SHORTCUTS IN SELECTION OF TAPE WOUND CORES FOR MAGNETIC CIRCUITRY

MAGNETICS®
A Division of Spang and Company

SHORTCUTS IN SELECTION OF TOROIDAL TAPE WOUND CORES

FOR MAGNETIC CIRCUITRY

Magnetics Inc. has developed three sets of curves helpful to design engineers working in the areas of INVERTERS, MAGNETIC AMPLIFIERS, and TRANSFORMERS. There is a characteristic curve for each of three materials...Magnesil, Orthonol, and Permalloy 80...in each device area. The curves were developed by solving Faraday's Law and using specific basic assumptions in solving this equation.

Magnetics Inc. core tables (Bulletin TWC-PN and TWC-300) contain a column headed "$W_a\ A_c$". This column lists the value of the relative power handling capacity of each core. By equating this value against Faraday's Law, the following relationships have been obtained:

I Solving for Saturating Type Inverter Designs

$$\text{Faraday's Law} = E = 4\ Bm\ Ac\ N\ f \times 10^{-8}$$

Solving for $NAc = \dfrac{E}{4\ Bm\ f \times 10^{-8}}$

However, the Window Utilization Factor

$$K = \frac{NAw}{Wa} = .1$$

$$NAw = .1Wa$$

Multiply both sides by Ac and transpose

$$NAc = \frac{.1WaAc}{Aw}$$

Combining and solving for WaAc

$$.1WaAc = \frac{E}{4 \times Bm \times f \times 10^{-8}}$$

$$WaAc = \frac{E\ Aw}{.4 \times Bm \times f \times 10^{-8}}$$

$$WaAc = \frac{2.5 \times E \times Aw}{Bm \times f \times 10^{-8}}$$

Assume 85% efficiency and 750 $\dfrac{\text{cir mils}}{\text{amp}}$ current capacity of wire.

However the primary winding has a 50% duty factor giving a current capacity of 375 $\frac{\text{cir mils}}{\text{amp}}$.

Therefore the formula becomes:

$$WaAc = \frac{1.1 \times \text{Power Output}}{Bm \times f \times 10^{-11}}$$

Since the inverter is a saturating device,

Bm = 17000	(Magnesil)
Bm = 14500	(Orthonol)
Bm = 7000	(Permalloy 80)

Formulas used for inverter curves are:

$$WaAc = \frac{6.5 \times \text{Power Output} \times 10^{6}}{\text{frequency}} \quad \text{(Magnesil)}$$

$$WaAc = \frac{7.6 \times \text{Power Output} \times 10^{6}}{\text{frequency}} \quad \text{(Orthonol)}$$

$$WaAc = \frac{14.3 \times \text{Power Output} \times 10^{6}}{\text{frequency}} \quad \text{(Permalloy 80)}$$

II Solving for Typical Sine Wave Magnetic Amplifier Designs

$$\text{Faraday Law} = 4.44\ BmAcN\ f \times 10^{-8}$$

$$K = .3 \text{ and } WaAc = \frac{.75 \times E \times Aw}{Bm \times f \times 10^{-8}}$$

Assume 94% efficiency and 750 cir mils/amp.

Therefore formula becomes:

$$WaAc = \frac{.60 \times \text{Power Output}}{Bm \times f \times 10^{-11}}$$

Since magnetic amplifiers are saturating devices use Bm noted for Inverters.

Formulas used for Magnetic Amplifier curves are:

$$WaAc = \frac{3.5 \times \text{Power Output} \times 10^{6}}{\text{frequency}} \quad \text{(Magnesil)}$$

$$WaAc = \frac{4.15 \times \text{Power Output} \times 10^6}{\text{frequency}} \quad \text{(Orthonol)}$$

$$WaAc = \frac{9.35 \times \text{Power Output} \times 10^6}{\text{frequency}} \quad \text{(Permalloy 80)}$$

III Solving for Typical Transformer Design Where Flux Swing Doesn't Exceed .5 Bm.

$$\text{Faraday's Law} = E = 4.44 \; B \; Ac \; N \; f \times 10^{-8}$$

$$K = .2 \text{ and } WaAc = \frac{.89 \times E \times Aw}{B \times f \times 10^{-8}}$$

Assume 95% efficiency and 750 cir mils/amp.

