

Transformer Cores

Transforming tomorrow



About the company


Dear business partners,

it is my great pleasure to present to you our expanded offer of cores for transformers. This, being for us a very important expansion, symbolically coincides with the commemoration of the 15th anniversary of founding the company. In human terms, 15 years means a period of maturity and our company has reached that period, when it wants to become one of the most important suppliers of core on the European market.

To meet this goal, we have put into effect a setup that allows for the production of core for distribution transformers, the so-called Stacked cores.

Cores for distribution transformers are the most important component for the construction of transformers that are used for distributing energy. We are aware of the responsibility that arises from this position, therefore we will do everything possible in our strength to be able to be a reliable partner for you in this segment. A partner supplying quality products.

We look forward to working together with you



Tomasz Janas, MBA
Director of the ArcelorMittal Technotron s.r.o (Ltd) company

Synergic actions from the ArcelorMittal connection are still developing, which brings long-term prospects and many other benefits such as:

- united and integral purchase and sale
- simple and fast distribution to the whole world
- access to new markets
- reliable and secured deliveries of input materials
- reliable and strong background
- access to technologies and common know-how

The company's long-term goal consists in a prosperous, well-performed and marketing-managed company satisfying our customer's needs and expectations with an emphasis on quality, timeliness of supplies and optimization of payment terms and conditions. The company management respects environmental requirements.

Technotron is situated in Moravskoslezský region about 20 kilometers southwest from Ostrava. Our company occupies about 8000 m² and employs more than 110 employees.

High product quality, qualified employees, the highest level of customer care, flexibility and total filling of client requests classify our company as a market leader.

The most important aspects for our cooperation with partners are customer care, collective growth, cooperation on projects and collective negotiation of high targets.

ArcelorMittal Technotron s.r.o. is ideal partner for clients who prefer high quality of products and services.

Our products

Our products are produced in 3 production plants. Manufacture program results from long tradition of oriented transformer sheets upgrading uses in electrical industry, also high-quality and low-quality steel and metals upgrading uses in machine-building industry, building industry and mining. Our company is a market leader in the Czech Republic in all of manufacturing majors and the most customize company to our customers needs.

Manufacturing programme of **ArcelorMittal Technotron** consists of 3 majors:

EXPANDED METAL

WINDED TRANSFORMER CORES

STACKED TRANSFORMER CORES

Benefits resulting from our cooperation:

- more than 20 years production tradition,
- guaranteed quality, only about 0,22% of all claims in whole sales in 2008 – 0,24%, in 2009 – 0,21%, in 2010 – 0,28%
- quality and timeliness deliveries, fast dispatching time,
- variability of deliveries,
- periodical consultation and technical advice for solutions of production problems,
- technical service,
- possibility of core handling,
- individual approach to each order ,
- customer awareness.



About the products

TRANSFORMER CORES

Transformer cores make a very important part for transformers production and their quality is crucial for the final parameters of magnetic circuit.

A transformer core consists of magnetic circuit where its induction flux caused by the current passage flowing through the primary coiling induces electric voltage in the secondary coiling.

Wound transformer cores are used as compact cores (toroid) or as cores with air-gaps. ArcelorMittal Technotron s.r.o. manufactures cores from grain oriented transformer metal band with silicium alloyed Goss texture of about 3 %, thickness range form 0.15 to 0.35 mm.



We offer these types of magnetic cores:

TOROID CORES

CUT CORES

CRUCIFORM CORES

UNICORE CORES

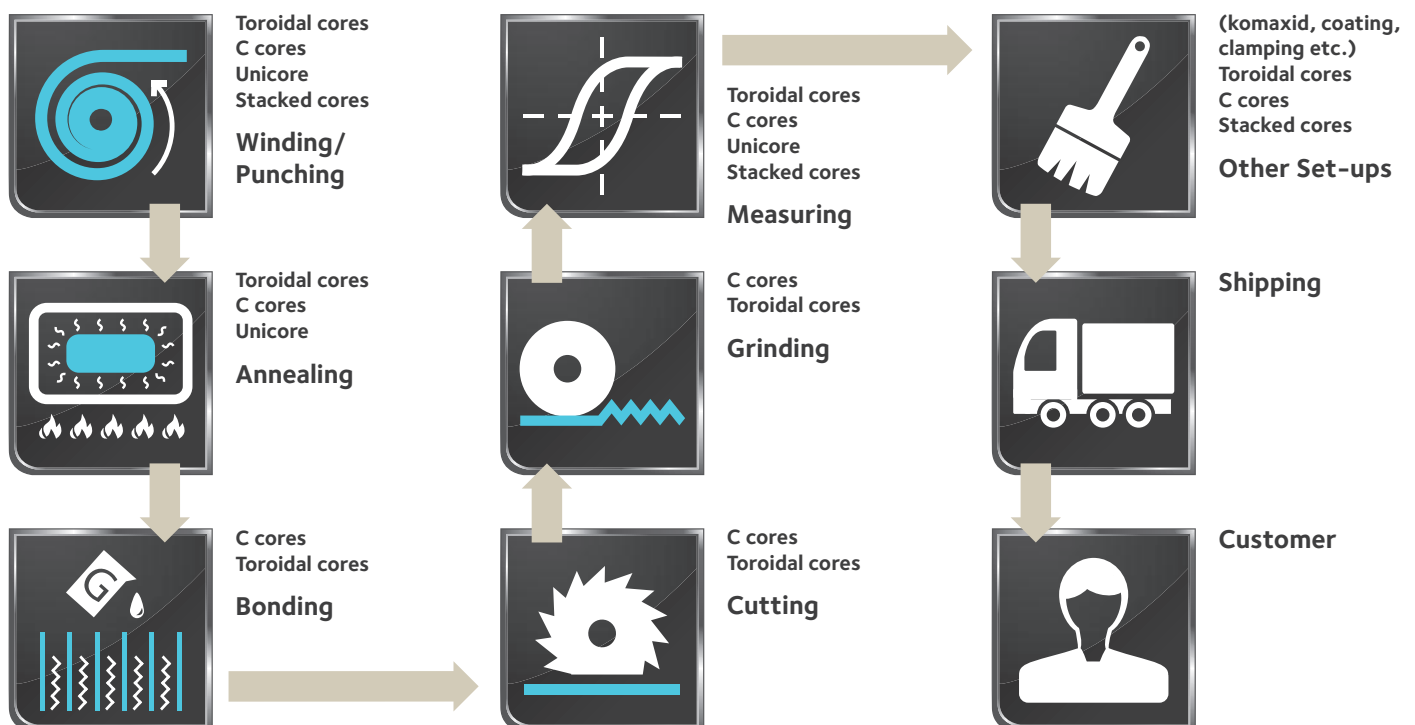
STACKED CORES

Application possibilities of transformer cores

Transmission transformers.
Instrument transformers.
Measurement transformers.
Voltage transformers.
Current transformers.
Supply transformers.
Power transformers.
Low loss applications.
Inductors.

Converters.
Suppression technology.
Regulating transformers.
Pulse transformers.
Special transformers.
Rectangular current transformers.
Transformers up to approximately 10 MVA.
Single-phase and three-phase distribution transformers.
Single-phase and three-phase chokes.

Production process of magnetic cores



About the products

MAGNETIC PROPERTIES OF TRANSFORMER CORES

Magnetic properties of transformer cores are directly depended on band quality and thickness used for cores. The cores are tested individually and each core which is leaving the production is measured to provide the 100% quality of each delivery.

