In general

The stated technical explanations indicate many application areas besides also valid special and exceptional rules. The following is intended as a short introduction into the complex subject.

CE mark

The council of the European Community (EC) has issued EC-directives basing on the founding contract of the European Economy Community (EEC), in particular article 100. EC-directives serve to adapt legal and administrative rules in the diverse European Union (EU) member states whenever differences in national rules cause commercial handicaps or in any other way obstruct EU-interior market. The directives are to be translated into national law by respective national legislative authorities within a given deadline. Manufacturers must CE mark their products to demonstrate conformity once products fall within certain EC-directives. Concerned are all products contained in the 'new conception' directives (decree May 8, 1985), which state requirements for technical condition.

CE mark:  Communautés Européennes

EC-directives are obligatory legal rules within the European Union and meeting these requirements are precondition for any product sale in Europe. The remaining world trade market is not affected. As soon as a product is CE marked, it indicates its conformity with respective fundamental requirements of all relevant directives. The CE mark merely is a directive conformity proof for supervisory authorities. Quite often it is misinterpreted as a 'quality symbol' though and therefore frequently requested, yet lacking any legal basis.

As such we refrain from printing the CE mark as a marketing tool in our catalogue and brochures. EC-directives must be adhered to as a matter of course by all manufacturers or importers.

Although manufacturers must provide EC conformity declarations only for the supervisory authority (for at least 10 years counting from last delivery date) our customers may certainly request a respective copy.

The directive in question is stated in each respective product's EC conformity declaration. The most frequent directives concerning our product spectrum are:

1. **Low tension directive (73/23/EEC)** for electric appliances in rated voltages between 50 VAC and 1000 VAC and between 75VDC and 1500VDC.

   Title: Directive by council for adaptation of legal rules among member states pertaining electric appliances for application within certain voltage limits 73/23/EEC, Feb. 19, 1973.

Just about all Riedel products fall within the scope of the low tension directive. Conformity with directive's protection requirements for each electric appliance, device, each system and each equipment must be confirmed by the manufacturer via EC conformity declaration and product or packing must be marked with EC conformity mark CE.

2. **EMC directive (89/336/EEC)** for devices which can cause electromagnetic interference or of which operation can be impaired by such interference.

   Title: Directive by council for adaptation of legal rules among member states pertaining electromagnetic compatibility 89/336/EEC, May 03, 1989.

Legal basis:

On May 03, 1989, the council of the European Community (EC) issued an obligatory directive to adapt legal rules in its member states. The Federal Republic of Germany has translated same into national law November 09, 1992 by virtue of law about electromagnetic compatibility (EMVG). The settlement authority for mail and telecommunication (formerly BAPT) and their branch offices have been appointed for it's enforcement (supervision).

Definition, according to excerpt from article 1:

"Electromagnetic compatibility" is the ability of an apparatus, appliance or system, to operate satisfactory in an electromagnetic environment and not creating electromagnetic interference itself which would be unacceptable for any apparatus, appliance or system present in this environment.

Norm scope, according to excerpt from article 2:

The directive is valid for equipment able to cause electromagnetic interference or of which operation can be impaired by such interference.

Information:

"Equipment" (according to article 1) are all electrical and electronic apparatuses, appliances and systems containing electrical and/or electronic components.

Principle of procedure:

As of Jan. 01, 1992 (transition time until Dec. 31, 1995) only such electrical and electronic equipment, system and appliance may be traded with or put into operation in the European Union that meets EMC-protection requirements laid down in the directive. Conformity with directive's protection requirements for each electric appliance, each system and each equipment must be confirmed by the manufacturer via EC conformity declaration and the product must be marked with an EC conformity mark CE.

Components without obligatory mark:

The definition component within the meaning of EMC-directive is any element to be installed in equipment, yet in itself not possessing a function and not destined to be used by ultimate customers. According to EMC-directive, article 1, components are not equipment and therefore not touched by the directive.

Examples:

a. components (for pcb, units, switch cabinets), as integrated components not obligatory CE marked - for example resistors, capacitors, inductivities, integrated circuits, chokes, transformers
b. components obligatory CE marked (incl. cabinet and protected against accidental contact), which are independently operable and/or for sale to ultimate customers - for example plug-in power supplies, battery chargers, personal computers, test sets and meters, isolating transformers for construction sites or service, transformers for halogen lamps

Norms

The norm scope concerning inductivities has simplified resp. will simplify.

The essential norms for the manufacture of dry-type transformers (safety and isolating transformers, formerly DIN VDE 0551 / EN 60742; control and power transformers, formerly DIN VDE 0550) have been integrated into the new norm structure DIN VDE 0570 / EN 61558.