Therefore formula becomes:

$$WaAc = \frac{.70 \times \text{Power Output}}{B \times f \times 10^{-11}}$$

Since B is only 1/2 of the Bm value for each core material,

B = 8500	(Magnesil)
B = 7250	(Orthonol)
B = 3500	(Permalloy 80)

Formulas used for Transformer curves are:

$$WaAc = \frac{8.25 \times \text{Power Output} \times 10^6}{\text{frequency}} \quad \text{(Magnesil)}$$

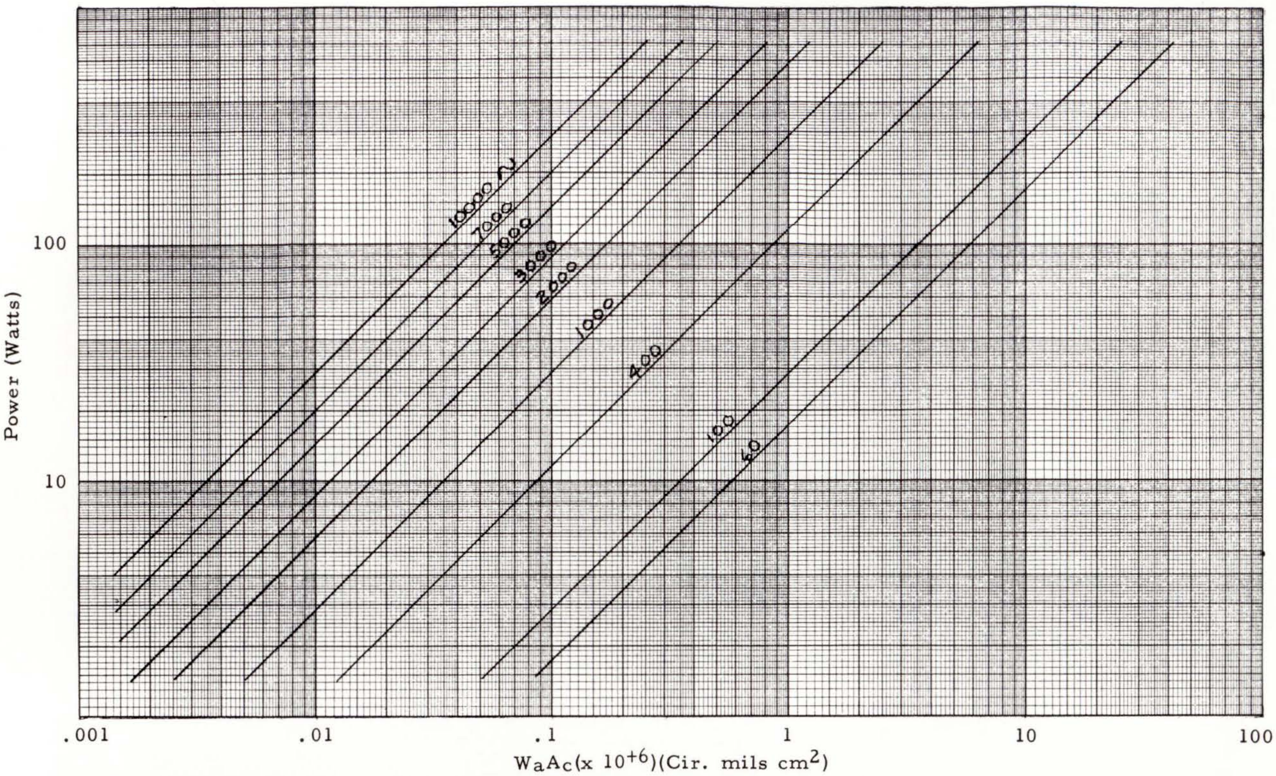
$$WaAc = \frac{9.7 \times \text{Power Output} \times 10^6}{\text{frequency}} \quad \text{(Orthonol)}$$

$$WaAc = \frac{20 \times \text{Power Output} \times 10^6}{\text{frequency}} \quad \text{(Permalloy 80)}$$

To use the curves, the output power and operating frequency must be known. Select the proper frequency curve from the family of curves chosen. Read across from the power output to the intercept point on the frequency curve. Read down to the proper WaAc value. Refer to TWC-300 or TWC-PN for the selection of the proper core by its WaAc.