Measuring process is operated and scanned by technological computer. This computer evaluates following values:

effective value non-sinusoidal actuating current T_{μ} [A]

intensity of magnetic field H_{ef} [A/m]

magnetic induction B_{max} [T]

apparent power S [VA]

active input (losses) P [W]

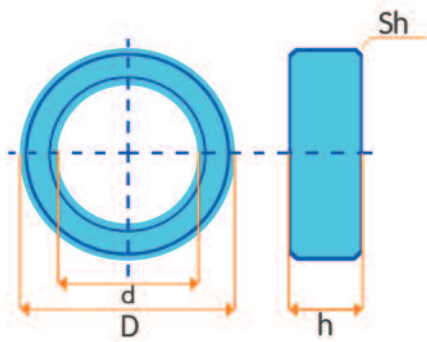
amplitude permeability μ

These values are measured fluently in whole range of alternating magnetizing characteristic and are limited by maximum power exciter circuit of measuring instrument.



Toroid cores

Producing assortment



Toroid core is basically wound grain oriented silicon strip containing approximately 3% of silicium to the circle or other form.

Toroid cores can be in different types and different shapes according to customer wish and project (for example chamfered edges, protecting coating, protective finish, with air gap, etc.)

Benefits of toroid cores

- Close flux path.
- Low magnetic leakage.
- Low noise of transformers.
- Compact dimensions.
- Low weight of transformers.

Toroid cores are supplied in different types of construction and in different types of quality according to used base material.

Before shipment the cores are re-measured, we provide the electromagnetic values attest upon customer's request.

Dimension	min. (mm)	max. (mm)
D-outer diameter	27	800
d-inner diameter	17	500
h-core height	10	180
Sh-chamfered edge*	2x45*	5x45*

*by customer request

The table of toroid cores qualities

Quality	Typical values B _{max} (T)* H _{eff} =3A/m	Guaranteed values B _{max} (T) H _{eff} =30A/m	Color marking**
N-normal	0,050	min 1,30	black
S-standart	0,075	min 1,40	red
SU-super	0,110	min 1,60	green
SU-EX-extra	0,130	min 1,70	white

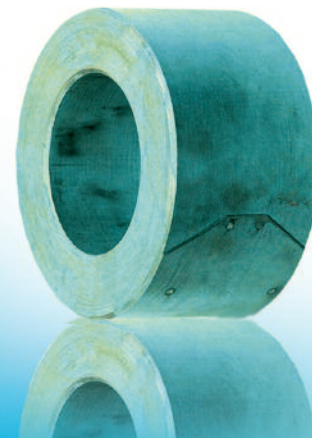
* typical values – by customer's request
** color marking - by customer's request



Toroid cores

Types of toroid cores

Toroid cores can be chamfered on the inside and outside edges and make possible to wound the coil without using protective capping strip. Another advantage of chamfered edges is to eliminate possibility of breakage the banding and also to eliminate possibility of breakage the winding.



Due to customers' wish the cores can be supplied with protective lamination, called **KOMAXIT**.

These cores can be also in combination with **chamfered edges**. This brings a big advantage because you can wound winding without using protective capping strip. Also you don't have to band the cores before wound base threads.

Another big advantage of **protective coating** is hardening of the core therefore the whole cores or just the core fronts are more resistant against mechanical influence and have better stability of magnetic properties.

Toroid cores **with air gap** can be produced with exactly defined one or more air gaps.

These cores are usually used for chokes, combined instrument transformers and also for transformers for audio technology (e.g. amplifiers).

Toroid cores of **special shapes** are produced due to customers' requirements and can be cone, elliptical, ovoid shapes and so on.

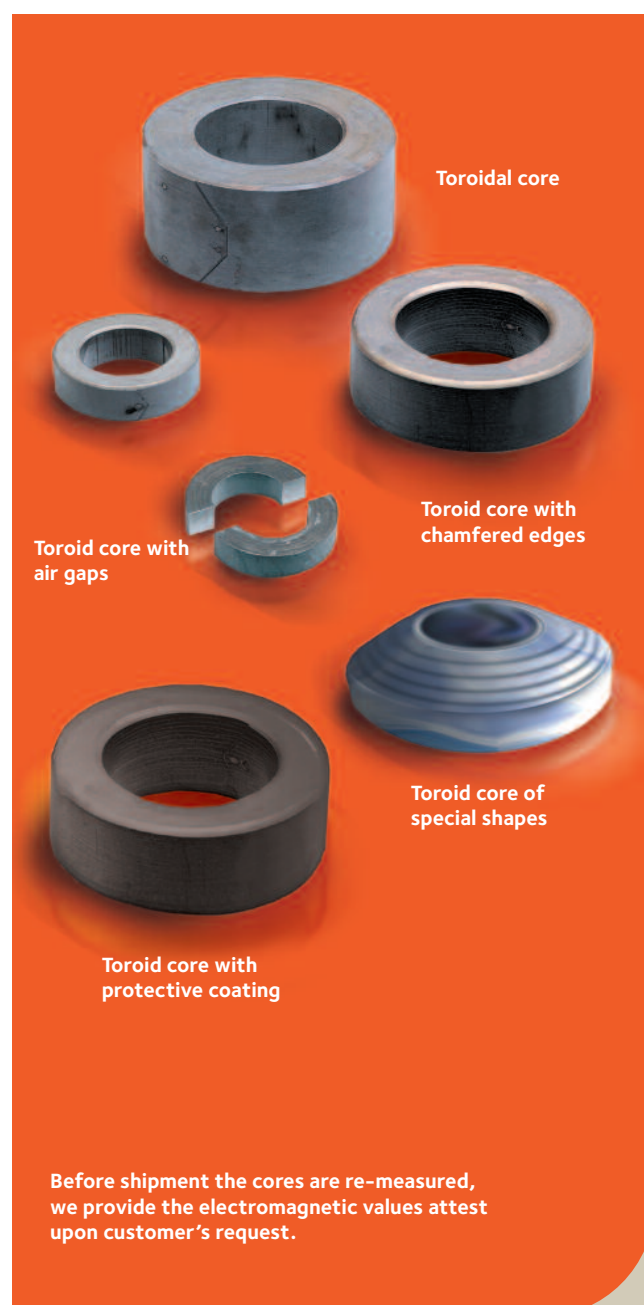
These cores are usually used for illuminating and measurement engineering.

The tolerance of toroid cores dimensions

Inner diameter	Acceptable deviation	Outer diameter	Acceptable deviation
to 50	± 0,5	to 50	± 0,75
50–100	± 0,75	50–100	± 1
100–150	± 1	100–150	± 1,2
150–300	± 1,2	150–300	± 1,5
300–400	± 1,5	300–400	± 1,75
400–500	± 2	400–500	± 2
500–800	± 2,5	500–800	± 3
800–1000	± 3	800–1000	± 3,5
1000–1200	± 5	1000–1200	± 5,5

Core height

Band width	Acceptable deviation
to 50	± 0,2
from 50	± 0,3



Cut cores

Cut C cores

Cut transformer cores are manufactured in process of winding up the transformer strip on a mandrel followed by the processes of cutting the hot-manufactured and synthetic resin-bond core. Wound cores shape is better adapted for course of the magnetic induction current and the structure of material grain is used more effectively when compared with cores composed of sheet stampings of various shapes.

Cut cores are assembled with a certain air-gap between the pieces, insulation pieces are placed in these gaps during the assembly of the bobbins. Cut surfaces of these cores can be rounding, oval and rectangular.

Benefits of cut C cores

Electrical energy saved thanks to low specific iron watt losses. Saving in quantity of used copper for winding thanks to smaller dimensions and weight of cut cores. Saving in work costs exert for transformers assembly thanks to easy assembly. Low noise.

