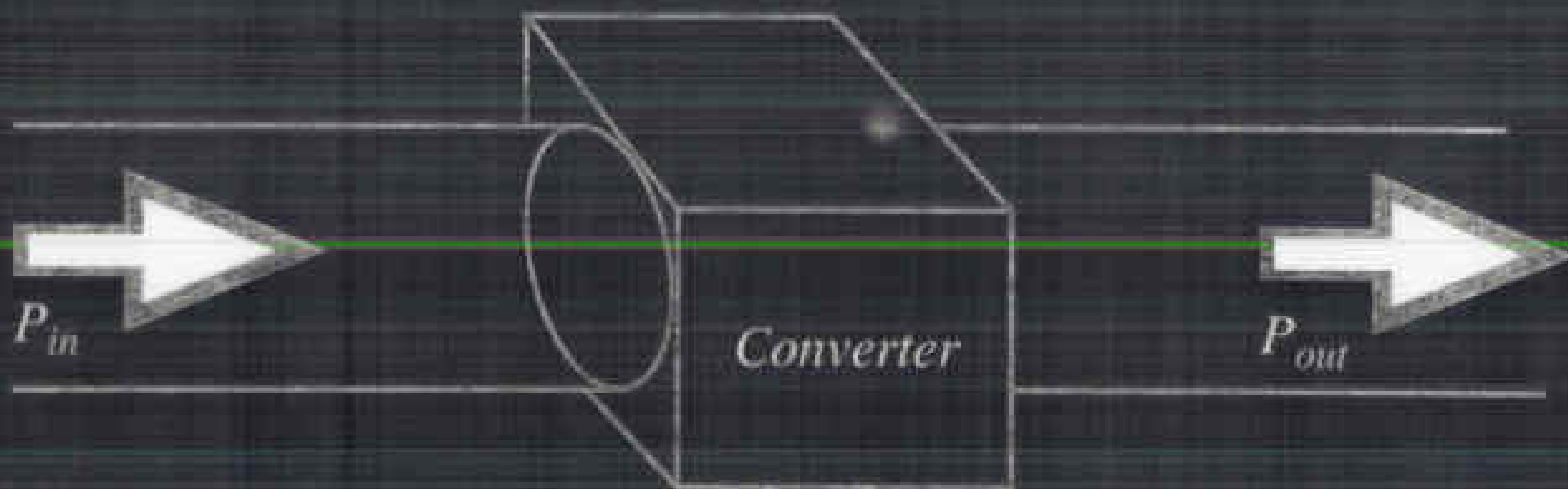
LINEAR REGULATORS -SIMPLE -POOR EFFICIENCY	1960's and earlier
SWITCHING REGULATORS -COMPLEX -HIGHER EFFICIENCY -DEMAND IC CONTROLS -HIGH NOISE -SLOW RESPONSE	1970's
CURRENT MODE CONTROL -IMPROVED REGULATION -BETTER PROTECTION -HIGHER BANDWIDTH	1980's

Fig. 1 - Power System Development History

5 to 20 kHz	-AUDIBLE NOISE -SLOW BIPOLAR SWITCHES -LARGE L's AND C's
20 to 100 kHz	-ABOVE AUDIBLE RANGE -FAST BIPOLAR TRANSISTOR -MAGNETICS BECOME IMPORTANT -SMALL SIZES
100 to 500 kHz	-POWER MOSFET SWITCHES -LOSSES IN L's AND C's -DIODE RECOVERY TIME -RFI AND EMI -PACKAGING PROBLEMS

