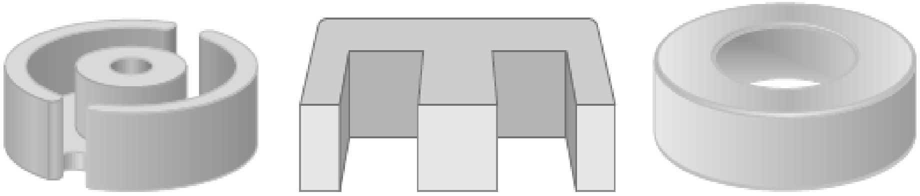
IMA-STD-100 2011.04

IMA
The International Magnetics Association



Standard Recommendations:

Soft Ferrite Cores, A User's Guide

The International Magnetics Association

An operating group of:
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THIS USER’S GUIDE

This User’s Guide is intended to acquaint the new user with the advantages, limitations, and applications of soft ferrites; and also to enhance the knowledge of more experienced users.

CORE STANDARDS

IMA Standards now available:

- IMA-STD 110, Standard Specification for Pot Style Cores
- IMA-STD 120, Standard Specification for Ferrite Threaded Cores
- IMA-STD 130, Standard Specification for Ferrite U, E, & I Cores
- IMA-STD 140, Standard Specification for Ferrite Toroid Cores

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Elmhurst , IL 60126
(P) 800-275-6312
(F) 732-451-0339

Dexter Magnetics
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Elk Grove Village, IL 60007
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(F) 847-956-8205

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(F) 732-906-4395

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SECTION 1.0, INTRODUCTION TO SOFT FERRITES

In the early days of the electrical industry, the need for magnetic materials was served by iron and its magnetic alloys. However, with the advent of higher frequencies, the standard techniques of reducing eddy current losses, using lamination or iron powder cores, were no longer efficient or cost effective.

This realization stimulated a renewed interest in “magnetic insulators” as first reported by S. Hilpert in Germany in 1909. It was readily understood that if the high electrical resistivity of oxides could be combined with desired magnetic characteristics, a magnetic material would result that was particularly well suited for high frequency operation.

Research to develop such a material was being done in various laboratories all over the world, such as by V. Kato, T. Takei, and N. Kawai in the 1930’s in Japan and by J. Snoek of the Philips’ Research Laboratories in the period 1935-45 in the Netherlands. By 1945 Snoek had laid down the-basic fundamentals of the physics and technology of practical ferrite materials. In 1948, the Neel Theory of ferrimagnetism provided the theoretical understanding of this type of magnetic material.

Ferrites are ceramic, homogeneous materials composed of various oxides with iron oxide as their main constituent. Ferrites can have several distinct crystal structures. However, for this brochure, we are only concerned with the magnetically soft ferrites, which have a cubic crystal structure.

Based upon the chemical composition, soft ferrites can be divided into two major categories, manganese-zinc ferrite and nickel-zinc ferrite. In each of these categories many different MnZn and NiZn material grades can be manufactured by changing the chemical composition or manufacturing technology. The two families of MnZn and NiZn ferrite materials complement each other and allow the use of soft ferrites from audio frequencies to several hundred megahertz.

The first practical soft ferrite application was in inductors used in LC filters in frequency division multiplex equipment. The combination of high resistivity and good magnetic properties made these ferrites an excellent core material for these filters operating over the 50-450 kHz frequency range.

The large scale introduction of TV in the 1950’s was a major opportunity for the fledgling ferrite industry. In TV sets, ferrite cores were the material of choice for the high voltage transformer and the picture tube deflection system.

For four decades ferrite components have been used in an ever widening range of applications and in steadily increasing quantities. Table 1A is a partial listing of major applications for soft ferrites. Table 1B is a partial listing of soft ferrite design advantages.

Table 1A
Soft Ferrite Applications

MAGNETIC DEVICES:	***USED IN:***
Power transformer and chokes	HF power supplies and lighting ballasts
Inductors and tuned transformers	Frequency selective circuits
Pulse and wideband transformers	Matching devices
Magnetic deflection structures	TV sets and monitors
Recording heads	Storage devices
Rotating transformers	VCRs
Shield beads and chokes	Interference suppression
Transducers	Vending machines and ultrasonic cleaners

Table 1B
Design Advantages

High resistivity	Large material selection
Wide range of operating frequencies	Versatility of core shapes
Low loss combined with high permeability	Low cost
Time and temperature stability	Lightweight

SECTION 2.0, PROCESSING

Ferrites are manufactured by processing a composition of iron oxide mixed with other major constituents such as oxides or carbonates of either manganese and zinc or nickel and zinc. The basic process is common to most ceramic process technologies and can be divided into four major functions:

- Preparation of the powder
- Forming powder into cores
- Firing and sintering
- Finishing the ferrite components

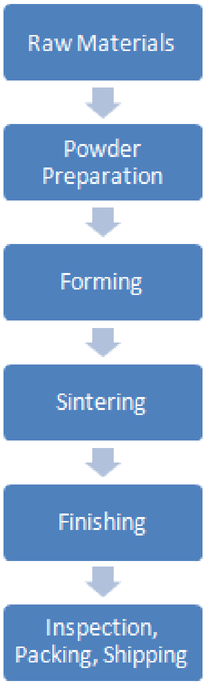


Figure 1
Processing Flow Diagram

Please note that quality assurance steps are not shown in order to simplify the diagram. Quality Assurance however, does play an integral part in the manufacturing process and will be discussed in the next section.