According to the ArcelorMittal Technotron internal norm

Core Type*	Max. specific losses $P_{1,5/50}$ [W/kg]	Max. magnetic field density H_{eff} at $B_{1,5T}$ [A/M]
C 8001–10000	2,5	400
C 10001–26003	2,2	350
C 26004–90005	2,2	300

*manufactured from M165-35S

Cut surface quality „A“ - according to the DIN/IEC norms

Core Type*	Max. specific losses $P_{1,7}$ [W/kg]	Max. magnetic field density H_{eff} at 1,7T [A/M]
SG = Q	2,2	265
SU = U	2,2	265
SE = R	2,2	265
SM = M	2,2	265

* manufactured from M150-30S/M140-27S

Cut surface quality „C“ - according to the DIN/IEC norms

Core Type*	Max. specific losses $P_{1,7}$ [W/kg]	Max. magnetic field density H_{eff} at 1,7T [A/M]
SG = Q	1,9	125
SU = U	1,9	125
SE = R	1,9	125
SM = M	1,9	125

* manufactured from M150-30S/M140-27S

Marking of cores

A core consists of two horse shoe – shaped parts. In order to secure their correct assemblage both parts are marked by a coloured position mark on their front side. The colour of the position mark also determinates the band thickness used for coiling of the core. The core is also marked by a serial number.

yellow	band thickness 0,35 mm
red	band thickness 0,30 mm
white	band thickness 0,27 mm
green	band thickness 0,15 mm

Guaranteed magnetic values of wound cores at frequency of 50 Hz



Cut cores

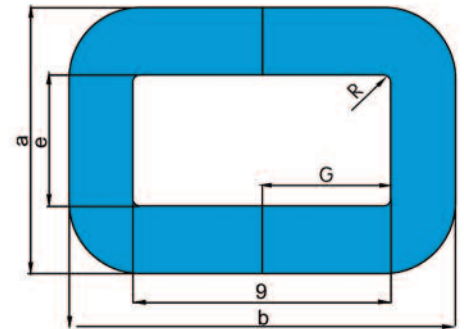
Cut C cores single phase

Type line of supplied cut C cores single phase

- According to the DIN 41309 norm – **SG, SU, SE, SM**
- According to the IEC 329 norm – **Q, R, M, U**
- According to the ArcelorMittal Technotron internal norm – **C**

(viz www.technotron.cz)

According to your project we will produce the exact type of your core.



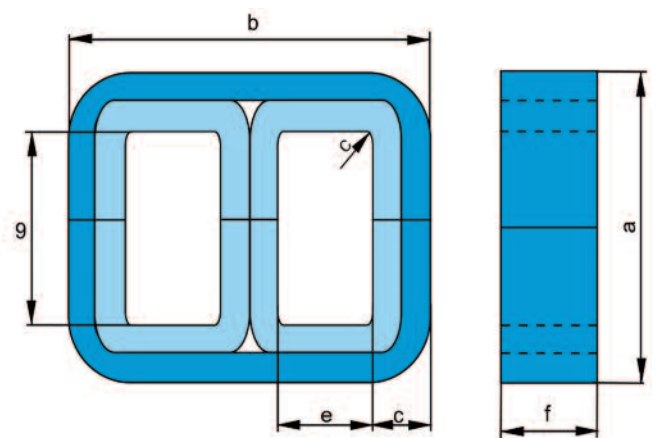
Cut C cores three phase

Type line of supplied cut C cores three phase

- According to the DIN 41309 norm – **S3U**
- According to the IEC 329 norm – **3U**

(viz www.technotron.cz)

According to your project we will produce the exact type of your core.



Cut cores

Cruciform Cut Cores

A Shape of cruciform cores allows better flow of magnetic flux density and their special grain structure is used more effectively as compared with cores composed of metal sheet stampings of various shapes. Specific intersection of these cores allows varied use of circular coils.

Benefits of cruciform cores

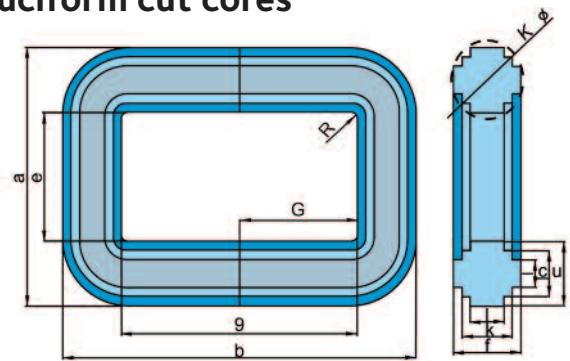
- Electrical energy saved thanks to low specific iron watt losses.
- Saving in quantity of used copper for winding thanks to smaller dimensions and weight of cut cores.
- Saving in work costs exert for transformers assembly thanks to easy assembly.
- Low noise.
- Better use of coils scope due to stepped cross-section.
- Easier winding of wire on a circular coil.

As a result of considerable variety of demands on construction we do not provide any standardized assortment. Cruciform cores are manufactured with two or three steps according to customer's specification.

Before shipment the cores are re-measured, we provide the electromagnetic values attest upon customer's request.



Cruciform cut cores

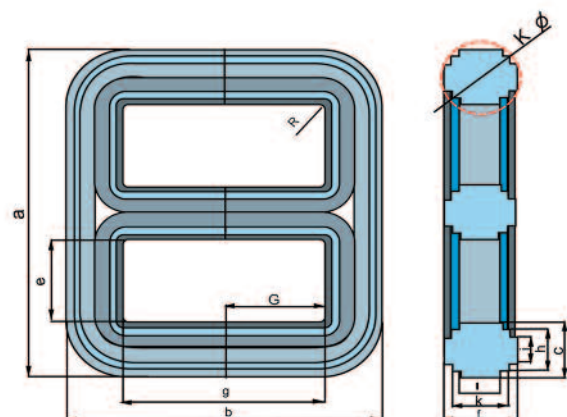


Guaranteed electric magnetic properties of cruciform cores with air gaps

Standard guaranteed highest permissible values of nominal losses and magnetic field intensity at the magnetic induction of $B_{max} = 1.5 ; 1.7 T$ and frequency of 50 Hz as divided into four groups:

Material	Nominal losses max. [W/kg]		Magnetic field intensity max. H_{eff} at $B_{max, 1.7T}$ [A/M]
	$P_{1,5}$	$P_{1,7}$	
M165-35S	2,0	2,5	350
M150-30S	1,9	2,3	300
M140-27S	1,8	2,2	300
M120-33S*	1,6	2,2	400

* at 400Hz/1T corresponding nominal losses 8 – 8.5 W/kg



Unicore

Unicore constitutes a new line of cores of magnetic circuits. The manufacturing technology was developed in 1997 and its aim was to simplify the existing technology and improvement of parameters of electrical machines. Due to advantages of their construction Unicore are apt to replace almost all conventional C cores.

Unicore advanced technology leads to low specific losses. Their construction is simplified – they don't have to pass through the time and cost consuming production process which contributes to very favorable price and short delivery time. At assembly the existing types of coil forms can be kept therefore there are no changes in transformer construction needed.

Specific losses

Unicore sums up all advantages of C cores, but their specific losses are lower by 20 – 40%. Therefore it is possible to economy in the magnetic circuit weight and amount of cooper used. We have tested the conventional cut core of C 31002 type (core cross-section 12 cm², L_s = 36.3 cm and weight = 3.10 kg) and Unicore – DUO2 and DUO3 cores of the same cross-section and medium-length. Comparison of results can be found in a table.

Benefits of Unicore

- Low specific losses.
- Easy assembly.
- Acceptable price.
- Saving in quantity of used copper.
- The banding of cores is not necessary.
- Short delivery time.

Core type	Heat treatment	H _{eff} A/m	B _{max} T	Specific losses W/kg	Input VA/kg
C 31002 (3,10 kg)	annealed	110	1,50	1,20	5,10
	annealed	260	1,70	1,85	13,90
C 31002 – DUO 02 UNICORE	unannealed	140	1,50	1,30	6,50
	unannealed	370	1,70	1,80	19,50
	annealed	45	1,50	0,95	1,90
	annealed	150	1,70	1,45	7,30
C 31002 – DUO 03 UNICORE	unannealed	150	1,50	1,40	7,50
	unannealed	450	1,70	1,95	24,00
	annealed	60	1,50	1,00	2,10
	annealed	240	1,70	1,55	12,00



Unicore

Primary types and sizes of Unicore

Unicore have been produced to replace classical C cores. The only limitation factor is a minimum dimension of the inner section (see a table below). During assembly the existing types of bobbins can be used therefore there are no changes in magnetic circuit construction needed.

