POWER TRANSFORMERS

INDUSTRIAL APPLICATIONS

MAIN FEATURES

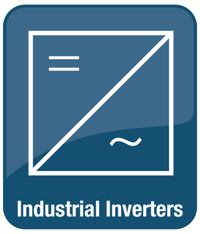
- Very high power density (total power up to 100 kW)
- High insulation strength and corona extinction voltage possible
- Highest energy efficiency (more than 99 %)
- Highest reliability over wide temperature range

DESCRIPTION

State-of-the-art DC/AC and DC/DC converters for high power applications enable high output power levels utilizing switching frequencies up to 50 kHz and more. Therefore sophisticated magnetic transformers are required to maintain safe galvanic separation between the input and output.

VAC power transformers offer transmittable powers of up to 100 kW in extremely compact volumes due to the high saturation flux density of the nanocrystalline alloy VITROPERM®. Depending on the required insulation level, the highest corona extinction voltages can be realized with modern winding techniques.

POSSIBLE APPLICATIONS



POWER TRANSFORMERS

CONSTRUCTIONAL BASICS

All VAC power transformers are based on toroidal cores made of VITROPERM 500 F. This nanocrystalline alloy offers excellent soft magnetic properties combined with lowest losses. The size and number of cores will be determined on the basis of the required power, working frequency, input voltage level, duty cycle and cooling conditions.

For modern designs, high frequency litz wire is used for the windings. Depending on the necessary insulation strength and the partial discharge requirements, different insulation methods are used. After winding, the transformer will be put into a cylindrical aluminum casing of the required size. The top of the casing is typically open.

Due to the almost zero magnetostriction of VITROPERM, it is possible to use a very strong and highly insulation epoxy resin, ensuring safe encapsulation of the transformer.

TYPICAL CHARACTERISTICS

Electric properties		
P	kW	3…100
f	kHz	5…60
$U_{1, rms}$	V	< 1,000
$I_{2, rms}$	A	< 500
$U_{is,rms}$	V	< 4,000
$U_{TA, rms}$	V	< 6,000

Magnetic properties		
n	typical	**1**:1 – **6**:1
L_1	mH	5…30
L_s	µH	1…10

Design parameters		
T_a	°C	-40…+70
T_{op}	°C	< 130
m	kg	2…30

The data in the table only represents typical characteristics – if you have different requirements (e.g. higher power or input voltage), please contact us directly.

TYPICAL VOLUME AND POWER

The following table gives an overview of the typical transmittable powers that can be achieved with differently sized casings. The power level is higher if the insulation voltage is below 1 kV:

Diameter [mm]	Height [mm]	Volume [l]	Transmittable power [kW] if $U_{is,rms}$	
			< 1 kV	> 1 kV
76	44	0.25	4	–
130	90	1.2	15	10
157	125	2.3	30	20
220	160	6	100	50

Assumptions: T_a = 55 °C (forced cooling), duty cycle 50 %, f = 25…40 kHz

The data in the table only represents typical characteristics – details of size, insulation methods and cooling techniques need to be discussed thoroughly.

KEY

P = transmittable power

f = working frequency

$U_{1, rms}$ = input voltage, rms value

$I_{2, rms}$ = output current, rms value

$U_{is,rms}$ = insulation voltage, rms value between primary and secondary windings

$U_{TA,rms}$ = corona extinction voltage, rms value

n = turns ratio (**bold**: primary winding)

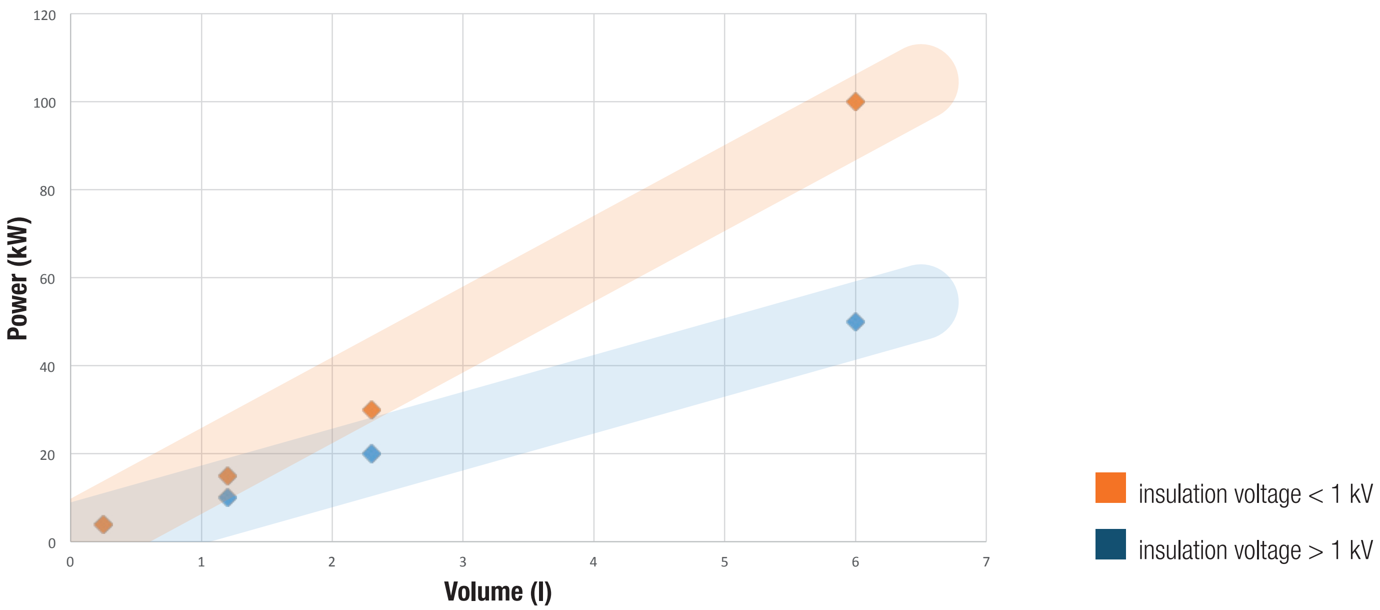
L_1 = primary inductance (typical value)

L_s = leakage inductance of primary winding with secondary windings shorted (typical value)

T_a = ambient temperature

T_{op} = operation temperature

m = weight of transformer



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CIRCUIT TOPOLOGIES

VAC power transformers are primarily optimized for hard switching full-bridge converter topologies, enabling the transmission of high power with highest efficiency. The common pursuit to reduce the losses in the semiconductors has resulted in many resonant topologies in recent years. In particular, the so called quasi-resonant systems have emerged with sinusoidal current and rectangular voltage, typically using Zero Current Switching (ZCS). It has to be considered that a certain percentage of reactive power will circulate in the system requiring more powerful transformers. The benefits of lower semiconductor switching losses need to be balanced against the necessary higher volume of the power transformer.

With the latest SiC semiconductors and their extremely low switching losses, conventional hard switching topologies might regain their position as a favoured solution.

COOLING

With an internal efficiency of more than 99 %, VAC power transformers are highly energy efficient. Nevertheless, cooling of the dissipated heat is still required – the following cooling techniques are widely used:

1. Pure convectional cooling
2. Forced air cooling
3. (Water) cooled base plate

In the case of low transmittable powers, convectional cooling might be sufficient, but the ambient temperature in close vicinity to the transformer must be monitored carefully. If forced air cooling is applied, casings with cooling fins should be used. Water cooled base plates are typically used in very compact designs where no sufficient air flow can be established. This issue has to be considered from the very beginning of the design stage, as the dominant heat transport needs to go through the base of the transformer.

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