For more information on Product Status Definitions, see page 3.

INTRODUCTION

Ferrites are used not only in the known consumer and professional electronics applications, but also in science and industry. The specifications and tolerances required for scientific and industrial applications are generally very demanding and critical. Experts in ceramic technologies know that making ferrite is one thing, machining it to close tolerances is another.

Hence there are only a few ferrite manufacturers in the world who can deliver ferrites with the required magnetic properties and within critical tolerances.

FERROXCUBE is one of those few manufacturers but with a difference. We bring along with us the experience gained by supplying customized products to some of the most prestigious scientific institutions and industries.

This means we can support you in finding the best solution for any inductive component you may need. Especially if your requirements cannot be met with ferrite cores from our standard ranges, the Advanced Design Center is at your service to make the necessary design calculations, machine first prototypes from solid blocks, or press and sinter small series using "quick tools".

Being a major worldwide supplier of a wide variety of Soft Ferrites gives us the experience and know-how to support such projects.

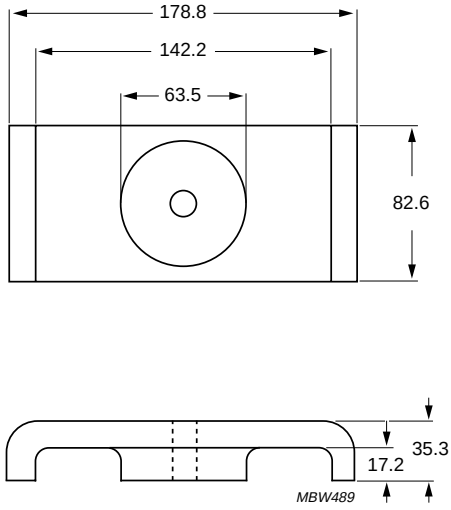
MACHINED FERRITES AND SPECIALTY SHAPES

We stock most of our material grades in blocks and are able to machine numerous prototype cores. Very close tolerances can be realized if required.

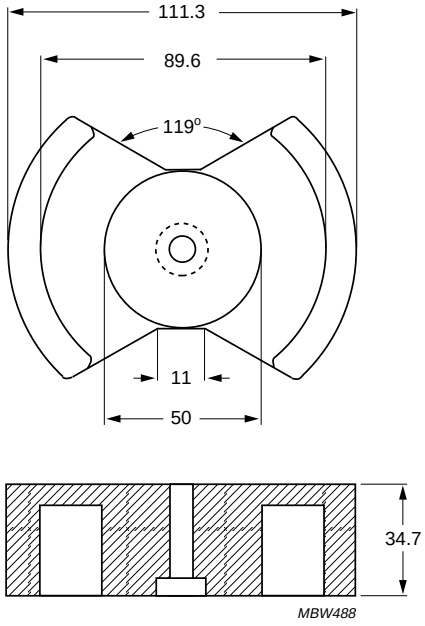
Ferrites, being very hard and brittle are difficult to work. The machining and grinding of ferrites and similar materials to micron precision, places stringent requirements on machines and men. To attain optimum standards requires close cooperation between us, the manufacturers of the machines and the machine tools we use.

There are several reasons to choose machined ferrite cores. Samples are sometimes required on very short notice, while pressing tools are not yet available. On other occasions, only a limited number of cores will be needed and it is not worthwhile to make a tool at all. Cores can be so complicated or large that machining is the only viable solution.

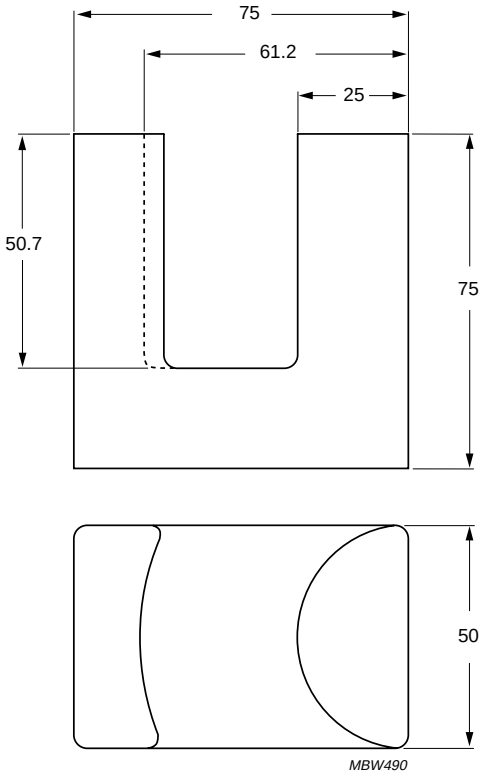
The drawings provide a good impression of the variety of cores we have produced. For some of the cores we also have pressing tools available.