Cores can be supplied annealed or unannealed. Subsequent annealing of cores decreases losses by 10% to 30 % depending on the core size. The core angle of a Unicore can be either 30°, 45° or 90° depending on their use by the electrical machines producer.

The core's parting line can be straight as at the classical C core (BUTT) or with cruciform cuts along one or two legs (e.g. DUO).

To specify your core request you need to know the inner section dimension, band thickness and width, thickness of wounded layer, corner angle, type of core and request material quality of the core.

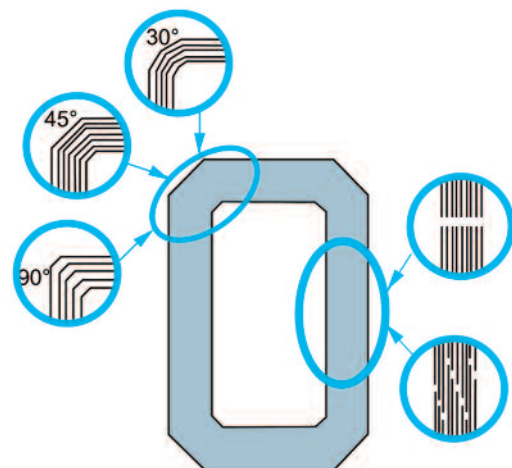
UNCUT UNICORE

Due to advantages of their construction UNICUT Unicores are apt to replace almost all conventional uncut C cores and rectangular toroid cores. Corner angle can be 45 or 90 degrees.

Application possibilities of UNICUT cores

Rectangular current transformers.
Voltage transformers.
Low loss transformers.

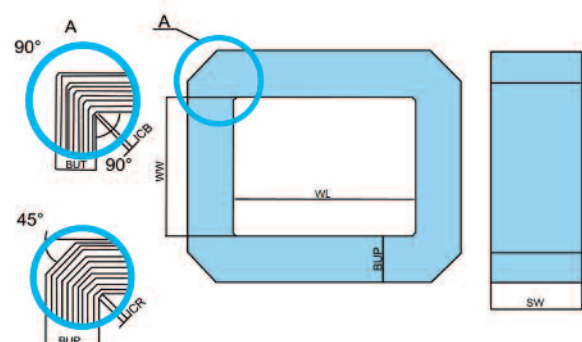
Primary types Unicore



Dimension	Minimum (mm)	Maximum (mm)
Inner section length	80	unlimited *
Inner section width	40	unlimited *
Band width	20	300
Wounded bezed	Band thickness	unlimited *

* Dimension is not restricted by manufacturing tools potential

UNICUT 45°, 90°



Unicore

DUO UNICORE

DUO core can replace conventional C cores. Due to its low specific losses it allows better output parameters of final magnetic circuit. Low losses can be reached as a result of air gaps layout along the core leg.

Application possibilities of DUO cores

- Single Phase transformers.
- Three Phase transformers.
- Power transformers.
- Current transformers.
- Measuring transformers.
- Instrument transformers.
- Transmission transformers.
- Regulating transformers.

DUO core has been developed to facilitate and accelerate cores assembly into 1 or 2 bobbins. It consists of two gradually divided halves – male and female – which gradually assemble into bobbins (bobbin). The inner lamination runs around the full circumference of the core and the last outer extended lamination functions also as tightening strap. The last lamination (TIG) is welded on the core which fixates the core perfectly. More details about DUO core assembly – please find on our website – www.technotron.cz



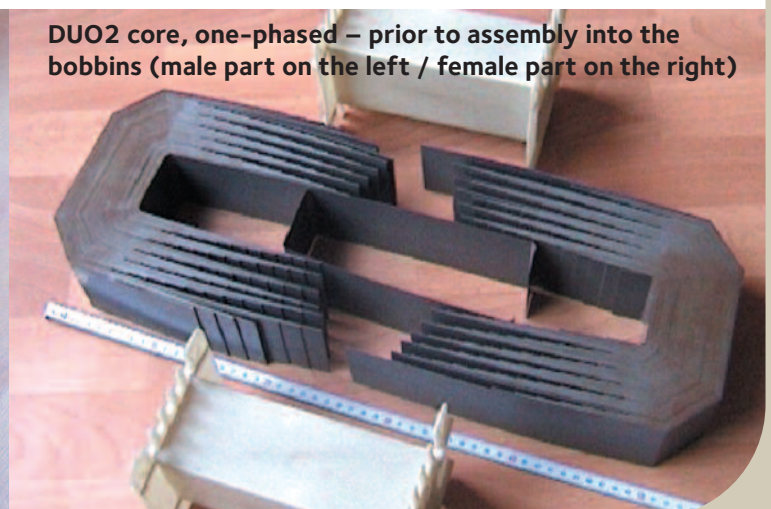
3F Duo Unicore prior to assembly into the bobbins.



3F Dou Unicore



DUO2 core, one-phased – prior to assembly into the bobbins (male part on the left / female part on the right)





Unicore

DUO Unicore types of construction



DUO 1
One lamination per overlap (repeating).
The lowest losses.
Relatively longer assembly of the core into coils.



DUO 2
Two laminations per overlap (repeating).
Combination between lowest losses and shortest assembly time.



DUO 3
Three laminations per overlap (repeating).
Relatively higher losses.
Fast core assembly into coils.

BENEFITS OF DUO CORES

- Easy assembly.
- Low core losses.
- Savings in core weight.
- Saving in quantity of used copper.
- No tightening straps necessary.

Butt Unicore

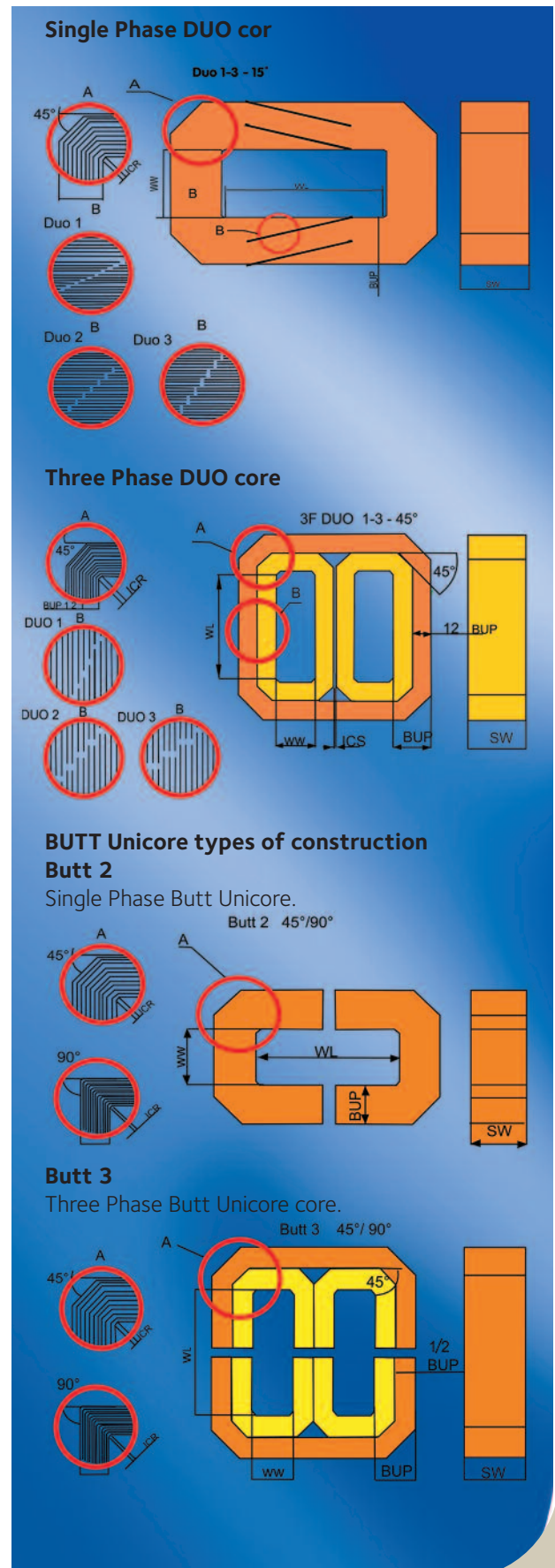
BUTT is a core suitable for chokes; its front surface is superposed thus enabling conventional C cores replacement. Individual layers are formed to create an even surface of the core column. The corner angle can be set to 45° or 90°, its radius is also possible to set.