Special inductivities, for example transformers for switch power packs, are treated separately in the directive.

We adapt all concerned products within transition deadlines.

If not agreed otherwise, we manufacture in "uptodate technical standard" complying to norms as stated on each catalogue page on headline or complying to norms on overleaf pages.

Standard stock items can be delivered within transition deadlines in the norm valid at manufacturing date and applied by you without problem.

Norm references

DIN VDE 0100
Erection of power installations with rated voltages up to 1000V

DIN VDE 0100 part 410 (01.97)
Erection of power installations with rated voltages up to 1000V
Protection against electric shock

DIN VDE 0105 part 1 (10.97)
Operation of power installations;
general specifications

DIN VDE 0106 part 100 (03.83)
Protection against electric shock;
actuating members positioned close to parts liable to shock

DIN VDE 0107 (10.94)
Electrical installations in hospitals and locations for medical use outside hospitals

DIN VDE 0108 part 1 (10.89)
Power installations and safety power supplies in communal facilities; general

DIN VDE 0110 part 1 (04.97)
Insulation coordination for electrical equipment within low-voltage systems - Principles requirements and tests

IEC 204-1 / EN 60204 part 1 / DIN VDE 0113 part 1 (11.98)
Electrical equipment of industrial machines; general requirements

DIN VDE 0118 part 1 (11.01)
Erection of electrical installations in mines -General requirements

DIN VDE 0160 (04.98)
Electronic equipment for use in power installations

EN 50014 / DIN VDE 0170/0171 part 1 (02.00)
Electrical apparatus for potentially explosive atmospheres - general requirements

EN 50019 (1978) / DIN VDE 0170/0171 part 6 (06.01)
Electrical apparatus for potentially explosive atmospheres - increased safety "e"

EN 50020 (1978) / DIN VDE 0170/0171 part 7 (04.96)
Electrical apparatus for potentially explosive atmospheres - intrinsic safety "i"

DIN VDE 0220 part 1 (11.71)
Specifications for detachable cable clamps to be used in power cable installations up to 1000V

IEC 112 (1979) / DIN VDE 0303 part 1 (06.84)
Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions

IEC 529 (1989) / DIN VDE 0470 part 1 (09.00)
Degrees of protection provided by enclosures (IP Code)

DIN VDE 0550 part 3 (12.69)
Particular requirements for control transformers as well as for mains-supply and insulating transformers above 1000V

DIN VDE 0532 part 6 (01.94)
Transformers and reactors - dry-type power transformers

EN 60289 / DIN VDE 0532 part 20 (05.94)
Reactors

DIN VDE 0532 part 21 (03.82)
Transformers and reactors - Starting transformers and starting reaktors

DIN VDE 0532 part 23 (08.94)
Transformers and reactors - stationary transformers in traction systems

EN 60076-1 / DIN VDE 0532 part 101 (12.97)
Power transformers - general

EN 60950 / DIN VDE 0805 (12.01)
Safety for equipment of the information technique

DIN VDE 0558 part 1 (07.87)
Semiconductors - converters

EN 61558-1 / DIN VDE 0570 part 1 (07.98)
Safety of power transformers, power supply units and similar - general requirements and tests

EN 61558-2-1 / DIN VDE 0570 part 2-1 (07.98)
Safety of power transformers, power supply units and similar - particular requirements for separating transformers for general use

EN 61558-2-2 / DIN VDE 0570 part 2-2 (10.98)
Safety of power transformers, power supply units and similar - particular requirements for control transformers

EN 61558-2-4 / DIN VDE 0570 part 2-4 (07.98)
Safety of power transformers, power supply units and similar - particular requirements for isolating transformers for general use

EN 61558-2-6 / DIN VDE 0570 part 2-6 (07.98)
Safety of power transformers, power supply units and similar - particular requirements for safety isolating transformers for general use

EN 61558-2-13 / DIN VDE 0570 part 2-13 (08.00)
Safety of power transformers, power supply units and similar - particular requirements for auto transformers for general use

EN 61558-2-15 / DIN VDE 0570 part 2-15 (11.01)
Particular requirements for isolating transformers for medical rooms

EN 61558-2-17 / DIN VDE 0570 part 2-17 (07.98)
Safety of power transformers, power supply units and similar - particular requirements for transformers for switch mode power supplies

EN 61558-2-19 / DIN VDE 0570 part 2-19 (09.01)
Particular requirements for interference reduction transformers

EN 61558-2-20 / DIN VDE 0570 part 2-20 (04.01)
Particular requirements for miniaturized reactors