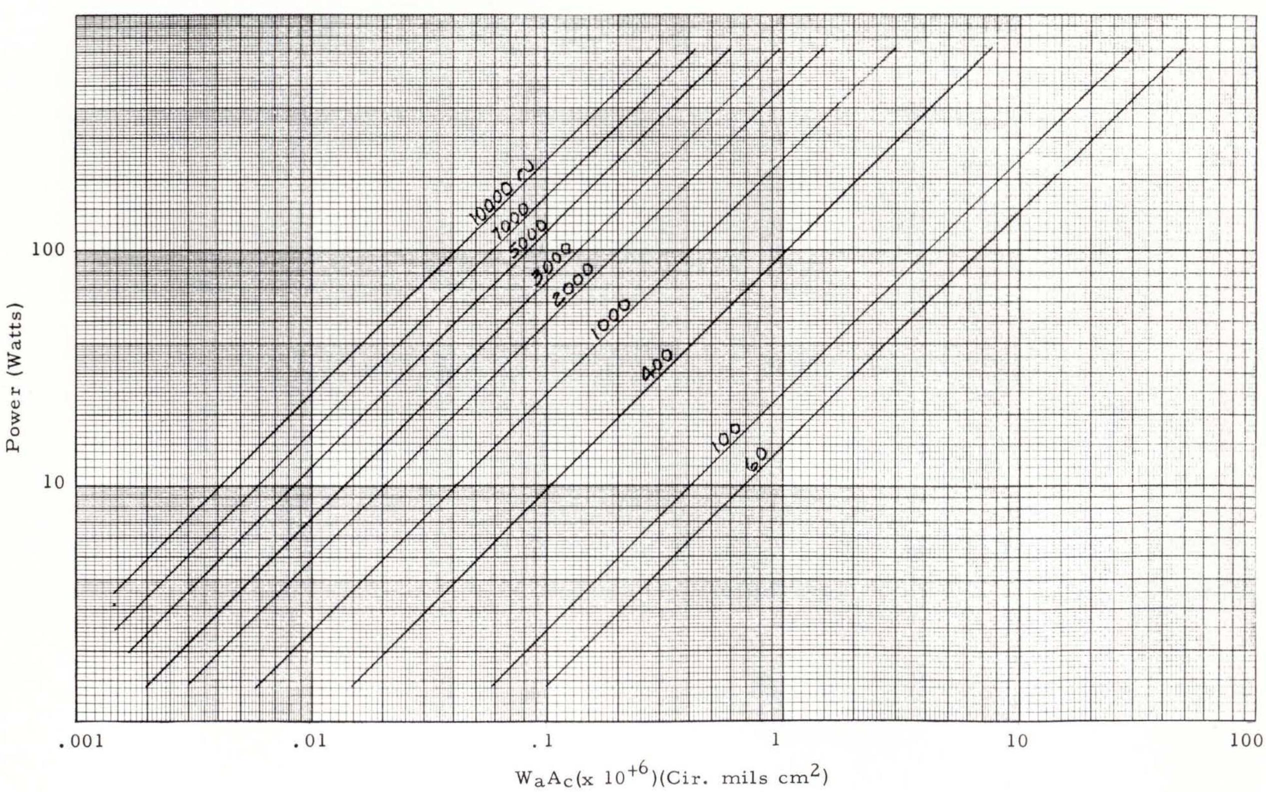
Relationship of Core W_aA_c to Output Power Capability

