Wound Magnetics

GROUP ARNOLD®

NATIONAL-ARNOLD MAGNETICS

July 2001

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Essential Raw Material Properties[1]

Composition	– 3% silicon, balance iron
Density	– 7.67 grams/cc
Resistivity	– 47 micro-ohm-cm
Curie Temperature	– 1346°F or 730°C
Saturation Induction	– 20.0 kilogauss
Sat. Magnetostriction	– 4 ppm at 20°C, Roll Direct.

Three percent grain oriented silicon steel is the most widely used of the soft magnetic materials due to a combination of high saturation flux and relatively low cost. Table 1 shows some typical commercially important magnetic properties for a range of gages. Table 2 shows typical applications for various tape thicknesses. Especially notable is the 2 thousandths of an inch grain oriented silicon steel provided by **National-Arnold Magnetics**, because of its exceptional pulse permeability, i.e., greater than 2000 for pulse widths greater than one microsecond. Higher flux applications or components designed to saturate should use high "B" materials. "B" is the abbreviation for flux density. We denote high "B" materials with a "Z" suffix. The 11 thousandths of an inch "Z" material has the highest flux density for 50 – 60 Hz magnetic component designs. The remainder of this section discusses some important factors when selecting among the thin gages, i.e., 1 thousandth to 4 thousandths of an inch thickness.

Table 2 – Typical Applications

Thick (in)	0 - 10 kHz	> 10 kHz
0.001	2.4 - 10 kHz xfmr	Pulse xfmr, choke
0.002	0.8 - 2.4 kHz xfmr	Pulse xfmr, choke
0.004	0.4 - 0.8 kHz xfmr	Pulse xfmr, choke
0.004 "Z"	0.4 - 0.8 kHz xfmr	Pulse xfmr, choke
0.007	60 - 400 Hz xfmr	Pulse transformer
0.007 "Z"	60 - 400 Hz xfmr	Pulse transformer
0.009 "Z"	50 - 60 Hz xfmr	Pulse transformer
0.011 "Z"	50 - 60 Hz xfmr	Pulse transformer
0.012	50 - 60 Hz xfmr	Pulse transformer

Table 1 – Typical Values

Gage (in)	SF	Coercive Force (Oe)	Usable Flux (kilogauss)
0.001	.75 – .83	0.60	14
0.002	.85 – .89	0.50	16
0.004	.90	0.40	16
0.004 "Z"	.90	0.40	18
0.012	.95	0.30	16

One and Two Thousandths of an Inch Material

Table 2 shows that 1and 2 thousandths of an inch materials are primarily used for pulse transformers and chokes. These gages are also used in high frequency transformer applications and charging chokes, where significant high frequency components of exciting current are present. The use of 1and 2 thousandths of an inch gages is advantageous only at comparatively high frequencies, since their core loss and excitation characteristics are relatively poorer than 4 to12 thousandths of an inch gages at lower frequencies. Core loss, impedance permeability[2] and VA for these gages are shown as a function of flux density and frequency in the "Graphs" section.

Because 1 and 2 thousandths of an inch gages are typically used at higher frequencies, testing for core loss and excitation current must be done under operating conditions. *For this reason application specific specifications for thin gage materials require consultation with customer service.* Our testing capability limits are 250 KHz and 1200 watts for sine wave excitation. Pulse capabilities include pulse widths down to 100 nanoseconds and pulse energies up to 4 joules.

1. Source of properties information is Allegheny Ludlum Silectron® product information and the book "Ferromagnetism" by Richard Bozorth, IEEE Press, 1993
2. 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, 1988

Four Thousandths of an Inch Material

Four thousandths of an inch material is available in two different grades, reflecting differences in performance, i.e., “CH” and “CZ”. Both types are typically used in 400 Hz transformer applications. Other uses include filter chokes, reactors and magnetic amplifiers at higher frequencies. Both grades are also used for pulse transformers.

The “CZ” grade is preferred for applications where the operating conditions are greater than 16 kilogauss, because of its higher permeability at high flux density. However the core loss of the “CZ” grade is nearly identical to the “CH” grade.

At lower inductions the 4 thousandths of an inch gage can be used over a wide frequency range. In fact, the choice between 4 thousandths and the 2 or 1 thousandth of an inch gages depends on the specifics of operating frequency and magnetic induction. Usually, choices are made after consulting typical core loss curves as a function of flux density and frequency. Plots of core loss, permeability and VA for this gage are shown as a function of flux and frequency in the “Graphs” part of this section.

Magnetic amplifier applications require a material with a rectangular hysteresis loop or sharp saturation characteristics, i.e., square loop. The standard 4 thousandths of an inch material satisfies this requirement, and is used in many 400 Hz power magnetic amplifiers. In cut cores it is desirable to diamond lap the core for this application category to reduce the air gap as much as possible. This process avoids excessive shearing of the hysteresis loop, which normally results from adding a gap in a core. Shearing can be very significant for small cores, due to the increased ratio of gap to magnetic path length.

Pulse transformers may also be able to use the 4 thousandths of an inch gage in many cases with some reduction in incremental induction. This is particularly true in applications having long pulse durations, i.e., 5 microseconds or greater, combined with low duty cycle and longer rise times. The major condition that needs to be satisfied to use 4 thousandths of an inch material in high frequency applications is to keep the core loss and excitation current well within the operating limits for the given design flux density. Where a range of frequencies is encountered, the design needs to be based on the lowest operating frequency.

Table 3 - Typical Magnetic Properties at 60/400 Hz

Thickness (inches)	CCFR Settings:[3] H_m = 6 Oe, delta B = 20 kG		
Gage	**B_m (kG) @ 3 Oe**	**$B_m - B_r$ (kG)**	**H_1 (Oe)**
0.001	13.0 – 15.5	1.0 – 2.00	0.80 – 1.20
0.002	15.0 – 17.5	1.4 – 2.20	0.40 – 0.70
0.004	16.0 – 18.0	1.6 – 2.75	0.30 – 0.60
0.004 "Z"	17.5 – 18.5	1.4 – 2.20	0.30 – 0.60
0.007	16.0 – 18.5	2.0 – 3.00	—
0.007 "Z"	17.0 – 19.0	1.8 – 2.75	—
0.009 "Z"[4]	17.0 – 19.0	1.5 – 2.75	—
0.011 "Z"[4]	17.0 – 19.0	1.5 – 2.75	—
0.012[4]	16.0 – 18.0	2.0 – 3.00	—

Summary

Consult the “Introduction and Specification” section of this catalogue for details concerning the specification limits of the offered gages. Contact customer service for further details about how the discussed factors affect core selection and design. Table 3 expands on Table 1, showing typical magnetic properties based on CCFR[3] readings.

3. 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. 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
4. 0.009, 0.011 “Z” and 0.012 gage material were measured at 60 Hz. The other gages were measured at 400 Hz

Introduction to Part Number Listings

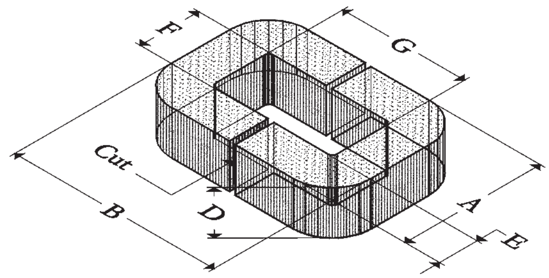
The following section lists a selection of part numbers for each available silicon steel gage. The selections are primarily designed to meet the typical needs of transformer cores, and are therefore ranked in order of progressively increasing *DEFG* product, i.e., D × E × F × G. The figure shows the *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".[5] 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.

National-Arnold Magnetics 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



Depiction of Cut "C" Core Basic Dimensions

- Excessively squat windows, i.e., G/F « 2, tend to run hotter in the copper winding

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"C" and "E" Core Configurations

Graphs for Silicon Steel

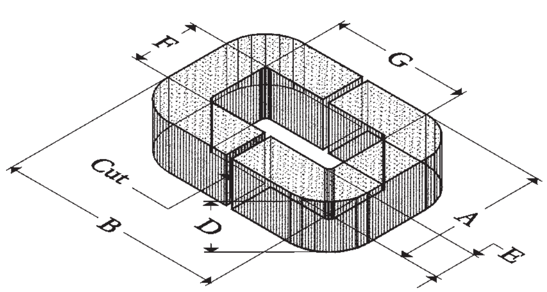
Consult the Introduction and Specifications secton for the standard tolerances and specifications that apply.

5. VA is the Volt-Amp capability 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

One Thousandth of an Inch Gage Part Numbers – "CM" Series

CM 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
0.001" Gage	inches	inches	inches	inches	inches	inches	inches	in^2	in^2	in^2	in^4	lbs
CM-53	0.125	0.125	0.187	0.375	0.437	0.625	1.34	0.013	0.070	0.705	0.001	0.005
CM-2-D	0.125	0.125	0.250	0.500	0.500	0.750	1.71	0.013	0.125	0.893	0.002	0.006
CM-3	0.250	0.125	0.250	0.500	0.500	0.750	1.71	0.026	0.125	1.34	0.003	0.013
CM-7-D	0.375	0.187	0.250	0.625	0.624	0.999	2.10	0.058	0.156	2.51	0.009	0.036
CM-4	0.375	0.250	0.250	0.875	0.750	1.375	2.73	0.078	0.219	3.66	0.017	0.063
CM-3-H	0.500	0.250	0.312	1.000	0.812	1.500	3.10	0.104	0.312	4.95	0.032	0.095
CM-5-F	0.500	0.375	0.375	1.187	1.125	1.937	3.83	0.156	0.445	7.34	0.069	0.180
CM-11	0.750	0.375	0.375	1.187	1.125	1.937	3.83	0.233	0.445	9.44	0.104	0.270
CM-49	0.750	0.437	0.500	1.250	1.374	2.124	4.32	0.272	0.625	11.3	0.170	0.358
CM-14	1.000	0.500	0.625	1.562	1.625	2.562	5.30	0.415	0.976	17.5	0.405	0.669
CM-52	1.000	0.625	0.750	2.312	2.000	3.562	7.32	0.519	1.73	25.6	0.900	1.13
CM-20	1.000	0.875	0.937	2.500	2.687	4.250	8.52	0.726	2.34	35.3	1.70	1.87
CM-12-E	1.500	1.000	1.000	3.000	3.000	5.000	9.86	1.25	3.00	54.6	3.74	3.76
CM-2757	1.500	1.000	1.500	3.187	3.500	5.187	11.2	1.25	4.78	61.5	5.95	4.23
CM-24-W	1.500	1.500	1.500	6.000	4.500	9.000	17.7	1.87	9.00	117	16.8	10.1

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

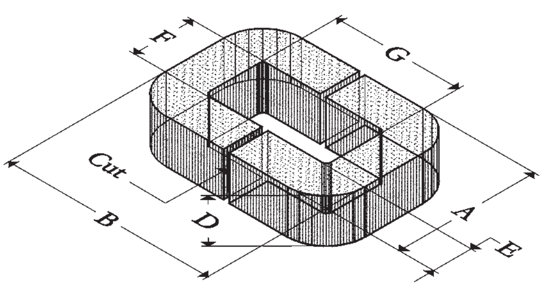


1. Nominal dimensions are reported. Standard tolerances are defined in the Introduction and Specifications section
2. *MGL* is the adjusted Mean Gross Length. It is the magnetic path length in the direction of the circumference
3. A_n is the Area (Net). It is (D × E) × SF, and is the magnetically active cross-sectional area of the core. SF is 0.83, 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 $A_n \times W_a$.