Powder Preparation

The first step in the production of powder starts with the chemical analysis of the raw materials, the oxides or carbonates of the major constituents. The purity of these materials contributes directly to the quality of the final product and needs to be controlled to assure a batch-to-batch consistency. The exact amount of the major constituents is weighed and thoroughly mixed into a homogeneous mixture. This mixing can be done in a dry process, or water can be added to form a slurry and then mixed in a ball mill. When wet mixing is used, a drying procedure is required to reduce the moisture content prior to calcining. Calcining is a preferring process in which the powder temperature is raised to approximately 1000 “C in an air atmosphere. During the calcining there is a partial decomposition of the carbonates and oxides, evaporation of volatile impurities and a homogenation of the powder mixture. There is a degree of spine1 conversion during calcinin’g and this pre-firing step also reduces the shrinkage in the final sintering.

After calcining the powder is mixed with water and the slurry is milled to obtain small and uniform particle sizes. At this stage of the process binders and lubricants are added. The type of binder and lubricant is determined by the forming technology.

The last step in the powder preparation is to spray dry the slurry in a spray dryer. Figure 2 illustrates the powder preparation flow.

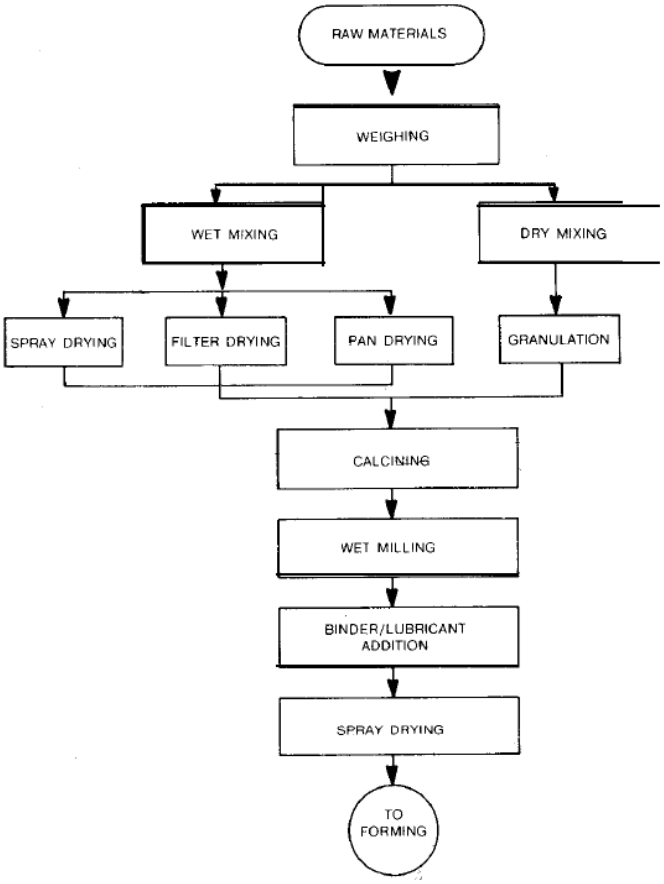


Figure 2
Powder Preparation Flow Chart

Forming

The second step in the ferrite processing technology is the forming of the component. The most often used technique is dry pressing the powder into the core configuration. Other techniques are extruding and isostatic pressing.