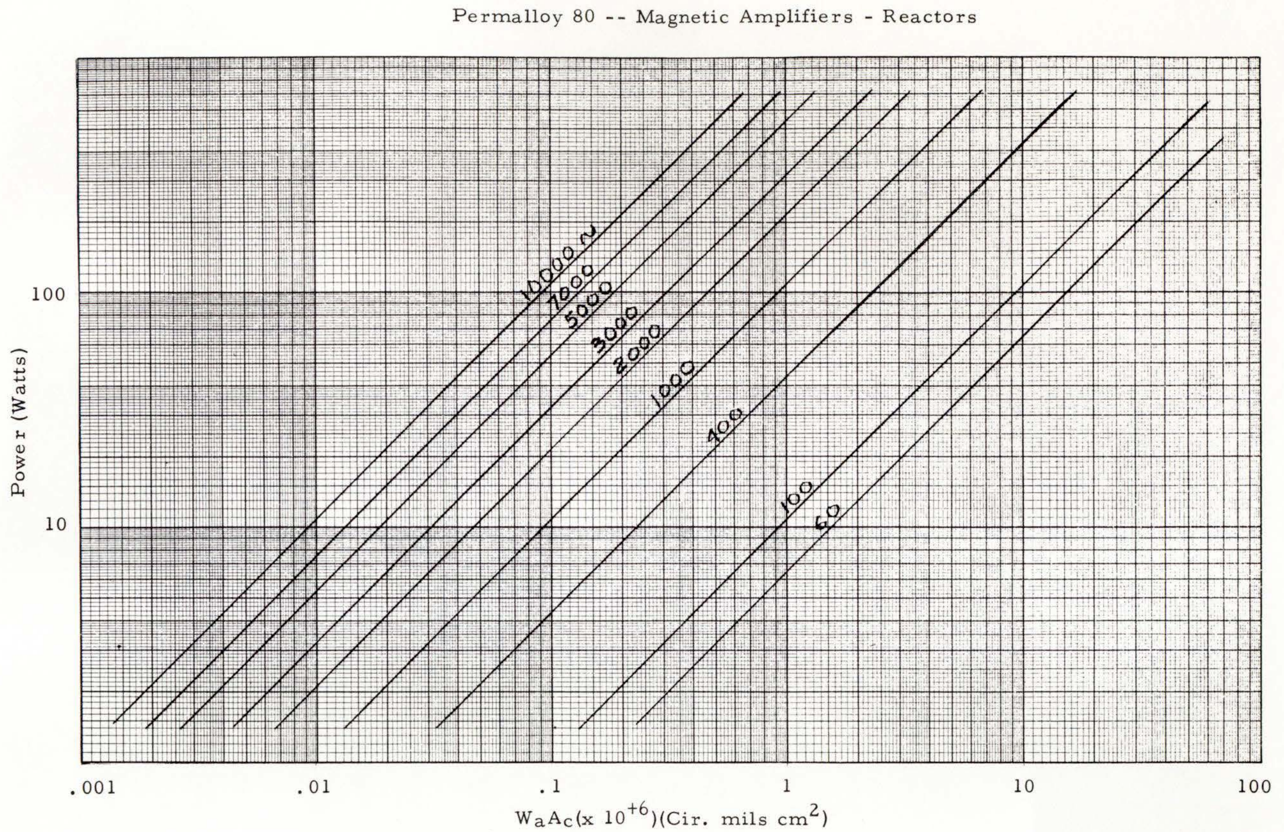
Magnesil -- Magnetic Amplifiers - Reactors



NOTE: These graphs can be used to select a tape wound core from core tables listing the W_aA_c in terms of circular mils centimeters^2. To use, determine the material to be used, the operating frequency, and the output power. Locate the proper frequency curve and its intercept point at the output power required. Read down from this intercept point to obtain the W_aA_c from the graph.

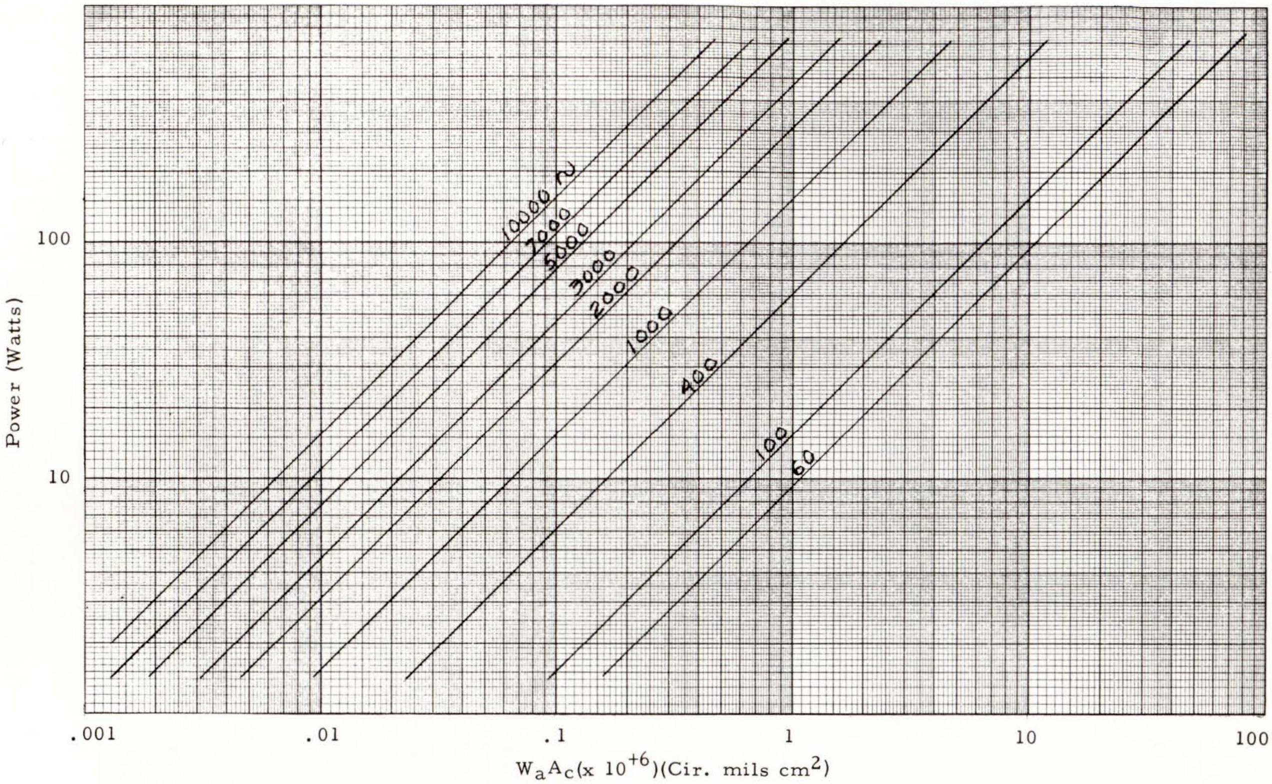
Orthonol -- Magnetic Amplifiers - Reactors



