 1 : 10,000
100 dB = 1 : 100,000
120 dB = 1 : 1,000,000
140 dB = 1 : 10,000,000

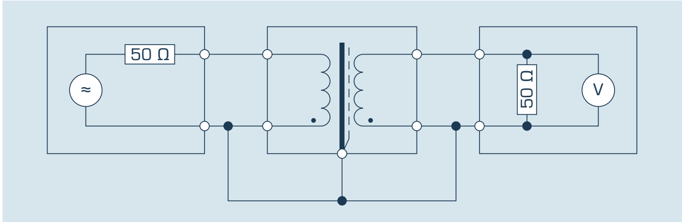
In cases of Interference protection transformers and magnetic voltage stabilisers, it is desirable to obtain an attenuation of interference which is as high as possible. Depending on a (sine) measuring frequency, If one applies the associated attenuation a (calculated according to the formula shown above), then one will obtain the attenuation characteristic curve:



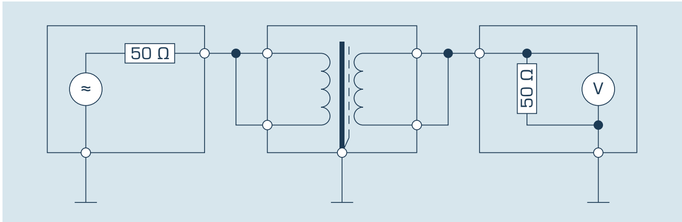
The observation, assessment takes place here for the frequency range up to 1 MHz. An essential distinction is made in accordance with two types of mains borne interference:

- **Symmetrical interference**
- **Asymmetrical interference**

Symmetrical interference occurs between the two power supply lines (L and N). Below the associated basic measurement configuration



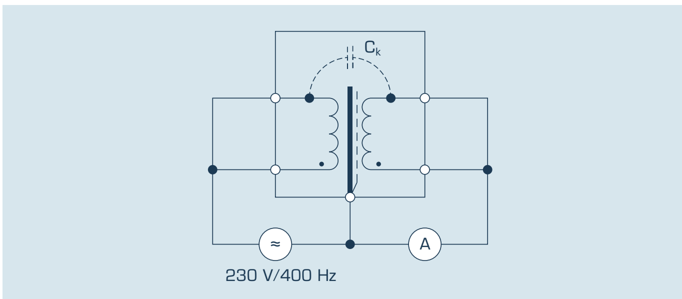
Asymmetrical interference occurs between one of the two power supply lines (L, N) and earth (PE). Below the associated basic measurement configuration



The attenuation represents a non-system-dependent evaluation criterion, preferably with real terminal resistors of 50 Ω, and based on a standardised norm measuring procedure (Ref.: CISPR 17).

Coupling capacity

The coupling capacity represents a measure for the possible transmission of interference between the input and the output sides in cases inductive components are present, such as transformers with metallic isolation of the coils. The value of the coupling capacity should be kept as small as possible and can be influenced by design measures. The decisive influence on the determination of the coupling capacity is the selection of the applied measurement methods and measurement frequencies (despite theoretical frequency independence). In addition, for direct measurement using a C-measuring bridge, a measuring configuration using a test voltage selected to reflect orderly operation appears to make more sense:



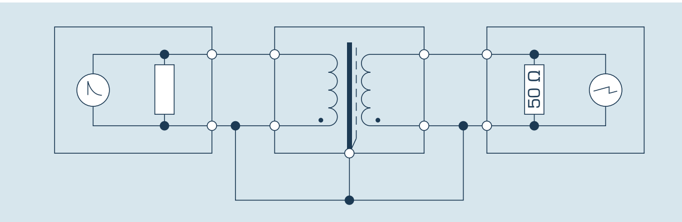
The flowing electrical current is measured by means of the coupling capacity, taking into account the interference suppression measures (e.g. shield and core earthing), in series connection to the testing generator. The coupling capacity C_K is calculated using:

$$C_K = \frac{I}{2 \times \pi \times f \times U} \text{ [F]}$$

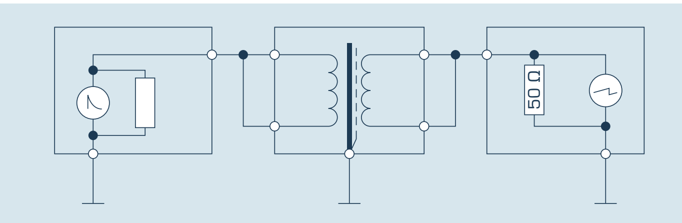
I = electrical current A
π = 3.14
f = frequency Hz
U = voltage V