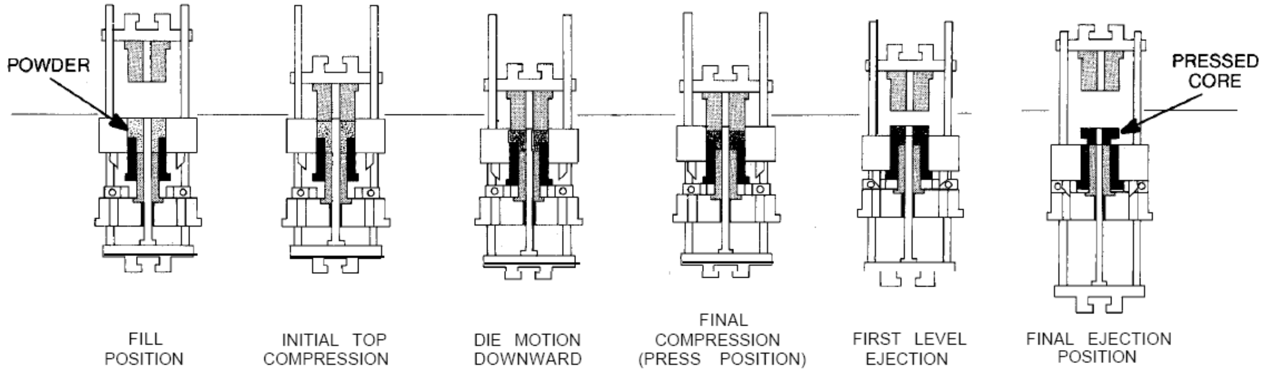


Figure 3
Dry Pressing Techniques

Dry pressing or compacting is done using a combined action of top and bottom punches in a cavity such that a part of uniform density is formed. Today’s presses and tooling technology enable the pressing of multiple parts and very complex core shapes. Since compacting is only along the vertical axis, the only size adjustment that can be made is of the press height. See Figure 3 for some aspects of this pressing technique.

Isostatic pressing typically uses flexible containers, such as thick rubber molds, which have very rudimentary shapes (blocks, rods, discs, etc...). The container is filled with non bindered powder, sealed, and placed inside a pressure chamber or vessel (Isostatic press). Pressure is increased to a specific level, commonly 10K psi to 30K psi, and then decreased. The container is then removed from the vessel, unsealed and the pressed form is withdrawn ready for sintering. Organic binder is not used in this process because of the mismatch between the rate at which the binder is burned out during sintering and the shrinkage that is occurring at the same time. This mismatch could cause the product being sintered to literally tear itself apart. Isostatic pressing produces material with high, uniform density suitable for machining into complex geometries. This is valuable for prototype designing in which no dry press molds (tools) exist. This process can also produce geometries that cannot be produced using standard pressing techniques such as large core volume or non-pressable shapes.

Extruding is typically used to form long, small cross section parts such as rods and tubes. The spray dried powder is mixed with a moisturizing plasticizer that allows the powder to be forced through the appropriate extruding die.

In all of the above forming methods the dimensions of the forming tool must be larger than the final product dimensions by a factor that allows for shrinkage during sintering.

Sintering

This is the most critical step in the manufacturing of ferrites. It is during this phase of the process that the product achieves its final magnetic and mechanical characteristics.

Sintering of maganese-zinc ferrites requires an equilibrium between time, temperature and atmosphere along each phase of the sintering cycle. Sintering starts with a gradual ramping up from room temperature to approximately 800” C as impurities, residual moisture, binders, and lubricants are burned out of the product. The atmosphere in this part of the sintering cycle is air.

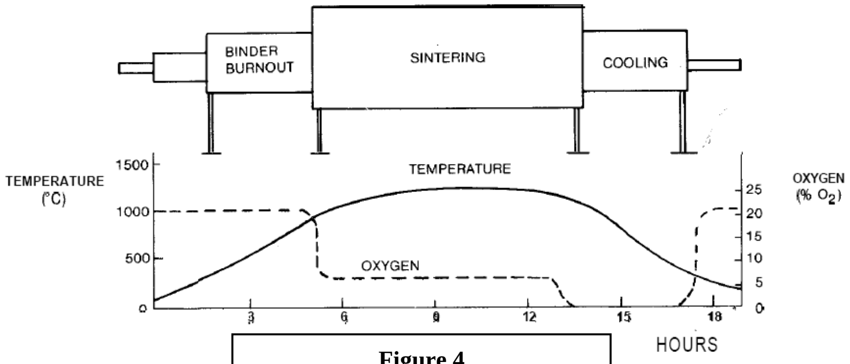


Figure 4
Typical MnZn Sintering Cycle

The temperature is further increased to the final sinter temperature. of IOOO- 1500” C, depending upon the type material. While the temperature is increasing, a non oxidizing gas is introduced into the kiln to reduce the oxygen content of the kiln atmosphere. During the cool-down cycle a reduction of oxygen pressure is very critical in obtaining high quality MnZn ferrites.

The sintering of nickel-zinc ferrites occurs at lower temperatures, in the range of 1000-1200” C. This material can be sintered in an air atmosphere.

During sintering the parts shrink to their final dimensions. Different material and processing techniques result in variance in this shrinkage but typical linear shrinkage ranges from 10 to 20% of the formed dimensions. The final part dimensions can be held to mechanical tolerances of +2% of the nominal part dimensions. Figure 4 shows a typical manganese-zinc sintering cycle in a tunnel kiln.

Finishing

After sintering most ferrite parts will require some form of finishing operation to meet customer requirements. Although the intrinsic magnetic properties have been set during sintering and cannot be altered, proper finishing techniques can optimize the magnetic performance of ferrite cores. The following are common examples:

Gapping

There are two accepted methods for specifying a gap. One is by specifying an AL value, the second is to specify a mechanical gap length. The former allows for tighter A, tolerance but with slightly varying gap lengths from batch to batch. Thus the user must specify one of the two methods, never both.

