ZETTLER MAGNETICS

Standard Transformer Applications

General Transformer Glossary

- Input Voltage/Current
- Output Voltage/Current
- Frequency
- Topology/Duty Cycle
- OCL/Leakage Inductance.
- Temperature rise
- Ambient Temperature. Ta70B

Safety Related Info

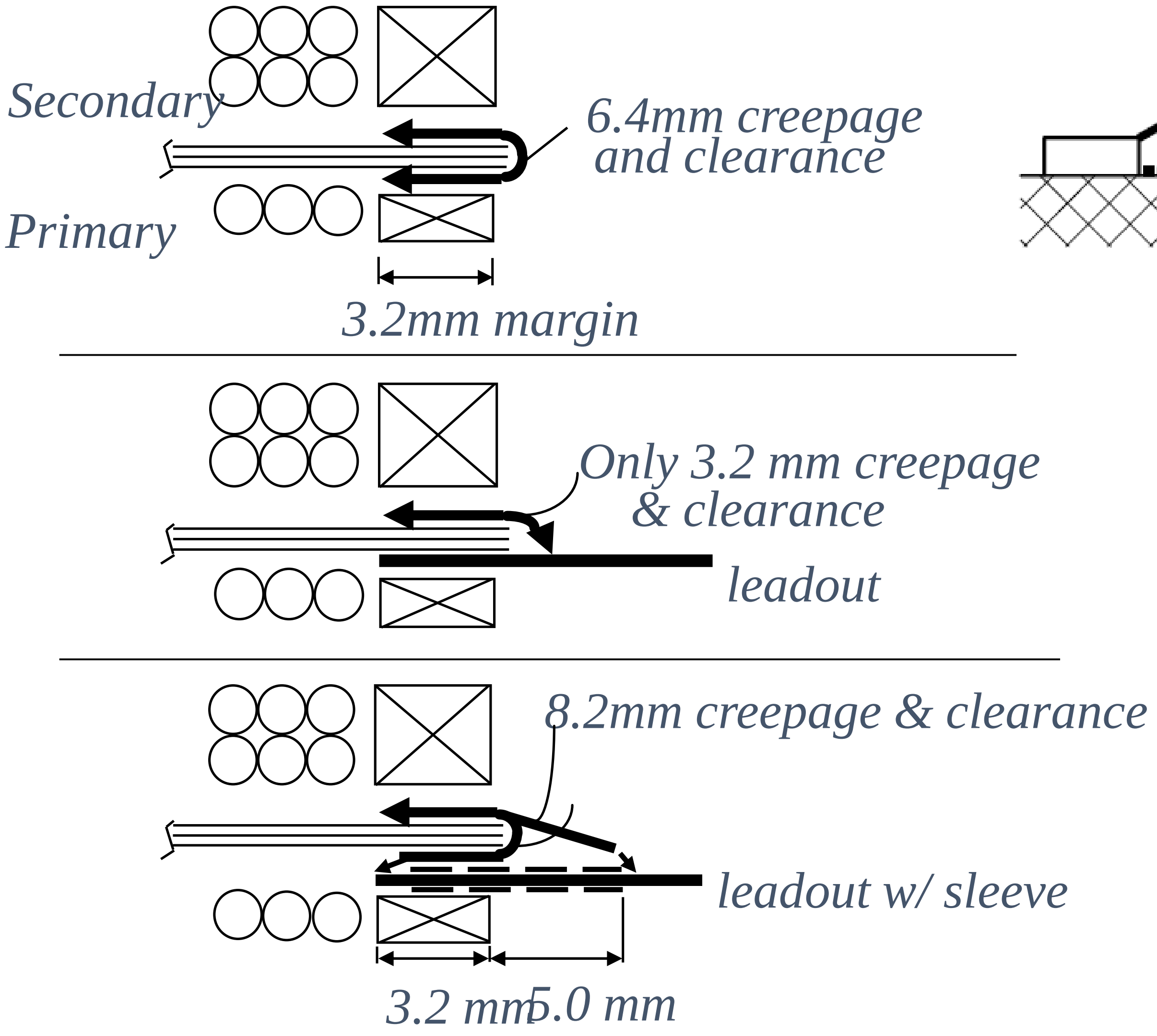
- Output Voltage Limit
  - EN60950… SELV for 42.4Vpk or 60VDC
  - UL5085… Class II 30Vmax

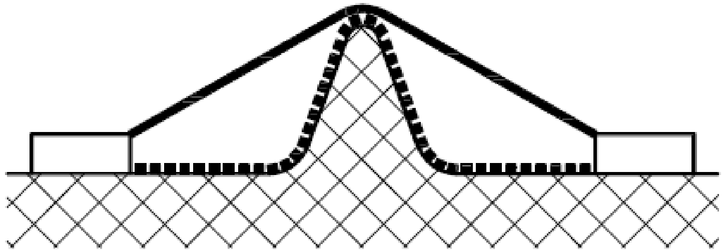
    Class III 30-100V or 150V
  - EN61558-2-6… 50VRMS/120V ripple free DC
- Transformer Class
  - Class I/II/III in EN60950/EN61558 → Protection
  - Class I/II/III in UL5085 → Voltage

Safety related info

- Insulation Grade
  - Class A 105C → 100C max
  - Class E 120C → 115C max
  - Class B 130C → 120C max
  - Class F 155C → 140C max
  - Class H 180C → 165C max
- TEX-E or Twisted Wire
- MW82 wire and etc.