Impulse attenuation

The specification of the voltage impulse attenuation in dB is a further criterion for the evaluation of the interference protection characteristics for inductive component parts such as Interference protection transformers and magnetic interference protection voltage stabilisers. Impulses of many kilovolts (kV) are not at all unknown in networks as the result of the effects of lightning. To simulate the impulse, the standard lightning surge voltage in the form of 1.2/50 µs can be applied. Here possible measurement configurations:



Symmetrical impulse attenuation

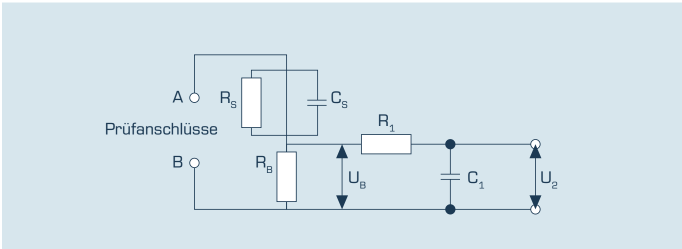


asymmetrical impulse attenuation

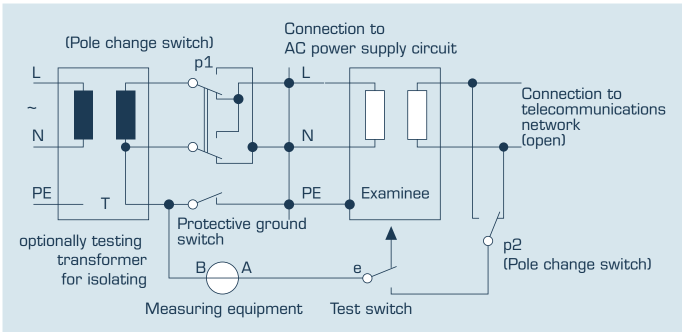
The statements already made concerning attenuation can be applied in their essentials for the determination of the impulse attenuation. One difference, however, is that an impulse with a buildup time of 1.2 µs and a fall time of 50 µs with a voltage level of 5 kV will be applied instead of that of the (sinusoidal) measurement frequencies.

Leakage current

Leakage current is an unwanted flowing alternating current between electrical poles which possesses different levels of voltage potential. The maximum limit values for the leakage current are established in some regulations for installations and devices (e.g. DIN VDE 0100 maximum 0.75 mA, DIN VDE 0750 maximum 0.25 mA). Some of the possible measurement configurations are listed below (e.g. substitute leakage current measurement based upon DIN VDE 0701). The leakage current of a piece of electrical equipment ought to be small, since an additive buildup of current takes place on the mains as a result of the simultaneous operation of several devices.



DIN EN 60990: Measuring circuit for touch current, evaluated for appreciability and reaction



Measurement configuration for the determination of the touch current to EN 60950-1

Insulation resistance

The level of the insulation resistance offers information concerning the insulation capability of an electrical insulation system. For isolating and safety transformers with double or enhanced insulation (Ref.: VDE 0570/EN 61558/ IEC 61558), minimum limit values apply ranging from 2 MΩ to 7 MΩ. As far as the measurement configuration used for the determination of the insulation resistance is concerned, one can proceed the same as with leakage current. One difference, however, is that a direct current voltage of 500 V_{dc} is put into place for testing purposes. The Insulation resistance is then computed as R = U/I.

the EU-Symbol (Communautés Européennes)

The CE marking

General Note

The technical explanations contained here represent points of departure for many areas of application, a number of rules apply in addition to special and exceptional cases. The intention here is to provide a brief introduction into the complex subject field.