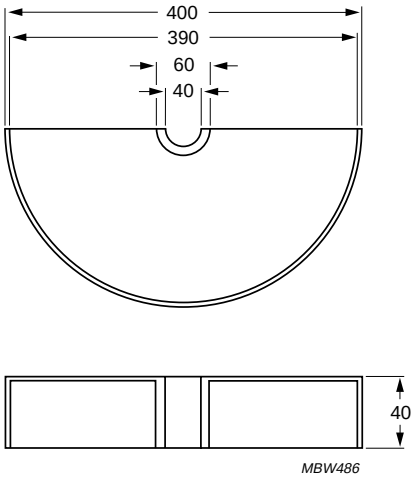
ER type core



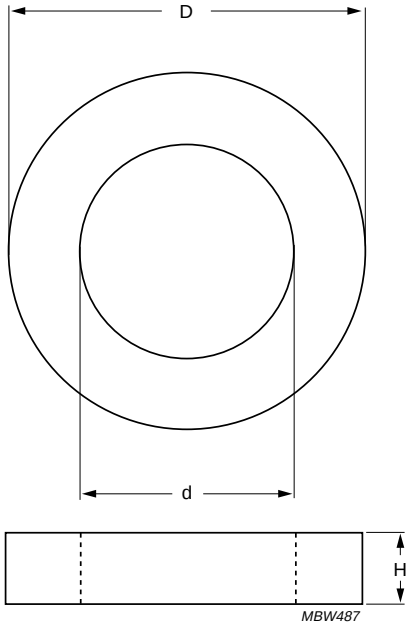
PM type core.



Quarter part of an ETD150 core set.



Huge P core section



Example of large ring cores:
T90/40/35, T120/60/35, T130/80/35

FERRITE IN ANECHOIC CHAMBERS FOR EMI MEASUREMENT

The application

Regulations are in place for every kind of electromagnetic interference from equipment. Especially free field radiation limits would require outdoor testing and would need a lot of space. This can be overcome with the help of anechoic chambers. They have walls with a very low reflection and thus approach outdoor testing. Ferrite tiles are a compact alternative to large carbon pyramid absorbers, to reduce the size of EMI test chambers.

Our product range

The absorber material 4S60 has been designed for broadband operation (up to 1000 MHz). Its parameters were matched to achieve low reflection of incident waves. The high-frequency losses of the ferrite do the rest of the job as the wave travels up and down the tile. See the material specification section for all characteristics of 4S60.
Common tile size is 100 x 100 mm, available with and without hole for screw mounting and gluing respectively. All sides are ground to tight tolerances to achieve flatness and squareness for optimum performance of the tiled chamber walls.

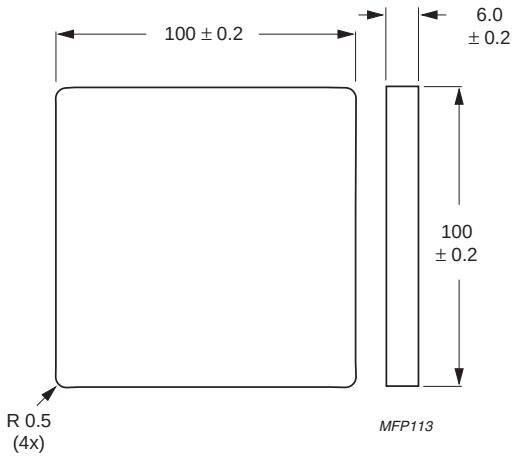


Fig.1 Plate PLT100/100/6-4S60.