Application possibilities of BUTT cores

- single phase choking coil,
- three phase choking coil

BENEFITS OF BUTT CORES

- Easier assembly than classical C cores.
- Significantly lower price than classical C core.
- It is possible to add the last full lamination for welding of TIG by welding machine – functions as a tightening strap.



Unicore

STEP BUTT UNICORE

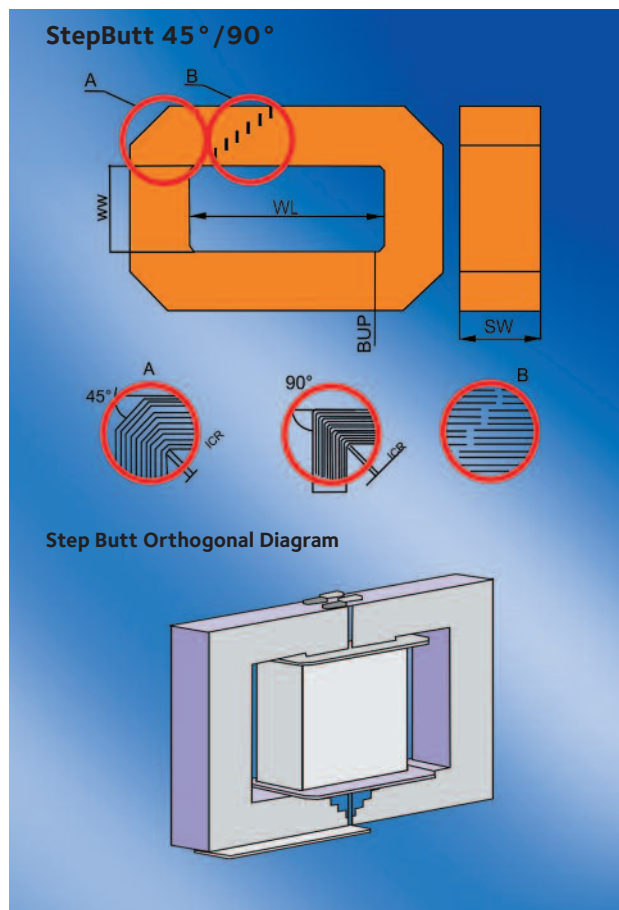
Step Butt Unicore belongs to the group of BUTT Unicore. The air gap is designed as steps. Step Butt Unicore can be annealed to reduce loss and make assembly easier.

Benefits of Step Butt Unicore

- Lower core losses than comparable cut C cores.
- Higher transformer output.
- Lower weight of transformers.

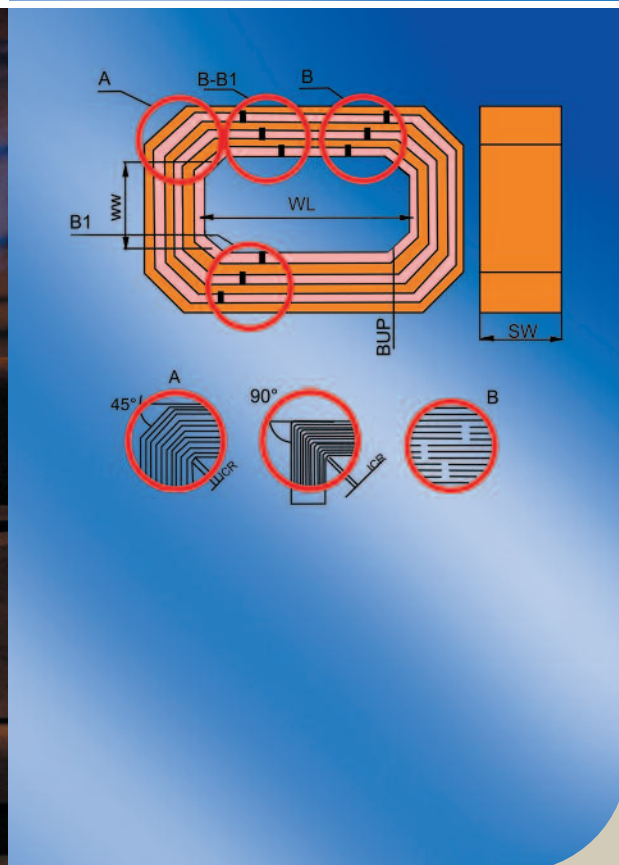
Application possibilities of STEP BUTT cores

Transformers up to approximately 1 KVA.



Combi Step Butt Unicore

Combi Step Butt Unicore also belongs to the group of STEP BUTT Unicore. The gaps are on the opposite sides of the core. So the gap is on every other packet in the one leg. Thanks to this we can achieve reduction of losses and noise.



Unicore

DGAP CORES

Diving gap of DGAP core is placing around one core leg. This solution brings the lowest specific losses and very low level of magnetizing current. It makes them ideal for low loss applications. The DGAP core characteristics are very similar to those of a toroid core.

Application possibilities of DGAP cores

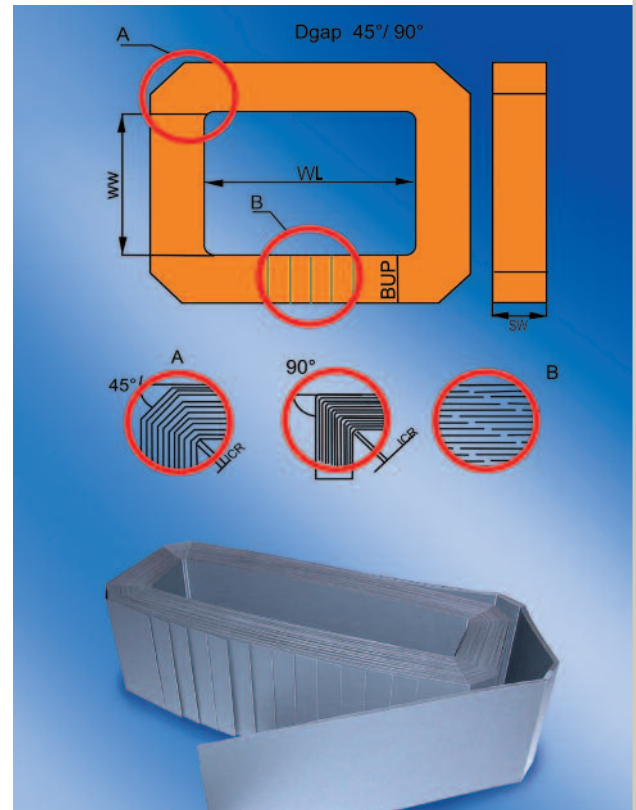
Low loss applications.
Transformers up to approximately 10 MVA.
Single phase and three phase distribution transformers.

The position and specification of each DG face can be easily and accurately specified to best suit your application.