EC Designation

EU guidelines have been issued by the Council of the European Union, based upon the Treaty for the Establishment of the European Economic Community (EEC), particularly under Article 100. These EU guidelines are for the purpose of establishing conformity among the legal and administrative regulations of the different member states of the European Union (EU) in cases where differences among national regulations lead to trade restrictions or otherwise hinder the functioning of the internal market of the EU. The guidelines are to be adopted by the national lawmakers within prescribed time periods for the respective national legal system.

The manufacturer is required to attach the EU designation to products which fall under the authority of certain EU regulations as a sign of conformity with them. The products affected are those which are covered by the guidelines made in accordance with the "New Concept" (issued 07.05.1985) which contain requirements governing the technical quality of different products.

EU guidelines are binding legal directives of the European Union. That means that the fulfillment of these requirements is a **precondition for the marketing of the products in Europe. This does not affect the rest of the world trade market.** The attachment of the EU designation confirms product conformity with the corresponding fundamental requirements of all (applicable) guidelines affecting the product. As the documentation of conformity with directives, the EU designation is solely intended for monitoring government agencies. It is, however, often misinterpreted as a "Quality Seal". Because of this, it is unfortunately often demanded in cases where there is no legal requirement for it.

For this reason, our company dispenses with any advertising display of the EU symbol in our catalogue and prospectus pages, since the placement of the EU designation on products is done solely to satisfy a legal requirement which all manufacturers and importers are obligated to adhere to.

Although the EU declaration of conformity on the part of the manufacturer is kept on file only for the purposes of the monitoring agencies (for at least 10 years following the last bringing of the product into circulation), respective copies of it can be made available to customers upon request.

The determination of which guideline(s) is (are) to be applied can be deduced from the EU Declaration of Conformity for the respective product. The directives and their changed directives most commonly applied to our company's range of products are:

1. The Low Voltage Directive (72/23/EEC) for electrical equipment to be used with a rated voltage of between 50 Vac and 1000 Vac and between 75 Vdc and 1500 Vdc.

Title: Directive of the Council for the Establishment of Conformity among Legal Directives of the Member States with respect to Electrical Equipment for Use between Certain Voltage Limits 73/23/EEC of 19. 02. 1973

Almost all of the products in our manufacturing program fall under the area of application of the Low Voltage Directive. The conformity of each piece of electrical equipment, every device, every system and every installation with the safety requirements of the directive is to be certified by

2. The EMC directive (89/336/EEC) for devices which could cause electromagnetic interference or whose operation could be impaired by this kind of interference.

Title: Directive of the Council for the Establishment of Conformity among Legal Directives of the Member States with respect to Electromagnetic Compatibility 89/336/EEC of 03. 05. 1989

Legal basis:
For the purpose of establishing conformity among the legal directives of the member states, the Council of the European Community issued a binding directive for its members on 03. 05. 1989, which was in turn put into effect on 09. 11. 1992 by the Federal Republic of Germany in the form of a federal law governing electromagnetic compatibility (EMVG). The Bureau of Directive for Telekommunikation und Post (RegTP) and its external offices were charged with responsibility for the implementation (monitoring) of the EMC law.

Definition, in accordance with the following extract from Article 1:
Electromagnetic compatibility is the ability of an apparatus, equipment or a system to operate satisfactorily in the electromagnetic environment without itself causing electromagnetic interference while doing so which would be unacceptable to any of the devices, installations or systems present in this environment.

Area of application, in accordance with the following extract from Article 2:
This directive applies to all devices which could cause electromagnetic interference or whose operation could be impaired by such interference.

Note: "Devices" (in accordance with Article 1) consist of all electrical and electronic apparatuses, installations and systems which contain electrical and/or electronic modules.

Fundamental procedural methods:
Starting 01. 01. 1992 (with transition grace period until 31. 12. 1995), only those electrical and electronic devices, systems and installations may be brought into circulation or put into operation in the European Union which are in conformance with the established EMC safety requirements contained in the directive. The conformity of every device, every system and every installation with the safety requirements of the directive is to be certified by the manufacturer by means of an EU Declaration of Conformity and to mark the product with the EU Sign of Conformity.

