ESSENTIAL RAW MATERIAL PROPERTIES[1]

Composition – 49% Co, 49% Fe, 2% V
Density – 8.15 grams/cc
Resistivity – 26 micro-ohm-cm
Curie Temperature – 1724ºF or 940ºC
Saturation Induction – 23 kilogauss
Sat. Magnetostriction – 65 to 70 ppm at 20ºC

Forty nine percent cobalt – 49% iron and 2% vanadium has the highest flux density of any commercially available strip core alloy. This property makes it an ideal choice for transformers or chokes (inductors) operating in small spaces or where weight is a premium. Table 1 shows typical commercially important magnetic properties for available gages. Table 2 shows typical applications for available tape thicknesses. This material is available in both an oriented square and non-oriented round loop finished product.

TABLE 2 – TYPICAL APPLICATIONS

Thick (in)	0 - 1 KHz	> 1 KHz
Square	(Supermendur[2])	
0.002	Not used	> 10 kHz choke
0.004	400 Hz xfmr	< 10 kHz choke
Round	(2V Permendur[3])	
0.002	Not generally used	Not generally used
0.004	Motor stator	Not used

Oriented Square Loop (Supermendur[2])

The square loop alloy, Supermendur, has the highest usable flux density of any commercially available alloy. This makes it useful wherever weight or space is a premium, which makes it ideal for 400 Hz airborne transformer applications. In addition it is also very useful for small, light saturable reactors, magnetic amplifiers, filter chokes, DC converters and inverters operating from 1 kHz to 100 kHz. It is used in pulse transformers, where size and weight are important and pulse widths are on the order of microseconds. The four thousandths of an inch gage is used primarily below10 kHz with the main usage at 400 Hz. The two thousandths of an inch gage is used almost exclusively above 10 kHz.

TABLE 1 – TYPICAL VALUES

Gage (in)	SF	Coercive Force (Oe)	Usable Flux (kilogauss)
0.002	.85 – .89	0.18	20
0.004	.90	0.18	21

Non-oriented Round Loop (2V Permendur[3])

The round loop alloy, 2V Permendur, is primarily used in motor stators in the lower frequency range. This product is generally used in thicker gages and lower frequencies.

Summary

The losses are on the same order as for silicon steel for comparable gages. The major application area is for very small or light transformers (400 Hz) and chokes operating up to 10 – 30 kHz. Core loss, impedance permeability[4] and VA for this alloy are shown as a function of flux density and frequency in the “Graphs” section. Consult the “Introduction and Specifications” section of this catalogue for details concerning the specification limits of the offered gages. Contact customer service for further

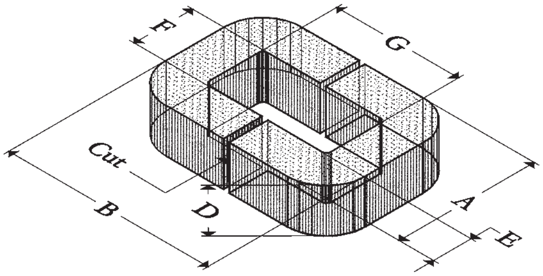
---

[1] Source of property data is “Ferromagnetism” by Richard Bozorth, IEEE Press, 1993

[2] *Supermendur* is the discontinued product name of Carpenter Technology

[3] *2V Permendur* is the discontinued product name of Carpenter Technology

[4] The permeability available to the application or *effective permeability* is a function of impedance permeability and core geometry, which includes path length and number of cuts or gaps. For filter chokes or inductors the incremental permeability is specifically related to both incremental or AC induction and steady state or DC induction in the core. A text that gives a thorough discussion of the interelationship between permeability and geometry is: “Electronic Tranformers and Circuits”, Reuben Lee, Wiley Interscience,



Depiction of Cut "C" Core Basic Dimensions

details about how the discussed factors affect core selection and design. Table 3 expands on Table 1, showing typical magnetic properties based on CCFR[5] readings.

Introduction to Part Number Listings

The following section lists a selection of part numbers for four thousandths of an inch Supermendur. The selections are primarily designed to meet the typical needs of transformer cores, and are therefore ranked in order of progressively increasing *DEFG* product, i.e., D × E × F × G. The figure shows the *DEFG* product is the product of the core's magnetic cross-section (net area) and the window area of the coil. Other terminology for the *DEFG* product is the area product, window-area product and relative power handling factor. It directly relates to the power handling capability or "VA".[6] Since inductors are frequently used with significant air gaps, inductor core designs tend to have narrower strip widths than transformers for a given *DEFG* product to reduce fringing effects.