Typically, ungapped cores have tolerances of *25% on the A,. Standard “gapped A, values” have tolerances from 1.0% to 5%, if gap depth is 0.010 inches or larger. Shown in Figure 5 is an example of A, vs. gap length curves. As you move up the A, scale, it becomes increasingly difficult to hold tight tolerances. This is due to the decreasing size of the gap coupled with limitations of the machine performing the gapping.

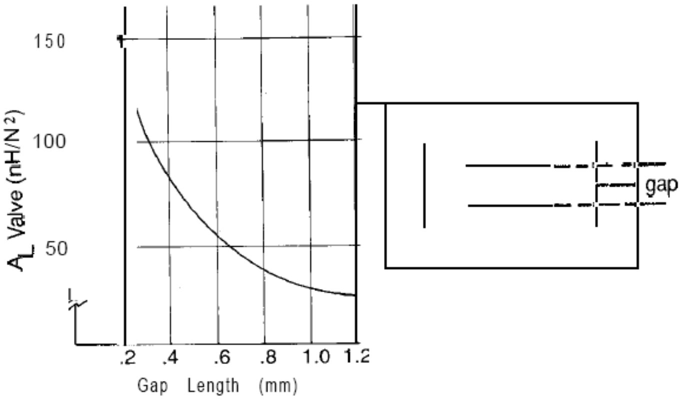


Figure 5
A, vs. Gap Length

Lapping

Lapping is an additional production process used to decrease the effects of an air gap on mated cores, typically done on mated cores with material permeabilities over 5000 in order to achieve the maximum A, value for a given material. The process involves polishing the mating surface of the core, after grinding, using a slurry based media. This produces a “mirror-like” finish that requires careful handling in packaging and in customer assembly. However, cosmetic appearance is secondary to the specified ‘4,. Since this is a time consuming secondary operation, the cost impact vs. minimum A, should be considered.

Coating

Coating of toroids is done after tumbling to enhance dielectric resistance, reduce edge chips, and provide a smooth winding surface. Among the choices of coatings are nylon, epoxy paint and parylene.

The nylons and epoxy paints typically need a minimum coating thickness of .005” to ensure uniform protection. Because of this restriction, they are used mainly on toroids with outer diameters of .500” or greater. One advantage of these coatings is that the color can be varied for core material identification without stamping. Breakdown voltages are between 500 to 1000 volts per .003” of coating. Parylene is a colorless coating used on toroids with outer diameters less than .500” due to the high cost of the raw material.

Parylene offers the advantage of higher voltage breakdown, at approximately 1000 volts per .OOl”. The coating thickness can be controlled down to .0005” and still maintain uniform protection. Table 2 lists additional finishing operations.

Surface grinding to obtaining tight mechanical tolerances
Slicing rods and tubes of beads on wire
Profile grinding of threaded cores
Cementing wires for identifcation
Marking for identification
Packaging for automated assembly
Installing tuner nuts in pot cores and RM cores
Gapping to Control A_L, and bias capability

Table 2
Ferrite Finishing Operations

SECTION 3.0, PROCESS CONTROL / QUALITY ASSURANCE

As is the case in most technologies, ever increasing demands are being placed on soft ferrite manufacturers to further improve their performance in terms of both product quality and adherence to specified delivery schedules. Successful worldwide competitiveness, in all areas of commercial endeavor, requires that the highest levels of quality and reliability be maintained. The member companies of the IMA Working Group have recognized the needs of the industries they serve, and have instituted measures to insure that they are able to meet their customers’ quality requirements. The implementation of statistical process control, SPC, and the attendant emphasis on controlling quality at each process step rather than inspection of the final product, has led to significant improvements in overall performance.

Implicit in every manufacturing step indicated in Figure 1 of Section 2, is a process control function. The capability of each step of the process is first determined, and the performance of the operation is then constantly measured against the established standard. By insuring that each discreet process is functioning within predetermined acceptable limits, a high probability exists that the properties of the final product will conform to expected values. Each step of the process generally has several critical parameters, which if permitted to vary from the established allowable limits, will result in the final product not attaining its required properties. One cannot deem any of the processing steps as being the most important, since failure to properly control any one of them will result in an unpredictable final result. Listed below are examples of some of the processing parameters which must be controlled in the manufacture of soft ferrites, along with indications of the effects of the variations beyond acceptable limits. The list is not meant to be all inclusive.

Raw Materials

- Impurities must be present below specified upper limits.
  For example, excessive silica in manganese zinc
  ferrite material will severely limit the attainable permeability.

- Specific surface area must be within allowable limits.
  Variations will produce adverse effects on magnetic
  properties and changes in sintering shrinkage

Powder Preparation

- Chemical composition must be kept within allowable limits in order to achieve desired magnetic properties. This control is achieved using advanced analytical instrumentation.

Physical Aspects of Powder

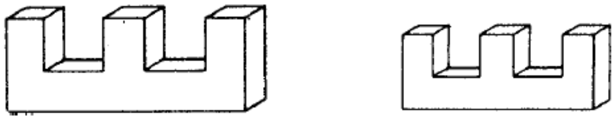
- Moisture content, flowability, and particle size distribution must be controlled to insure that a structurally sound part is formed.