Modules which are not required to carry the designation of conformity:
For the purposes of the EMC directive, a module is defined as any element which is used for installation in a device but which possesses no function of its own and which is not intended for use by an ultimate consumer. In accordance with Article 1 of the EMC directive, modules are therefore not devices and from the onset do not fall under the jurisdiction of this directive.

Examples:

a) **Modules (for circuit boards, devices, control cabinets)**, which as built-in components are not required to bear the EU designation sign, such as resistors, capacitors, inductance, integrated switching circuits.

b)**Modules** which are required to bear the EU designation sign **(with housing and with protection against accidental contact)**, which are to be operated autonomously and/or are to ultimate consumers, such as plug-ready power supply units, battery charging sets, personal computers, testing and measuring apparatus, isolating transformers for construction sites or service, transformers for halogen lights.

Electromagnetic compatibility

Definition

According to the definition contained in the EMC Regulation 89/336/EEC, electromagnetic compatibility is the capability of a device to be able to work satisfactorily in the electromagnetic environment without itself causing electromagnetic interference while doing so which would be unacceptable to any of the devices, installations or systems present in this environment.

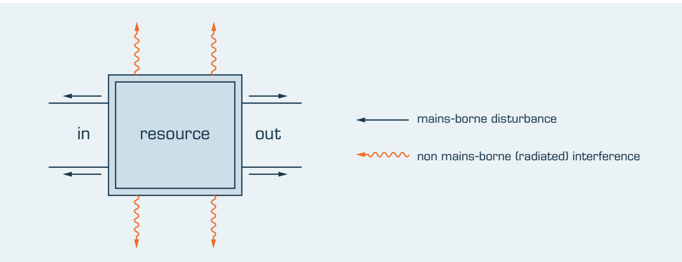
A distinction is made between
1. Electromagnetic interference (EMS)
2. Electromagnetic immunity (EMI)

Electromagnetic interference (EMS)

Electromagnetic interference (emitted interference) is every kind of electromagnetic event (e.g. noise, unwanted signal), which could impair the functioning of a device, an installation or a system.
The basic specification for emitted interference is

- EN 61000-6-3 (Residential, business, trade areas and small-scale enterprises)
- EN 61000-6-4 (Industrial area)

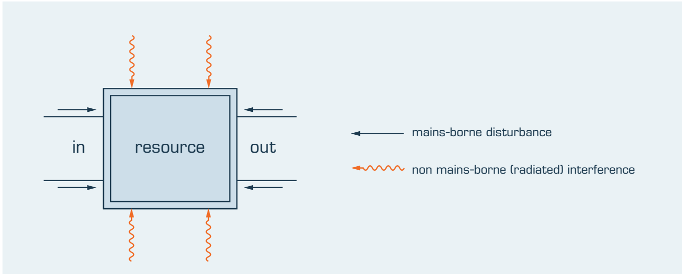
A large number of basic standards (IEC 61000, CISPR) and product standards are also to be taken into consideration as required.



Electromagnetic immunity (EMI)

Test standards are:

- EN 61000-4-2:1995 +A1:1998 +A2:2001
  Electrostatic discharge immunity test
- EN 61000-4-3:2006 +A1:2008
  Radiated, radio-frequency, electromagnetic field immunity test
- EN 61000-4-4:2004
  Electrical fast transient/burst immunity test
- EN 61000-4-5:2006
  Surge immunity test
- EN 61000-4-6:2007
  Immunity to conducted disturbances, induced by radio-frequency fields
- EN 61000-4-8:1993 + A1:2001
  Power frequency magnetic field immunity test
- EN 61000-4-11:2004
  Voltage dips, short interruptions and voltage variations immunity tests

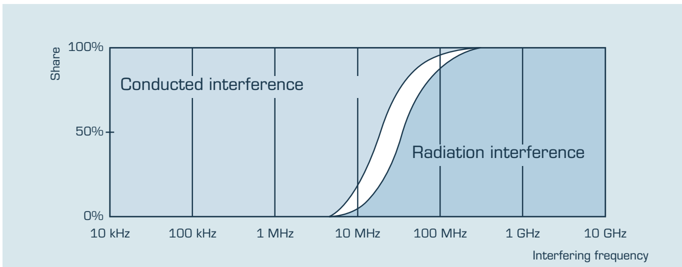


Shielding from interference

There are many opportunities for interference to be transmitted:

- by means of metallic contact as electrical current and voltage, carried by power mains
- as a magnetic field
- as an electrical field
- as an electromagnetic wave or radiation

Propagation of mains borne and radiated interference generally behaves as follows:

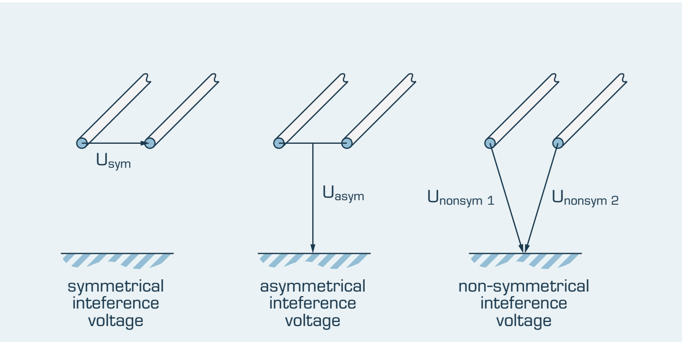


The attenuation of interference is achieved by construction which takes EMC into consideration, involving such things as low-impedance earthing, filters, shielded lines, metallic housing and spatial clearance. The EMC measures to be carried out, however, are highly dependent on the components utilised and on the operating parameters of the system, which means that it is almost impossible to make universally valid statements.

Mains borne interference

Interference voltage often occurs on electrical lines, between conductors and between conductors and the earth, in intensities which can range up to a frequency of circa 30 MHz. A distinction is made between symmetrical, asymmetrical and non-symmetrical interference voltage.

Reactors, capacitors and filters are particularly suitable for the attenuation of mains borne interference, as are – indirectly – shielded cables. As a rule, additional protection measures (radio links, varistors) are necessary against energy-rich interference, e.g. caused by lightning bolts.



EMC Standards

The fundamental principles for EMC standardisation are generally compiled by

- CISPR, founded in 1934 (International Special Committee on Radio Interference, Comité international Spécial des Perturbations Radioélectriques)

and

- IEC TC77, founded in 1974 (International Electrotechnical Commission Technical Committee 77, Comité d'études 77 de la Commission Electrotechnique Internationale)

in coordination with the IEC Regulation Guide 107 (EMC-Guide to the drafting of electromagnetic compatibility publications).

The purpose of Guide 107 is to ensure that identical procedures and points of view are applied during the course of EMC standardisation and to keep everything as conclusive as possible. Observations are carried out on line-borne and radiated phenomena occurring in the frequency range between 0 Hz and 400 GHz, in which electromagnetic compatibility is to be achievable.

Generally speaking, four categories of EMC standards are defined, whereby each EMC standard is, as a whole, assigned to only one of the four categories.

1. Basic publications (Basic Standards) e.g.

- IEC 61000-2, -3, -4, -5 etc.
- CISPR 11, 13, 14, 15, 16, 22

The Basic Standards can have the status of a standard or even that of a technical report. They contain the respective measuring procedures, classification of environmental conditions and testing techniques for EMC, but no measurement limiting values for individual products or product families. Constant reference is made to the Basic Standards in the basic specifications, product family standards and product standards. It should be clear from the title alone that it is a Basic Standard (Basic Norm) which is being dealt with.

2. Basic specifications (Generic Standards)

- Residential and small-scale business enterprises field:
  EN 61000-6-3 (Emitted Interference), EN 61000-6-1 (Interference Immunity)
- Industrial field:
  EN 61000-6-4 (Emitted Interference), EN 61000-6-2 (Interference Immunity)

The basic specifications are to be applied to products for which neither product family standards nor product standards exist. There is always a distinction made between the environmental conditions of industry (supplied by industrial networks) and those of residential, business and trade areas and small-scale enterprises (supplied by public electricity networks). While limited number of EMC tests specify minimum interference limit values and maximum interference emission limit values, they do not address certain product characteristics.