Two Thousandths of an Inch Gage Part Numbers – "CL" Series

CL Series Part Number	Strip D^1	Buildup E^1	Window F^1	G^1	Outside Dimen. A^1	B^1	Nominal Dimensions Apply for Calculations MGL^2	A_n^3	W_a^4	S_a^5	$DEFG^6$	Mass
0.002" Gage	inches	inches	inches	inches	inches	inches	inches	in^2	in^2	in^2	in^4	lbs
CL-1-S	0.125	0.125	0.125	0.375	0.375	0.625	1.21	0.014	0.047	0.643	0.001	0.005
CL-26-A	0.250	0.125	0.187	0.375	0.437	0.625	1.34	0.028	0.070	1.06	0.002	0.011
CL-163	0.250	0.156	0.250	0.500	0.562	0.812	1.78	0.035	0.125	1.53	0.004	0.018
CL-3	0.375	0.187	0.250	0.625	0.624	0.999	2.10	0.062	0.156	2.51	0.010	0.038
CL-6	0.500	0.250	0.250	0.875	0.750	1.375	2.73	0.111	0.219	4.39	0.024	0.090
CL-123	0.500	0.250	0.375	1.000	0.875	1.500	3.23	0.111	0.375	5.14	0.042	0.105
CL-11	0.750	0.375	0.375	1.187	1.125	1.937	3.83	0.250	0.445	9.44	0.111	0.290
CL-211	0.750	0.375	0.500	1.562	1.250	2.312	4.83	0.250	0.781	11.7	0.195	0.359
CL-19	1.000	0.500	0.625	1.562	1.625	2.562	5.30	0.445	0.976	17.5	0.434	0.717
CL-24	1.000	0.625	0.750	2.312	2.000	3.562	7.32	0.556	1.73	25.6	0.965	1.21
CL-128	1.125	0.687	0.937	2.500	2.311	3.875	8.18	0.688	2.34	32.0	1.61	1.67
CL-3618	1.125	0.906	1.125	2.875	2.937	4.687	9.70	0.907	3.23	43.2	2.93	2.66
CL-36	1.250	1.000	1.375	3.000	3.375	5.000	10.6	1.11	4.13	52.5	4.59	3.59
CL-176	1.500	1.375	1.250	4.250	4.000	7.000	13.4	1.84	5.31	86.9	9.75	7.65
CL-56	1.625	1.500	2.000	4.687	5.000	7.687	16.1	2.17	9.37	112	20.3	10.7
CL-3613	2.000	2.000	2.500	4.250	6.500	8.250	16.9	3.56	10.6	157	37.8	19.2
CL-228-C	2.500	1.750	2.500	6.000	6.000	9.500	20.1	3.89	15.0	189	58.4	23.9
CL-3812	3.000	2.000	3.000	8.000	7.000	12.000	25.4	5.34	24.0	281	128	41.4
CL-3802	3.500	2.000	4.500	9.000	8.500	13.000	30.4	6.23	40.5	364	252	56.9

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



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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 $A_n \times W_a$.

Four Thousandths of an Inch Standard Gage Part Numbers – "CH" Series

CH 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
CH-122-L	0.250	0.187	0.281	0.500	0.655	0.874	1.91	0.042	0.141	1.79	0.006	0.024
CH-172	0.375	0.250	0.250	0.625	0.750	1.125	2.23	0.084	0.156	3.04	0.013	0.057
CH-246	0.375	0.250	0.312	1.000	0.812	1.500	3.10	0.084	0.312	4.13	0.026	0.077
CH-39	0.375	0.250	0.500	1.312	1.000	1.812	4.10	0.084	0.656	5.38	0.055	0.100
CH-187	0.500	0.375	0.500	1.125	1.250	1.875	3.96	0.169	0.563	7.56	0.095	0.201
CH-4621	0.625	0.375	0.625	1.500	1.375	2.250	4.96	0.211	0.938	10.6	0.198	0.310
CH-457-F	0.875	0.500	0.500	2.000	1.500	3.000	5.93	0.394	1.00	17.8	0.394	0.702
CH-16	1.125	0.625	0.625	1.937	1.875	3.187	6.26	0.633	1.21	24.4	0.766	1.22
CH-63-M	1.250	0.625	0.875	2.250	2.125	3.500	7.44	0.703	1.97	30.0	1.38	1.55
CH-188	1.500	0.750	1.000	3.000	2.500	4.500	9.42	1.01	3.00	45.6	3.04	2.83
CH-33	1.750	1.000	1.000	3.000	3.000	5.000	9.86	1.58	3.00	60.1	4.73	4.75
CH-461	2.000	1.000	1.375	3.000	3.375	5.000	10.6	1.80	4.13	70.1	7.43	5.80
CH-249-S	2.250	1.000	1.500	4.000	3.500	6.000	12.9	2.03	6.00	90.5	12.2	7.78
CH-4489	2.500	1.500	2.000	5.000	5.000	8.000	16.7	3.38	10.0	148	33.8	17.2
CH-4633	3.000	2.000	1.750	7.000	5.750	11.000	20.9	5.40	12.3	236	66.2	35.1
CH-3083	3.000	3.000	2.500	7.250	8.500	13.250	24.4	8.10	18.1	345	147	64.2
CH-4584	4.000	4.000	4.500	7.000	12.500	15.000	29.2	14.4	31.5	566	454	141

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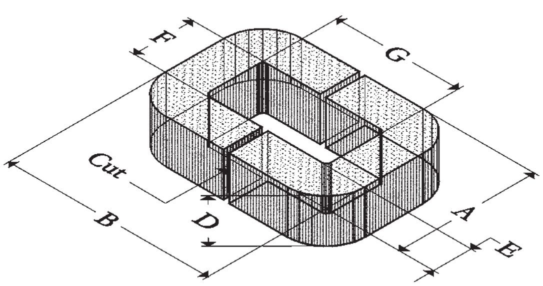

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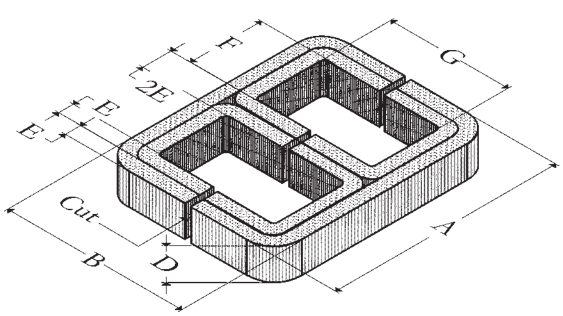
4. W_a is the gross window area. It is F × G. W_a does not include any correctional factors for coil winding packing density
5. S_a is the total Surface Area of the core
6. *DEFG* is the area-window product or relative power handling factor: (D × E × F × G) × SF or $A_n \times W_a$.

Four Thousandths of an Inch Standard Gage Part Numbers – "CTH" Series

CTH Series	Strip	Buildup	Window		Outside Dimen.		Nominal Dimensions Apply for Calculations				
Part Number	*D*[1]	*(2 × E)*[1]	*F*[1]	*G*[1]	*A*[1]	*B*[1]	A_n[2]	W_a[3]	S_a[4]	*DEFG*[5]	Mass
0.004" Gage	inches	inches	inches	inches	inches	inches	in^2	in^2	in^2	in^4	lbs
CTH-43-E	0.250	0.250	0.250	0.625	1.250	1.125	0.056	0.156	3.85	0.013	0.061
CTH-53-D	0.375	0.187	0.500	0.625	1.561	0.999	0.063	0.313	5.10	0.030	0.081
CTH-97	0.375	0.250	0.437	1.000	1.624	1.500	0.084	0.437	7.13	0.055	0.136
CTH-69	0.500	0.375	0.437	1.000	1.999	1.750	0.169	0.437	11.0	0.111	0.300
CTH-69-F	1.000	0.375	0.437	1.000	1.999	1.750	0.338	0.437	17.1	0.221	0.599
CTH-116	1.000	0.500	0.500	1.375	2.500	2.375	0.450	0.688	24.5	0.464	1.05
CTH-90	1.000	0.500	0.750	2.000	3.000	3.000	0.450	1.50	33.1	1.01	1.40
CTH-24	0.875	0.750	0.937	2.500	4.124	4.000	0.591	2.34	46.5	2.08	2.38
CTH-4	1.250	0.750	1.250	2.500	4.750	4.000	0.844	3.13	62.0	3.96	3.70
CTH-82	1.000	1.000	1.625	3.375	6.250	5.375	0.900	5.48	83.4	7.40	5.27
CTH-75	1.625	1.000	1.500	5.062	6.000	7.062	1.46	7.59	133	16.7	10.4
CTH-32-B	2.000	1.000	2.250	4.500	7.500	6.500	1.80	10.1	159	27.3	13.5
CTH-75-F	2.000	2.000	2.500	5.750	11.000	9.750	3.60	14.4	288	77.6	36.5
CTH-501	2.750	1.875	2.625	8.000	10.875	11.750	4.64	21.0	394	146	55.6

THE LISTING IS A SELECTION OF PART NUMBERS FROM A LARGE LIST OF POSSIBILITIES. THE GIVEN GEOMETRY GENERALLY CONFORMS TO GOOD DESIGN PRACTICE FOR THREE PHASE TRANSFORMER CORES. CONTACT CUSTOMER SERVICE FOR ASSISTANCE IN YOUR APPLICATION

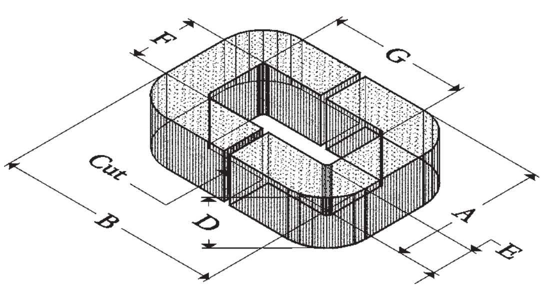


1. Nominal dimensions are reported. Standard tolerances are defined in the Introduction and Specifications section
2. A_n is the Area (Net). It is (D × 2E) × SF, and is the magnetically active cross-sectional area of the core. SF is 0.90, the space factor specification for this gage
3. W_a is the gross window area for each window. It is F × G. W_a does not include any correctional factors for coil winding packing density
4. S_a is the total Surface Area of the core
5. *DEFG* is the area-window product or relative power handling factor: (D × E × F × G) × 3.0 × SF or $A_n \times W_a \times 3.0$. The correction factor, 3.0, applies to 3 phase power calculations, where each copper winding occupies half the window area. For this calculation the "E" dimension is half the actual buildup of 2 × E.

Four Thousandths of an Inch "Z" Gage Part Numbers – "CZ" Series

CZ 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" Z" Gage	inches	inches	inches	inches	inches	inches	inches	in^2	in^2	in^2	in^4	lbs
CZ-121-A	0.250	0.125	0.250	0.500	0.500	0.750	1.71	0.028	0.125	1.34	0.004	0.014
CZ-121-M	0.250	0.187	0.250	0.750	0.624	1.124	2.35	0.042	0.188	2.17	0.008	0.029
CZ-4	0.375	0.187	0.375	1.000	0.749	1.374	3.10	0.063	0.375	3.63	0.024	0.056
CZ-46	0.500	0.250	0.500	1.000	1.000	1.500	3.48	0.113	0.500	5.52	0.056	0.114
CZ-99-B	0.625	0.625	0.312	1.000	1.562	2.250	3.76	0.352	0.312	11.2	0.110	0.435
CZ-215	0.875	0.437	0.500	1.312	1.374	2.186	4.45	0.344	0.656	12.8	0.226	0.464
CZ-34-R	1.000	0.562	0.625	1.750	1.749	2.874	5.78	0.506	1.09	20.0	0.553	0.895
CZ-3205	1.000	0.625	0.875	1.875	2.125	3.125	6.64	0.563	1.64	23.9	0.923	1.14
CZ-3214	1.250	0.750	1.250	3.250	2.750	4.750	10.4	0.844	4.06	44.6	3.43	2.60
CZ-98-F	1.625	0.812	1.750	3.500	3.374	5.124	12.0	1.19	6.13	62.6	7.27	4.21
CZ-33-R	2.000	1.875	1.000	4.000	4.750	7.750	13.3	3.38	4.00	121	13.5	14.6
CZ-3270	2.000	2.000	1.750	4.000	5.750	8.000	14.9	3.60	7.00	141	25.2	17.5
CZ-3181	2.500	2.250	1.750	7.500	6.250	12.000	22.3	5.06	13.1	241	66.4	35.4
CZ-3175	3.000	2.000	2.500	7.500	6.500	11.500	23.4	5.40	18.8	261	101	38.9
CZ-479-F	3.750	2.500	3.500	8.000	8.500	13.000	27.2	8.44	28.0	383	236	71.4
CZ-3216	3.750	3.750	5.000	12.000	12.500	19.500	39.9	12.7	60	684	759	159

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 $A_n \times W_a$.