Creepage and Clearance





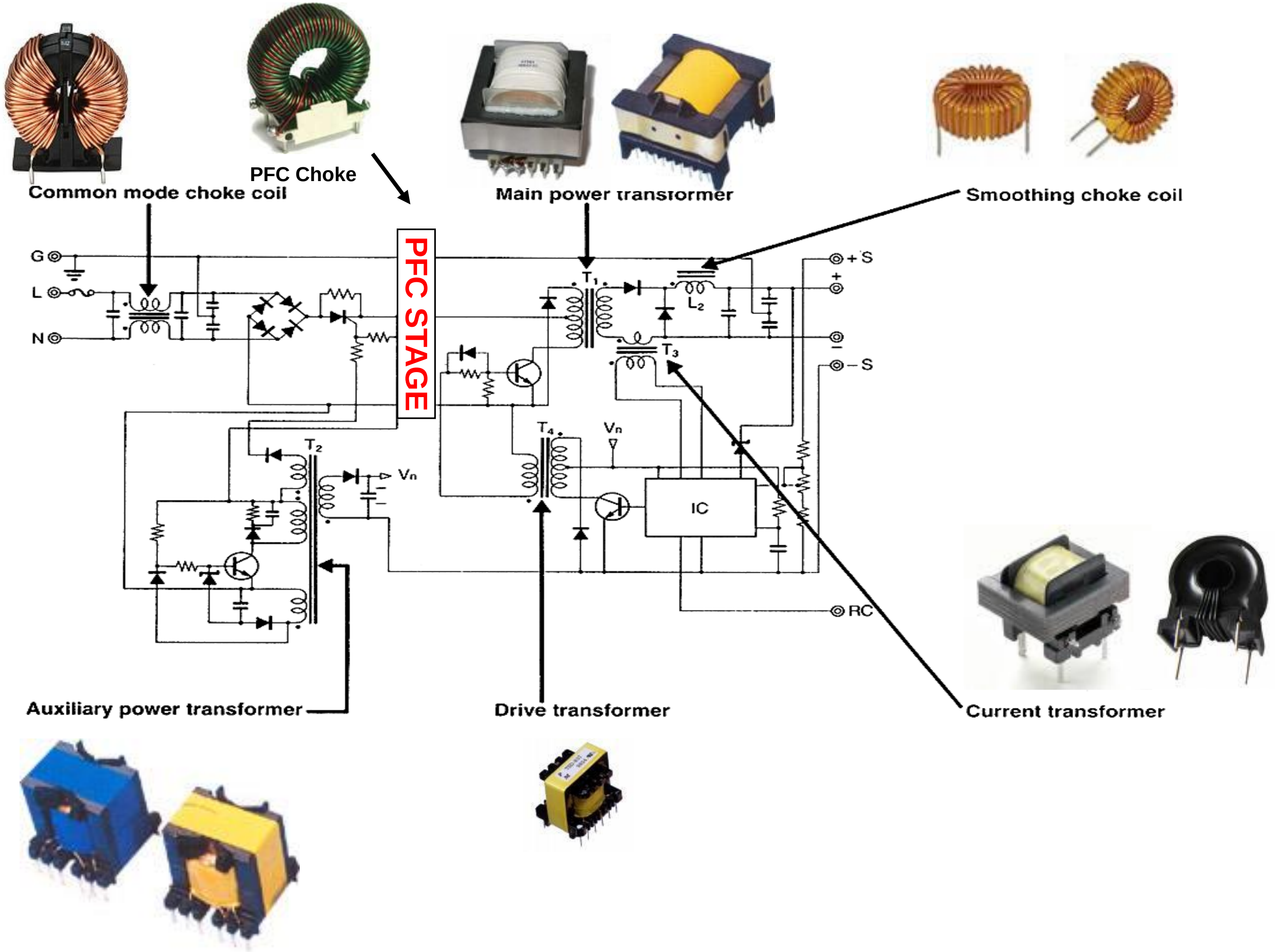
Laminated Transformer Types

- Print PCB Transformer
- UI Core low profile pin type transformer
- Current Sensing Transformer
- Lead type transformer
- Power everywhere
- New edge why still use the laminated transformer?

Laminated transformer materials

- Lamination material
  Lamination: Z11, H12, H14, H18, H23, H50
- Standard Sizes
  EI28/30/35/41/48/57/66
- Insulation materials
  Bobbin (PET, NYLON), TAPE (Polyester), Varnish (C1105, AC43)

Standard Ferrite Magnetics SMPS Application



Choke Types

- Choke Types by Application
  - Common Mode Choke
  - Differential Mode Choke
  - Energy Stock Choke (PFC, BUCK)
- Choke Types by Material
  - Ferrite Core
  - Powdered Core (iron, MPP, Sendust)
  - Laminated Core (EI, taped, Amorphous)

Ferrite XFMR Types

- Ferrite XFMR Types by Application
  - Flyback XFMR (with Gap)
  - Forward XFMR
  - PushPull
  - Full bridge
- Ferrite XFMR Types by Shapes
  - EE 13, EE 16… …
  - EFD20,
  - ER28, ETD34…
  - Planar E40

Ferrites (continued)

- Ferrite XFMR Material
  - TDK PC-40
  - Nicera NC-2H
  - China Material TDG, DMEGC ……
- Ferrite XFMR Bobbins
  - EE 13, EE 16… …
  - EFD20,
  - ER28, ETD34…
  - Phenolic PM9820 T375J