3. Product Family Standards, e.g.

- EN 55011 (Emitted Interference), Industrial, Scientific, Medicinal (ISM) Devices
- EN 55013 (Emitted Interference), EN 55020 (Interference Immunity), Audio, TV, Radio devices
- EN 55014 (Emitted Interference), EN 55104 (Interference Immunity), Household Appliances

The product family standards are tailored to specific product families and contain particular specifications (e.g. limit values, test design, operational criteria and criteria for complaints). Concerning measuring procedures, Basic Standards are referred to and limit values are coordinated with the basic specifications. Product family standards for EMC can exist as independent standards, but also as (autonomous) parts of standards which govern the other aspects (e.g. electrical safety) for the product family.

4. Product standards (Dedicated Product Standards), e.g.

- EN 61800-3, Frequency Converters
- EN 50199, Electric Arc Welding Devices

The product family standards are intended for special products, they enjoy the highest application priority and are therefore the only ones to be applied for ensuring the EMC of the product. In terms of the inclusion of Basic Standards and basic specifications, the rules which apply to the product family standards are the same as those for the product standards.

Classifications

Protection class

The protection class 0, I, II or III (Ref.: VDE 0140/EN 61140/IEC 61140) is a **construction feature** for the classification of electrical equipment for the purpose of security against dangerous fault or leakage currents (electrical shock), e.g.:

- Protection class 0:
  Device with basic insulation as a precaution for basic protection, but without provision for fault protection
- Protection class I:
  Device with protective conductor connection and (at least) basic insulation
- Protection class II:
  Device without protective conductor connection and double or enhanced insulation
- Protection class III:
  Device supplied with SELV (Safety Extra-Low Voltage) and in which no voltages higher than the SELV are generated.

Electrical equipment intended for installation in devices have no safety class and can only be "prepared for" one of these. Electrical equipment which has been prepared for utilisation in protection class II devices can also be utilised in protection class I devices.

Type of protection

Specification of the type of protection (Ref.: DIN VDE 0470, EN 60 529, IEC 60529) describes the protection of electrical equipment by means of housing, covers, enclosures and similar.

The type of protection is specified by letter symbols (IP Code), whereby the first code number (0 to 6) offers information concerning protection against contact and against the penetration of foreign objects. The second code number (0 to 8) provides information about protection against the water penetration.

Common types of protection in use:

- IP 00
  No special protection against accidental contact or against the penetration of foreign objects. No special protection against water. **Constructions of the "open design type" are manufactured for the IP 00 type of protection.**
- IP 20
  Protection against contact and against the penetration of solid foreign objects larger than ø 12 mm. No special protection against water.
- IP 23
  Protection against contact and against the penetration of solid foreign objects larger than ø 12 mm. Protection against water spray falling at any angle of up to 60° to the vertical, so that such jets will have no damaging effects.
- IP 40
  Protection against contact and against the penetration of solid foreign objects larger than ø 1 mm. No special protection against water.
- IP 44
  Protection against contact and against the penetration of solid foreign objects larger than ø 1 mm. Protection against water spray so that no spray hitting the equipment from any direction will have any damaging effect.
- IP 54
  Complete protection against contact. Protection against damaging dust deposits. While dust penetration is not completely prevented, the dust which does enter may not amount to quantities which will impair working procedures. Protection against water spray, so that no spray hitting the equipment from any direction will have any damaging effect.
- IP 65
  Complete protection against contact. Protection against dust penetration. Protection against water spray. Protection against water jets from spray nozzles directed at the equipment from all directions to the extent that no spray will have any damaging effect.
- IP 67
  Complete protection against contact. Protection against the dust penetration. Protection against the effects of temporary immersion in water. Water shall not be permitted to penetrate in a quantity which will would cause damaging effects when the housing is temporarily immersed in water under standardised pressure and time conditions.
- IP 68
  Complete protection against contact. Protection against the dust penetration. Protection against the effects of immersion in water for an indefinite time. Water shall not be permitted to penetrate in a quantity which will would cause damaging effects when the housing is immersed in water under standardised pressure conditions.

Note: The specification of the type of protection refers to the condition at the time of delivery and to the established or usual method of setting up the equipment. The type of protection can change as the result of a different setup or installation method.