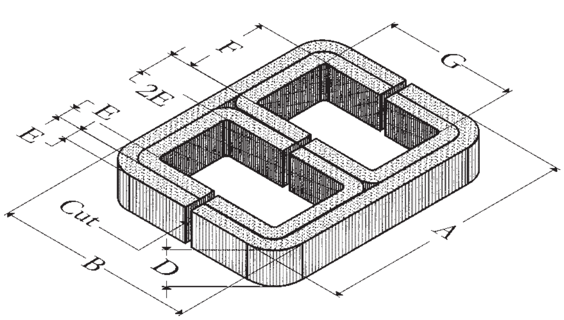
17030 Muskrat Ave., Adelanto, California 92301
www. grouparnold.com
Email: contactus@grouparnold.com

TOLL FREE: 800-877-7641
PHONE: (+1) 760-246-3020
FAX: (+1) 760-246-3870

Four Thousandths of an Inch "Z" Gage Part Numbers – "CTZ" Series

CTZ Series Part Number	Strip D^1	Buildup $(2 \times E)^1$	Window F^1	Window G^1	Outside Dimen. A^1	Outside Dimen. B^1	Nominal Dimensions Apply for Calculations A_n^2	W_a^3	S_a^4	$DEFG^5$	Mass
0.004" "Z" Gage	inches	inches	inches	inches	inches	inches	in^2	in^2	in^2	in^4	lbs
CTZ-53-A	0.250	0.250	0.250	0.750	1.250	1.250	0.056	0.188	4.22	0.016	0.067
CTZ-53-D	0.375	0.187	0.500	0.625	1.561	0.999	0.063	0.313	5.10	0.030	0.081
CTZ-96-C	0.375	0.250	0.437	1.000	1.624	1.500	0.084	0.437	7.13	0.055	0.136
CTZ-69	0.500	0.375	0.437	1.000	1.999	1.750	0.169	0.437	11.0	0.111	0.300
CTZ-104-A	0.875	0.375	0.500	1.000	2.125	1.750	0.295	0.500	16.2	0.221	0.545
CTZ-12	1.000	0.500	0.750	1.000	3.000	2.000	0.450	0.750	24.1	0.506	1.03
CTZ-90	1.000	0.500	0.750	2.000	3.000	3.000	0.450	1.50	33.1	1.01	1.40
CTZ-29	1.000	0.500	1.000	3.000	3.500	4.000	0.450	3.00	44.6	2.03	1.88
CTZ-19	2.000	0.750	1.000	2.250	4.250	3.750	1.35	2.25	75.3	4.56	5.26
CTZ-85-D	1.500	0.750	1.375	3.875	5.000	5.375	1.01	5.33	90.5	8.09	5.73
CTZ-14-E	2.000	1.000	1.955	3.032	6.910	5.032	1.80	5.93	126	16.0	10.7
CTZ-528	1.750	1.250	2.625	9.500	9.000	12.000	1.97	24.9	266	73.6	24.4
CTZ-607-A	2.000	1.375	5.000	9.000	14.125	11.750	2.48	45.0	356	167	36.5

The listing is a selection of part numbers from a large list of possibilities. The given geometry generally conforms to good design practice for three phase transformer cores. Contact customer service for assistance in your application

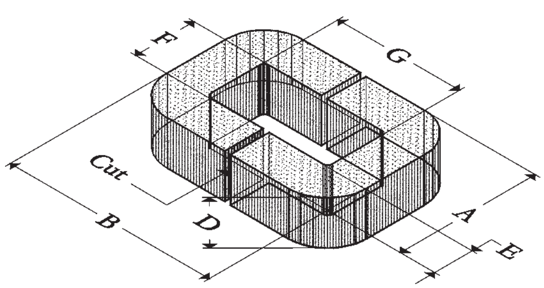


1. Nominal dimensions are reported. Standard tolerances are defined in the Introduction and Specifications section
2. A_n is the Area (Net). It is $(D \times 2E) \times SF$, and is the magnetically active cross-sectional area of the core. SF is 0.90, the space factor specification for this gage
3. W_a is the gross window area for each window. It is $F \times G$. W_a does not include any correctional factors for coil winding packing density
4. S_a is the total Surface Area of the core
5. *DEFG* is the area-window product or relative power handling factor: $(D \times E \times F \times G) \times 3.0 \times SF$ or $A_n \times W_a \times 3.0$. The correction factor, 3.0, applies to 3 phase power calculations, where each copper winding occupies half the window area. For this calculation the "E" dimension is half the actual buildup of $2 \times E$.

Seven Thousandths of an Inch Standard Gage Part Numbers – "CJ" Series

CJ 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
0.007" Gage	inches	inches	inches	inches	inches	inches	inches	in²	in²	in²	in⁴	lbs
CJ-1097	0.375	0.312	0.375	1.187	0.999	1.811	3.72	0.108	0.445	5.49	0.048	0.119
CJ-1075	0.625	0.500	0.750	0.937	1.750	1.937	4.30	0.288	0.703	10.9	0.202	0.384
CJ-1030	0.750	0.750	0.750	1.250	2.250	2.750	5.34	0.518	0.938	18.7	0.485	0.893
CJ-1073	1.250	0.500	1.000	2.562	2.000	3.562	8.08	0.575	2.56	29.7	1.47	1.35
CJ-1032	1.250	0.750	1.250	3.250	2.750	4.750	10.4	0.863	4.06	44.6	3.50	2.65
CJ-1067	1.250	1.250	2.000	5.000	4.500	7.500	16.3	1.44	10.0	88.6	14.4	7.03
CJ-1045	2.000	2.000	2.000	4.500	6.000	8.500	16.4	3.68	9.00	153	33.1	19.4
CJ-1044	2.000	2.000	3.000	5.500	7.000	9.500	20.4	3.68	16.5	185	60.7	23.4
CJ-1055	3.000	2.000	3.500	6.000	7.500	10.000	22.4	5.52	21.0	251	116	38.2
CJ-1031	3.000	2.000	5.000	10.000	9.000	14.000	33.4	5.52	50.0	361	276	55.0
CJ-1095	5.000	4.500	3.000	10.500	12.000	19.500	33.8	20.7	31.5	778	652	234

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
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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 0.92, 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 $A_n \times W_a$.

Seven Thousandths of an Inch "Z" Gage Part Numbers – "CJZ" Series

CJZ 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
0.007" "Z" Gage	inches	inches	inches	inches	inches	inches	inches	in^2	in^2	in^2	in^4	lbs
CJZ-1028	0.218	0.218	0.312	1.187	0.748	1.623	3.41	0.044	0.370	3.12	0.016	0.043
CJZ-1054	0.375	0.312	0.375	1.000	0.999	1.624	3.34	0.108	0.375	4.98	0.040	0.108
CJZ-1118	0.500	0.250	0.500	1.000	1.000	1.500	3.48	0.115	0.500	5.52	0.058	0.117
CJZ-1037	0.500	0.500	0.625	1.000	1.625	2.000	4.18	0.230	0.625	9.43	0.114	0.299
CJZ-1122	0.625	0.375	0.625	1.875	1.375	2.625	5.71	0.216	1.172	12.1	0.253	0.361
CJZ-1014	1.000	0.375	0.750	2.000	1.500	2.750	6.21	0.345	1.50	18.1	0.518	0.626
CJZ-1013	1.500	0.625	0.750	2.375	2.000	3.625	7.44	0.863	1.78	34.0	1.54	1.90
CJZ-1056	2.500	0.875	1.312	3.500	3.062	5.250	11.3	2.01	4.59	82.1	9.24	6.75
CJZ-1115	2.500	1.750	2.500	7.250	6.000	10.750	22.6	4.03	18.1	211	73.0	27.5

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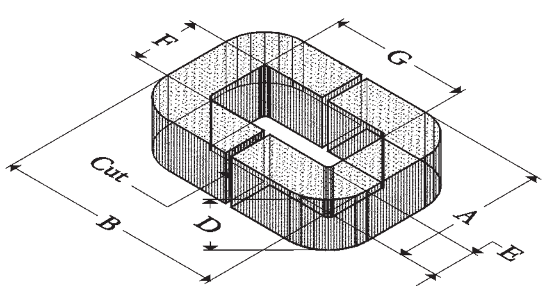

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4. W_a is the gross window area. It is F × G. W_a does not include any correctional factors for coil winding packing density
5. S_a is the total Surface Area of the core
6. *DEFG* is the area-window product or relative power handling factor: (D × E × F × G) × SF or $A_n \times W_a$.

Eleven Thousandths of an Inch "Z" Gage Part Numbers – "CAZ/CSZ" Series

CAZ/CSZ 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
0.011" "Z" Gage	inches	inches	inches	inches	inches	inches	inches	in²	in²	in²	in⁴	lbs
CAZ-42-C	0.500	0.437	0.625	2.000	1.499	2.874	6.07	0.208	1.25	12.2	0.259	0.373
CAZ-42-D	0.750	0.750	0.625	2.000	2.125	3.500	6.59	0.534	1.25	22.5	0.668	1.11
CAZ-134-B	0.875	0.562	1.000	4.000	2.124	5.124	11.1	0.467	4.00	33.2	1.87	1.49
CAZ-1037	1.000	1.000	1.375	3.000	3.375	5.000	10.6	0.950	4.13	46.7	3.92	3.06
CAZ-1013	1.250	1.250	1.500	5.000	4.000	7.500	15.3	1.48	7.50	83.6	11.1	6.85
CAZ-300-T	1.500	1.000	3.000	4.250	5.000	6.250	16.4	1.43	12.8	87.1	18.2	6.85
CAZ-1093	2.000	1.000	4.000	6.000	6.000	8.000	21.9	1.90	24.0	138	45.6	12.0
CAZ-1106	2.500	2.000	3.500	6.500	7.500	10.500	23.4	4.75	22.8	235	108	34.2
CAZ-1082	2.500	2.500	4.000	9.000	9.000	14.000	30.2	5.94	36.0	337	214	55.1
CAZ-1046	3.000	3.000	6.500	12.000	12.500	18.000	41.9	8.55	78.0	555	667	109
CAZ-1100	3.000	3.000	7.500	15.000	13.500	21.000	49.9	8.55	113	651	962	128
CAZ-1085	3.000	3.000	11.000	30.000	17.000	36.000	86.9	8.55	330	1,090	2,820	215

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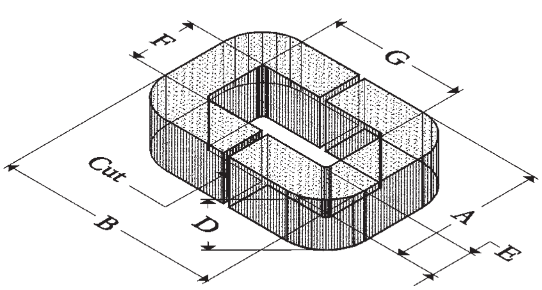

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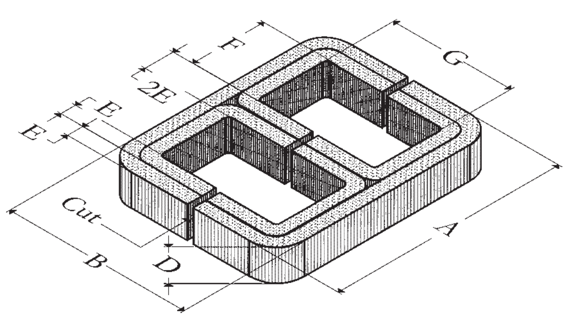
3. A_n is the Area (Net). It is (D × E) × SF, and is the magnetically active cross-sectional area of the core. SF is 0.95, the space factor specification for this gage
4. W_a is the gross window area. It is F × G. W_a does not include any correctional factors for coil winding packing density
5. S_a is 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 $A_n \times W_a$.