BENEFITS OF DGAP UNICORE

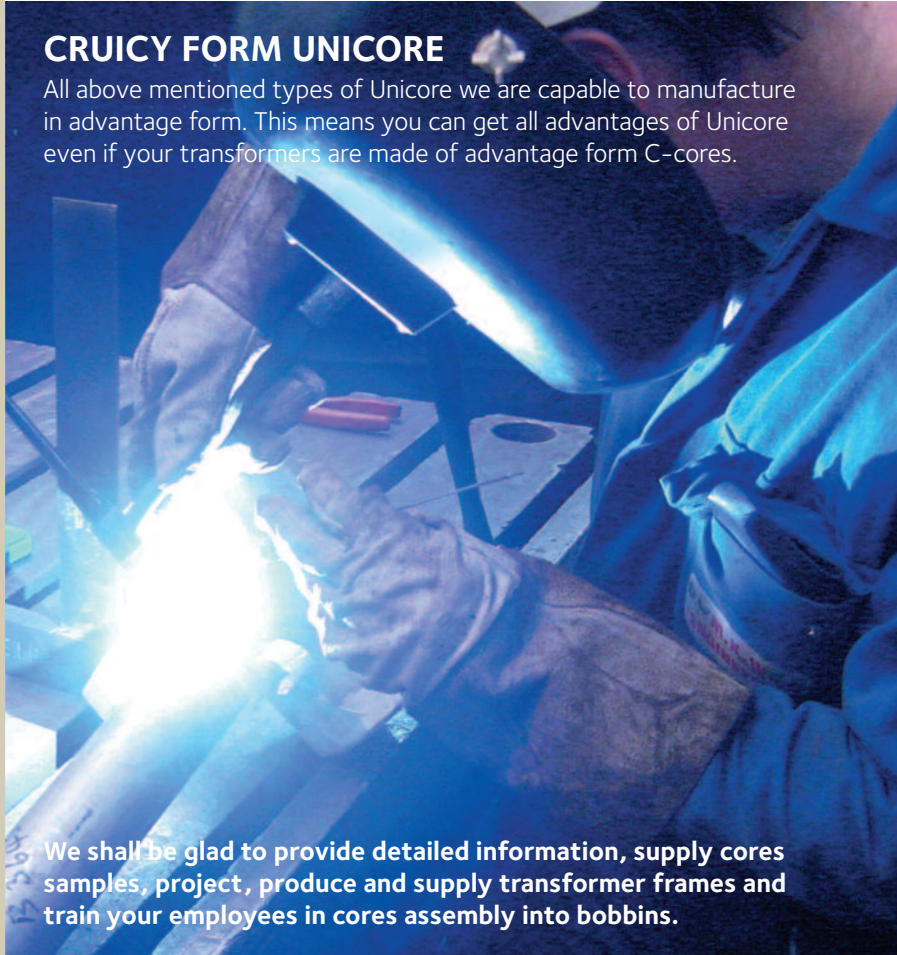
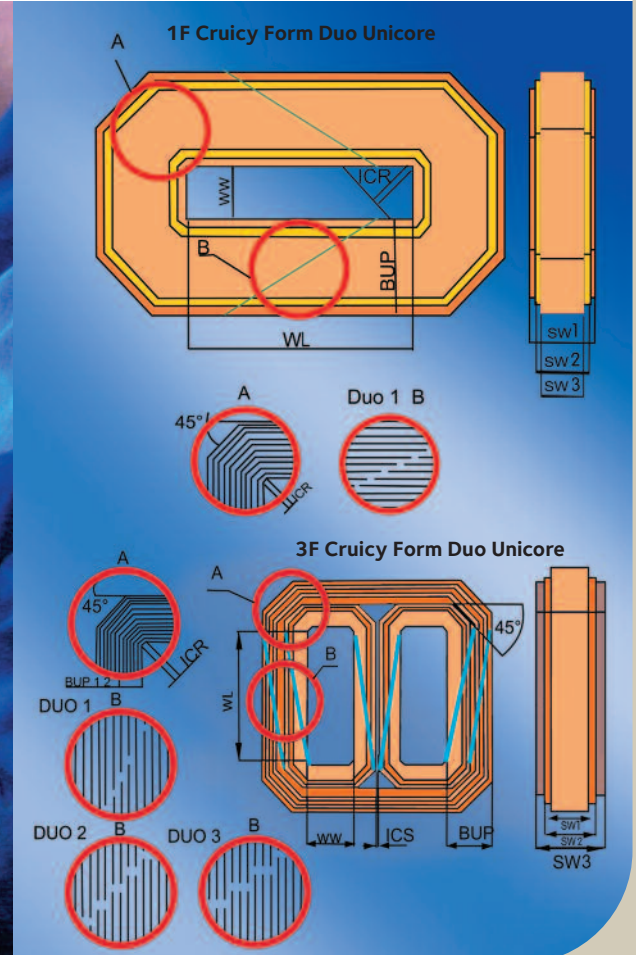
The lowest core losses.
Higher transformer output.
Lower transformer weight.
Saving in quantity of used copper.

Before shipment the cores are re-measured, we provide the electromagnetic values attest upon customer's request.



CRUICY FORM UNICORE

All above mentioned types of Unicore we are capable to manufacture in advantage form. This means you can get all advantages of Unicore even if your transformers are made of advantage form C-cores.



We shall be glad to provide detailed information, supply cores samples, project, produce and supply transformer frames and train your employees in cores assembly into bobbins.

Stacked cores

Benefits of stacked cores:

- Reduction in core losses
- Easy assembly

Delivery options:

- assembled
- non assembled

Material used: all type of SI steel

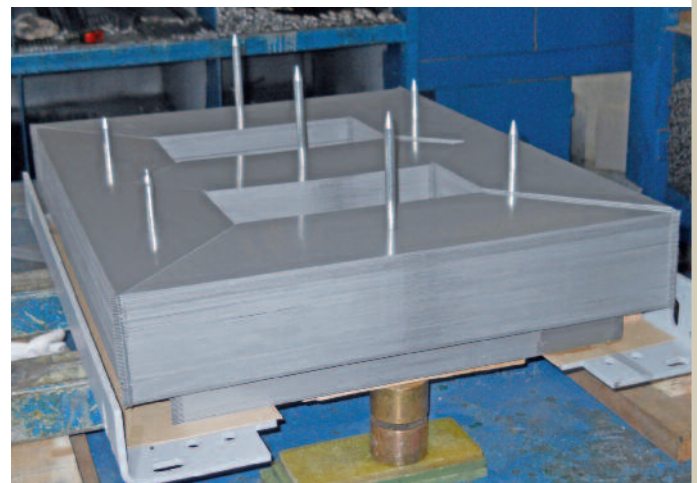
Our production range:

	max.	min.
Thickness:	0,23 mm	0,35 mm
Width:	40 mm	400 mm
Sheets centre-line length*	250 mm	2000 mm

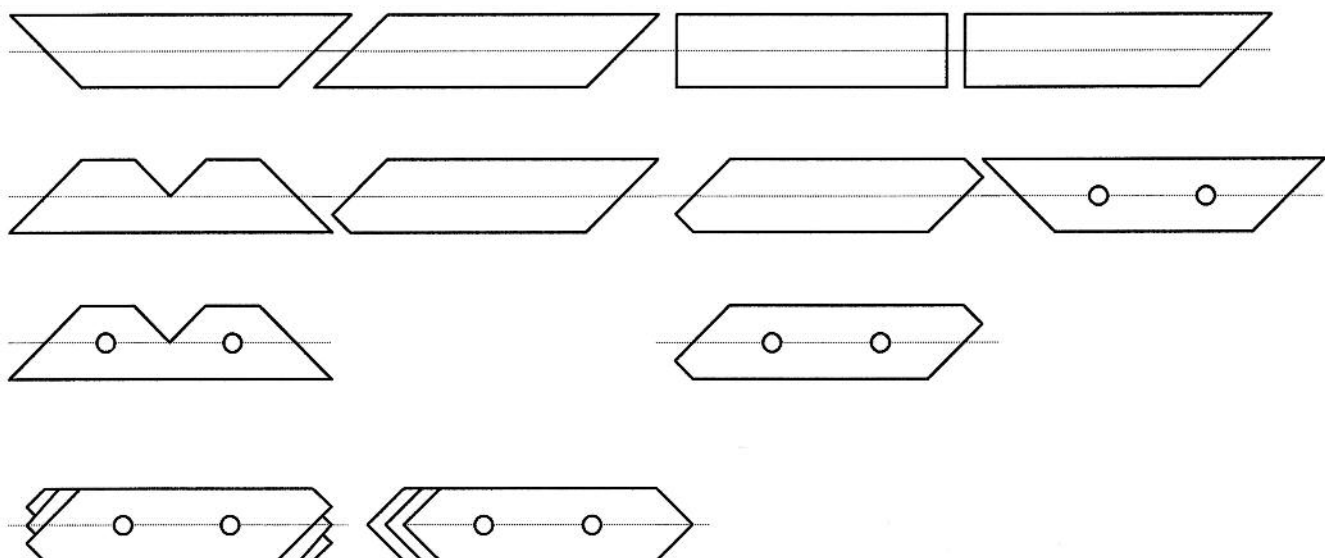
*Minimum length 250 to 500 mm can be obtained up to max. width of 160 mm moving the 45°shears