Insulation material class

The regulations (Ref.: VDE 0301/ HD 566S1/IEC 60085) in addition to (Ref.: VDE 0304/HD 611.1S1/IEC 60216) describe among other things the thermal resistance of electrical insulation materials. The different insulation material classes are assigned temperatures in reference to their periods of thermal resistance.

Common Insulation material classes:
A (105 °C), E (120 °C), B (130 °C), F (155 °C), H (180 °C)

Unless other arrangements have been made, transformers and power reactors are designed in accordance with the specifications of the insulation material classes E or B.

Insulation system (EIS)

An electrical insulation system (EIS) is an insulating arrangement made up of one or more insulation materials (electrical insulation materials) which is installed together with the associated conduction parts in one piece of electrical equipment (Ref: VDE 0302 Teil 1/ EN 60505/ IEC 60505 sowie VDE 0302 Teil 11/ EN 61857-1/ IEC 61857-1). A judgement is made under thermal stresses of whether or not the combination of insulation materials is suitable for operation in the respective insulation material class.

Ambient air temperature for measurement

The ambient air temperature for measurement is the highest ambient air temperature at which a piece of electrical equipment or an electrical device or an installation component (e.g. transformer, reactor, filter) can be operated continuously under normal operating conditions. It is the air temperature of the immediate surroundings. Electrical values often refer to the ambient air temperature for measurement and they can change with different temperatures! Special attention is to be paid to the installation of components in housings with a higher type of protection. Possible deficient cooling can lead to non-authorised high temperatures in the housing. A reduction of the expected service life of the component is possible in this case (see "Insulation material class").

The ambient air temperature for measurement is specified using a shortened notation form (Ref.: VDE* 0570, EN 61558, IEC 61558).

Example:
ta=25 °C or ta=40 °C

Unless other arrangements have been made, the rated ambient temperature used for the design of components intended for installation is set at 40 °C and at 25 °C for (table) devices which are to be operated independently.

*Association of german electrical engineersBemessungsumgebungstemperatur ausgelegt.

Test class

The test class indicates climate category (Ref.: DIN EN 60068/EN 60068/ IEC 60068) as the key to the designation of the climatic usability of component parts.

Example:

25/085/21
25 = –25 °C, Test A: coldness, 085 = + 85 °C, Test B: dry heat,
21 = 21 days, Test Ca: moist heat constant

The individual tests are defined in different parts of the standard.

Characters and symbols

VDE 0570 Part 2–6/EN 61558-2-6/IEC 61558-2-6
Safety transformer, short circuit-proof, double or increased insulation between PRI and SEC, PRI max. 1000 V, SEC max. 50 V AC voltage (effective value) and/or 120 V smoothed DC voltage, frequency max. 500 Hz

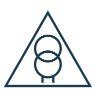
VDE 0570 Part 2–6/EN 61558-2-6/IEC 61558-2-6
Safety transformer, not short circuit-proof, double or increased insulation between PRI and SEC, PRI max. 1000 V, SEC max. 50 V AC voltage (effective value) and/or 120 V smoothed DC voltage, frequency max. 500 Hz

VDE 0570 Part 2–4/EN 61558-2-4/IEC 61558-2-4
Isolating transformer, short circuit-proof, double or increased insulation between PRI and SEC, PRI max. 1000 V, SEC max. 500 V AC voltage or 708 V smoothed DC voltage, frequency max. 500 Hz.

VDE 0570 Part 2–4/EN 61558-2-4/IEC 61558-2-4
Isolating transformer, not short circuit-proof, double or increased insulation between PRI and SEC, PRI max. 1000 V, SEC max. 500 V AC voltage or 708 V smoothed DC voltage, frequency max. 500 Hz.