EN 50091-1-2 / DIN VDE 0558 part 512 (05.99)
Uninterruptible power systems (UPS) - general and safety requirements for UPS used in restricted access location

DIN EN 60999/VDE 0609 part 1 (12.00)
Connecting devices - safety requirements for screw-type and screwless-type clamping units for electrical copper conductors

IEC 445
DIN 42404
Terminal markings for transformers, safety transformers, variable transformers, small reactors

IEC 947-7-1 (1989) EN 60947-7-1 (1991) /
DIN VDE 0611 part 1 (08.92)
Low-voltage switchgear and controlgear
Part 7: ancillary equipment, terminal blocks for copper conductors

DIN VDE 0611 part 3 (05.00)
Modular terminal blocks for connection of copper conductors; protective conductor terminal blocks for copper conductors

DIN VDE 0635 (02.84)
Low-voltage fuses -
D-fuses E 16 up to 25 A, 500 V;
D-fuses up to 100A, 750 V;
D-fuses up to 100A, 500 V

EN 60947-1/VDE 0660 part 100 (12.99)
Low-voltage switchgear and controlgear - general rules

IEC 439-1 / EN 60439-1 /
DIN VDE 0660 part 500 (08.00)
Low-voltage switchgear and controlgear assemblies; requirements for type-tested and partially type-tested assemblies

DIN EN 60127-2
DIN VDE 0820 part 2 (09.01)
Miniature fuses - Cartridge fuse-links

EN 50 022 (1977) / DIN EN 50022 (05.78)
Low-voltage switchgear and controlgear for industrial use; mounting rails, top hat rails 35 mm wide for snap-on mounting of equipment

EN 50 035 (1978) / DIN EN 50035 (04.80)
Low-voltage switchgear and controlgear for industrial use; mounting rails; mounting rails for terminal blocks

EN 50 045 (1980) / DIN EN 50045 (04.82)
Low-voltage switchgear and controlgear for industrial use; mounting rails, top hat rails 15 mm wide for mounting of terminal blocks

DIN EN 50081-1 (03.93)
Electromagnetic compatibility (EMC) - generic emission standard - residential, commercial and light industry (VDE 0839 part 81-1)

DIN EN 50081-2 (03.94)
Electromagnetic compatibility (EMC) - generic emission standard - part 2: industrial environment (VDE 0839 part 81-2)

DIN EN 50082-1 (11.97)
Electromagnetic compatibility (EMC) - generic immunity standard - residential, commercial and light industry (VDE 0839 part 82-1)

DIN EN 61000-6-2 (03.00)
Electromagnetic compatibility (EMC) - generic immunity standard - industrial range (VDE 0839 part 6-2)

DIN EN 61000-3-2 (12.01) / VDE 0838 part 2
Electromagnetic compatibility (EMC) - limits for harmonic current emissions

IEC 38 (1983) / DIN IEC 38 (05.87)
IEC-standard voltages

IEC 326-3 (1980) / IEC 326-3A (1982)
DIN IEC 326 part 3 (03.85)
Printed circuits, circuit boards, design and use of circuit boards

IEC 352-1 (1983)
DIN IEC 352 part 1 (05.87)
Solderless electric connections, wire-wrap connections, general requirements, testing methods and practical guidance

IEC 760 (1989) /
DIN IEC 760 (04.91), draft,
rectangular cable connections

DIN 40802 part 2 (02.76)
Metal laminated base materials for printed circuits, types

IEC 740 / DIN 41302
Laminations for transformers and inductivities for use in telecommunication and electronic equipment

DIN 41571
Instrument fuses
Fuse links 250 V, interchangeable

DIN 41576
Instrument fuses
Indicating fuse links 250 V, interchangeable

DIN 41611 part 4 (04.86)
Solderless electrical connections, clip connections, terminology, requirements, tests

IEC 512-3 (1976) / DIN 41640 part 3 (07.84)
Testing procedures and measuring methods for electromechanical components;
Test 5 b: current-carrying capacity

IEC 127 (1974) / DIN 41660 (05.79)
Instrument fuses
Fuse links 5 mm x 20 mm, quick, high breaking capacity

IEC 127 (1974) / DIN 41661 (05.79)
Instrument fuses
Fuse links 5 mm x 20 mm, quick, low breaking capacity

IEC 127 (1974) / DIN 41661 (05.79)
Instrument fuses
Fuse links 5 mm x 20 mm, slow, low breaking capacity

IEC 127 (1974) / DIN 41668 (05.79)
Instrument fuses
Fuse links 6,3 mm x 32 mm, quick, low breaking capacity

DIN 43714 (06.79)
Measuring, control; electric temperature detectors; compensating leads for thermocouples