Tolerances

Differences on strip width	+/-0.2 mm
Linearity on length = 1500 mm	0.8 mm
Edge burr	0.02 mm
Length accuracy	+/-0.1 mm
Angle accuracy	+/-0.01
Punching diameter	10.5 mm



Possible shape combination



Possible Cross and Longitudinal Step Lap

Materials used

Materials used for manufacturing of toroid cores, wound cores and UNICORE cores operating at frequency of 50 Hz

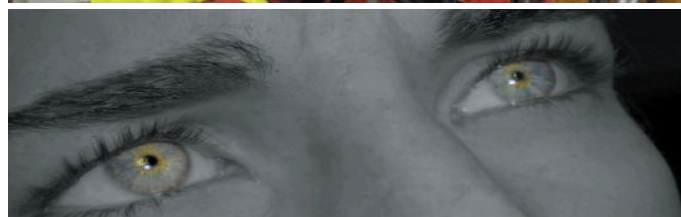
The selection of optimal thickness of a GO band is based on the fact that smaller is the thickness of higher are the hysteretic losses. On the other hand specific losses caused by eddy current decrease of the sheet thickness by a quadrate. The total of both losses results in significant minimum of total specific losses for range of band thickness from 0.23 to 0.35 mm and 50 Hz frequency.

Wound cores of magnetic circuits produced by ArcelorMittal Technotron are manufactured from grain oriented transformer metal band with oriented structure. Thanks to this oriented structure these materials provide high magnetic orientation and are divided to several qualities, as you can see in the table below.

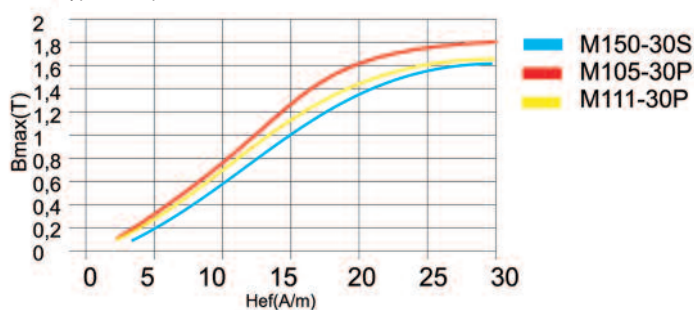
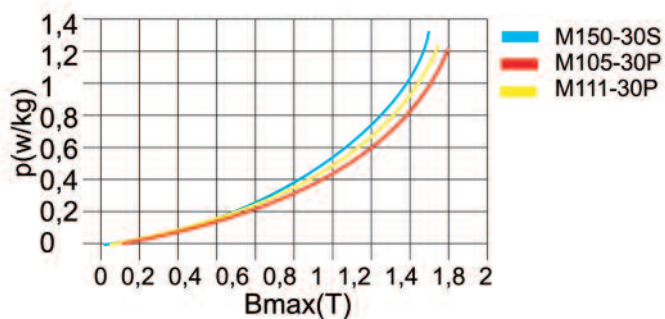
Elementary specification of materials manufactured according to the IEC 60404-1; 2000 Standard.

Identification C22
 Material Fe 3% Si
 Thickness..... 0.15 – 0.35 mm

Nominal thickness mm	Quality			Max. specific losses (W/kg)		Min. magn. induction (T)
	EN10107	DIN46400	AISI	$P_{1,5/50Hz}$	$P_{1,7/50Hz}$	B_{800}
0,18	M110-18S			0,63	0,927	1,875
0,23	M127-23S		23M3	0,8	1,27	1,75
0,27	M140-27S	VM89-27N	27M4	0,89	1,40	1,75
0,30	M150-35S	VM97-30N	30M5	0,97	1,50	1,75
0,35	M165-35S	VM111-35N	35M6	1,11	1,65	1,75
0,23	M110-23S			0,73	1,1	1,78
0,23	M120-23S			0,77	1,20	1,78
0,27	M130-27S	VM130-27S		0,85	1,30	1,78
0,30	M140-30S	VM140-30S		0,92	1,40	1,78
0,35	M150-35S	VM155-35S		1,05	1,50	1,78
0,23	M100-23P				1,00	1,85
0,27	M103-27P		27MOH		1,03	1,88
0,30	M105-30P		30MOH		1,05	1,88
0,30	M111-30P	VM111-30P	30M1H		1,11	1,88
0,30	M117-30P	VM117-30P	30M2H		1,17	1,85



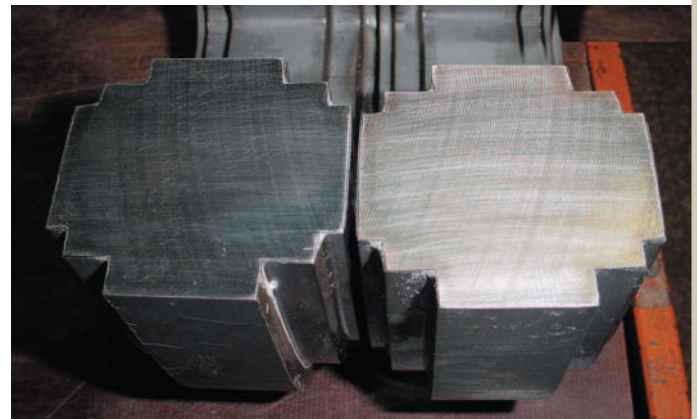
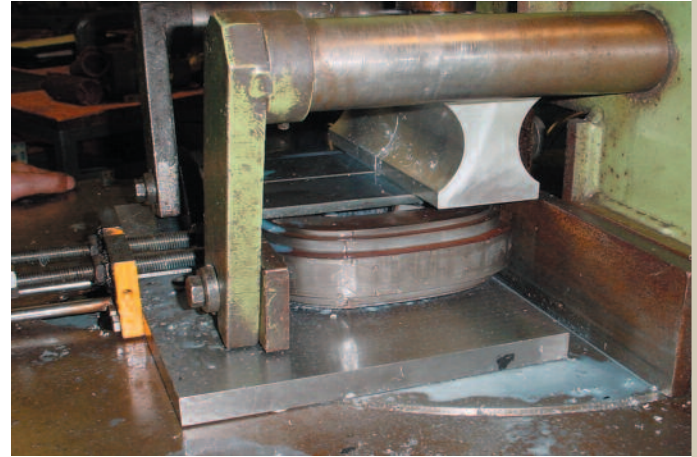
Typical dependence $B_{max}=f(H_{ef})$ toroidal cores 50 Hz