VDE 0570 Part 2–15/EN 61558-2-15/IEC 61558-2-15
Isolating transformer for supplying medical areas, not short circuit-proof, double or increased insulation between PRI and SEC; windings installed one above the other; windings-core; windings-shield; shield-core; PRI max. 1000 V, SEC max. 250 V, frequency max. 500 Hz

VDE 0570 Part 2–12/EN 61558-2-12/IEC 61558-2-12
Magnetic voltage stabiliser acting as isolating transformer, short circuit-proof, double or increased insulation between PRI and SEC, PRI max. 1000 V, SEC max. 500 V, frequency max. 500 Hz (30 kHz internally)



VDE 0570 Part 2–2/EN 61558-2-2/IEC 61558-2-2
Control transformer, not short circuit-proof, basic insulation between PRI and SEC, PRI max. 1000 V, SEC max. 1000 V AC voltage or 1415 V smoothed DC voltage, frequency max. 500 Hz

VDE 0570 Part 2–1/EN 61558-2-1/IEC 61558-2-1
Mains transformer, not short circuit-proof, basic insulation between PRI and SEC, PRI max. 1000 V, SEC max. 1000 V AC voltage or 1415 V smoothed DC voltage, frequency max. 500 Hz

VDE 0570 Part 2–13/EN 61558-2-13/IEC 61558-2-13
Autotransformer, not short circuit-proof, no insulation between PRI and SEC, PRI max. 1100 V, SEC max. 1000 V AC voltage or 1415 V smoothed DC voltage, frequency max. 500 Hz

VDE 0570 Part 2–20/EN 61558-2-20/IEC 61558-2-20
Small reactor, not overload-free, max. 1000 V, frequency max. 1 MHz

Specification for the fuse assigned in the case of transformers that are not short circuit-proof; here, 6.3 A time-lag

Thermal overcurrent release; here, 20 A miniature circuit breaker

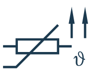
Temperature fuse

Temperature fuse

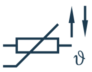
Self-resetting thermal relay
, e.g. thermal time delay switch

Non-self-resetting thermal relay Reset by switching off the mains connection, e.g. thermal time delay switch with locking function, PTC

Non-self-resetting thermal relay Manual reset (e.g. thermal overcurrent release, miniature circuit breaker)



PTC thermistor



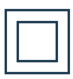
NTC thermistor

ta 40 °C
ta 40

Rated ambient temperature; here, 40°C

CL.B
CL.130
class 130

Class of insulation; here, B



Safety class II, total insulation

Protective conductor, earth

Connection for mount or core

Suitable for use with fitments whose flammability properties are not known, e.g. wood, furniture, intermediate ceilings. Sign in acc. with VDE 0710 Part 14.

Sign for domestic use, only for dry rooms, general

Voltage warning, general

Heat source warning: hot surface, general

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AC current, also spelled A. C. or ac (alternating current)

⎓

DC current, also spelled D. C. or dc (direct current)

1.1
1.2
1.3
1.4
1.5

cetification marks

CE mark, legal mark of conformity in Europe (stands for Conformité Européenne)

ENEC mark of conformity, Europe; in Germany: certification by VDE (10), European Norms Electrical Certification

VDE mark of conformity, Germany, VDE Testing and Certification Institute

UL mark of conformity (recognized component), USA and Canada; in Germany: certification by UL, Underwriters Laboratories Inc.

transformer only

UL mark of conformity (recognized component), USA and Canada; in Germany: certification by UL, Underwriters Laboratories Inc., only relates to the integrated transformerr.

UL mark of conformity (recognized component), USA, Underwriters Laboratories Inc.

UL mark of conformity, (Listed) USA, Underwriters Laboratories Inc

CSA mark of conformity, Canada, Canadian Standards Association

GL mark of conformity, certification by Germanischer Lloyd

AS-Interface mark of conformity, certification by AS-International Association

Special signs by BLOCK

XtraDenseFill: XtraDenseFill from BLOCK, a casting technique that ensures cavity-free filling of the transformer's entire internal structure thanks to high vacuum and pressure phases. It significantly reduces creepage distances and clearances and enables the electrical equipment to enjoy long-term protection against the effects of its environment. A more compact design can also be used.

BLOCK ImpEx: Ensures the winding material is covered evenly, thus providing extensive protection against external influences. The resin developed specifically for BLOCKImpEx, together with our in-house-developed impregnation process, seals as many cavities as possible and creates a temperature reserve to ensure efficiency during long periods of operation.

The BLOCK logo: a sign of quality

The old BLOCK logo: our original logo