TABLE 3 - TYPICAL MAGNETIC PROPERTIES AT 400 HZ

Thickness (inches)	CCFR Settings:[5] H_m = 6 Oe, delta B = 20 kG		
Gage	**B_m (KG) @ 3 Oe**	**$B_m - B_r$ (KG)**	**H_1 (Oe)**
0.002	20	2	0.40 – 1.0
0.004	21	2	0.30 – 0.85

Magnetic Metals Corp can, within very broad limits, manufacture any strip core geometry required for an application. However for a standard transformer and choke (inductor) design, when the volts per turn are not too high, there are certain ratios that typically apply for the C-Core configuration:

- Strip width to buildup: 1:1 <= D/E <= 3:1
- Window dimensions: 2:1 <= G/F <= 4:1

When the volts per turn become high, then the D/E ratio needs to drop to prevent insulation breakdown between laminations. Most of the core designs that are listed in this section follow these rules. The reasons:

- The core becomes more difficult to build when these ratios become too extreme
- Cores with large strip width to buildup ratios, i.e., D/E » 3, tend to run hotter compared to cores within the given range limits
- Cut cores with either large or small strip width to buildup ratios are difficult to align along the cuts
- Excessively tall windows, i.e., G/F » 4, tend to be less efficient in use of copper space
- Excessively squat windows, i.e., G/F « 2, tend to run hotter in the copper winding

---

5. CCFR settings refer to the drive level (H_m) and flux density, B, for a **C**onstant **C**urrent **F**lux **R**eset test set with sine current excitation. The net area is required for all measurements. In CCFR terms: B_m is the maximum flux of the material in kilogauss measured at the given drive level, H_m. ($B_m - B_r$) is the difference between the maximum flux, B_m, and the remanence, B_r (residual induction). ($B_m - B_r$) is a measure of "Squareness" of the hysteresis loop in kilogauss. H_1 is a measure of coercive force (slightly larger) for the given drive level, H_m. Both H_m and H_1 are in oersteds

6. VA is the Volt-Amp capacity of a transformer. It is discussed in "Electronic Transformers and Circuits", Reuben Lee, Wiley Interscience 1988; "Transformer and Inductor Design Handbook", Colonel Wm. McLyman, 2nd Edition, Marcel Decker, 1988

Table of Contents

“C” Core Configuration

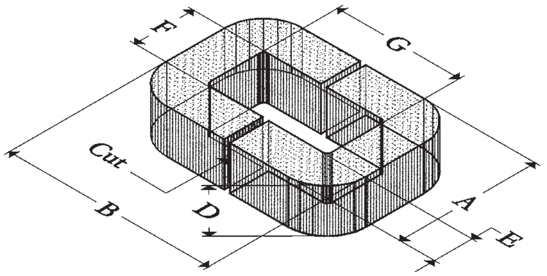
Graphs for 49% Ni – 49% Fe – 2% V Alloy

Consult the Introduction and Specifications section for the standard tolerances and specifications that apply.