Core Suppliers

NO.,	Supplier	Quality (50)	Cost (15)	Delivery time (15)	Service (20)	Total	Grade
1	TDK	48	11	10	17	86	A
2	TDG	47	12	12	18	89	A
3	ACME	47	14	12	19	92	A
4	DMEGC	47	14	14	18	93	A
6	NEC	45	11	12	16	84	B
5	MAGSOURCE	43	14	12	15	84	B
7	GUANDA	40	15	10	14	79	C

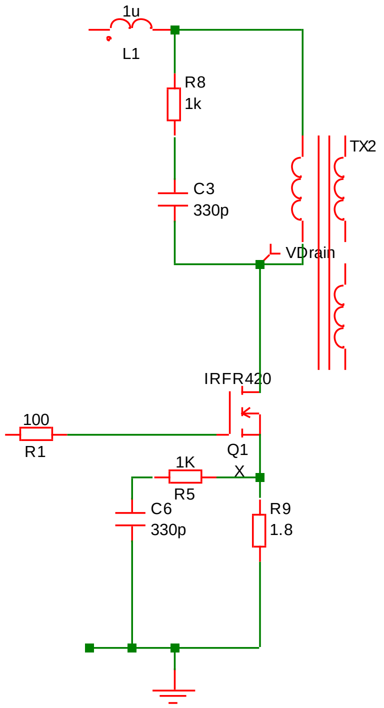
Core Suppliers

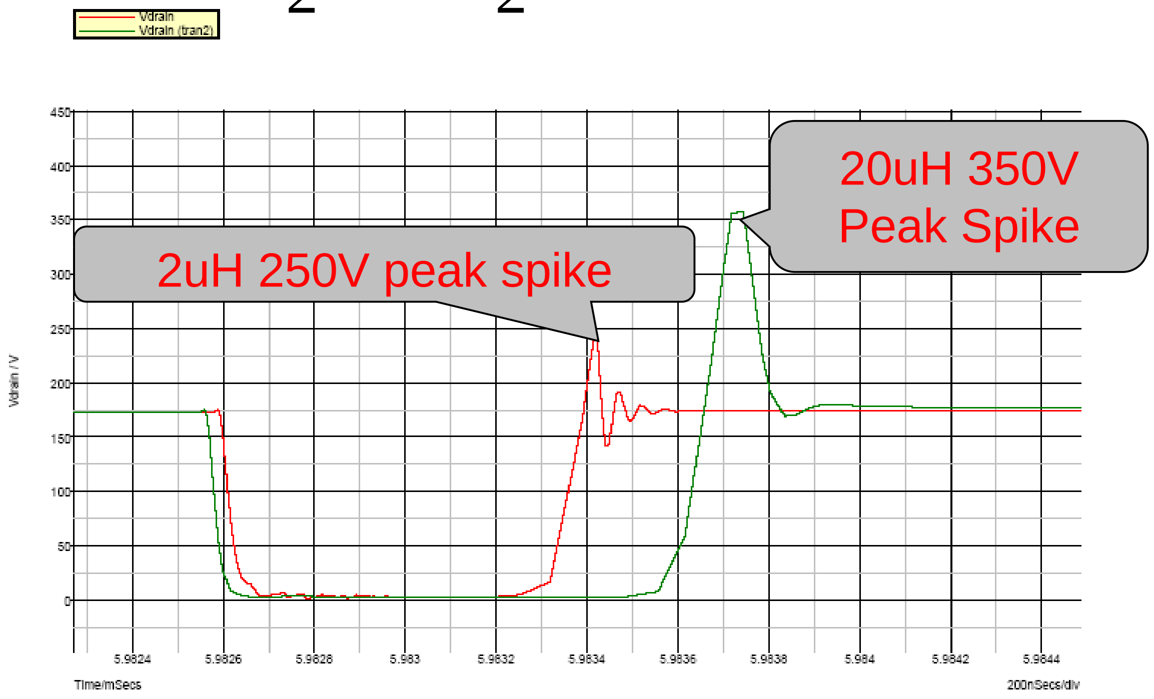
Item	Symbol	Conditions		Unit	Nicera NC-2H	TDK PC47	TDK PC40	TDG TP4	TDG TP4A	DMEGC DRM40	DMEGC DRM44	ACME P4	ACME P41
Initial permeability	μi	F:10KHz B<0.25mT	25℃	——	2300±25%	2500±25%	2300±25%	2300±25%	2400±25%	2300±25%	2400±25%	2500±25%	2400±25%
Saturation flux density	Bs	F:10KHz H:800A/m	25℃	mT	500	520	530	510	510	510	510	480	495
			100℃		370	440	420	390	390	390	400	380	395
Remanent flux density	Br	25℃		mT	140	180	95	100	110	95	130	100	170
		100℃			92	60	55	55	60	55	60	70	70
Coercivity	Hc	25℃		A/m	15.9	13	14.3	14	13	14	15	10	11
		100℃			8	6	8.8	9	6.5	9	6	6	6
Curie temperature	Tc	f:10KHz B<0.25mT		℃	230	230	215	≧215	≧220	≧215	≧215	≧220	≧230
Density	d	______		Kg/m^3	4.80×10^3	4.80×10^3	4.80×10^3	4.80×10^3	4.80×10^3	4.80×10^3	4.80×10^3	4.80×10^3	4.80×10^3
Power Loss	Pcv	100KHz-200mT	25℃	KW/m^3	600	600	600	650	600	600	600	700	650
			60℃		430	400	450	480	410	450	400	540	500
			100℃		400	250	410	410	300	410	300	450	350
			120℃		480	360	500	500	400	500	380	500	500
The relative price level					High	High	High	Medium	medium	medium	medium	medium	medium
Delivery					2-3months	2-3months	2-3months	1-2weeks	1-2weeks	1-2weeks	1-2weeks	1-2weeks	1-2weeks