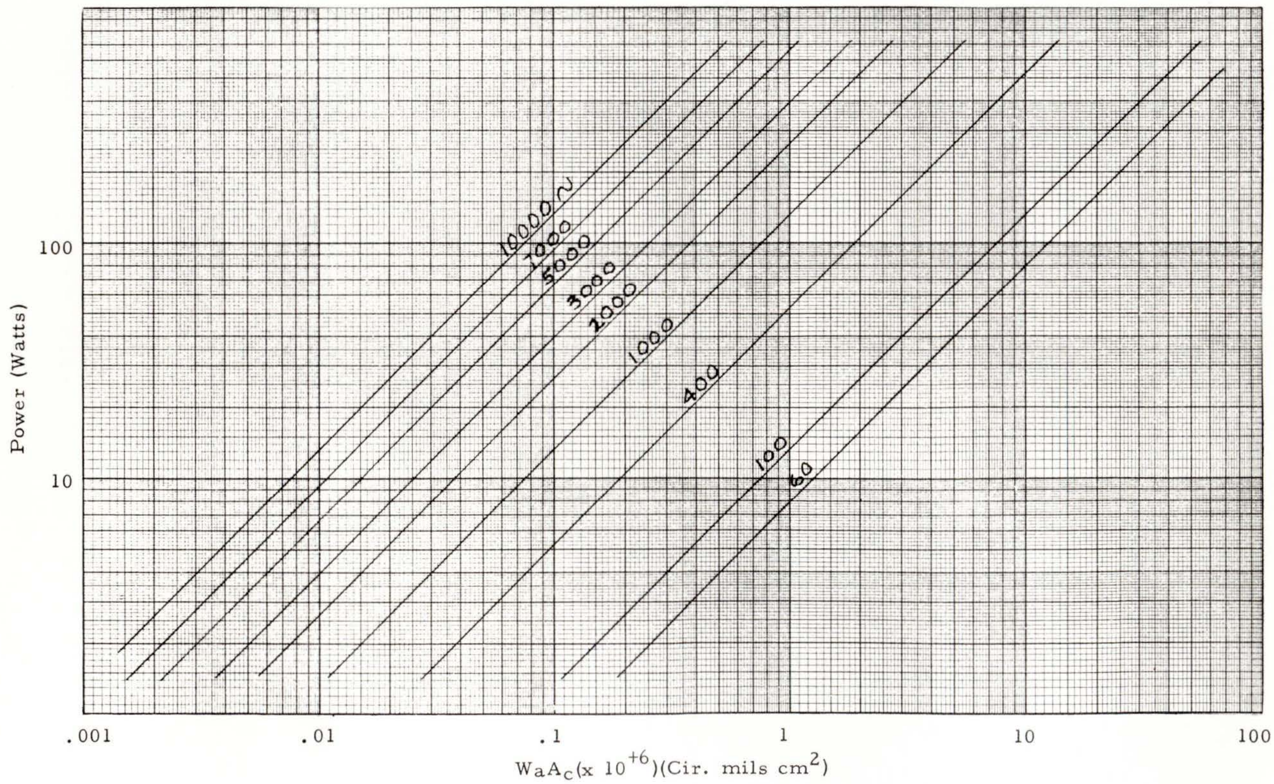

Permalloy 80 -- Magnetic Amplifiers - Reactors
Power (Watts)
100
10
.001
.01
.1
1
10
100
WaAc(x 10+6)(Cir. mils cm2)
10000 ~
7000
5000
3000
2000
1000
400
100
60