DIN 46234 (03.80)
Cable sockets for solderless connections; ring-shape without protective sleeve for copper conductors

DIN 46237 (07.70)
Crimp-type cable sockets for solderless connections, insulated, for copper conductors

DIN 46247
Pin bushings without protective sleeve

IEC 304 (1982) / DIN 47002 (08.87)
Colors for low frequency cables and wires

DIN 49515 (12.83)
D-fuse links D II, D III, D IV H, 500 V

DIN 49522 (04.81)
D-fuse links D 01, D 02, D 03, 380 V, 250 V ~

DIN 49360
D-fuses

ISO/DIS 8820 (1988) / DIN 72581 part 3 (08.87)
Fuses for low voltage installations; blade type fuse links

VBG 4 (04.79)
Electrical installations and appliances

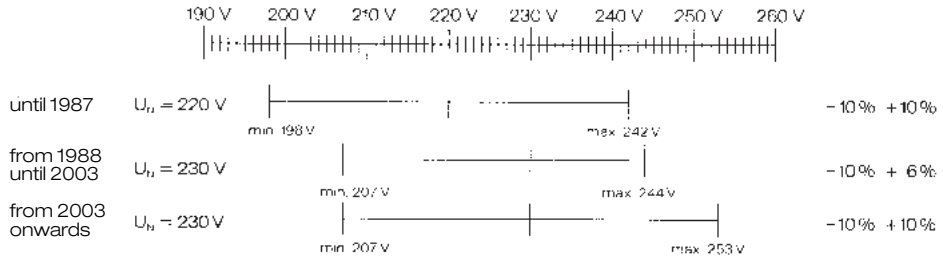
Conversion of low-voltage systems comp. to DIN IEC 38

DIN IEC 38 "IEC- standard voltages" has determined to replace previous standard voltages 220V/380V and 240V/415V by standardized voltages 230V/400V.

Public power supply companies have largely completed their conversion to the new standardized voltages.

Accordingly, converted all series products to the new standardized voltages and voltage tolerances.

All standard products feature +-5% tappings allowing voltage adaptation to the new mains.



Limit values for rated direct voltage comp. to DIN EN 61131-2 / part 2 (05.95)

Power packs provide electronic controls with the permissible operational voltage independent from load and line voltage fluctuations comp. to DIN IEC 38. Thanks to close magnetic coupling and a generous design, power packs provide a stable voltage remaining within limit values for direct voltages laid down in DIN EN 61131-2.

Excerpt from the norm:

Rated value (U_e) 24VDC: -15%/+20% tolerance (min-max)

Rated value (U_e) 48VDC: -15%/+20% tolerance (min-max)

Annotation 1: Apart from voltage tolerances a total alternating voltage component with peak value of 5% of rated voltage is permissible. Absolute limits are: 30/19,2V direct voltage for 24V direct voltage and 60/38,4V direct voltage for 48V direct voltage.

Protection systems

Protection systems are indicated by abbreviations always starting with code letters IP followed by two code numbers for the protection rate (comp. to EN 60529).

Protection ratings for protection against accidental contact and foreign bodies

First code no.	Protection degree	
	Designation	Definition
0	No protection	No special protection of persons against direct contact with active parts. No protection against penetration of solid foreign bodies.
2	Protection against medium-sized foreign bodies	Protection against finger contact with active parts. Protection against penetration of solid foreign bodies (diameter greater 12 mm).
4	Protection against grain shaped foreign bodies	Protection against contact with active parts via tools, wires or similar with a thickness greater 1 mm. Protection against penetration of solid foreign bodies (diameter greater 1 mm).
5	Protection against dust deposits	Full protection against contact with active parts. Protection against harmful dust deposits. Dust penetration is not entirely prevented, but must not impair function.
6	Protection against dust penetration	Full protection against contact with active parts. Protection against dust penetration.

Protection ratings for water protection

Second code no.	Protection degree	
	Designation	Definition
0	No protection	No particular protection
1	Protection against water drops falling vertical 	Water drops striking vertical must have no harmful effect.
3	Protection against spraying water 	Water falling at any angle up to 60° from the vertical must have no harmful effect.
4	Protection against splashing water 	Water splashing from any direction must have no harmful effect.
5	Protection against water jets 	Water projected by a nozzle against transformer from any direction must have no harmful effect.
6	Protection at overflow 	Water must not penetrate transformer in harmful quantities at temporary overflow.
7	Protection at immersion  ... bar	Water must not penetrate in harmful quantities when transformer is immersed in water within laid down pressure and time conditions.

For firedamp and explosion-proof transformers initials SCH respectively EX are used also.