Four Thousandths of an Inch Gage Part Numbers – “CHC” Series

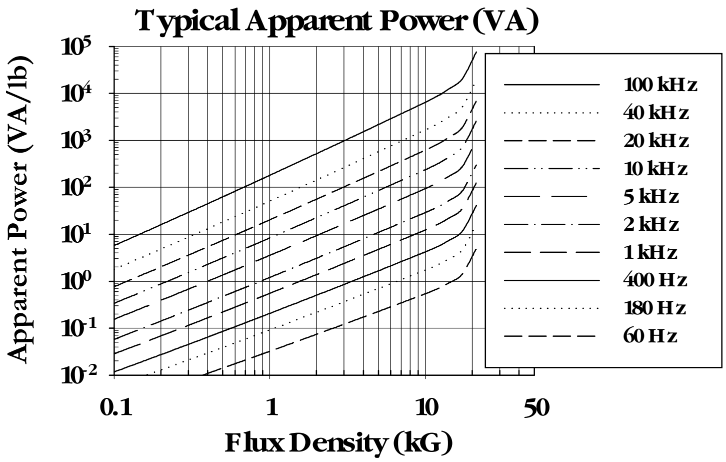
CHC Series	Strip	Buildup	Window		Outside Dimen.		Nominal Dimensions Apply for Calculations					
Part Number	*D*[1]	*E*[1]	*F*[1]	*G*[1]	*A*[1]	*B*[1]	*MGL*[2]	A_n[3]	W_a[4]	S_a[5]	*DEFG*[6]	Mass
0.004" Gage	inches	inches	inches	inches	inches	inches	inches	in^2	in^2	in^2	in^4	lbs
CHC-1031	0.125	0.125	0.250	0.500	0.500	0.750	1.71	0.014	0.125	0.89	0.002	0.007
CHC-121-A	0.250	0.125	0.250	0.500	0.500	0.750	1.71	0.028	0.125	1.34	0.004	0.015
CHC-447	0.250	0.187	0.250	0.625	0.624	0.999	2.10	0.042	0.156	1.95	0.007	0.028
CHC-173-B	0.500	0.250	0.250	0.750	0.750	1.250	2.48	0.113	0.188	4.02	0.021	0.089
CHC-7-D	0.500	0.250	0.312	1.000	0.812	1.500	3.10	0.113	0.312	4.95	0.035	0.109
CHC-43-B	0.625	0.375	0.375	1.125	1.125	1.875	3.71	0.211	0.422	8.14	0.089	0.253
CHC-428-A	0.750	0.375	0.625	1.250	1.375	2.000	4.46	0.253	0.781	10.8	0.198	0.359
CHC-478-A	1.000	0.390	0.625	1.937	1.405	2.717	5.86	0.351	1.21	17.4	0.425	0.644
CHC-1037	1.000	0.750	0.937	2.500	2.437	4.000	8.30	0.675	2.34	31.6	1.58	1.79
CHC-1041	1.500	0.750	0.750	3.000	2.250	4.500	8.92	1.01	2.25	43.4	2.28	2.87

The listing is a selection of part numbers from a large list of possibilities. The given geometry generally conforms to good design practice for transformer cores. Inductor cores may have narrower strip widths for a given *DEFG* product. Contact customer service for assistance in your application