NOTES

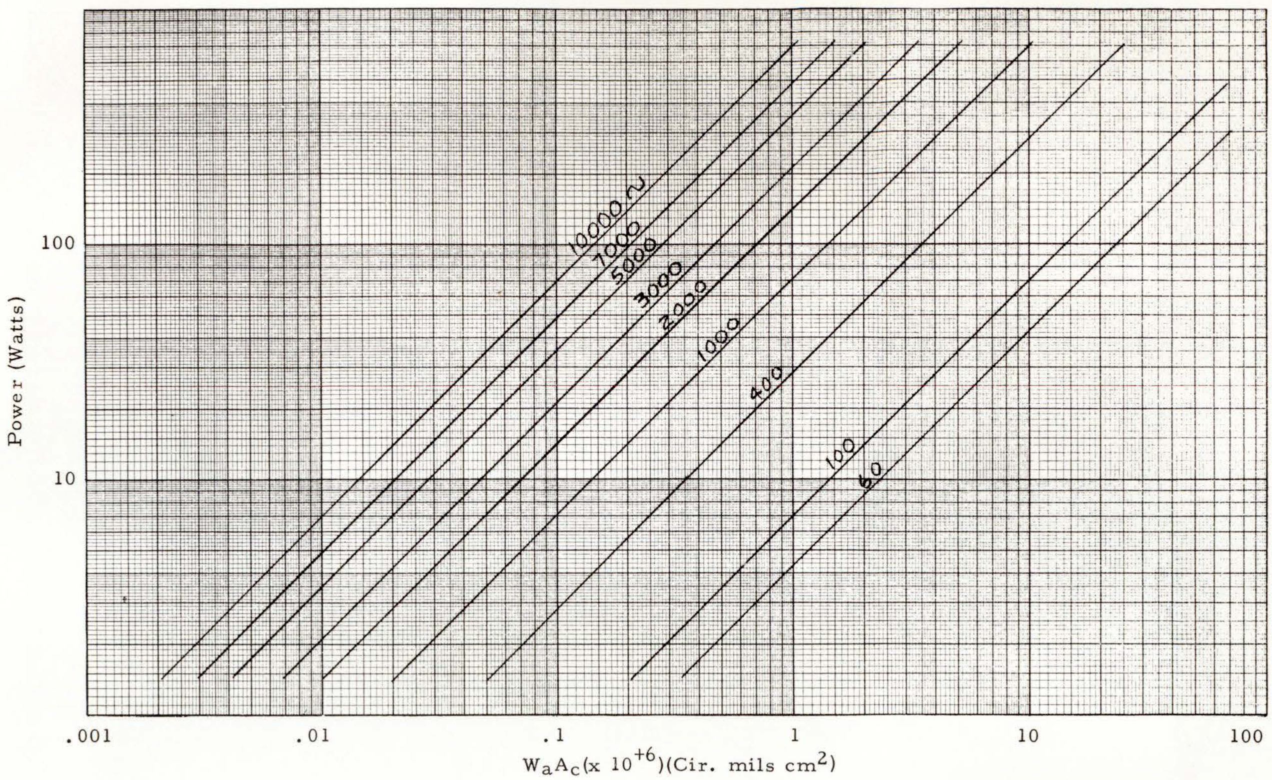
Magnesil -- Inverters



Orthonol -- Inverters



Permalloy 80 -- Inverters