Pressing

- Pressed density must be controlled in order to achieve desired sintering dimensions, as sintering shrinkage is a function of the density of the green (unsintered) part.

- Green density uniformity must be controlled over the entire volume of a pressed part in order to prevent distortion upon sintering, such as the warpage of E core legs, or cracked cores.

- Press height must be controlled to achieve desired sintered height. As noted earlier, the sintering shrinkage is a function of the green density as well as the inherent material shrinkage, at a given pressed density. Figure 6 is a representation of the typical change in core volume from the green to the sintered state, which is typically 40 to 50%.



Unsintered (Green)

Sintered

Figure 6
Typical change in core volume from the green to the sintered state

Sintering

- Temperature Profile **-** temperatures constituting the sintering process must be maintained within tight limits in order that correct physical and magnetic properties are attained. Improper control during the initial stages of sintering can result in physical problems due to overly rapid binder removal. Poorly controlled initial stages of heating, or later stages of cooling, can result in stress induced fracture. A difference of as little as 3” out of 1400” C in peak temperature can have a profound effect on final properties.

- Atmosphere Profile - proper control of atmosphere during sintering is necessary to achieve desired magnetic properties. Inadequate control, to the extent of 0.1% oxygen during the cooling stages of sintering a manganese zinc ferrite, or even 0.01% oxygen at the very end of the process, can have extremely deleterious effects.

Finishing

- Grinding of Mating Surfaces - proper control of the flatness and degree of finish of the mating surface is essential to achieving the desired A, value of parts such as E, EC, RM, ETD, and Pot Cores.

- Development of Edge Radius - tight control of the tumbling operation for toroids, beads and baluns, is necessary in order that a sufficient radius is developed along with chip and crack free cores.

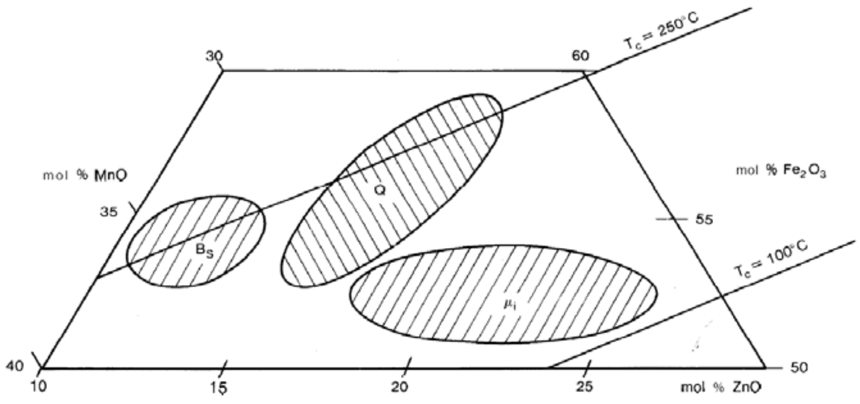
In addition to extensive process control measures, the member companies of the MMPA utilize other means to achieve improved quality and reliability. These include the implementation of quality manuals and quality audits, the use of quality circles and the establishment of continuing training programs. Maintaining good supplier/user communications is also a key factor in providing a quality product meeting customer requirements. The user's contribution is critical to this process. All these measures insure a highly controlled final product which in theory does not require final inspection. Achievement of this state is a fundamental necessity for predictable cost effective manufacturing. It provides the user with consistent quality, lot-to-lot, shipment-to-shipment.

SECTION 4.0, MATERIALS & GEOMETRICS

As mentioned earlier, soft ferrites are a class of ferrite materials based on the spine1 or cubic crystal structure. They are produced in two material categories, manganese-zinc and nickel-zinc.

Manganese-Zinc Ferrites.

This type of soft ferrite is the most common, and is used in many more applications than the nickel-zinc ferrites. Within the MnZn category a large variety of materials is possible. The material selection is mainly a function of the application that needs to be accommodated. The application dictates the desirable material characteristics, which in turn determines the chemical composition of the ferrite material. Manganesezinc ferrite is primarily used for frequencies less than 2 MHz. Figure 7 shows the composition diagram for MnZn ferrites in mol % for Fe,O,, MnO and ZnO. It identifies the composition which gives optimum performance for saturation flux density (Bs), low losses (Q) and high initial permeability (pi). It also identifies the Curie temperature (T,) lines for 100 and 250°C. From this composition chart, it is clear that not one composition, not one MnZn ferrite, can fulfill all design objectives.



ure 7. Composition Diagram for MnZn Ferrites

B_s - Compositions of Higher Saturation
Q - Compositions of Higher Q
μ_i - Compositions of Higher Initial Permeability

Figure 7
Composition Diagram for MnZn Ferrites

Nickel-Zinc Ferrites.

This class of soft ferrites is characterized by its high material resistivity, several orders of magnitude higher than MnZn ferrites. Because of its high resistivity NiZn ferrite is the material of choice for operating from l-2 MHz to several hundred megahertz. To cover such a wide frequency range and different applications, a large number of nickel-zinc materials have been developed over the years.