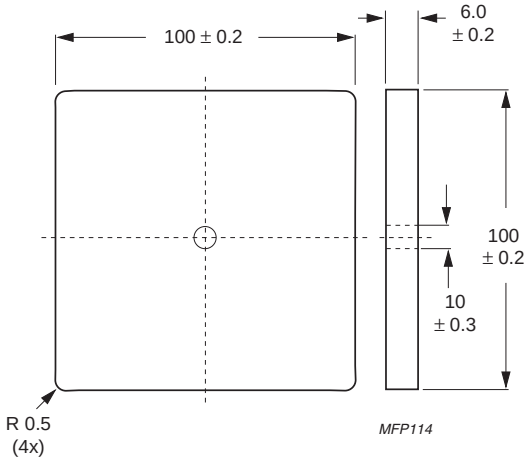


Fig.2 Plate PLT100/100/6/H-4S60

FERRITE IN SCIENTIFIC PARTICLE ACCELERATORS

The application

Ferrites are used extensively in modern scientific experiments. One of the most exciting and advanced applications is in particle accelerators. Scientists are trying to discover the mysteries of the universe by smashing atomic particles with titanic forces. This requires particle beams to be accelerated to very high speeds and guided into a collision chamber with the help of specially designed magnetic rings and kicker magnets.

Our materials

At Ferroxcube's research and development laboratories located in Eindhoven, The Netherlands, we can build on 50 years' experience in ferrite technology. We developed the required materials which fulfil the demanding specifications. Due to our long involvement with ferrite technology, we are one of only two major suppliers in the world who support such demanding projects. Because of the extremely demanding nature of the specifications, these magnetic rings and blocks are designed and developed in close interaction with the scientists. This has enabled us to develop unique material grades, which are processed in our highly controlled production environment to deliver the required product performance.

Our product range

Our range of large ring cores and blocks was developed especially for use in scientific particle accelerators. Applications include kicker magnets and acceleration stations. Dynamic behaviour under pulse conditions is important for both applications, so special ferrite grades are optimized for low losses at high flux densities. These large rings have also been used successfully in delay lines for very high powers such as in pulsed lasers or radar equipment. Sizes other than those mentioned in the following tables can be made on request.

- Standard range of sizes
- Optimized grades for particle accelerators
- Other sizes on request.

General properties of the grades are described in the section on Material Grades. Specific properties, related to their use in particle accelerators, are provided in the following table.

Relevant properties of ferrites in accelerator applications

Properties specified in this section are related to room temperature (25 °C) unless otherwise stated. They have been measured on sintered, non-ground ring cores of dimension $\varnothing 25 \times \varnothing 15 \times 10$ mm which are not subjected to external stresses.

Products generally do not fully comply with the material specification. Deviations may occur due to shape, size and grinding operations. Detailed specifications are given in the data sheets or product drawings.

MATERIALS FOR PARTICLE ACCELERATORS

Materials and relevant values

PARAMETER	8C11	8C12	4M2	4E2	4B3
μ_i (±20%)	1200	900	140	25	300
μ_{rem} approx.	850	600	130	20	–
B_s 25 °C (mT, 800 A/m)	≥300	280	250	250	≥300
B_s 40 °C (mT, 800 A/m)	≥280	250	220	220	–
H_c (A/m, after 800 A/m)	≤20	30	100	500	<80
ρ DC (Ωm)	$>10^5$	$>10^5$	$>10^5$	$>10^5$	$>10^5$
T_C (°C)	≥125	≥125	≥150	≥400	≥250
μQ in remanence 200 kHz:					
10 mT		15×10^3			
20 mT		9×10^3			
50 mT		4×10^3			
μQ in remanence 500 kHz:					
10 mT		10×10^3			
20 mT		6×10^3			
50 mT		25×10^3			
μQ in remanence 1 MHz:					
5 mT		10×10^3	20×10^3		
10 mT		75×10^3	20×10^3		
20 mT		5×10^3	15×10^3		
30 mT		–	8×10^3		
μQ in remanence 2.5 MHz:					
5 mT			20×10^3		
10 mT			20×10^3		
20 mT			15×10^3		
30 mT			7×10^3		
μQ in remanence 5 MHz:					
5 mT			15×10^3		
10 mT			15×10^3		
20 mT			10×10^3		
30 mT			7×10^3		
μQ in remanence 10 MHz:					
5 mT			12×10^3		
10 mT			10×10^3		
μQ in remanence 80 MHz:					
1 mT				2.5×10^3	
μQ in remanence 100 MHz				2×10^3	
Decrease in μQ (%), measured 10 ms after application of DC bias (approx.)		10	15	30	
μ_Δ with DC bias field (approx.):					
0 A/m		600	130		
250 A/m		120	80		
500 A/m		50	40		
1000 A/m		22	22		
2000 A/m		8	12		
3000 A/m		5.5	8		
Frequency range (with or without DC bias) in MHz		up to 2	2 to 10	20 to 100	
Application area and special features	kicker magnets; high resistance	high frequency ratio possible with DC bias	fast recovery after magnetic bias	high frequency material	high ($B_s + B_r$)