Protection classes

Protection class is a constructional equipment feature about safety against dangerous body flows.

Open frame transformers destined to be installed in switch cabinets or systems do not possess a protection class. They can only be prepared for it.

Protection class I: System with protective earth terminal and basic insulation

Protection class II: System without protective earth terminal with double or reinforced insulation

Protection class III: System without protective earth terminal whereby protection against dangerous body flows rests on supply with protection low voltage (SELV) and no higher voltage can be produced than protection low voltage.

Safe clamping and protection against accidental contact

Accident prevention regulation (UVV) VBG 4 issued by the professional association for precision and electrical engineering is directed at operators of electrical installations. Its special safety requirements aim to prevent electrical accidents.

The regulation lays down safety clearances for work, operation and occasional handling close to shock- hazardous parts, so-called "active parts", of low-voltage installations up to 1000 V ~ resp. 1500V-.

Work on active, i.e. shock-hazardous parts is permissible only after ensuring that same are no longer active. Operating near active parts is only permissible, if parts are dead or protected against direct contact (§ 6). Safety measures while working near active parts are

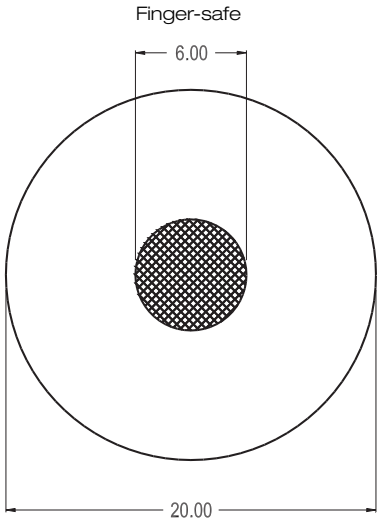
- establishing dead condition for the duration of works
  or
- preventing direct contact by covering or setting up barrier during works
  or
- ensuring that permissible proximity is observed (§ 7)

For operation of elements such as pushbuttons, snap switches, knobs close to shock-hazardous parts, the term "occasional handling" was introduced. According to DIN VDE 0105-1 it is an "operation with partial protection against direct contact".

Detailed regulations for "occasional handling" may be found in DIN VDE 0106-100. Among others it regulates the degree of cover required for active parts in the proximity of operating controls and bases on the definition of a "protection area for occasional handling"; it is the area into which one must reach occasionally during handling.

It is essential, that a level envelope of 30 mm radius surrounding the active parts is finger-safe, i.e. according to IEC 529/DIN VDE 0470-1 (test finger) shock-hazardous parts of electric apparatus must not be touchable by a straight VDE-test finger.

For the "more distant" area up to 100 mm surrounding the control element, back of hand safety is obligatory. Back of hand safety is given, when a force of 50 N is exerted on a sphere of 50 mm diameter and no contact is made with shock-hazardous part of appliance.
Outside this area no particular measure for contact safety is required.



Annotation: Equipment and appliances operated with protection low voltage up to 25 V ~ or 60 V - are considered "protected against direct contact".

According to VBG 4, § 5 / section 4, system inspection for due order prior to first startup may be scraped when the company receives confirmation from the manufacturer or installer stating that electric system and appliances concur with regulations VBG 4. The required confirmation refers to installed, ready to service systems and appliances and may only be submitted by the installer or assembly company. The manufacturer of electric appliances may just confirm that his products comply to relevant electrotechnical DIN VDE regulations stated in VBG 4. It is the installer's duty to select fitting appliances according to these aspects.

Technical information and directions

Terms and requirements

Referring to the inductivities stated in the catalogue following terms and requirements represent just a small excerpt from the great variety that could be named. We have limited ourselves to the relevant terms and requirements important for your selection. At wish you may certainly obtain further information from us.

Transformers in general

A transformer is a static unit featuring two or more windings which by electromagnetic induction transforms a system of alternating voltage and alternating current, usually with different values at the same frequency, as a means to transmit electric energy (ref: VDE 0570, IEV 421-01-01).

Insulation

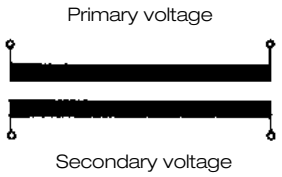
Transformers' constructive differences are principally determined by their designated application. Corresponding requirements are stated in installation and appliance norms (for example VDE 0100, VDE 0113, VDE 0700, VDE 0800) and transformer norms (for example VDE 0550, VDE 0551, VDE 0570).