Eleven Thousandths of an Inch “Z” Gage Part Numbers – “CTAZ/CTSZ” Series

CTAZ/CTSZ Series Part Number 0.011" "Z" Gage	Strip D^1 inches	Buildup $(2 \times E)^1$ inches	Window F^1 inches	Window G^1 inches	Outside Dimen. A^1 inches	Outside Dimen. B^1 inches	Nominal Dimensions Apply for Calculations $A_n{}^2$ in²	$W_a{}^3$ in²	$S_a{}^4$ in²	$DEFG^5$ in⁴	Mass lbs
CTAZ-13-C	0.625	0.437	0.500	1.625	2.311	2.499	0.259	0.813	18.4	0.316	0.635
CTAZ-13-B	1.375	0.437	0.625	1.437	2.561	2.311	0.571	0.898	31.0	0.769	1.39
CTAZ-28-S	1.000	0.750	0.750	2.250	3.750	3.750	0.713	1.69	44.8	1.80	2.58
CTAZ-369	1.000	0.500	1.500	3.375	4.500	4.375	0.475	5.06	54.0	3.61	2.40
CTAZ-12	1.500	1.000	0.937	2.500	4.874	4.500	1.43	2.34	76.9	5.01	6.24
CTAZ-3	1.000	0.875	1.625	3.500	5.875	5.250	0.831	5.69	77.3	7.09	4.82
CTSZ-382	1.375	0.875	1.500	3.625	5.625	5.375	1.14	5.44	92.0	9.32	6.58
CTSZ-300	2.000	1.000	1.250	3.125	5.500	5.125	1.90	3.91	111	11.1	9.95
CTAZ-125	2.500	1.000	1.500	2.500	6.000	4.500	2.38	3.75	123	13.4	11.9
CTAZ-3-B	1.750	1.000	1.750	3.875	6.500	5.875	1.66	6.78	125	16.9	10.7
CTAZ-3-E	2.000	1.000	1.625	4.500	6.250	6.500	1.90	7.31	144	20.8	12.9
CTAZ-237-B	2.500	1.000	1.750	4.500	6.500	6.500	2.38	7.88	172	28.1	16.5
CTAZ-281	1.750	2.000	1.625	4.750	9.250	8.750	3.33	7.72	222	38.5	27.8
CTAZ-311	3.000	1.500	2.000	4.000	8.500	7.000	4.28	8.00	237	51.3	31.9
CTSZ-187-H	2.750	1.500	3.000	5.000	10.500	8.000	3.92	15.0	283	88.2	36.8
CTSZ-80-N	2.500	2.500	2.500	7.000	12.500	12.000	5.94	17.5	420	156	70.5
CTSZ-35-D	2.000	3.250	3.750	9.000	17.250	15.500	6.18	33.8	596	313	98.3
CTSZ-35-W	4.500	3.750	4.000	6.500	19.250	14.000	16.0	26.0	859	625	237

The listing is a selection of part numbers from a large list of possibilities. The given geometry generally conforms to good design practice for three phase transformer cores. Contact customer service for assistance in your application

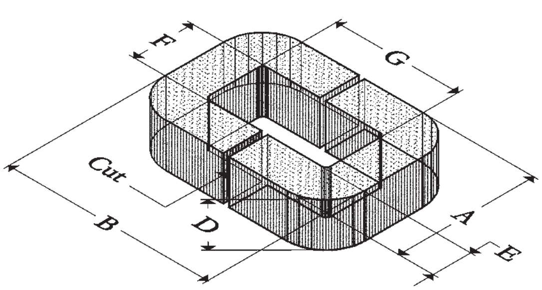


1. Nominal dimensions are reported. Standard tolerances are defined in the Introduction and Specifications section
2. A_n is the Area (Net). It is (D × 2E) × SF, and is the magnetically active cross-sectional area of the core. SF is 0.95, the space factor specification for this gage
3. W_a is the gross window area for each window. It is F × G. W_a does not include any correctional factors for coil winding packing density
4. S_a is the total Surface Area of the core
5. *DEFG* is the area-window product or relative power handling factor: (D × E × F × G) × 3.0 × SF or $A_n \times W_a \times 3.0$. The correction factor, 3.0, applies to 3 phase power calculations, where each copper winding occupies half the window area. For this calculation the “E” dimension is half the actual buildup of 2 × E.

Twelve Thousandths of an Inch Gage Part Numbers – "CA/CS" Series

CA/CS 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
0.012" Gage	inches	inches	inches	inches	inches	inches	inches	in^2	in^2	in^2	in^4	lbs
CA-6220	0.375	0.375	0.375	1.125	1.125	1.875	3.71	0.134	0.422	6.11	0.056	0.150
CA-6152	0.625	0.625	0.437	1.312	1.687	2.562	4.64	0.371	0.573	13.4	0.213	0.548
CA-204-B	0.750	0.500	0.750	1.562	1.750	2.562	5.55	0.356	1.17	15.2	0.417	0.599
CA-6110	0.750	0.500	1.125	2.250	2.125	3.250	7.70	0.356	2.53	20.3	0.902	0.797
CA-412-D	0.750	0.750	1.125	3.000	2.625	4.500	9.67	0.534	3.38	31.2	1.80	1.53
CA-391	1.000	1.000	1.375	3.000	3.375	5.000	10.6	0.950	4.13	46.7	3.92	3.06
CA-6172	1.250	1.250	1.500	3.500	4.000	6.000	12.3	1.48	5.25	68.6	7.79	5.62
CA-6421	1.250	1.250	2.250	4.000	4.750	6.500	14.8	1.48	9.00	81.1	13.4	6.64
CS-122-H	1.500	1.500	2.500	5.000	5.500	8.000	17.7	2.14	12.5	117	26.7	11.5
CA-6428	2.000	1.000	3.000	8.000	5.000	10.000	23.9	1.90	24.0	150	45.6	13.1
CA-6424	3.000	2.500	2.000	6.500	7.000	11.500	21.2	7.13	13.0	271	92.6	48.5
CA-6341	3.500	2.000	4.500	9.000	8.500	13.000	30.4	6.65	40.5	364	269	60.7
CA-6364	4.000	3.000	5.000	10.000	11.000	16.000	34.9	11.4	50.0	549	570	123
CA-5240	5.000	4.000	5.250	11.625	13.250	19.625	39.9	19.0	61.0	830	1,160	242
CA-6345	5.000	5.000	9.000	17.000	19.000	27.000	59.5	23.8	153	1,350	3,630	442
CA-6254	6.000	6.000	10.000	19.750	22.000	31.750	68.2	34.2	198	1,880	6,750	738
CA-6024	8.000	8.000	10.000	19.750	26.000	35.750	70.5	60.8	198	2,700	12,000	1,417
CA-6040	8.000	8.000	12.000	24.000	28.000	40.000	83.0	60.8	288	3,100	17,500	1,626

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

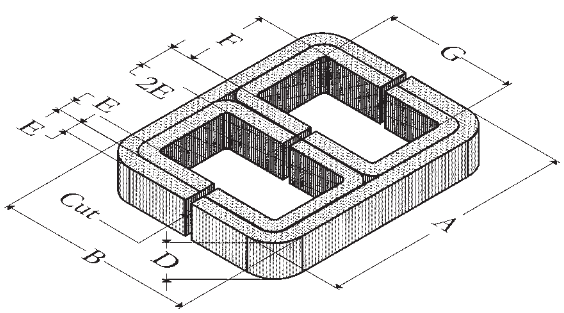


1. Nominal dimensions are reported. Standard tolerances are defined in the Introduction and Specifications section
2. *MGL* is adjusted Mean Gross Length. It is the magnetic path length in the direction of the circumference
3. A_n is the Area (Net). It is (D × E) × SF, and is the magnetically active cross-sectional area of the core. SF is 0.95, 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 $A_n \times W_a$.

Twelve Thousandths of an Inch Gage Part Numbers – "CTA/CTS" Series

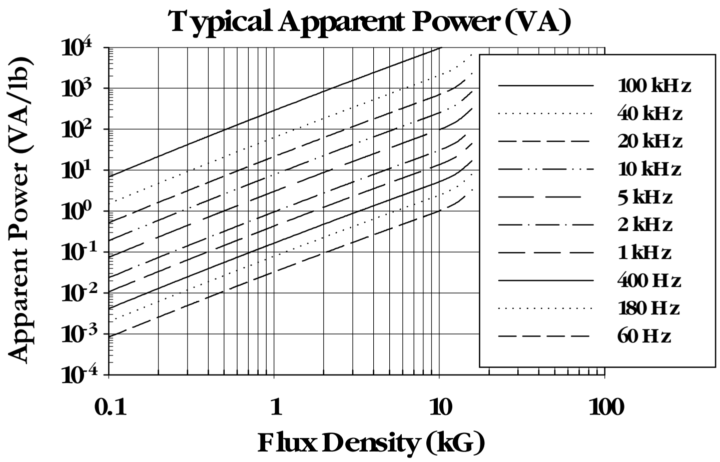
CTA/CTS Series	Strip	Buildup	Window		Outside Dimen.		Nominal Dimensions Apply for Calculations				
Part Number	*D*[1]	*(2 × E)*[1]	*F*[1]	*G*[1]	*A*[1]	*B*[1]	A_n[2]	W_a[3]	S_a[4]	*DEFG*[5]	Mass
0.012" Gage	inches	inches	inches	inches	inches	inches	in^2	in^2	in^2	in^4	lbs
CTA-5-J	0.750	0.250	0.500	1.687	1.750	2.187	0.178	0.884	16.0	0.225	0.400
CTA-78-A	1.000	0.500	0.500	1.500	2.500	2.500	0.475	0.750	25.6	0.534	1.15
CTA-9-G	1.000	0.625	0.625	2.125	3.125	3.375	0.594	1.33	36.8	1.18	1.91
CTA-47	1.875	0.500	0.625	2.500	2.750	3.500	0.891	1.56	56.2	2.09	2.99
CTA-20-D	0.875	0.875	1.000	3.750	4.625	5.500	0.727	3.75	66.1	4.09	3.86
CTA-20-B	2.000	1.125	1.000	2.500	5.375	4.750	2.14	2.50	101	8.02	9.87
CTA-16-A	2.000	1.500	1.250	3.000	7.000	6.000	2.85	3.75	143	16.0	16.6
CTA-53	2.375	1.000	2.750	3.500	8.500	5.500	2.26	9.63	172	32.6	16.3
CTA-307-D	2.000	1.500	2.500	6.250	9.500	9.250	2.85	15.6	246	66.8	28.2
CTA-1242	3.000	2.125	3.000	5.000	12.375	9.250	6.06	15.0	371	136	62.1
CTA-311-A	4.000	2.000	2.000	10.000	10.000	14.000	7.60	20.0	558	228	100
CTS-188-C	4.750	2.375	3.000	7.500	13.125	12.250	10.7	22.5	636	362	136
CTA-2862	4.125	1.500	6.250	9.000	17.000	12.000	5.88	56.3	654	496	95.8
CTA-2586	4.000	4.000	4.000	12.000	20.000	20.000	15.2	48.0	1,117	1,094	299
CTA-2772	5.750	4.000	4.000	13.000	20.000	21.000	21.9	52.0	1,414	1,704	449

The listing is a selection of part numbers from a large list of possibilities. The given geometry generally conforms to good design practice for three phase transformer cores. Contact customer service for assistance in your application