PRODUCT OVERVIEW AND TYPE NUMBER STRUCTURE

Product overview

CORE TYPE	V_e (mm^3)	A_e (mm^2)	MASS (g)
T76/38/13	38500	232	≈ 220
T170/110/20	251500	589	≈ 1300
T240/160/20	482000	789	≈ 2500
T498/270/25	3120000	2760	≈ 17000
T498/300/25	2900000	2420	≈ 15000
T500/240/25	3300000	3100	≈ 19000
T500/300/25	2950000	2450	≈ 16000

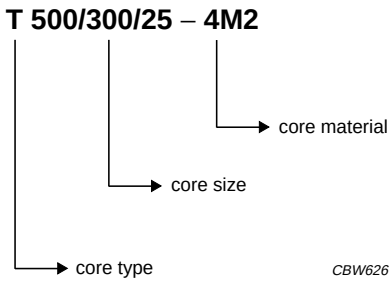


Fig.3 Type number structure for toroids.

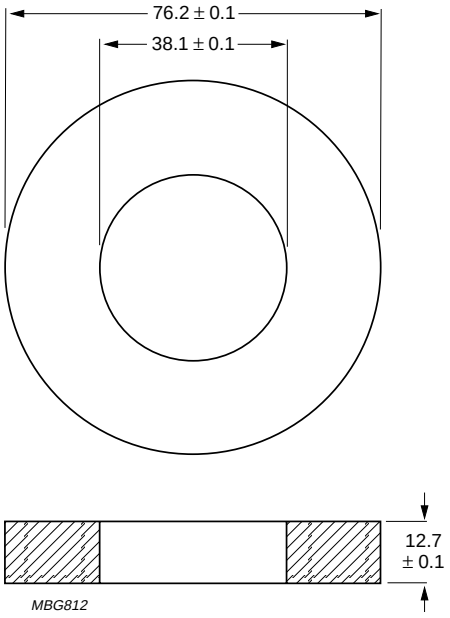
RING CORES T76/38/13

Effective core parameters

SYMBOL	PARAMETER	VALUE	UNIT
Σ(l/A)	core factor (C1)	0.716	mm^{-1}
V_e	effective volume	38500	mm^3
l_e	effective length	166	mm
A_e	effective area	232	mm^2
m	mass	≈ 220	g

Ring core data

GRADE	A_L (nH)	TYPE NUMBER
4M2	≈ 250	T76/38/13-4M2
8C11	≈ 2000	T76/38/13-8C11
8C12	≈ 1600	T76/38/13-8C12



Dimensions in mm.

Fig.4 Ring core T76/38/13.

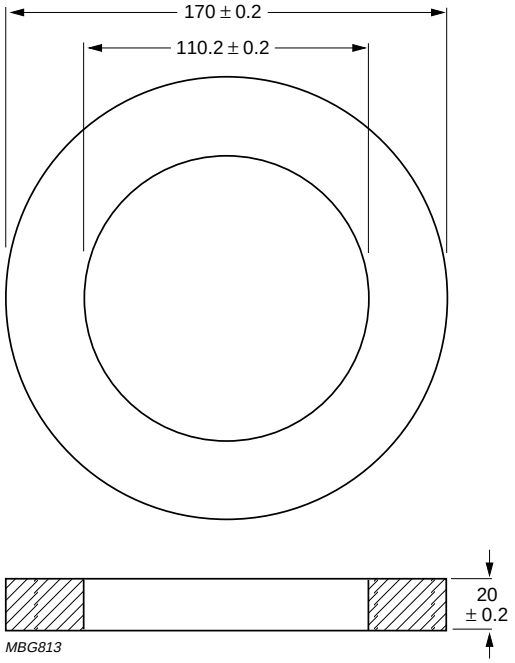
RING CORES T170/110/20

Effective core parameters

SYMBOL	PARAMETER	VALUE	UNIT
Σ(l/A)	core factor (C1)	0.725	mm^{-1}
V_e	effective volume	251500	mm^3
l_e	effective length	427	mm
A_e	effective area	589	mm^2
m	mass	≈ 1300	g

Ring core data

GRADE	A_L (nH)	TYPE NUMBER
8C11	≈ 2600	T170/110/20-8C11



Dimensions in mm.

Fig.5 Ring core T170/110/20.