It should be noted that certain nickel chemistries, especially those containing cobalt, can be adversely changed by some types of stress. Mechanical shocks from dropping or from some grinding operations are one possibility. Strong magnetic fields from holding devices and fixtures or magnetic chucks used in machining operations may also provide this stress.

These resulting changes can include increasing of permeability and core loss (lowering of Q). These changes cannot be reversed by degaussing or other electric/magnetic processes. In some cases, a thermal anneal at high temperature can restore some of the initial properties. The core manufacturer can provide details for treatment appropriate to core and process.

A summary of typical MnZn and NiZn materials, indicating the major material parameters and the operating frequency ranges, is shown in Table 3.

TABLE 3

TYPICAL FERRITE MATERIALS

PARAMETER	MANGANESE-ZINC				NICKEL-ZINC		
Initial permeability range	“1400 to 3500	750 to 3500	3500 to 4500	4500 to 15,000	10 to 75	75 to 200	200 to 1000
Curie temperature range (“C)	180 to 280	150 to 250	130 to 150	120	250 to 500	200 to 500	90 to 200
Flux density range (gauss)	3500 to 5200	2400 to 4750	3000 to 5000	3000 to 5000	1000 to 2500	2500 to 3500	2800 to 3500
at H (oersted)	12.5	12.5	12.5	12.5	100	50	25
Power loss density (mW/cm^3) at 100 kHz - 1000 G	< 100						
Loss factor $\tan\delta/\mu_i \times 10^{-6}$							
atf-30kHz				30			
100 kHz	10	5	20				
300 kHz							10-50
1 MHz		25				20-40	20-70
3 MHz						25-60	50-200
10 MHz					50-200	100	
30 MHz					100-1500		
100 MHz					400-2000		
**Typical frequency range kHz	10 to 500	10 to 2000	10 to 200	10 to 100			
MHz					10-150	2-30	1.5-5

*Materials for power applications

**This frequency range does not apply for ferrite materials used in EMI suppression applications.

Ferrite versus other Magnetic Materials.

After comparing the two types of soft ferrites, it might be of interest to see how soft ferrites compare with other magnetic materials such as magnetic alloys and iron powder. See Table 4.

TABLE 4

MAGNETIC MATERIALS

	FERRITES	ALLOYS	IRON POWDER	AMORPHOUS
Initial permeability range	5 to 15,000	5000 to 300,000	5 to 150	3000 to 150,000
Curie temperature range (°C)	100 to 500	500	750	210 to 485
Saturation flux density range (k gauss)	3 to 5	8 to 24	10 to 12	5.5 to 10
Coercive force (oersted)	.05	.003 to 3		.003 to 3
Loss factor tan $\delta/\mu_i \times 10^{-6}$ at f= 10 kHz	5	8	25	
100 kHz	10	80	30	
1 MHz	25	4000	100	
Resistivity (Q-cm)	10’ to 10^8	10^{-5}	10^4	1.4×10^{-4}

At high frequencies, ferrites have substantial advantages over conventional metallic materials, either in lamination or powder forming technology. Ferrites offer additional mechanical features as well. Ferrites can be shaped in a variety of different core geometries optimized for specific applications. For example, cores can be designed for ease of assembly, or made self shielding where required. Table 5 highlights the differences between soft ferrites and other magnetic materials.

TABLE 5

FERRITES VERSUS OTHER MATERIALS

ADVANTAGES	DISADVANTAGES
High resistivity	Low saturation flux density
Wide range of operating frequencies	Poor thermal conductivity
Low loss combined with high permeability	Low tensile strength
Time and temperature stability	Brittle material
Large material selection	± 2% tolerances on unfinished dimensions
Versatility of core shapes	
Low cost	

Core Geometries

As in the case with ferrite materials, where specific applications require materials developed for that application, core geometries can be tailored to meet specific magnetic and mechanical requirements. A tunable high Q inductor dictates a different core shape than one used in TV line output transformers. Figures 8-1, 8-2, and 8-3 on the next pages show an evaluation of the most popular core geometries for a number of design parameters and cost considerations.

Future Trends

The various material chemistries and their respective properties and trade-offs are well known to the core manufacturers. Specific application trends will drive future material development. High frequency power and noise reduction are major areas of user interest.

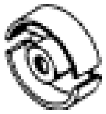
Development costs and manufacturing economics limit the number of materials manufacturers can produce. Each offering is a compromise designed to best meet ongoing customer needs. New material developments can take two to three years. Manufacturing logistics and economics also limit the combinations of core size/material, as do applications.

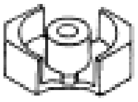
New shapes evolve more rapidly. Tooling made from carbide is expensive. Producing a die for low volume application is not economical or efficient. For special shapes, prototypes, and low volume applications, cores can frequently be machined or partly machined more economically than building a die. Discussions with suppliers regarding realistic quantity needs define the most cost effective manufacturing method.