An important criteria for selection is the insulation layout between input and output circuits:

Inductivity	For protective measure	Requirement	Insulation system Pri-Sec
Isolation transformer	Protective isolation	"high" safe isolation	Double or reinforced insulation
Safety transformer	Protection low voltage	"high" safe isolation	Double or reinforced insulation
Power transformer	(separate winding)	"low" non-safe isolation	Basic insulation
Control transformer	Protective earthing	"low" non-safe isolation	Basic insulation
Auto transformer	(no separate winding)	not indirect-coupled	-

Transformers with separate windings

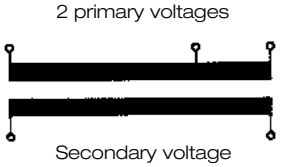
Such transformers do not have a conductive connection between individual windings. They are indirect-coupled.



Tappings

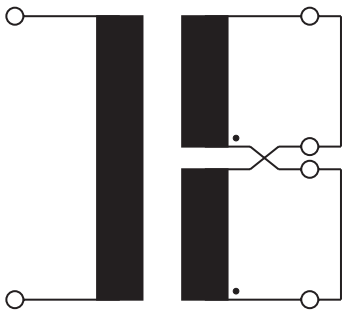
Transformers may be designed with primary as well as secondary tappings.

Primary tappings serve to adjust and apply a transformer in diverse supply voltages. The increased winding space requirement frequently necessitates turning to the next larger transformer type. There is no need for enlargements at mains adaption of app. 5 %.

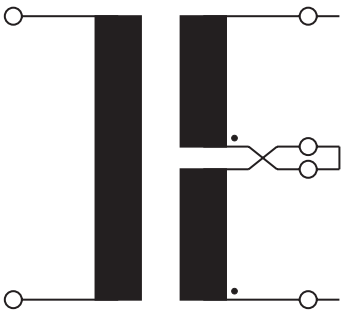


The need for further winding space also does not occur when a second primary voltage halved results in the first (for example 115 V - 230 V).

If two equal winding parts are connected in series or parallel the transformer can be used for both secondary voltages while retaining full output. Observe stated polarity!



Transformer switched to 115V



Transformer switched to 230V

In case of several secondary voltages, rated secondary current intensity is calculated based upon the highest secondary voltage. Therefore tappings can only be loaded with current intensity calculated from power and highest secondary voltage.

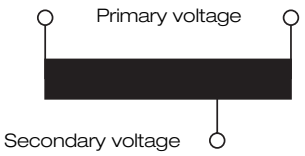
If full power is required for each individual secondary voltage, power or current intensity must be stated individually. It calls for further space requirement and possibly the next larger transformer type.

Transformers in economy winding

Economy windings show conductive connection between primary and secondary winding. The output power is transferred partly inductive and partly by current capacity. It may result in considerable size reduction as compared to transformers with separate windings. The smaller the difference between input and output voltage, the smaller the transformer.

Example: Transformer

rated output	1000 VA
undervoltage	230 V
upper voltage	400 V



$$\text{type power N} = \text{nominal power} \times \left(1 - \frac{\text{undervoltage}}{\text{upper voltage}}\right)$$

$$\text{type power N} = 1000 \left(1 - \frac{230}{400}\right) = 1000 \times 0{,}425 = 425 \text{ VA}$$

Therefore instead of a 1000 VA-sized transformer just one 425 VA in size is needed.

Operation modes

All Riedel standard transformers are designed for continuous operation **S1**. S1-operation is at hand, when a transformer operates any given time under permissible thermal rated current and the other remaining rated values. The declaration corresponds to 100% ED (on-period). Additionally, there are transformers that may be loaded higher for some time when a lower load has preceded.

Short-time load (standard S3 at declaration of ED in %) - on-period calculates as follows:

$$ED = \frac{\text{Load period in min.}}{\text{Duty cycle in min.}} \times 100\ (\%)$$

Duty cycle (off-time period + load duration) must not exceed 10 min., duty cycle > 10 min. is continuous operation.

Type power at short-time load calculates as follows:

$$NT = N \times \sqrt{\frac{ED\ (\%)}{100}}$$

N_T = type power
N = nominal power

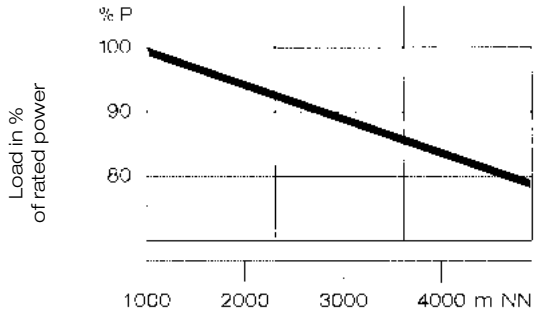
Further operation modes:
S2 (singular load with long off-time period), **S4**, **S5** (intermittent operation), **S6** (continuous duty with intermittent loading), **S7** (uninterrupted operation with varying rated current during start and/or end of duty cycle), **S8** (just as S7, but with any number of variation from rated current in fixed duration and level during one cycle (duty cycle)). We manufacture for these operation modes on request.