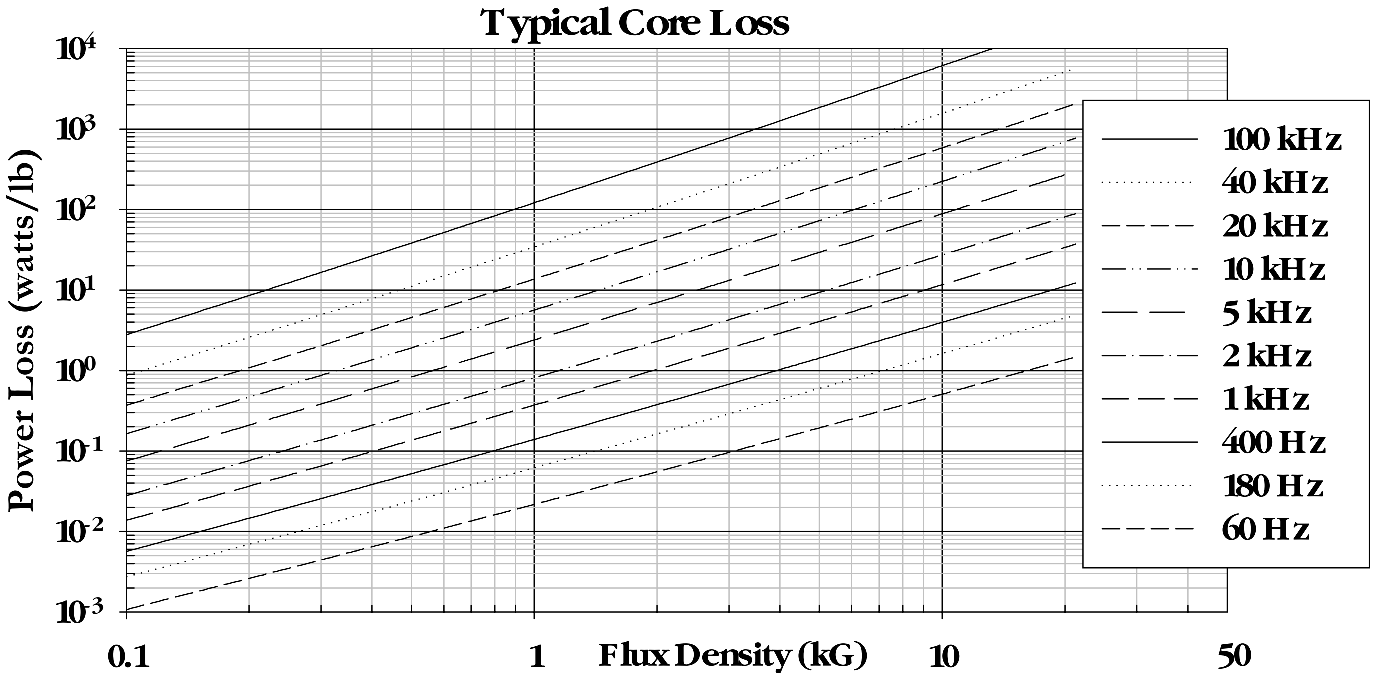


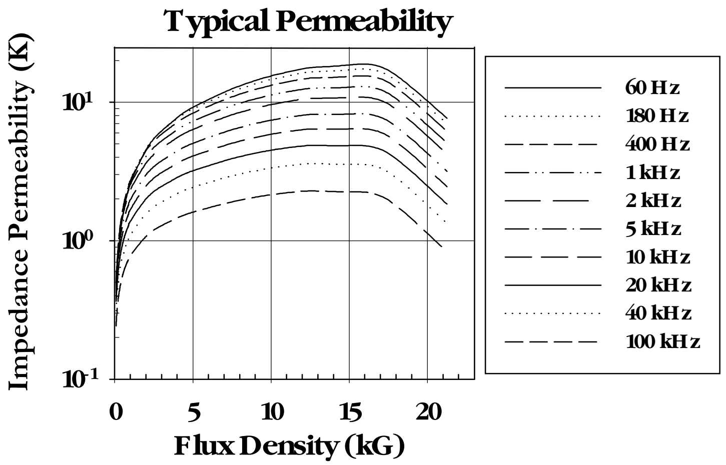
1. Nominal dimensions are reported. Standard tolerances are defined in the Introduction and Specifications section
2. *MGL* is the adjusted Mean Gross Length. It is the magnetic path length in the direction of the circumference
3. A_n is the Area (Net). It is (D × E) × SF, and is the magnetically active cross-sectional area of the core. SF is 0.90, the space factor specification for this gage
4. W_a is the gross window area. It is F × G. W_a does not include any correctional factors for coil winding packing density
5. S_a is the total Surface Area of the core
6. *DEFG* is the area-window product or relative power handling factor: (D × E × F × G) × SF or $A_n \times W_a$.

Graphs – Two Thousandths of an Inch Gage 49% Cobalt – 49% Iron – 2% Vanadium



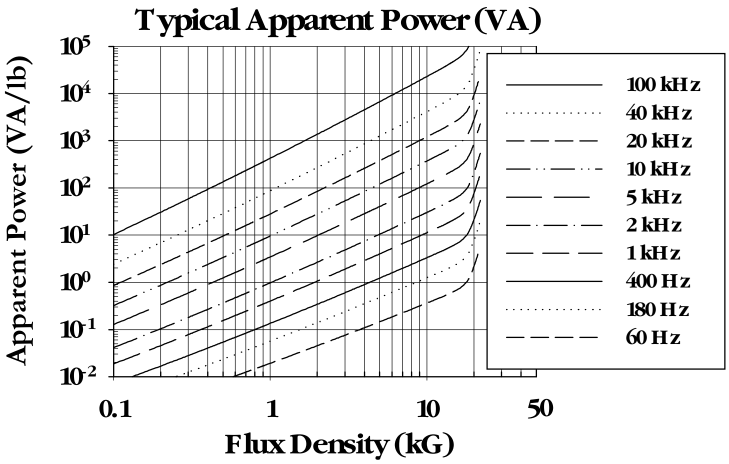
The graphs of apparent power, core loss and permeability apply to fully processed material, using cut "C" core configurations and the given tape gage. Standard processing and tolerances, were used for manufacturing. The equivalent graphs for "E" cores and cased, uncased toroids will differ.