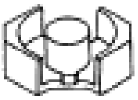
Major current shape development trends relate to low profile and surface mount applications. Low profile designs are simple shapes (See Figure 8-3) in which the core is inserted through a circuit board containing the “windings”. Other designs use longer, lower winding windows along with more sophisticated core designs to meet low height needs. “Integrated. Magnetics” attempts to optimize a total conductor/ core structure performing multiple magnetic functions for maximum density and efficiency.

Surface mount designs offer simple as well as complex approaches. Small beads can be connected with a simple formed conductor. Conventional through-hole bobbins for mated cores can be tooled with surface mount terminations. With this approach, the magnetic (transformer) design need not be redone. Other adaptations combine low profile designs with surface mount configurations to minimize space requirements.

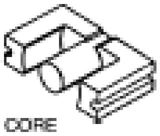
FIGURE8-1. Evaluation of Core Geometries

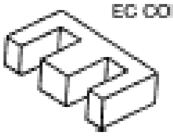

POT CORE

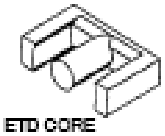

RM CORE

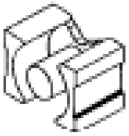

SOLID CENTER POST
RM CORE

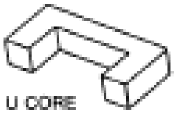
	POT CORES	RM CORES	SOLID CENTER POST RM CORES
APPLICATION	High Q inductors & tuned transformers		Power and wideband transformer
MAGNETIC SHIELDING	Very good	Good	Good
CAN BE SUPPLIED GAPPED	Yes	Yes	Yes
WITH TUNER	Yes	Yes	No
CORE STANDARDIZATION	Yes(IEC)	Yes (IEC)	Yes(IEC)
COST OF CORE	High	High	High
COST OF WINDING & ASSEMBLY	High	Average	Average
HEAT DISSIPATION	N A	N A	Poor
UNIFORM CROSS SECTION	No	No	No(but better than regular RM cores)

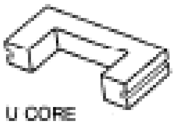

EC CORE


E CORE


ETD CORE

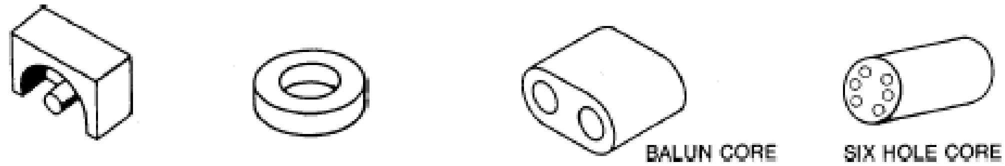

PQ CORE


U CORE

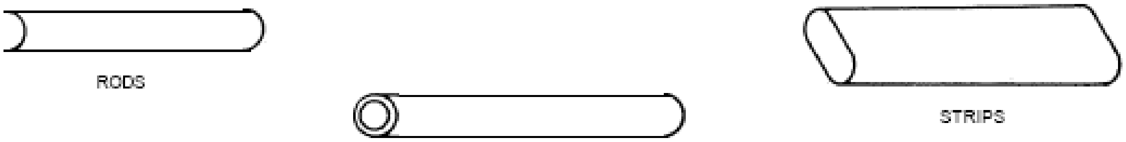

U CORE

	E CORES				U CORES
	E	EC	ETD	PQ	
APPLICATION	Power transformers and inductors				
MAGNETIC SHIELDING	External magnetic field generated close to the exposed winding				
CAN BE SUPPLIED GAPPED	Yes	Yes	Yes	Yes	No
CORE STANDARDIZATION	De facto	Yes (IEC)	Yes (IEC)	De facto	No
COST OF CORE	Low	Low	Low	Average	Low
COST OF WINDING & ASSEMBLY	Low	Low	Very Low	Average	Low
HEAT DISSIPATION	Very good	Very good	Very good	Very good	Very good
UNIFOM CROSS SECTION	Yes	No	Yes	No	Yes

Figure 8-2. Evaluation of Core Geometries

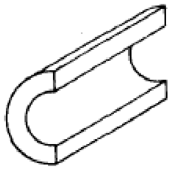


	EP CORES	TOROIDS	MULTI-APERTURE CORES
APPLICATION	Power	Wideband and pulse transformers Common mode chokes	
MAGNETIC SHIELDING	Very good	Excellent	Excellent
CAN BE SUPPLIED GAPPED	Yes	Rarely	No
CORE STANDARDIZATION	De facto	De facto	No
COST OF CORE	High	Low	Low
COST OF WINDING & ASSEMBLY	Average	Very High	Very High
HEAT DISSIPATION	Poor	Good	NA
UNIFORM CROSS SECTION	No	Yes	No



	RODS, TUBES & STRIPS
APPLICATION	Antennas, HF welding
MAGNETIC SHIELDING	Very poor
CAN BE SUPPLIED GAPPED	NA
CORE STANDARDIZATION	No
COST OF CORE	Very low
COST OF WINDING &ASSEMBLY	Average
HEAT DISSIPATION	Good
UNIFORM CROSS SECTION	Yes