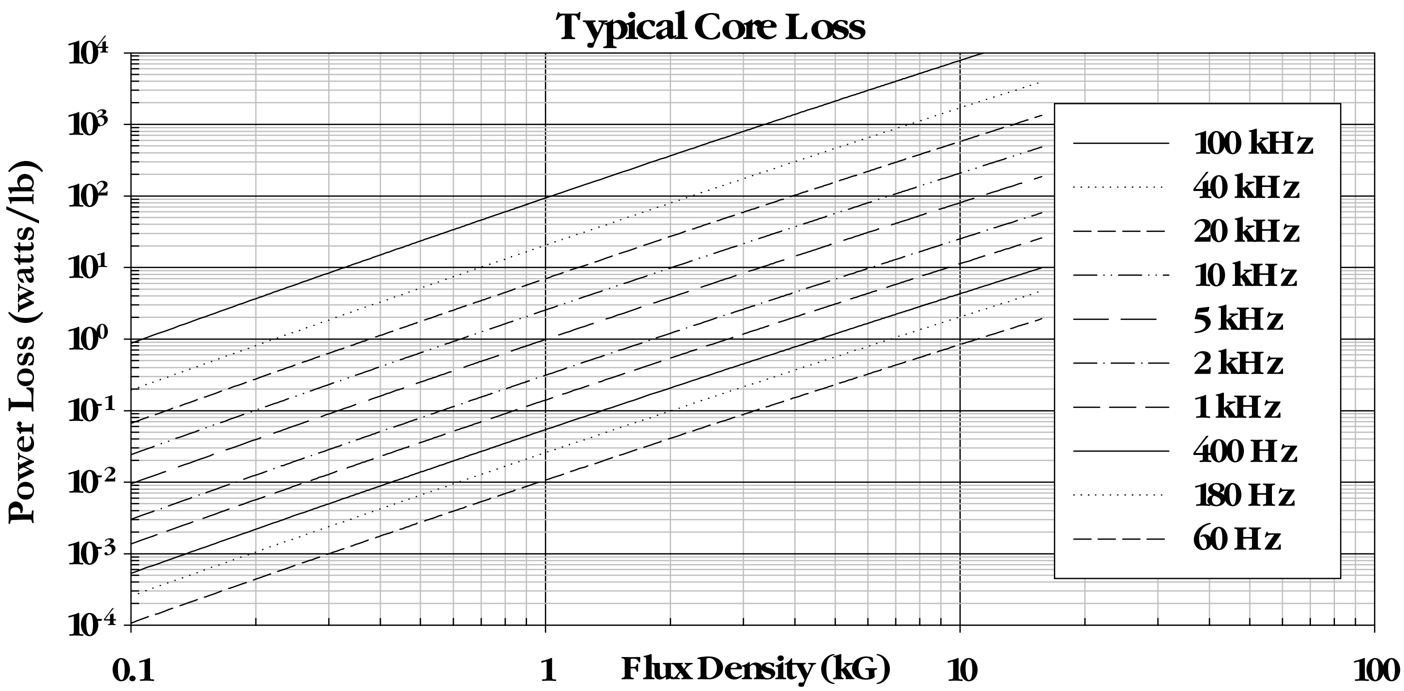


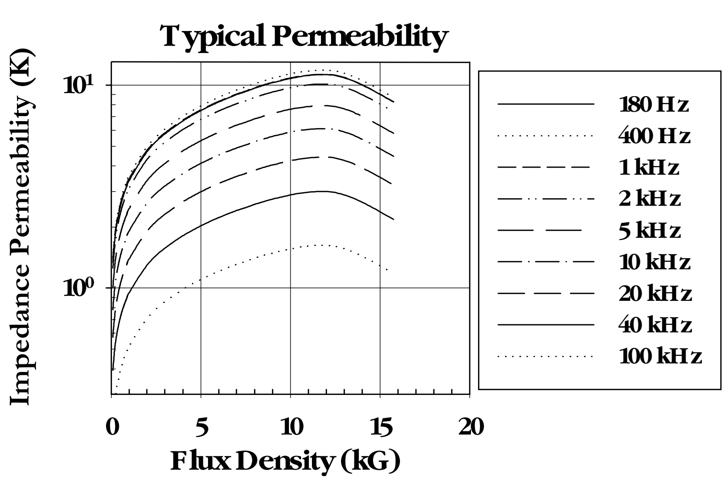
1. Nominal dimensions are reported. Standard tolerances are defined in the Introduction and Specifications section
2. A_n is the Area (Net). It is (D × 2E) × SF, and is the magnetically active cross-sectional area of the core. SF is 0.95, the space factor specification for this gage
3. W_a is the gross window area for each window. It is F × G. W_a does not include any correctional factors for coil winding packing density
4. S_a is the total Surface Area of the core
5. *DEFG* is the area-window product or relative power handling factor: (D × E × F × G) × 3.0 × SF or $A_n \times W_a \times 3.0$. The correction factor, 3.0, applies to 3 phase power calculations, where each copper winding occupies half the window area. For this calculation the "E" dimension is half the actual buildup of 2 × E.

Graphs – One Thousandth of an Inch Gage Silicon Steel



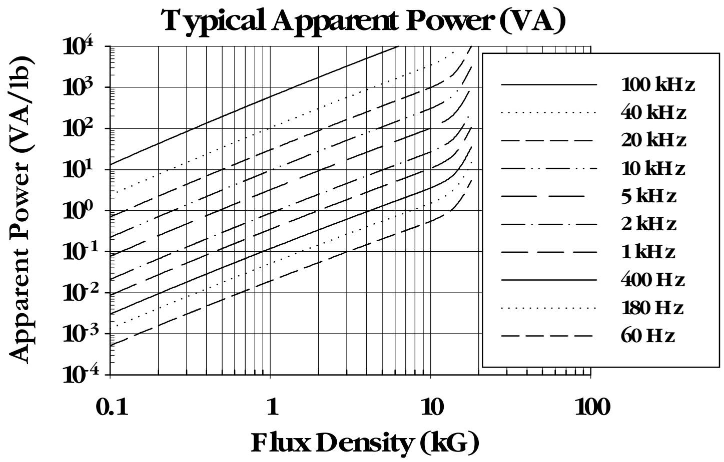
The graphs of apparent power, core loss and permeability apply to fully processed material, using cut "C" core configurations and the given tape gage. Standard processing and tolerances, were used for manufacturing. The equivalent graphs for "E" cores and cased, uncased toroids will differ.



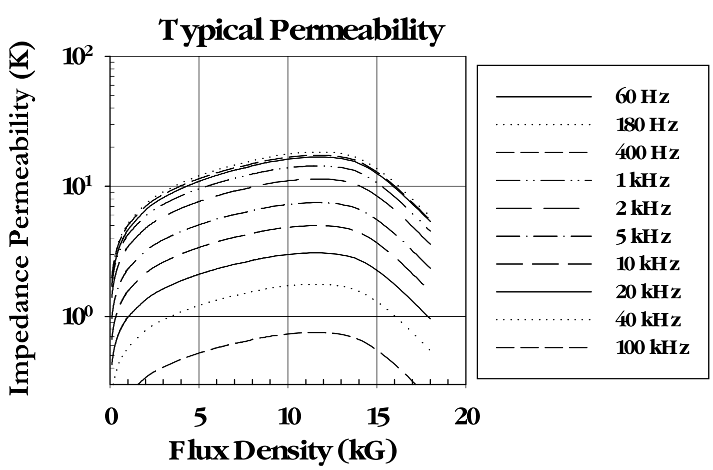


Sine voltages were used to take the data over a wide range of frequencies and flux densities. A curve fitting algorithm was used to process the data for plotting. Apparent power was derived from careful measurement of the magnetization current. Both the core loss and magnetization current were measured 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 – Two Thousandths of an Inch Gage Silicon Steel

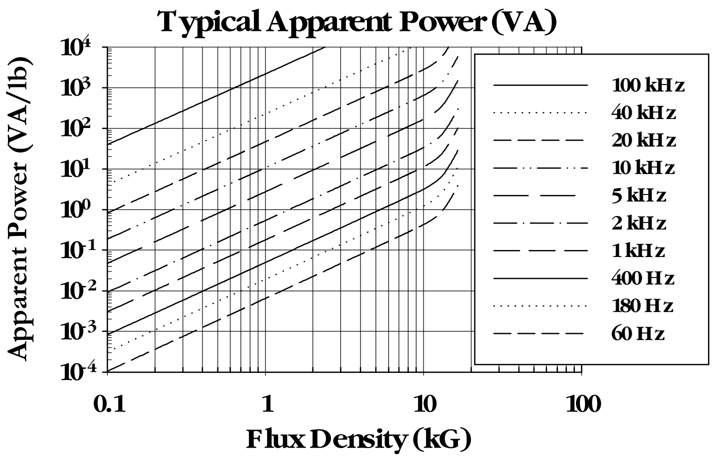


The graphs of apparent power, core loss and permeability apply to fully processed material, using cut "C" core configurations and the given tape gage. Standard processing and tolerances, were used for manufacturing. The equivalent graphs for "E" cores and cased, uncased toroids will differ.

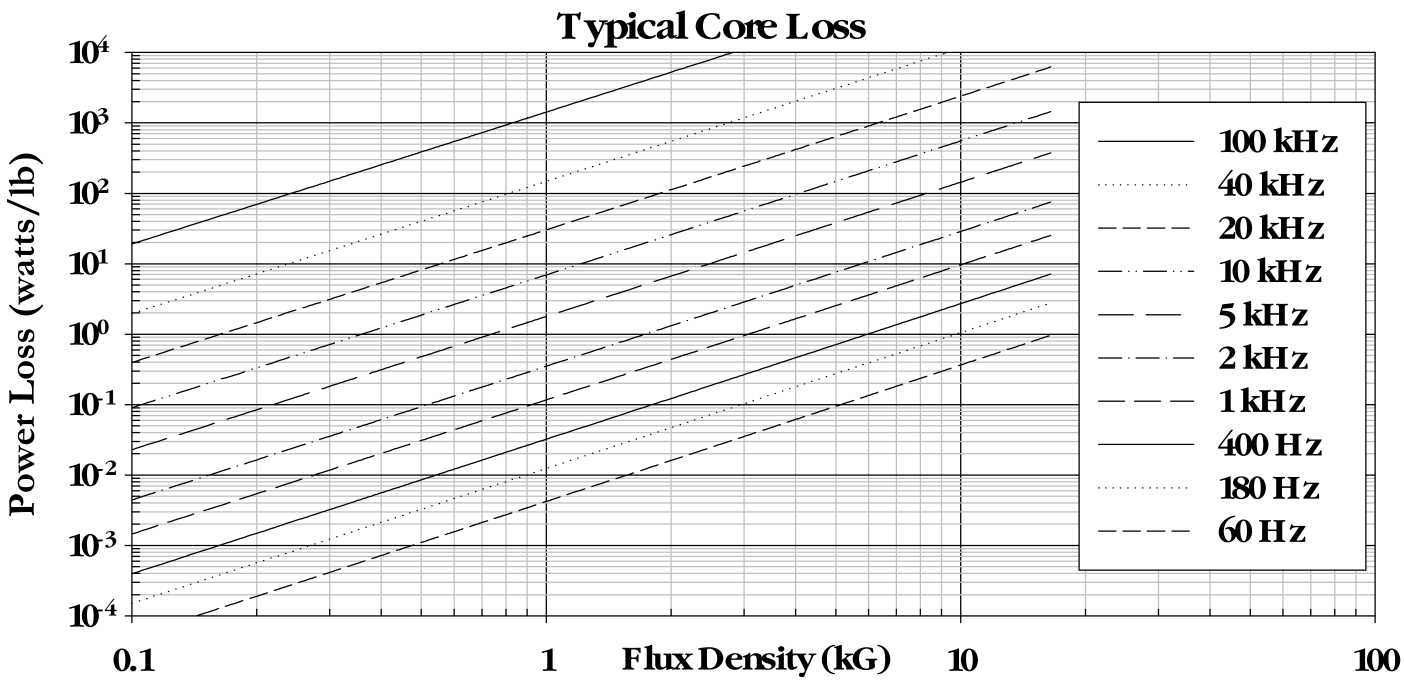


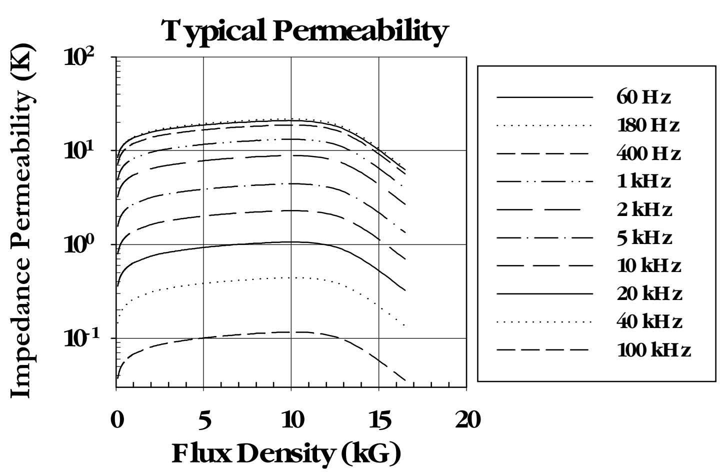
Sine voltages were used to take the data over a wide range of frequencies and flux densities. A curve fitting algorithm was used to process the data for plotting. Apparent power was derived from careful measurement of the magnetization current. Both the core loss and magnetization current were measured 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 Standard Gage Silicon Steel



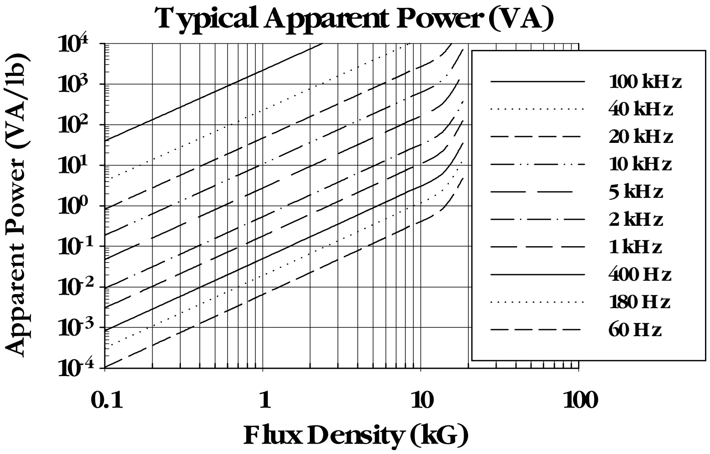
The graphs of apparent power, core loss and permeability apply to fully processed material, using cut "C" core configurations and the given tape gage. Standard processing and tolerances, were used for manufacturing. The equivalent graphs for "E" cores and cased, uncased toroids will differ.