Key Parameters Affect to your power supply

- Leakage Inductance

$$\frac{1}{2}LI^2 = \frac{1}{2}CV^2$$





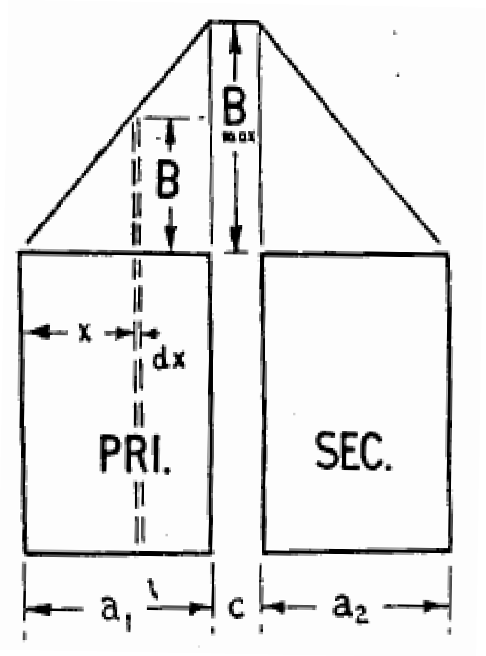
Leakage Inductance

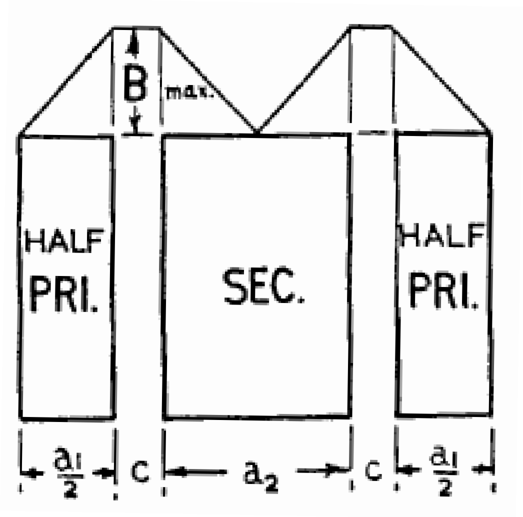
$$Lo \propto \int_0^a x^2 dx$$

$$Lo \propto \left(\frac{a1 + a2}{3} + c\right)$$

How about Multi-section?

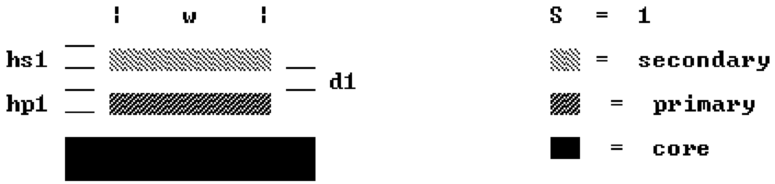
$$Lo = \frac{K}{X} * \left(\frac{a1 + a2}{3} + c\right)$$

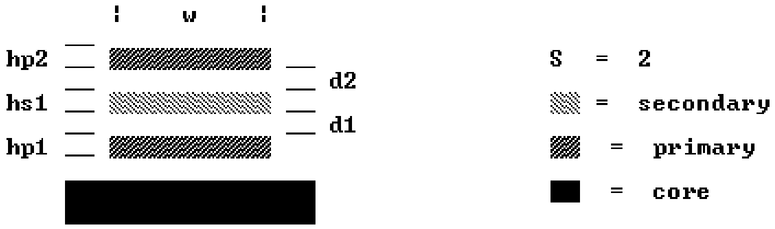




Leakage Inductance

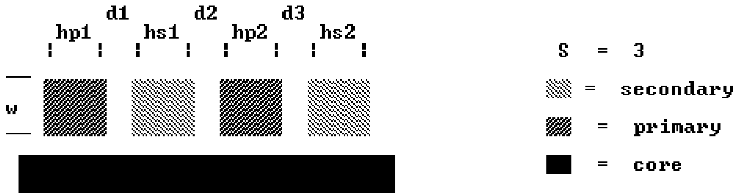
INTERLEAVED SINGLE COIL WINDINGS





$$LL = \frac{.4\pi N_p^2 \, l_m}{w \, S^2} \left[\Sigma d + \frac{\Sigma h_p + \Sigma h_s}{3} \right] \times 10^{-8}$$