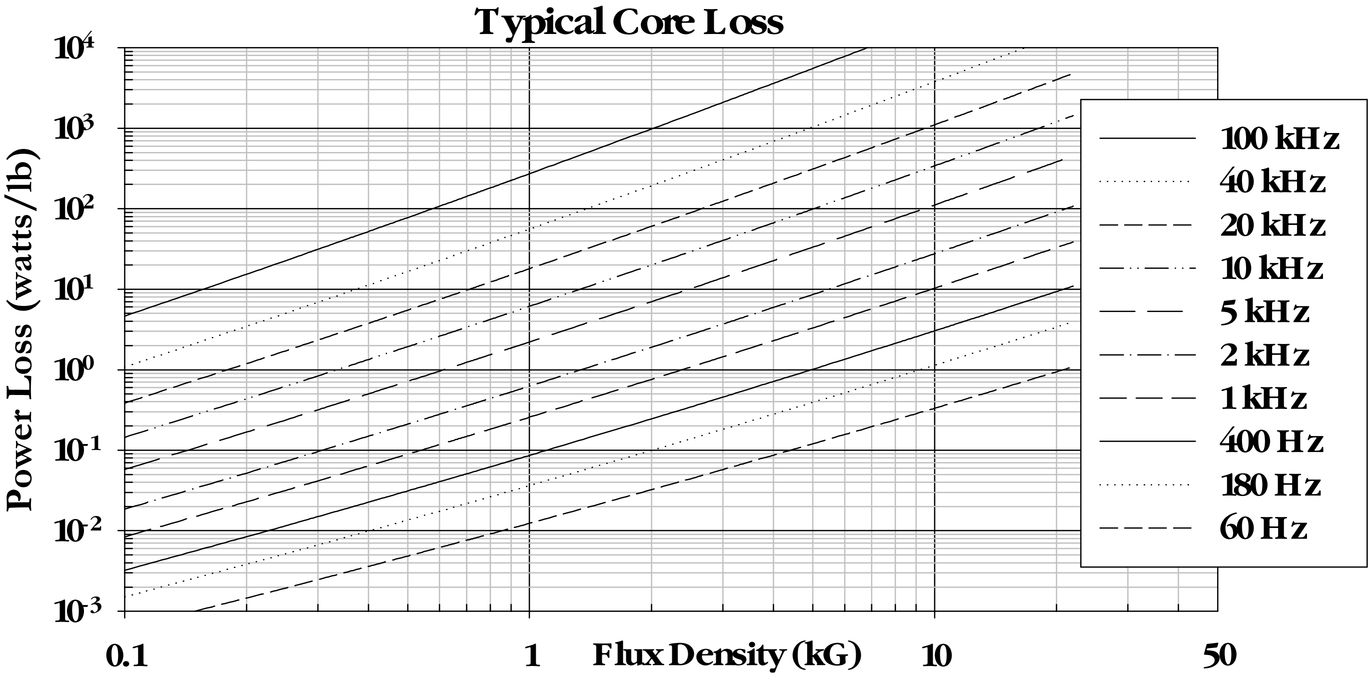


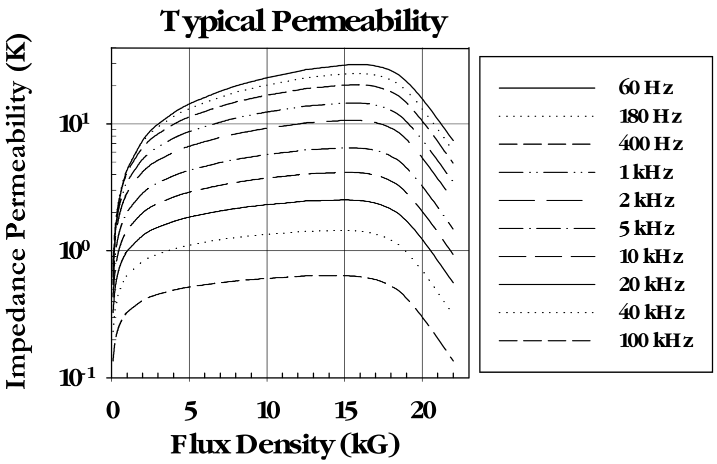
Sine voltages were used to take the data over a wide range of frequencies and flux densities. A curve fitting algorithm was used to process the data for plotting. Apparent power was derived from careful measurement of the magnetization current. Both the core loss and magnetization current were measured using a precision amplifier and wattmeter test set. The impedance permeability was derived from the apparent power, i.e., VA data. Contact customer service for information about toroids and "E" cores.

Graphs – Four Thousandths of an Inch Gage 49% Cobalt – 49% Iron – 2% Vanadium



The graphs of apparent power, core loss and permeability apply to fully processed material, using cut “C” core configurations and the given tape gage. Standard processing and tolerances, were used for manufacturing. The equivalent graphs for “E” cores and cased, uncased toroids will differ.





Sine voltages were used to take the data over a wide range of frequencies and flux densities. A curve fitting algorithm was used to process the data for plotting. Apparent power was derived from careful measurement of the magnetization current. Both the core loss and magnetization current were measured using a precision amplifier and wattmeter test set. The impedance permeability was derived from the apparent power, i.e., VA data. Contact customer service for information about toroids and “E” cores.