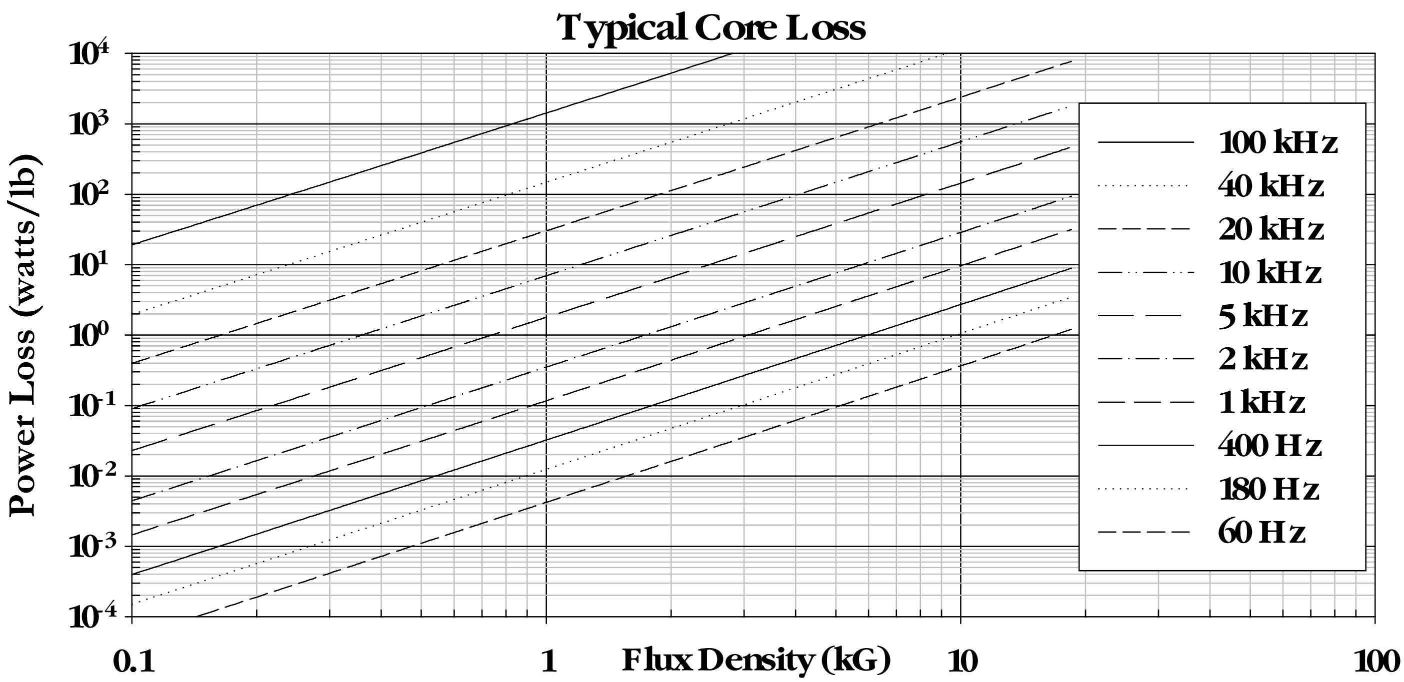


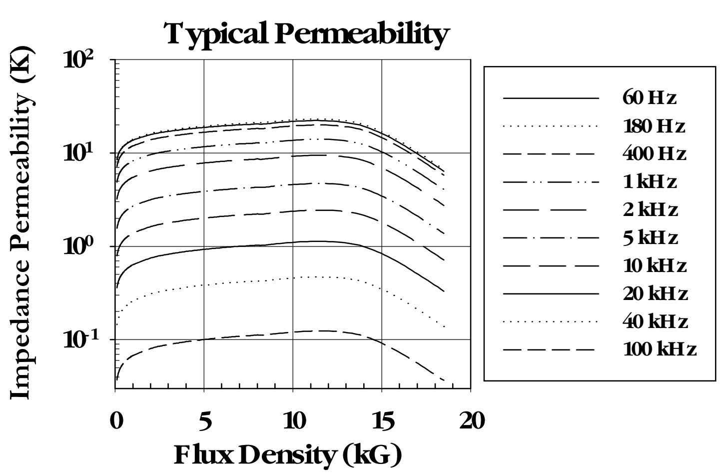
Sine voltages were used to take the data over a wide range of frequencies and flux densities. A curve fitting algorithm was used to process the data for plotting. Apparent power was derived from careful measurement of the magnetization current. Both the core loss and magnetization current were measured 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 "Z" Gage Silicon Steel



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.

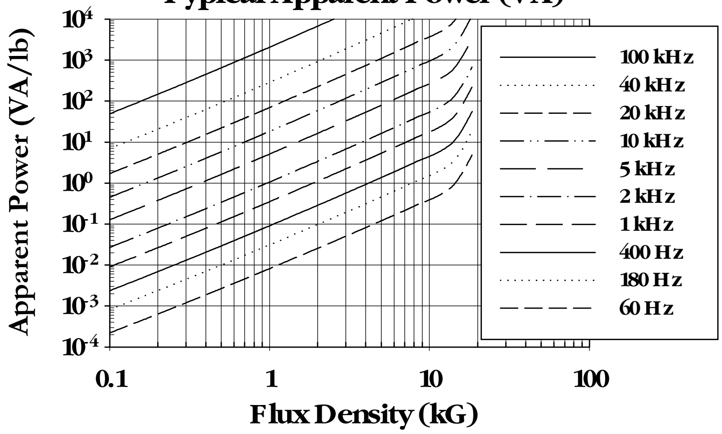




Sine voltages were used to take the data over a wide range of frequencies and flux densities. A curve fitting algorithm was used to process the data for plotting. Apparent power was derived from careful measurement of the magnetization current. Both the core loss and magnetization current were measured 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.

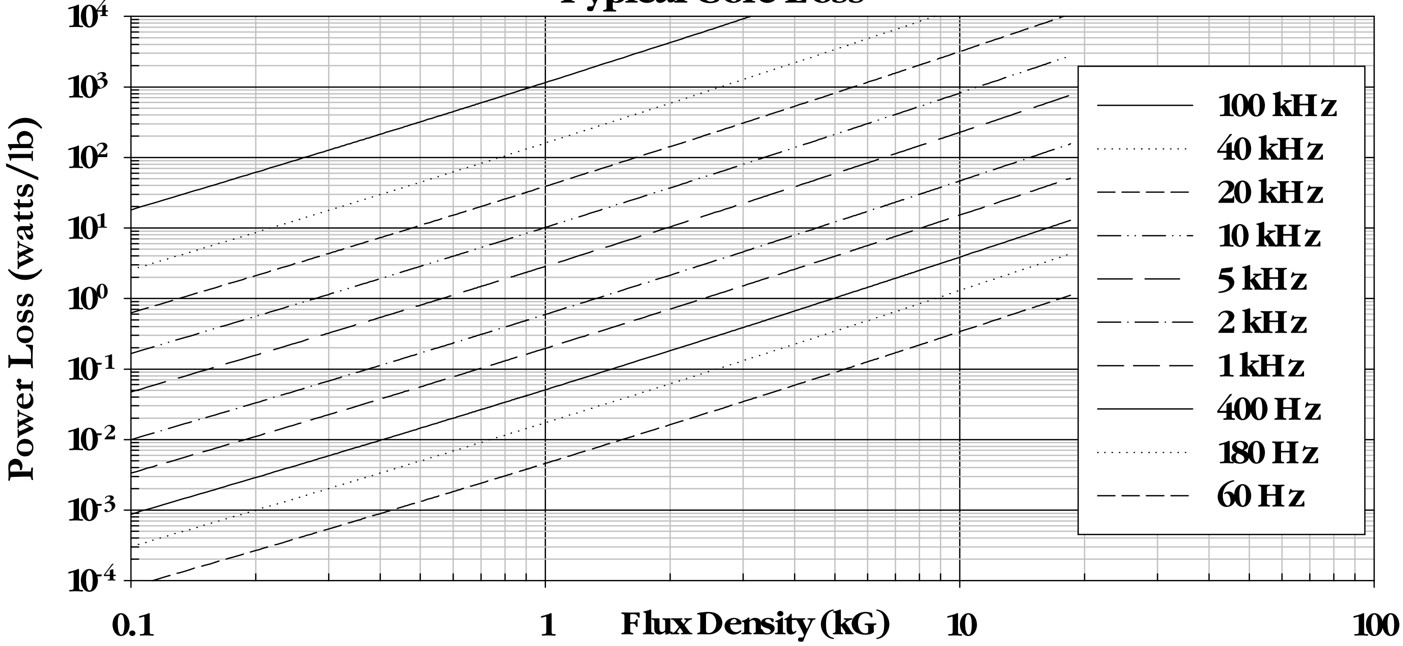
Graphs – Seven Thousandths of an Inch Standard Gage Silicon Steel

Typical Apparent Power (VA)

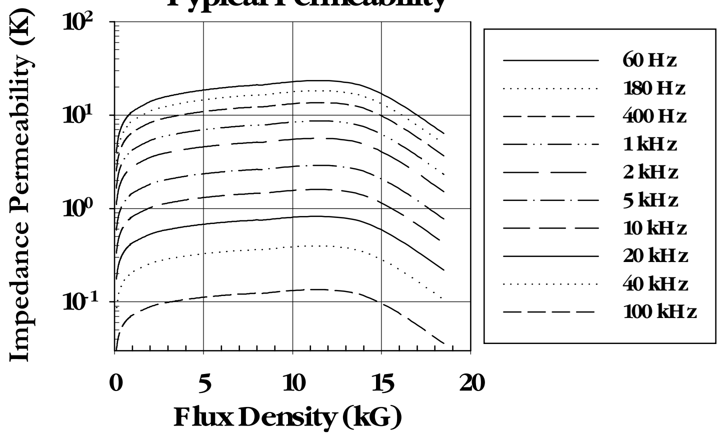


The graphs of apparent power, core loss and permeability apply to fully processed material, using cut "C" core configurations and the given tape gage. Standard processing and tolerances, were used for manufacturing. The equivalent graphs for "E" cores and cased, uncased toroids will differ.