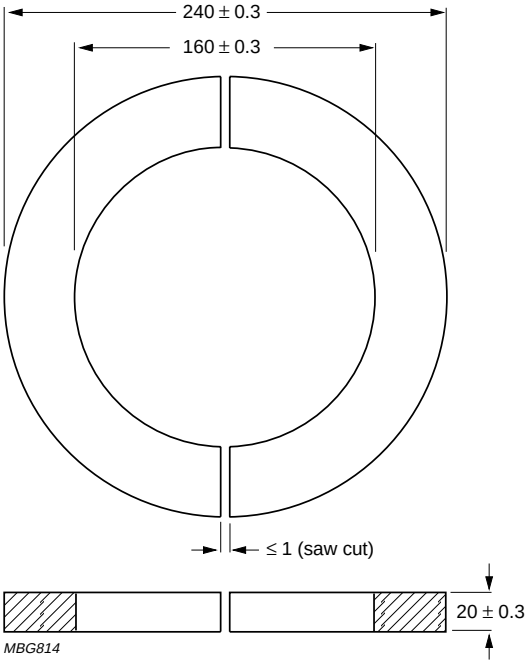
SPLIT RING CORE T240/160/20

Effective core parameters

SYMBOL	PARAMETER	VALUE	UNIT
Σ(l/A)	core factor (C1)	0.774	mm^{-1}
V_e	effective volume	482000	mm^3
l_e	effective length	611	mm
A_e	effective area	789	mm^2
m	mass	≈ 2500	g

Ring core data

GRADE	A_L (nH)	TYPE NUMBER
8C11	–	T240/160/20-8C11



Dimensions in mm.

Fig.6 Split ring core T240/160/20.

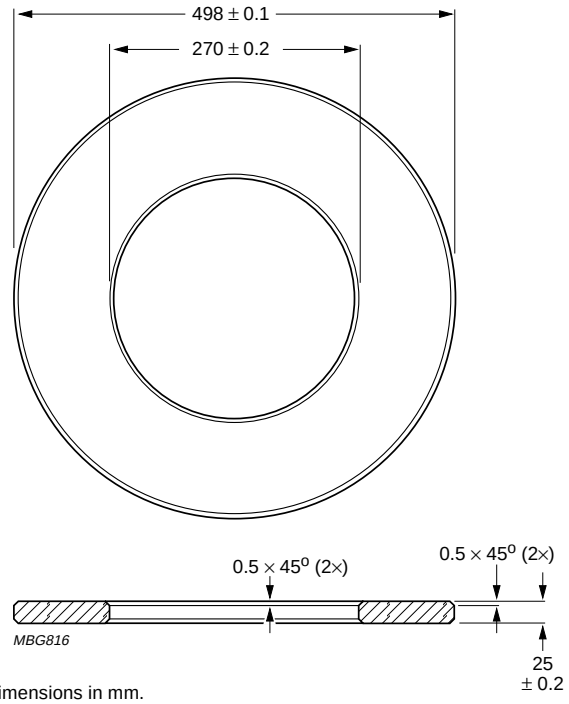
RING CORE T498/270/25

Effective core parameters

SYMBOL	PARAMETER	VALUE	UNIT
$\Sigma(l/A)$	core factor (C1)	0.409	mm^{-1}
V_e	effective volume	3120000	mm^3
l_e	effective length	1130	mm
A_e	effective area	2760	mm^2
m	mass	≈ 17000	g

Ring core data

GRADE	A_L (nH)	TYPE NUMBER
8C12	≈ 2800	T498/270/25-8C12



Dimensions in mm.

Fig.7 Ring core T498/270/25.