SECTIONALIZED OR PIE WINDINGS



Key Parameters Affect to your power supply

Wire Diameter Skin Effect Copper loss

$$Pcopper = DCR * I^2 \ ???$$

NO, the SKIN effect caused a Rac

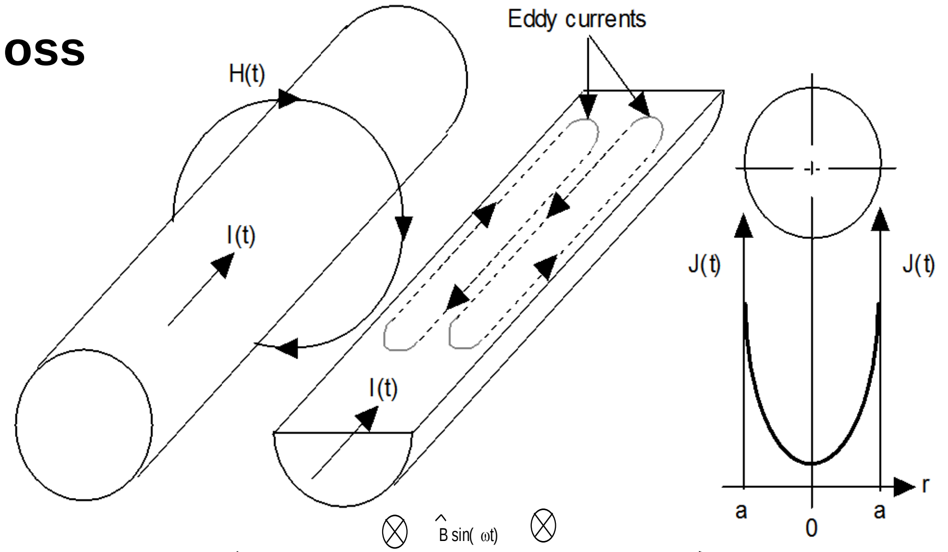
$$Ddep = \frac{76}{\sqrt{f}}$$

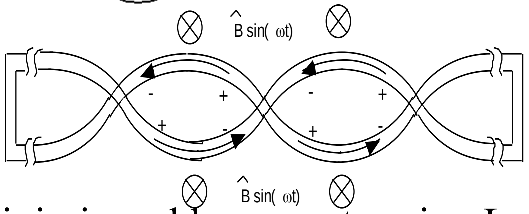
$$Rac = Rdc * K$$

IS:

$$\mathrm{PCopperLoss} = \mathrm{Rdc} * \mathrm{K} * \mathrm{I}^2$$

Not Really, the proximity effect.

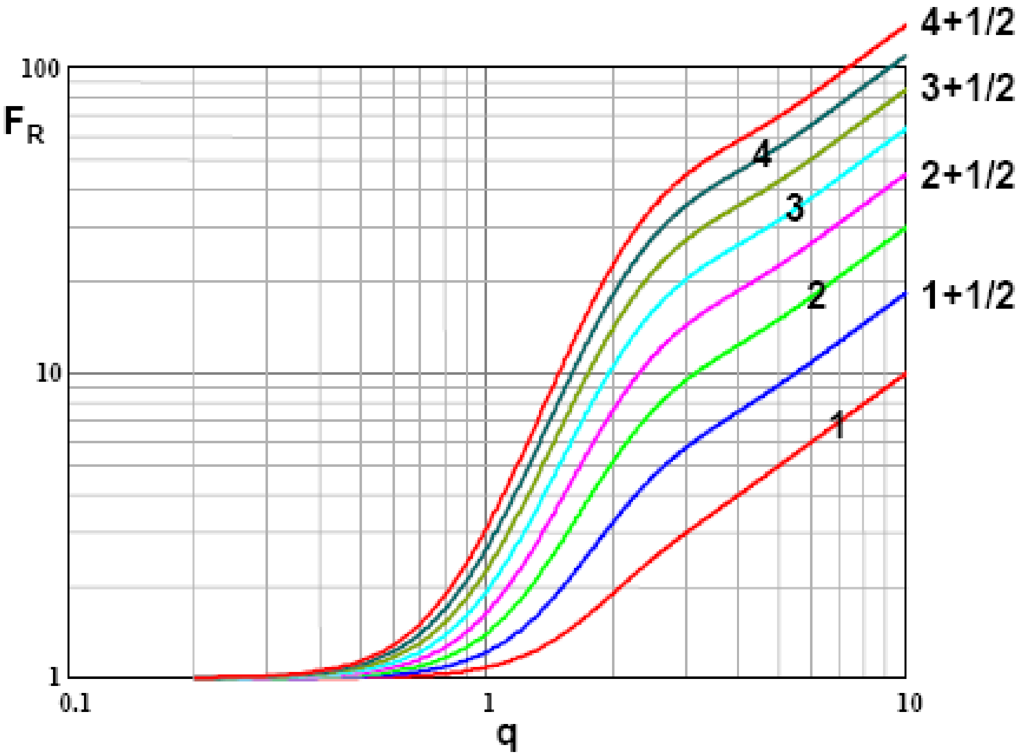


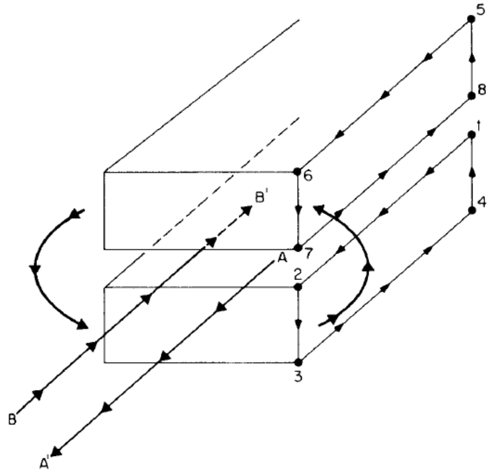


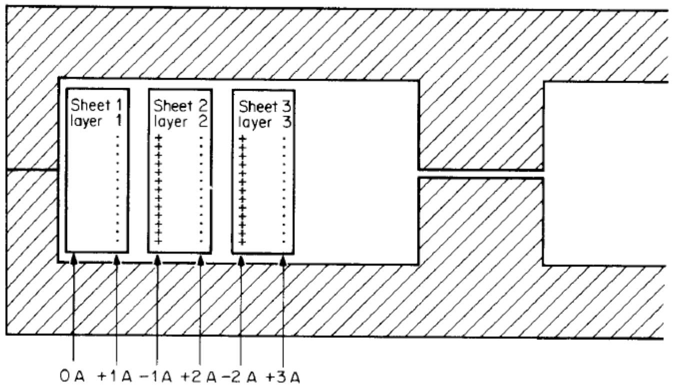
- Minimize eddy currents using Leitz wire bundle. Each conductor in bundle has a diameter less than a skin depth.