Typical Core Loss

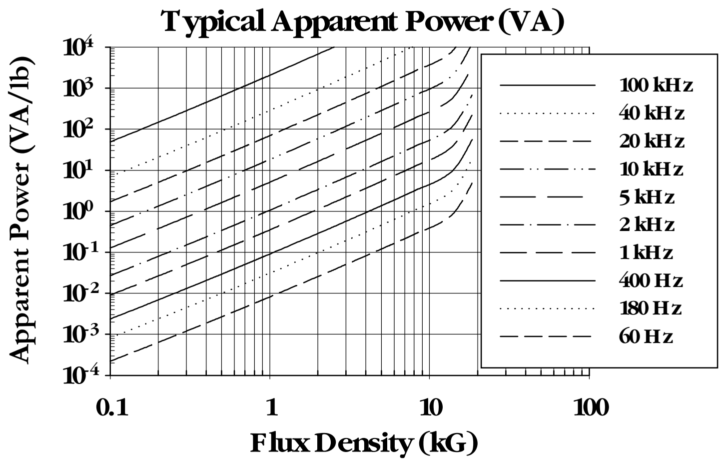


Typical Permeability

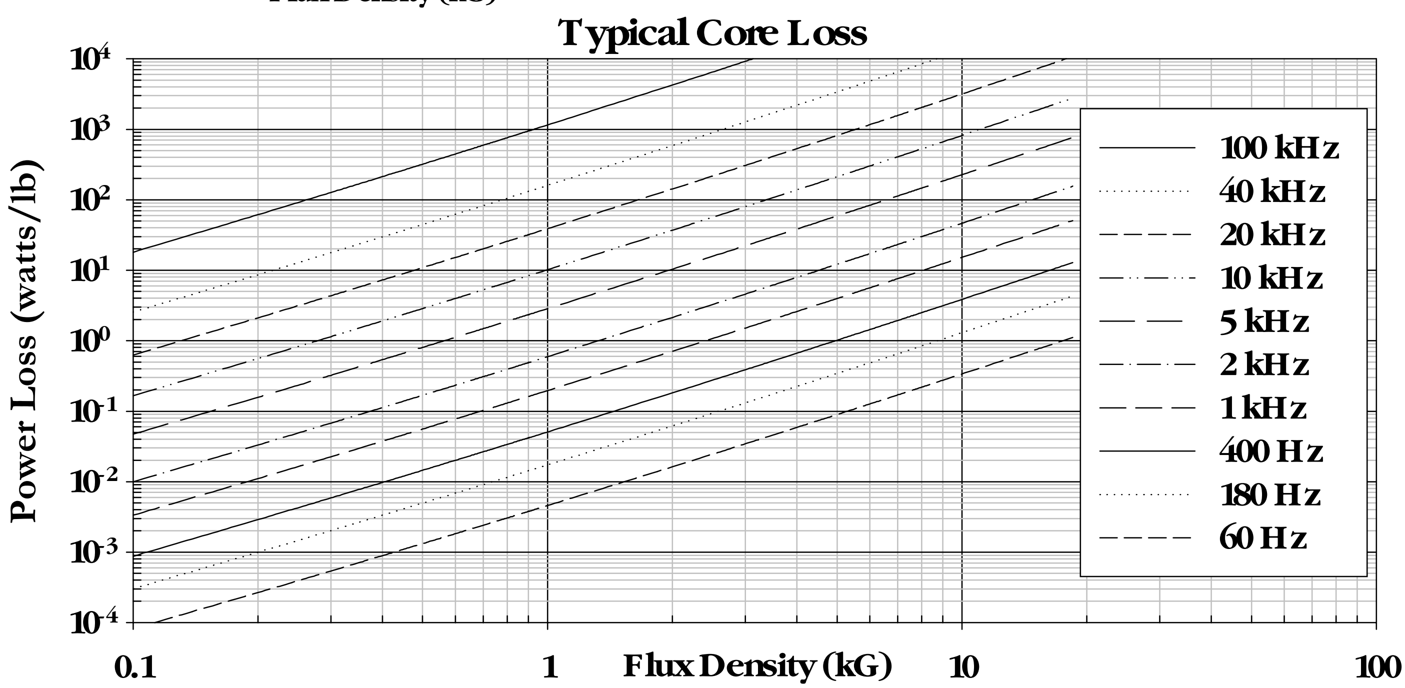


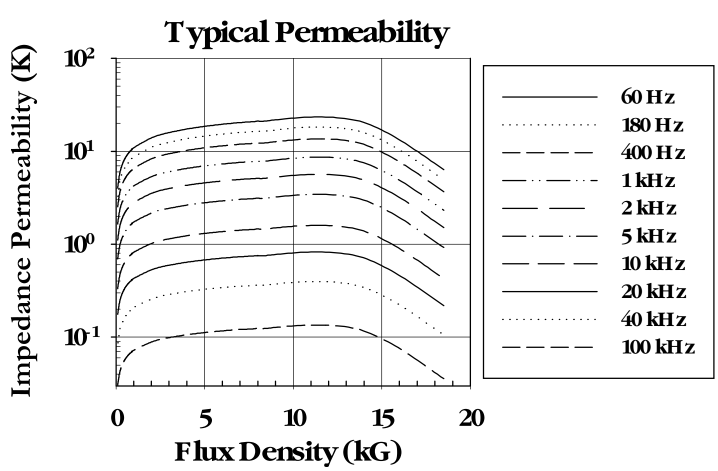
Sine voltages were used to take the data over a wide range of frequencies and flux densities. A curve fitting algorithm was used to process the data for plotting. Apparent power was derived from careful measurement of the magnetization current. Both the core loss and magnetization current were measured 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 – Seven Thousandths of an Inch "Z" Gage Silicon Steel



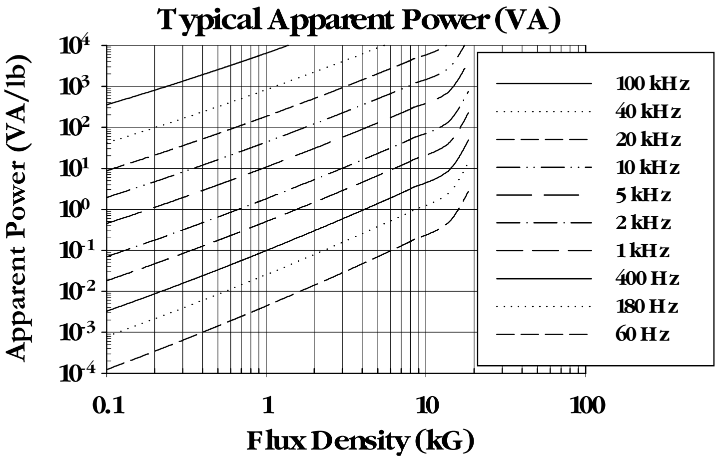
The graphs of apparent power, core loss and permeability apply to fully processed material, using cut "C" core configurations and the given tape gage. Standard processing and tolerances, were used for manufacturing. The equivalent graphs for "E" cores and cased, uncased toroids will differ.



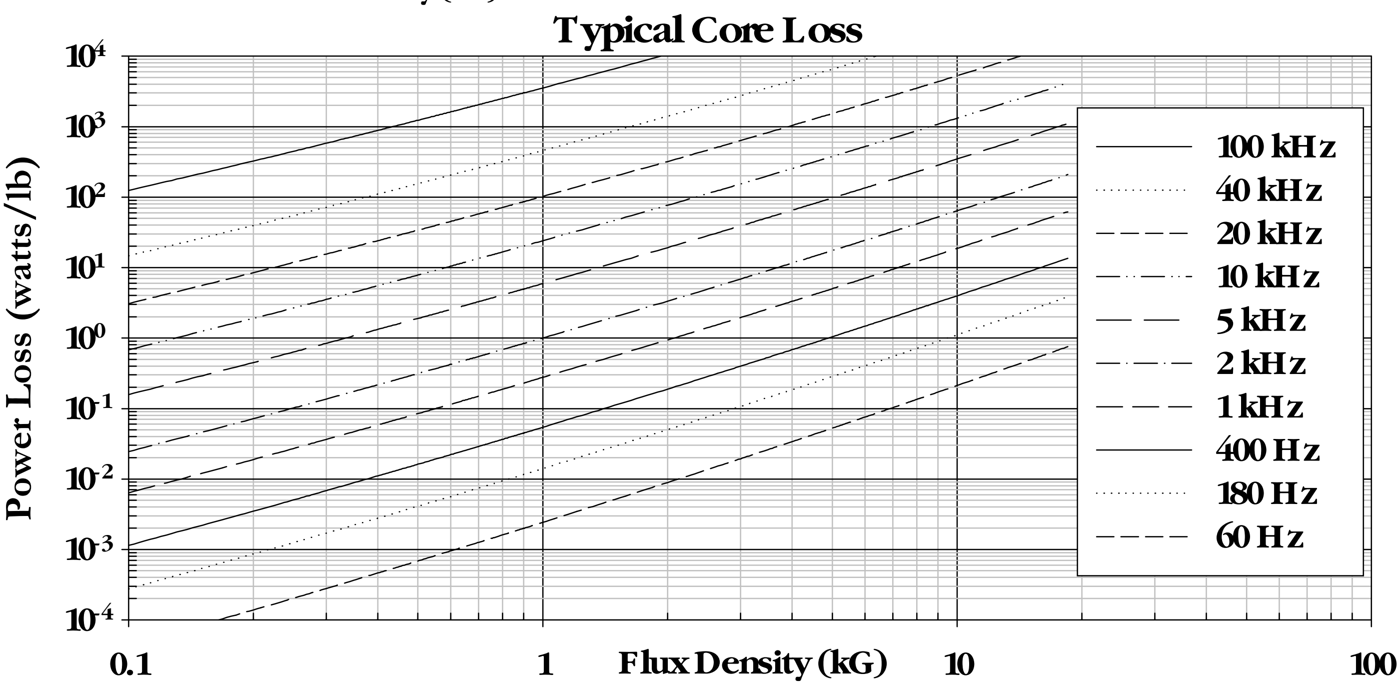


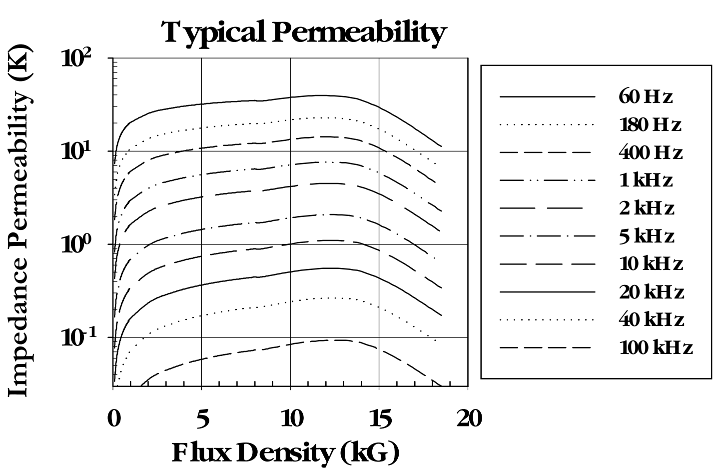
Sine voltages were used to take the data over a wide range of frequencies and flux densities. A curve fitting algorithm was used to process the data for plotting. Apparent power was derived from careful measurement of the magnetization current. Both the core loss and magnetization current were measured 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 – Nine Thousandths of an Inch "Z" Gage Silicon Steel



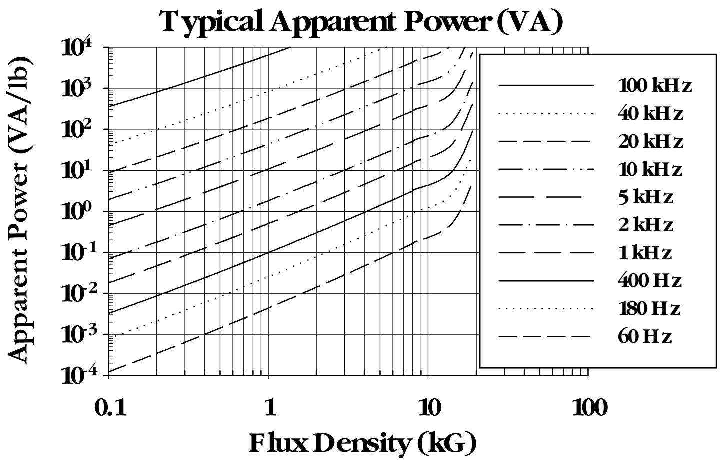
The graphs of apparent power, core loss and permeability apply to fully processed material, using cut "C" core configurations and the given tape gage. Standard processing and tolerances, were used for manufacturing. The equivalent graphs for "E" cores and cased, uncased toroids will differ.