Power

All stated power data refers to collected secondary power in VA resp. kVA at continuous operation, excitation with rated voltage, rated frequency, cos. phi = 1, an ambient temperature of max. 40°C and a set-up altitude up to 1000 m above sea level (NN).

Power is calculated from rated secondary voltage (volt) and rated secondary current (ampere) into VA or kVA.

Power reduction dependent on set-up altitude



Short-time rating of transformer

The layout of control transformers in control circuits with chief power demands by contactor coils and relay coils ensues according to the possible short-time rating (initial power of coil) at a cos f = 0,5 and a voltage drop of maximal 5%.

Frequency

Transformers stated in catalogue are suitable for mains with rated frequency 50 - 60 Hz. The rating plate states 50/60 Hz. Stated losses, voltage drops and efficiency refer to rated frequency 50 Hz. Frequencies other than 50 Hz cause a change in type power according to following chart:

f	(Hz)	16 ⅔	40	42	50	60	75	100	200	300
N	(%)	35	80	84	100	110	115	130	135	140

Rated power in mains with 60 Hz must not be exceeded, if it is a normal transformer with rating plate statement of 50/60 Hz.

Heating

Free access of cooling air must be ensured. At ambient temperatures above 40°C rated power must be reduced according to following chart:

°C	45	50	55	60
N (%)	95	85	80	75

Temperature rise

Principally transformers can be operated at higher power for a short time, but only if highest permitted medium temperature rise is adhered to and prior continuous load was beneath 100%..

Overload chart:

Prior continuous load in % of rated power	Permissible duration of overload in % of rated power				
	150 %	140 %	130 %	120 %	110 %
50	30 min.	45 min.	65 min.	105 min.	180 min.
60	25 min.	40 min.	60 min.	95 min.	170 min.
70	20 min.	30 min.	45 min.	80 min.	155 min.
80	15 min.	25 min.	40 min.	75 min.	140 min.
90	8 min.	15 min.	30 min.	60 min.	120 min.

Temperatures

During rated conditions transformers produce losses which transpose into heat. According to regulations this "self - heating" resp. "overtemperature" is bound to limit values by insulation class of insulating material and under consideration of ambient temperature. These values concern the winding and components directly in contact to it. Following chart refers to the medium temperature rise of overtemperatures at an ambient temperature of 40°C.

According to regulations the "hot spot" of class A can exceed following chart value 5K and class H 15K depending on insulation class. We manufacture in all stated insulation classes on request.

Insulation class	Final temperature
A	105°C
E	115°C
B	120°C
F	140°C
H	175°C

We recommend **not** to apply class H because of poor efficiency.

Short circuit strength

Transformers are subdivided according to their short circuit strength (ref: VDE 0570, EN 61558, IEC 61558):

A **short circuit proof transformer** is a transformer whose temperature does not exceed set limit values at overload or short circuit and who will fulfill all requirements of above stated regulations as before once overload or short circuit has been removed.

a. An **absolutely short circuit proof transformer** is a short circuit proof transformer **without protective device** whose temperature does not exceed set limit values at overload or short circuit and who can be operated again once overload or short circuit is removed.

   Remark: Because of their physics such transformers allow constructions with little rated active power up to 4 VA only. The no-load voltage factor can reach a value up to 2. The curve shape of output voltage can deviate from sinusoidal wave shape. Absolutely short circuit proof transformers must not necessarily be sustained short circuit proof.

b. A **relatively short circuit proof transformer** is a short circuit proof transformer **with a built-in protective device** which opens the circuit or limits the current in input or output circuit when transformer is overloaded or short circuited.

   Remark: Examples for protective devices are fuses, overload circuit breakers, temperature fuses, temperature limiters with or without automatic reset, PTC resistors and automatically acting mechanical safety switches.

A **non-circuit proof transformer** is a transformer destined to be protected against excess temperature via a **protective device** which is **not built-into** the transformer.

Remark: Unless otherwise agreed, transformer protection is taken care of by the customer.

Fusing

Observe the following for transformer fusing:

1. Selection of fuse media is determined by their ratings such as permissible voltage and current, their release characteristics and breaking capacity.

   In this connection consider that depending on fuse selection eventually back-up protection (advance fuse) may be necessary to cover the entire current / time spectrum.