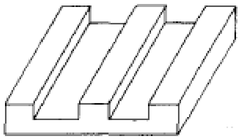
Figure 8-3. Evaluation of Core Geometries

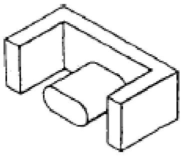

CABLE SUPPRESSION CORE


RIBBON CABLE SUPPRESSION CORE

EMI CORE SHAPES

PLANAR


LOW PROFILE CORE


EFD CORE
EPC CORE

LATEST CORE SHAPES

	EMI CORES	**LATEST CORE SHAPES**
APPLICATION	EMI Suppression	Low profile & surface mount power transformers
MAGNETIC SHIELDING	Good	Good
CAN BE SUPPLIED GAPPED	NA	Yes
CORE STANDARDIZATION	No	No
COST OF CORE	Average	Average
COST OF WINDING & ASSEMBLY	Low	Low
HEAT DISSIPATION	NA	Very good
UNIFORM CROSS SECTION	Yes	—

SECTION 5.0, DEMINSION NOMENCLATURE FOR SOFT FERRITE CORES

Scope

This standard presents a method for defining the designation nomenclature for the major physical attributes of soft ferrite core shapes. The purpose of this standard is to facilitate uniform usage of dimensional characters by manufacturers, specifiers, and users when describing core dimensions on drawing, in tables, and on catalog specification sheets.

General Assignment Guidelines

- Only upper case alphabetic characteristics are used.
- Only one character per dimension per ferrite piece.
- Character 2B and 2D may be used for core sets

Dimension Descriptions

Table 6 and Table 7 describe the alphabetic character assignments for the major dimensions of ferrite shapes. All other minor core dimensions designations are left to the discretion of the specifier.

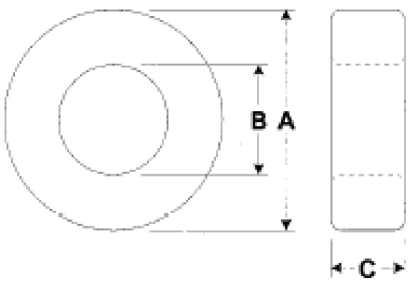
Letter	Dimension Description
A	Toroid outside diameter
B	Toroid inside diameter
C	Toroid height

Table 6
Torodial Core Dimension Designations

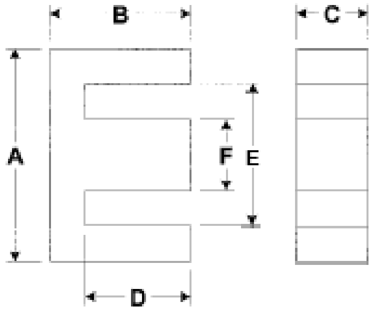
Letter	Dimension Description
A	Overall length of the core back or diameter
B	Outside leg length of height of core
C	Core width or floor width at wire aperture
D	Inside leg length or bobbin depth
E	Bobbin width or hole spacing
F	Center post thickness of diameter
G	Wire aperture or slot width
H	Center post hole diameter
J	RM core side-to-side parallel width
K	Center post offset dimension

Table 7
Ferrite Shapes Dimensions Designations

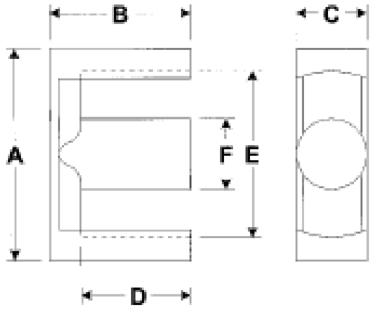
The following illustrations represent typical core geometries with the standard dimension nomenclature applied.



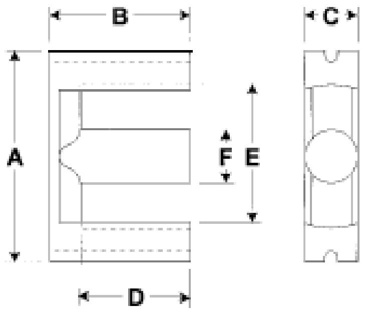
Toroid core



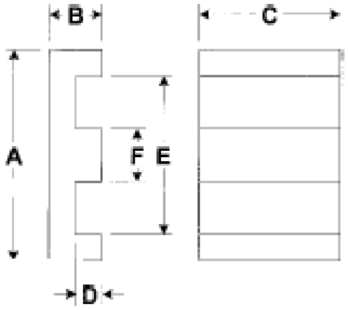
E-core



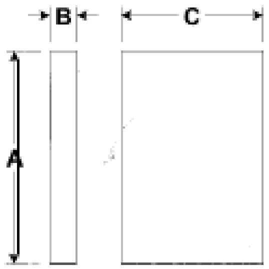
ETD or ER core



EC core



Planar E-core



I-core