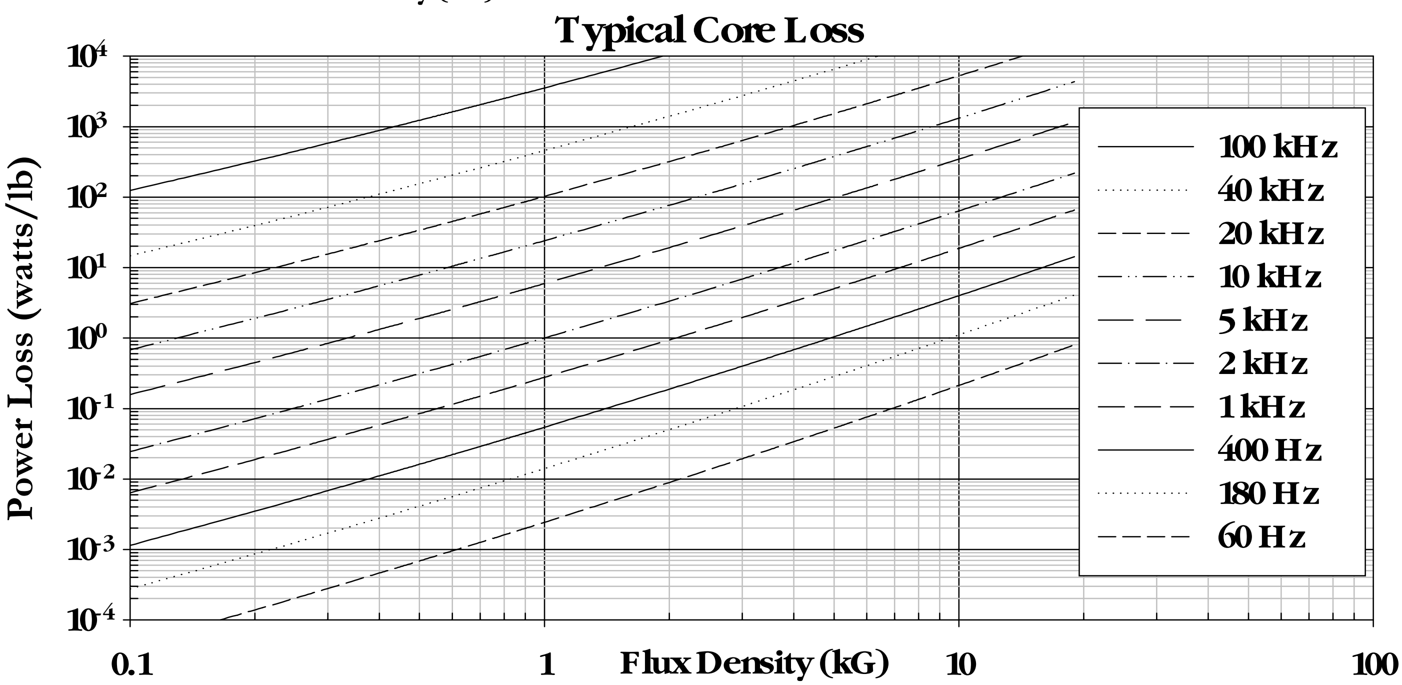


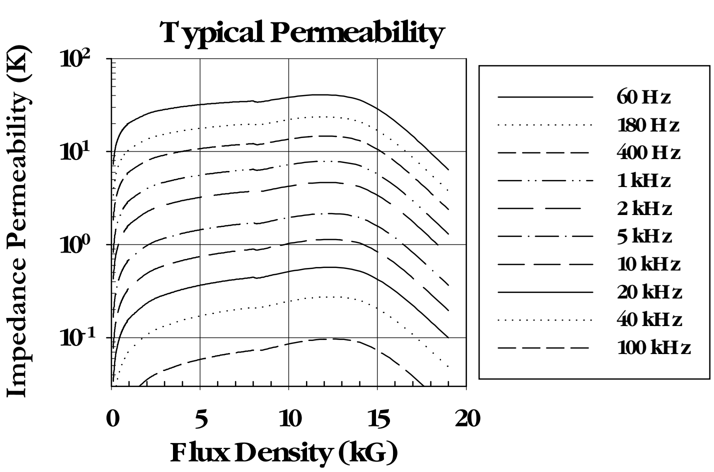
Sine voltages were used to take the data over a wide range of frequencies and flux densities. A curve fitting algorithm was used to process the data for plotting. Apparent power was derived from careful measurement of the magnetization current. Both the core loss and magnetization current were measured 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 – Eleven Thousandths of an Inch "Z" Gage Silicon Steel



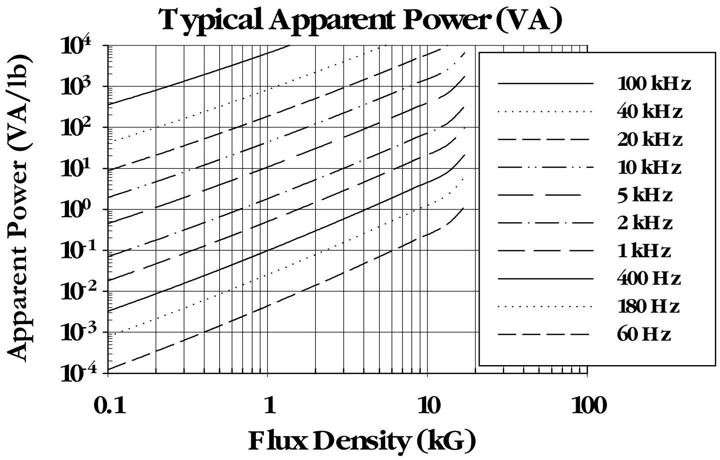
The graphs of apparent power, core loss and permeability apply to fully processed material, using cut "C" core configurations and the given tape gage. Standard processing and tolerances, were used for manufacturing. The equivalent graphs for "E" cores and cased, uncased toroids will differ.



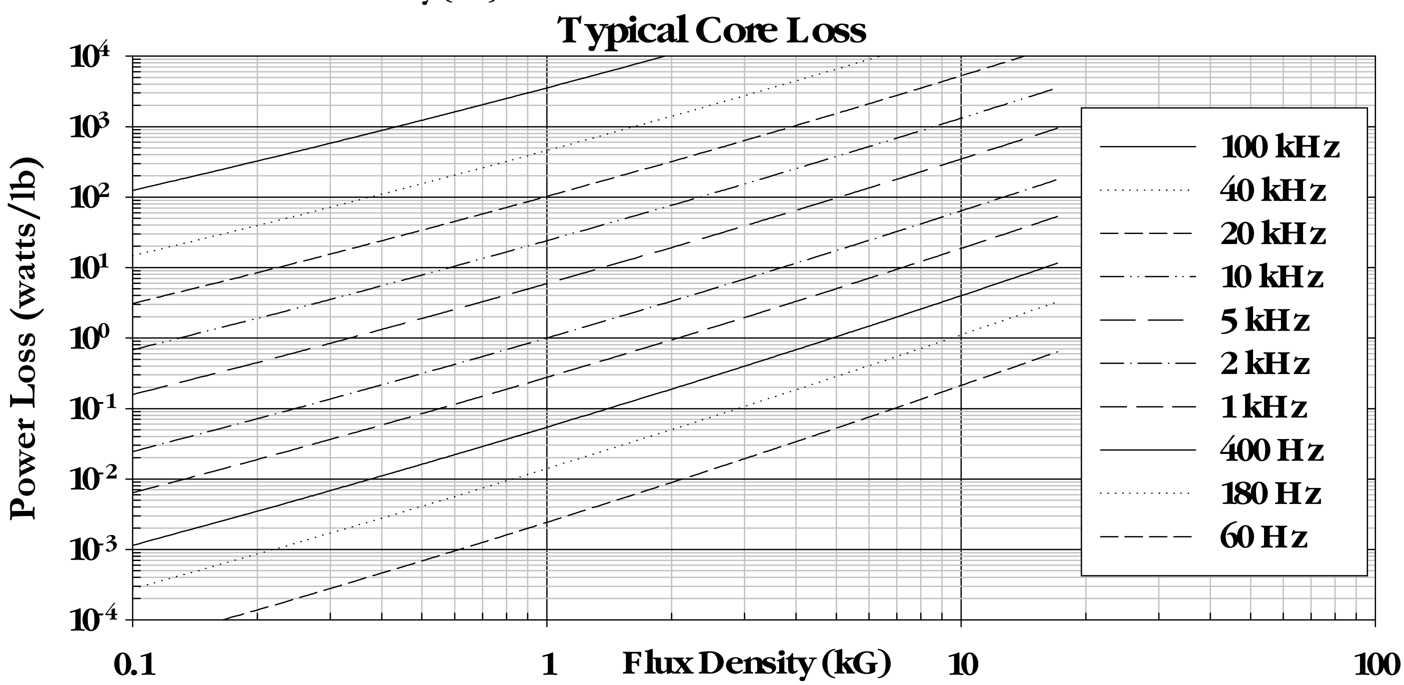


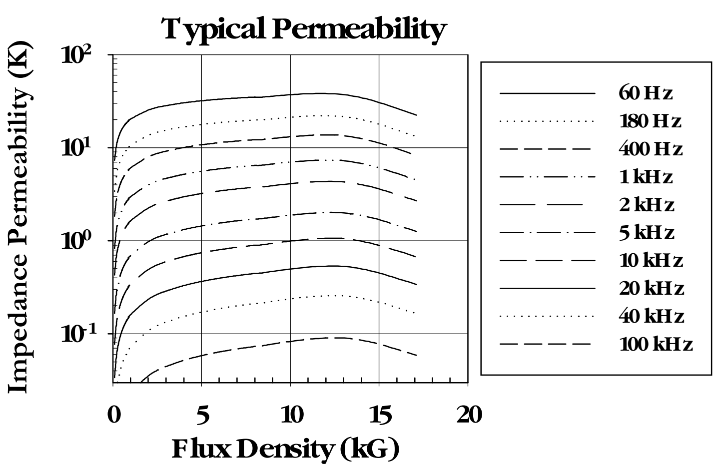
Sine voltages were used to take the data over a wide range of frequencies and flux densities. A curve fitting algorithm was used to process the data for plotting. Apparent power was derived from careful measurement of the magnetization current. Both the core loss and magnetization current were measured 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 – Twelve Thousandths of an Inch Gage Silicon Steel



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.

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Limited Warranty and Exclusive Remedy
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Powder Core Division 300 North West Street Marengo, Illinois 60152 Toll Free: (800) 545-4578 Phone: (815) 568-2000 FAX: (815) 568-2238	MPP, SUPER-MSS™ and HI-FLUX™, Soft magnetic powder cores
Rolled Products Division 300 North West Street Marengo, Illinois 60152 Toll Free: (800) 545-4578 Phone: (815) 568-2471 FAX: (815) 578-2477	Precision Rolled Alloy Strip and Foil
Ogallala Electronics Division P.O. Box 59 Ogallala, Nebraska 69153 Toll Free: (800) 426-5852 Phone: (308) 284-4093 FAX: (308) 284-4740	Alnico, Hard Ferrite and Rare Earth Magnet Materials; Electromagnets
Plastiform Division 1000 East Eisenhower Avenue Norfolk, Nebraska 68702-1567 Toll Free: (800) 328-1373 Phone: (402) 371-6100 FAX: (402) 371-8495	Flexible, Injection and Compression Bonded Ferrite and Rare Earth Magnets

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Swift Levick Magnets, Ltd. Barlborough Links, Barlborough Derbyshire S43 4TZ UK USA Toll Free: (800) 545-4578 FAX: (805) 568-2365 EUROPE Phone: (+44) 1246-570500 FAX: (+44) 1246-573000	Rare Earth Magnets Pressed to Shape and Sliced; Magnetic Assemblies and Cast Alnico Magnets
Magnetic Technologies Corp. 770 Linden Avenue Rochester, New York 14625-2764 Toll Free: (866) 405-0400 Phone: (716) 385-9010 FAX: (716) 385-5625	Precision Magnetic Components and Assemblies
Magnetic Technologies Europe Ltd. 101 Laker Road Rochester Airport Industrial Estate Rochester, Kent ME 13QX UK Phone: (+44) 1634-864500 FAX: (+44) 1634-867800 E-Mail: mpage@mteurope.com	Precision Magnetic Components and Assemblies
National-Arnold Magnetics 17030 Muskrat Avenue Adelanto, California 92301 Toll Free: (800) 877-7641 Phone: (760) 246-3020 FAX: (760) 246-3870	Tape Wound C-Cores E-Cores, Toroidal Cores and Special Configurations
Jade Magnetics Ltd. 2nd Industrial Zone, Yu Lu Gong Ming Town, Bao-An County Shenzhen City, China	Precision Magnetic Components and Assemblies
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