2. To pinpoint fuse value normally one must differentiate between primary and secondary side of transformer.

The "safe release" of a fuse in connection with transformers is more simple via the secondary side, i.e. fuse selection is easier because rated current is close to rated current of fuse. The fuse protects transformers reliably against short circuit and excess output overload. The overcurrent protection of a transformer, for example caused by interturn short circuit, can only be realized via primary-side fuses. But because of the inrush any fuse value must usually be calculated several times higher than rated current of transformer would demand. Therefore such fuses function more as short circuit protection than overload protection.

Concerning this there are remedies though such as inrush current limiters to select fuse value close to rated current of transformer.

There is a causal link between fuse value, fuse type, (large) line lengths, ambient temperature and permissible transformer temperature (acc. to regulation) in order to achieve optimal protection and operational conditions. Recommended fuse values stated on rating plates and data sheets of Riedel- transformers solely refer to transformer protection. The fuses must be placed directly after resp. in front of the transformer. When rated conditions deviate (for example ambient temperature) fuse values must be corrected. In priority our fuse recommendations base on instrument fuses (blow-out fuses), automatic circuit breakers and motor circuit breakers. Optimal protection is ensured with transformer circuit breakers available on the market because they are adjusted to inrush characteristic of transformers.

Remark: Observe current translation during overload in case of primary fusing for variable ratio ring transformers and transformers with several output voltages or output windings.

Three-phase transformers

Load capacity of neutral point (star point):

Regarding neutral point load capacity of three-phase transformers, observe below following to avoid additional losses and neutral point shifting:

Star-star connection:

The neutral point may only be loaded with full rated current (line-to-line current) when neutral conductor of supply line is connected rigidly to primary neutral point of transformer. Otherwise, neutral point may only be loaded with app. 10% line-to-line current.

The same rule applies for three-phase auto transformers in star-economy design.

Taking no special measures, following connection modes amount to 100% load of neutral point:

Delta-star connection with secondary extended neutral point Dy5
Star-zigzag connection with secondary extended neutral point Yz5

If three-phase sets are formed via 3 single-phase transformers, then load of neutral point must definitely be avoided.

Vector groups

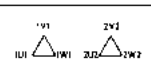
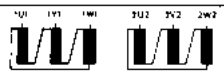
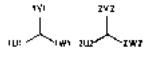
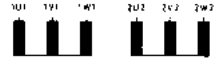
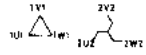
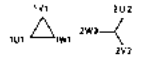
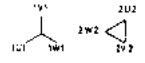
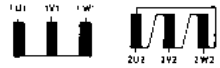
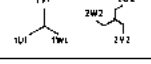
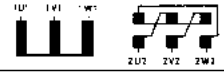
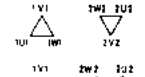
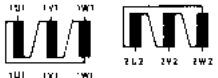
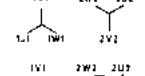
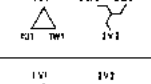
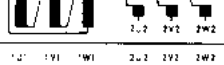
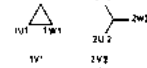
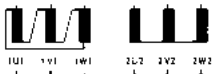
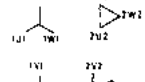
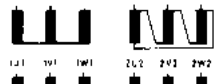
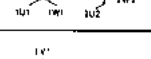
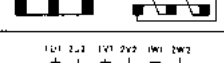
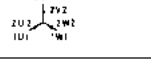
The vector group marks the circuitry of windings and their phase position to each other. It consists of a capital and small letter plus a code number.

The capital letter refers to the input winding, the small to the output winding. The upper voltage is marked by 1 in front, the undervoltage by a 2 in front, regardless of input- or output voltage. A 1 in back, on the contrary, marks the beginning of a winding, a 2 in back the end. Tabs are marked 3 and 4 in back. The numbers correlate to letters U V W and distinguish the 3 phases. The neutral point (star point) is always marked N.

The most common vector groups are summarized alongside, input left-hand, output right-hand.

Unless otherwise requested, three-phase transformers are preferentially delivered in star-star connection.

At requirement secondary for proportionally higher currents at smaller voltages than on primary side preferably Yd5 / Yd11 is employed due to winding cross sections.

Designation Code no.	Vector group	Vector diagram	Circuit configuration	Secondary star point
0	Dd0			none
	Yy0			10% load capacity
	Dz0			full load capacity
5	Dy5			full load capacity
	Yd5			none
	Yz5			full load capacity
6	Dd6			none
	Yy6			10% load capacity
	Dz6			full load capacity
11	Dy11			full load capacity
	Yd11			none
	Yz11			full load capacity
0	Yz0			10% load capacity