- Twisting of paralleled wires causes effects of intercepted flux to be canceled out between adjacent twists of the conductors. Hence little if any eddy currents.

Proximity Effect





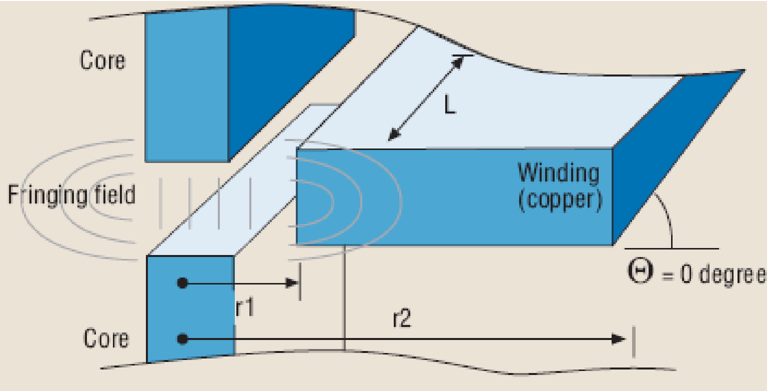


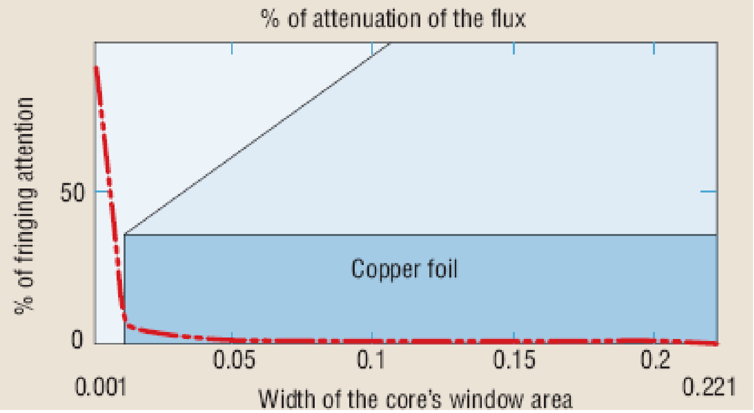
Rac=RdcXFr

Famous Dowell Curve

Gap Fringing Effect

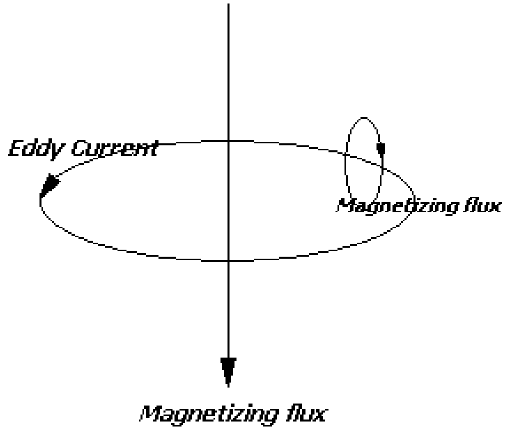
- Fringing cause significant eddy loss
- Avoid the fringing loss by design
- Fringing increases the OCL