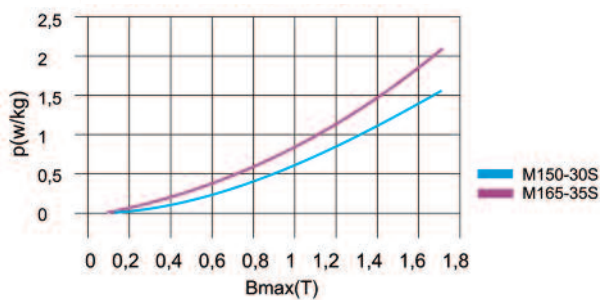
Materials used

Frequencies of 400 – 1000 Hz

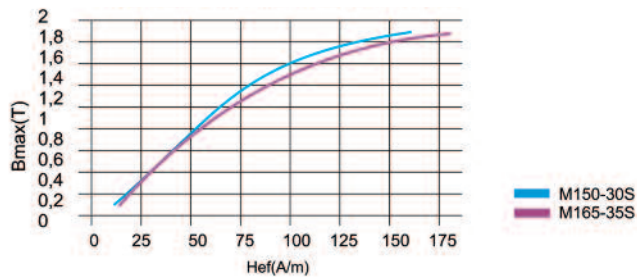
To be able minimize weight and volume of magnetic circuits we need to increase frequency of supply voltage. When the supply voltage frequency increases we are able to decrease the magnetic circuit cross-section and consequently its weight and volume. Upon customers' request we are able to manufacture wound magnetic circuits from Fe - 3% Si band, nominal thickness 0.15 mm, band and thickness 0.10 mm is also possible. The band used is ceramic insulated on both sides with the heat resistance up to 900 °C. Corresponding specific losses at frequency of 400 Hz/1T are 8 – 8.5 W/kg. Magnetic wound circuits made of 0.15 mm material are cost-effective for electrical machinery producers even though the fact that when compared with the C/0.30 mm cores their price is about 100 % higher.



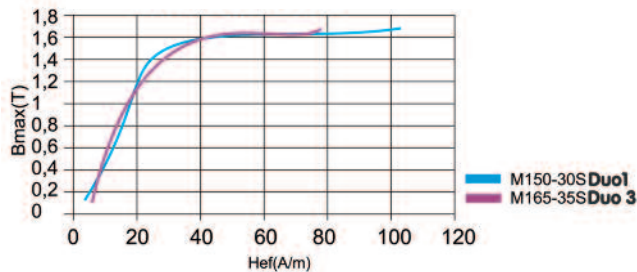
Typical dependence $p=f(B_{max})$ toroidal cores 50 Hz



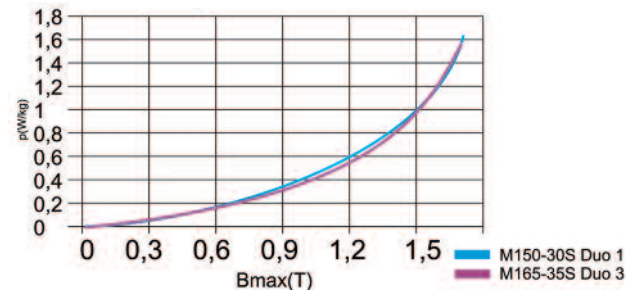
Typical dependence $B_{max}=f(H_{ef})$ toroidal cores 50 Hz



Typical dependence $B_{max}=f(H_{eff})$ unicore Duo 1 cores 50Hz



Typical dependence $B_{max}=f(H_{eff})$ unicore Duo 3 cores 50Hz

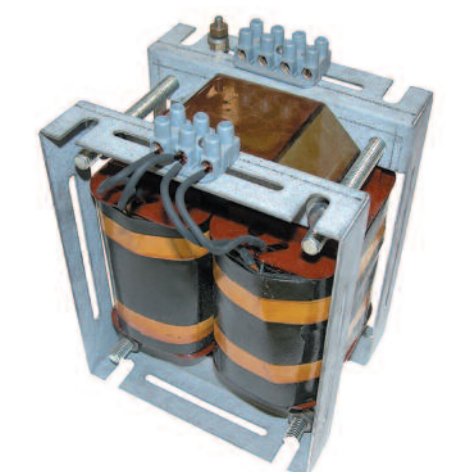
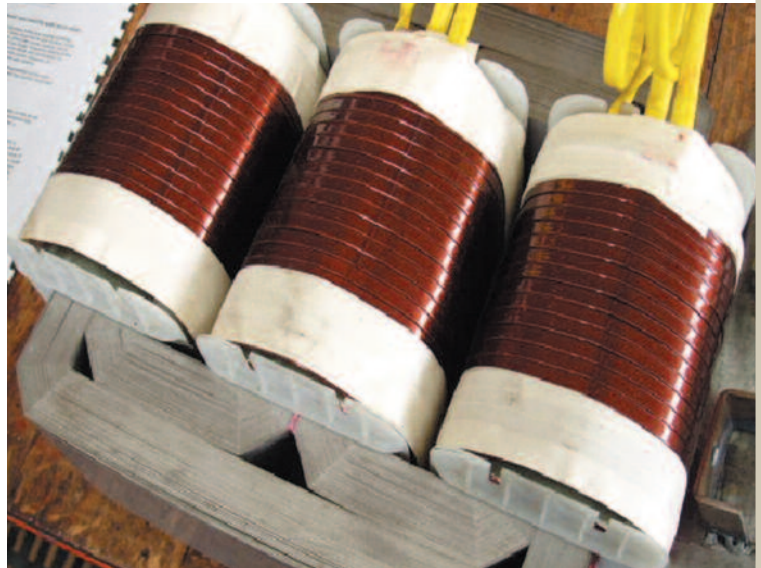
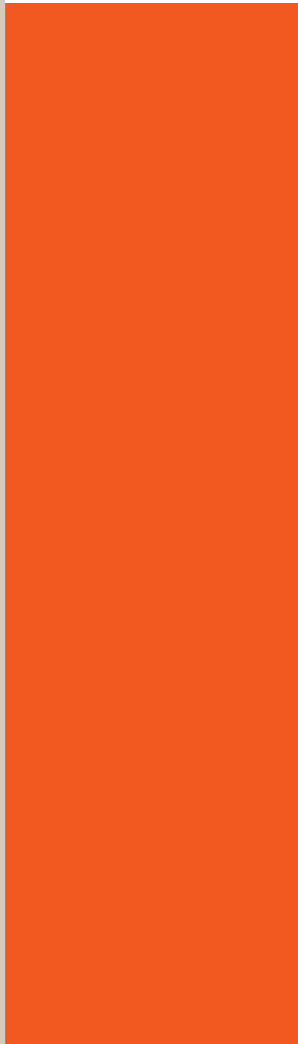
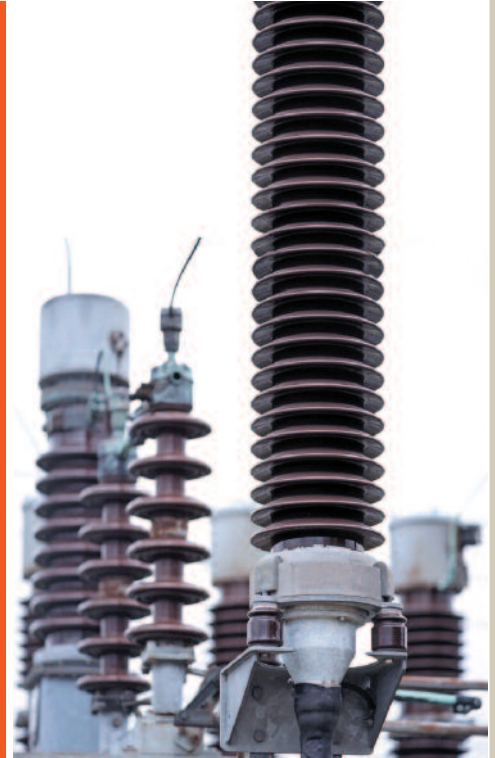


Elementary material properties as follows:

Thickness mm	Magnetizing frequency [HZ]	Nominal losses [W/kg]			Magnetic polarization J [T] at the magnetic field intensity H [A/m]				Initial permeability at magnetic field intensity	
		P _{1,0}	P _{1,5}	P _{1,7}	1,25	1,84	1,92	1,98	4000	8000
0,15	50	0,32	0,75	1,20	1,25	1,84	1,92	1,98	4000	8000
	400	7	15		0,65	1,83				
0,18	50		0,630	0,972		1,875				



Application, realization



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