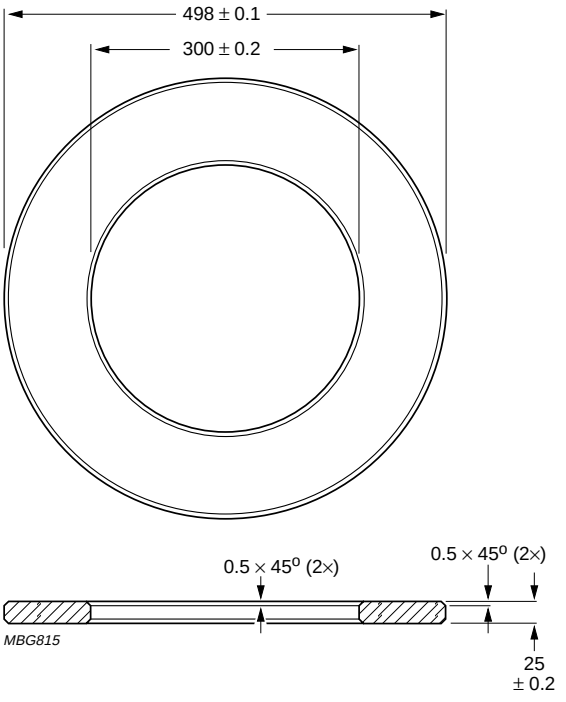
RING CORE T498/300/25

Effective core parameters

SYMBOL	PARAMETER	VALUE	UNIT
$\Sigma(l/A)$	core factor (C1)	0.496	mm^{-1}
V_e	effective volume	2900000	mm^3
l_e	effective length	1200	mm
A_e	effective area	2420	mm^2
m	mass	≈ 15000	g

Ring core data

GRADE	A_L (nH)	TYPE NUMBER
8C12	≈ 2300	T498/300/25-8C12



Dimensions in mm.

Fig.8 Ring core T498/300/25.

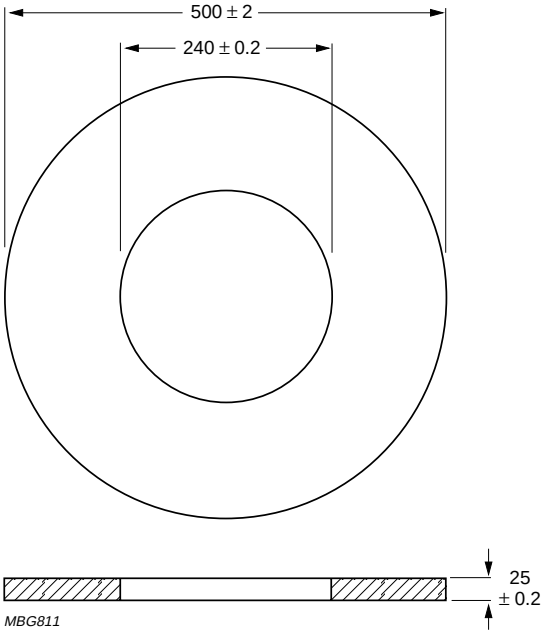
RING CORE T500/240/25

Effective core parameters

SYMBOL	PARAMETER	VALUE	UNIT
$\Sigma(l/A)$	core factor (C1)	0.342	mm^{-1}
V_e	effective volume	3300000	mm^3
l_e	effective length	1060	mm
A_e	effective area	3100	mm^2
m	mass	≈ 19000	g

Ring core data

GRADE	A_L (nH)	TYPE NUMBER
4B3	≈ 1300	T500/240/25-4B3



Dimensions in mm.

Fig.9 Ring core T500/240/25.

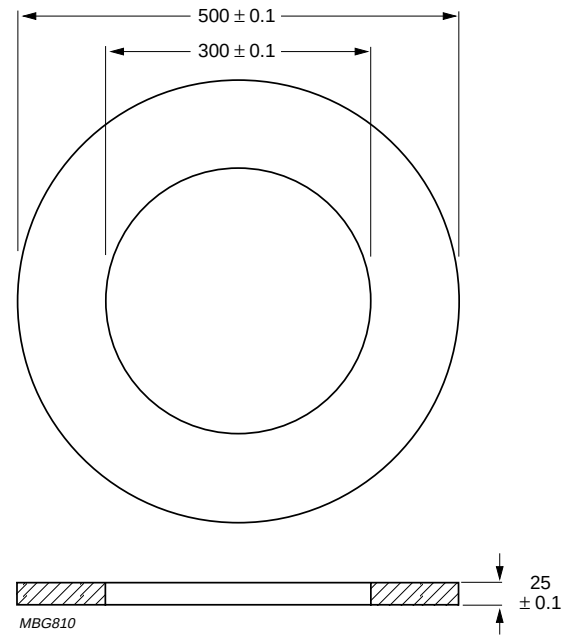
RING CORE T500/300/25

Effective core parameters

SYMBOL	PARAMETER	VALUE	UNIT
$\Sigma(l/A)$	core factor (C1)	0.49	mm^{-1}
V_e	effective volume	2950000	mm^3
l_e	effective length	1200	mm
A_e	effective area	2450	mm^2
m	mass	≈ 16000	g

Ring core data

GRADE	A_L (nH)	TYPE NUMBER
4M2	≈ 350	T500/300/25-4M2



Dimensions in mm.

Fig.10 Ring core T500/300/25.