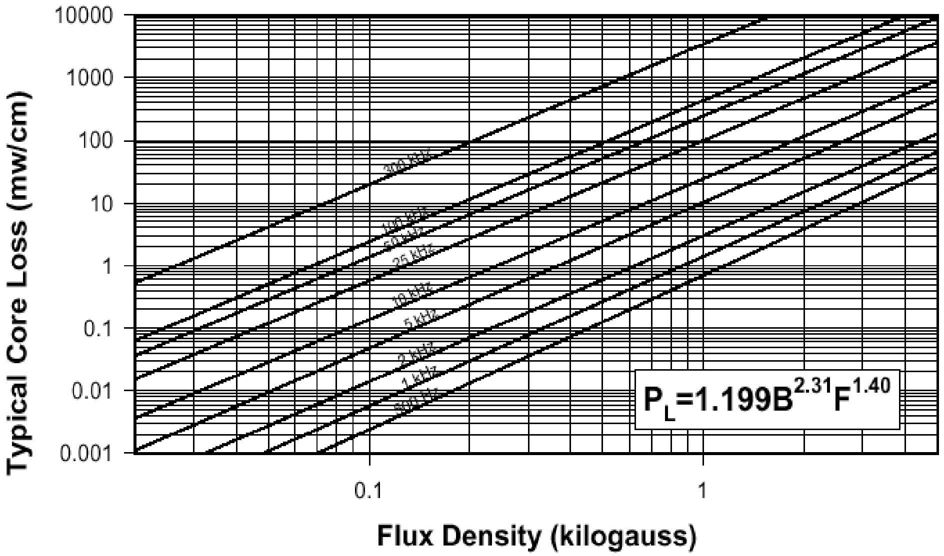




Core Losses

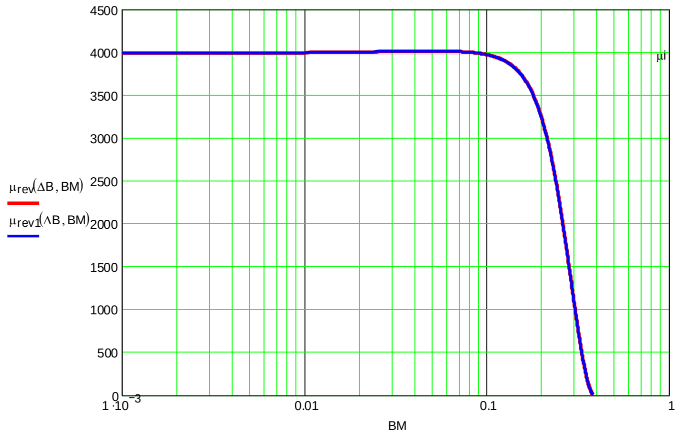
- Core Loss mW/cm^3 or mW/gram
- Different loss from different material
- Select right materials
  Not over design
- B vs Core loss
  No stress design





Gap, ue, Bdc

- Bsat → inherent characteristics
- Bdc → decided by peak current
- OCL →decided by turns and gapping size
- Basic formula:

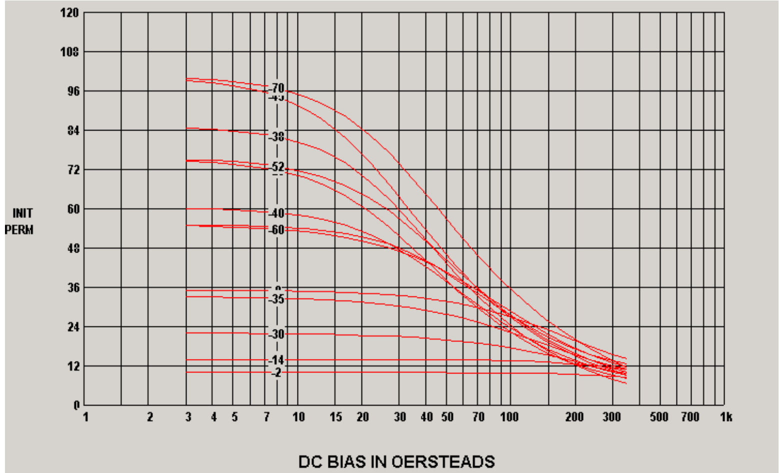


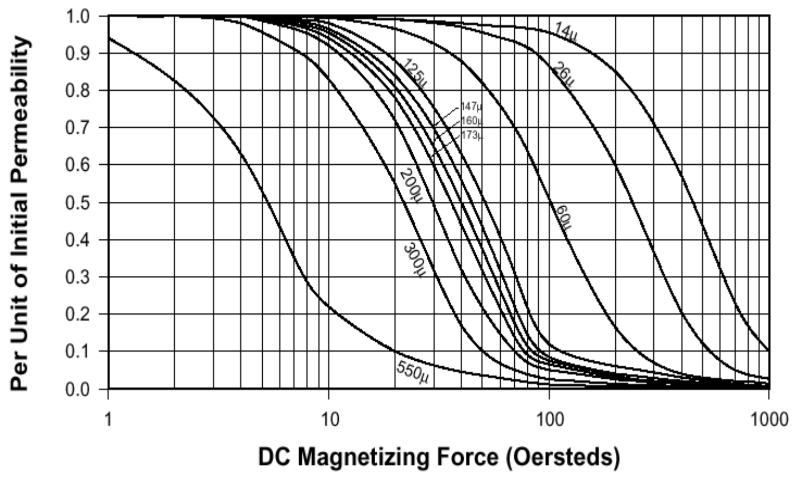
$$ue = \frac{ui}{1 + ui\,\frac{lg}{le}}$$

$$H = {0.4\pi NI}/{le}$$

Powder Core Characteristics

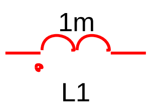
- Distribute gap
- Soft Saturation
- Different powder size →different core loss
- Thermal Aging issue
- Choose right core materials