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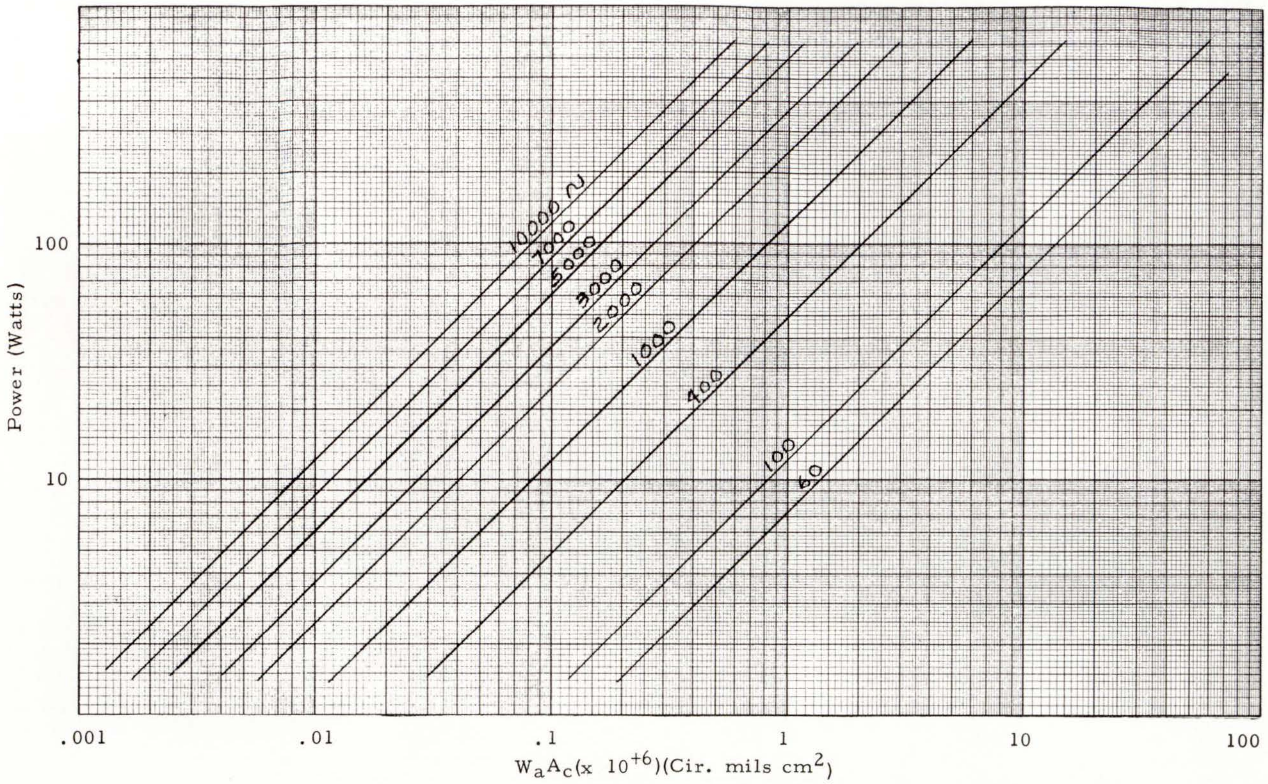
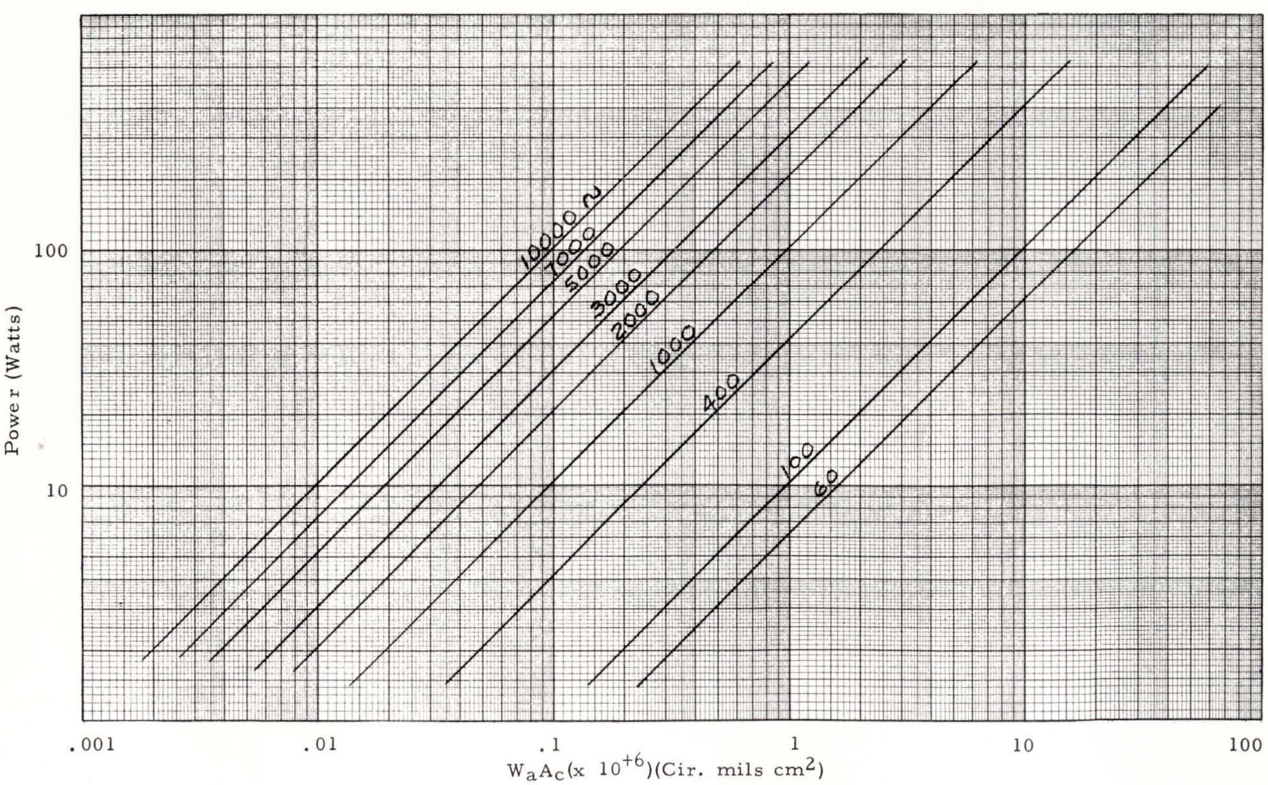
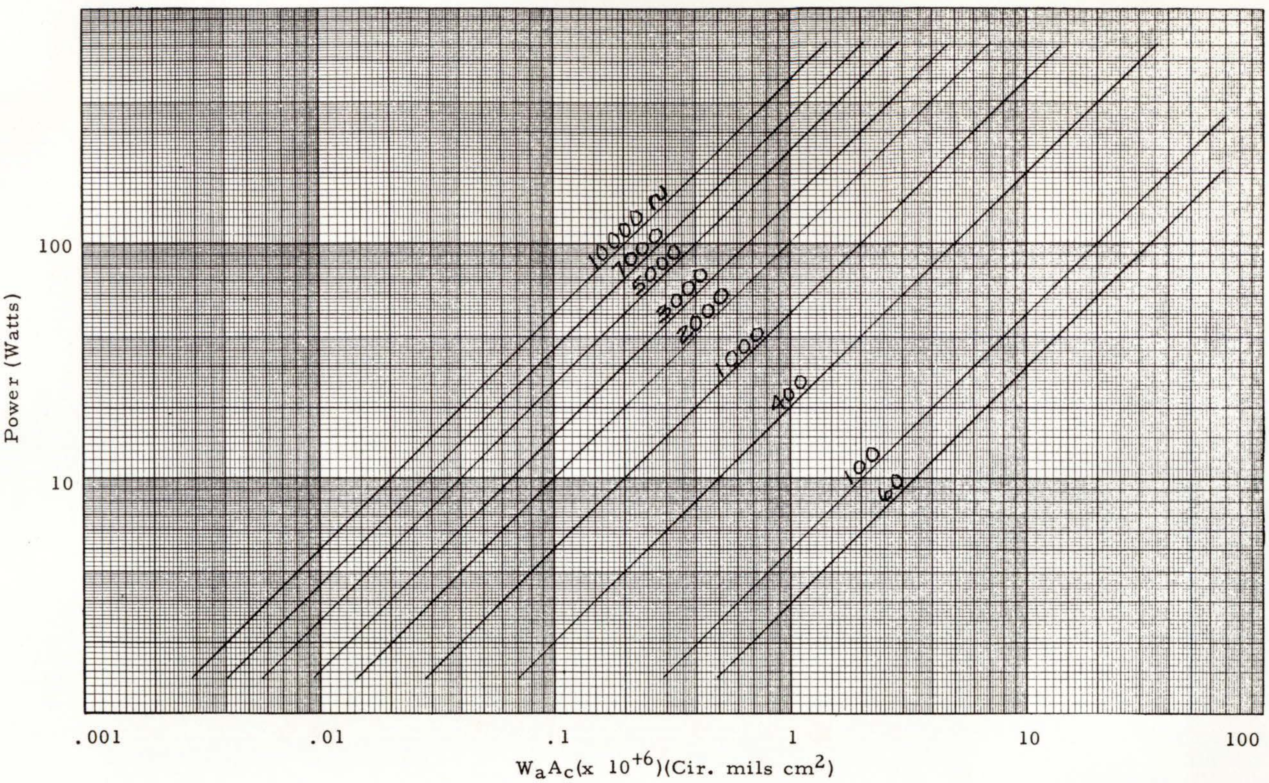
Magnesil -- Transformers



Orthonol -- Transformers



Permalloy 80 -- Transformers



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Form 113 3P