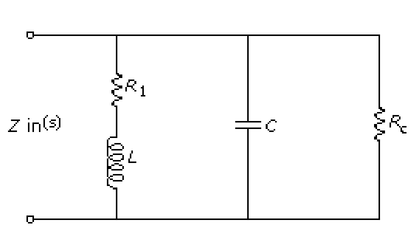


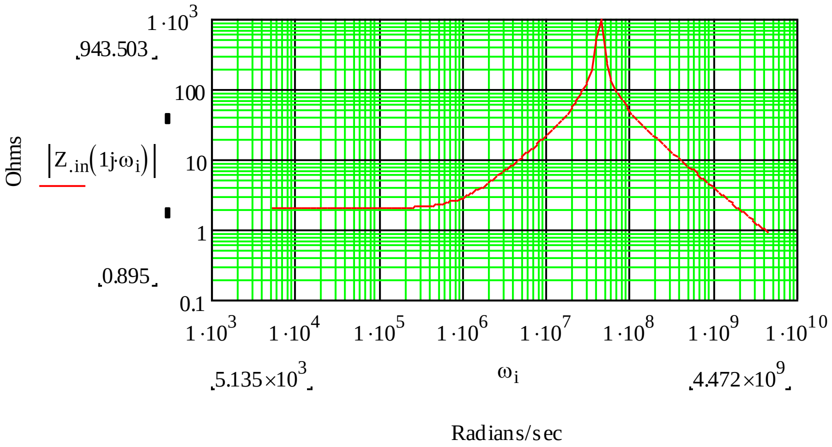


Common Mode Choke

- Impedance

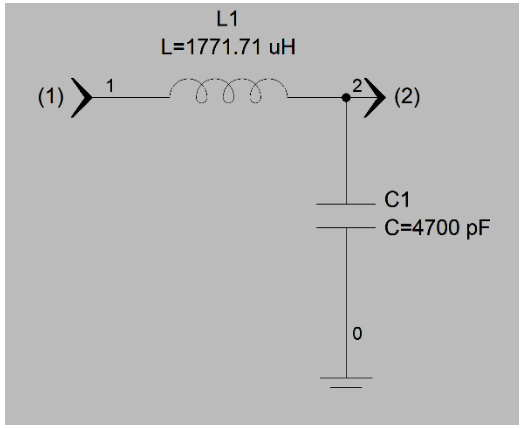


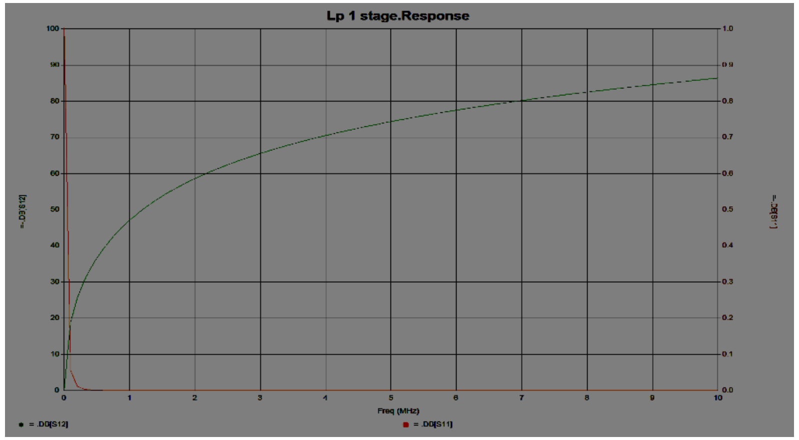


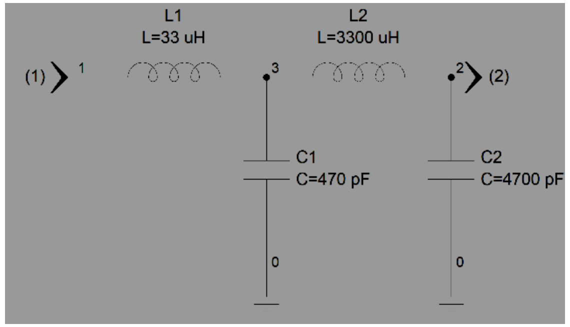


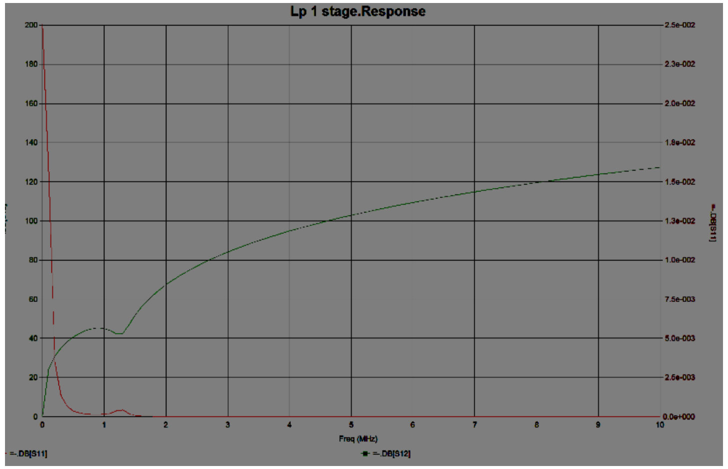
- EMI Filtering Network
- Mostly are low pass LC filtering circuit.

EMI Filtering Net Work







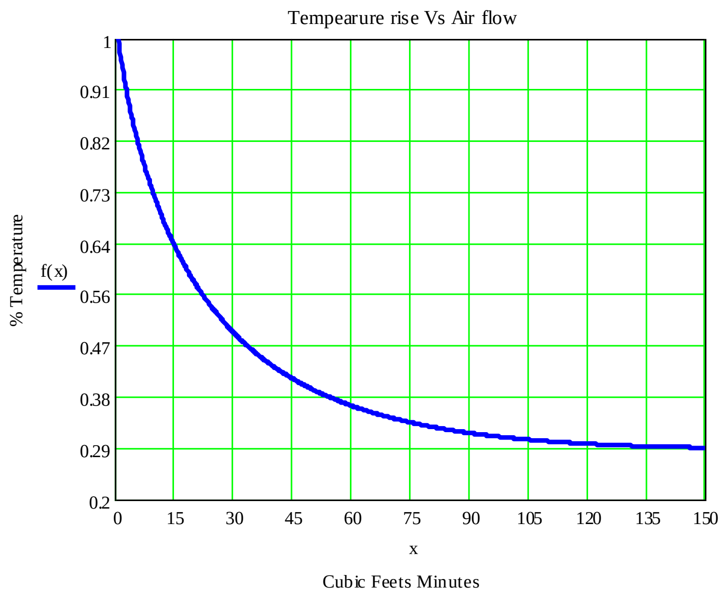


Magnetics Thermal Engineering

- Temperature Rise. Ploss includes copper loss and core loss

$$dT = \left(\frac{Ploss(mw)}{Asurf} \right)^{0.833}$$

- Forced Ventilation Effect



Reference

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