Fig. 2 - Power Supply Switching Frequencies

A high-efficiency converter

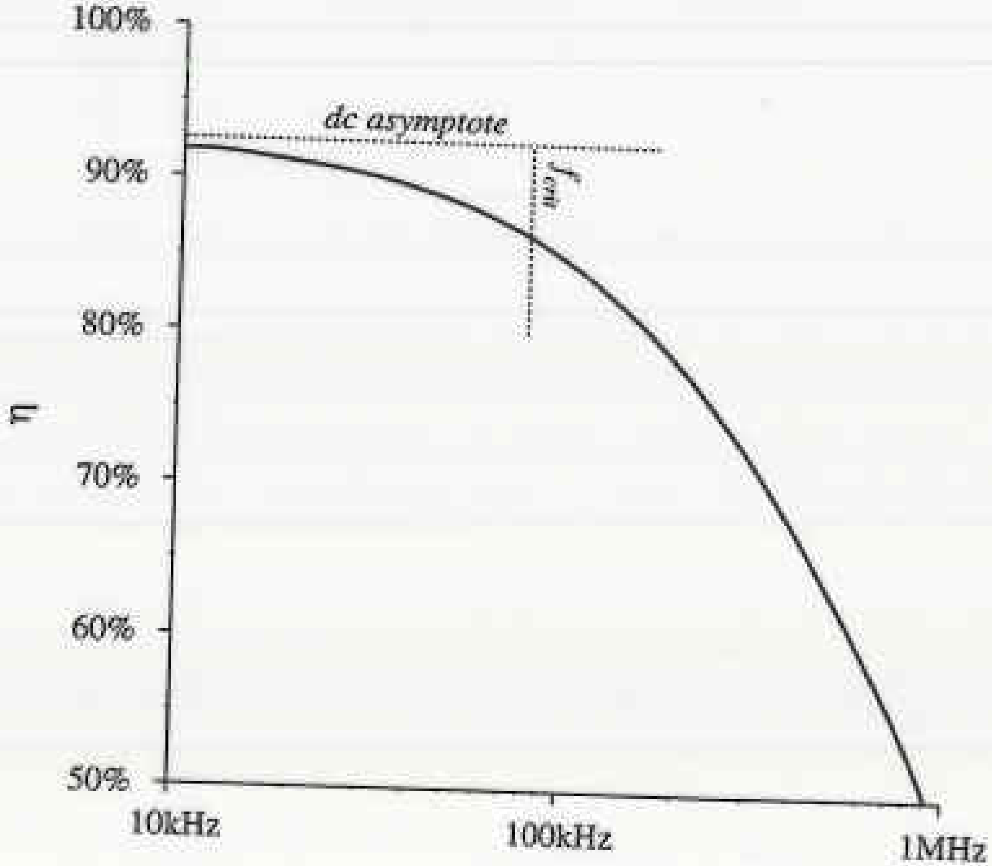


A goal of current converter technology is to construct converters of small size and weight, which process substantial power at high efficiency

High density power conversion

Efficiency vs. switching frequency

$$P_{loss} = P_{cond} + P_{fixed} + W_{tot}\, f_{sw}$$



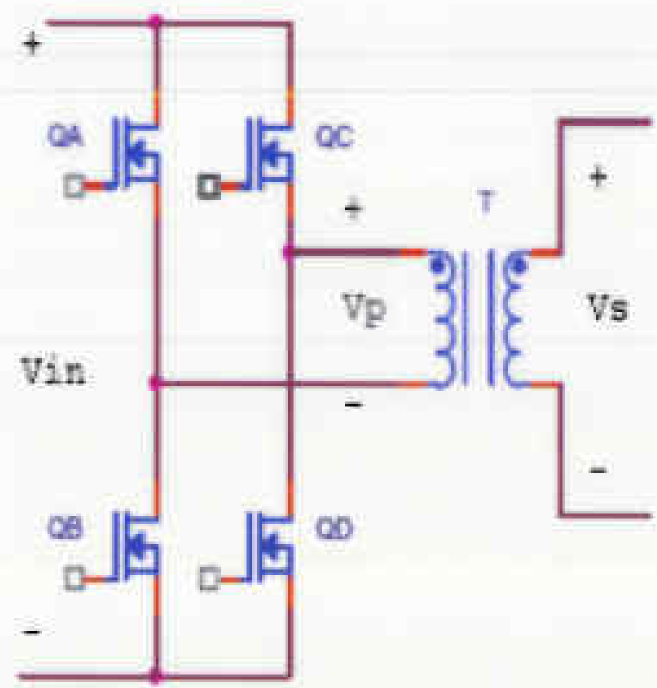
Switching losses are equal to the other converter losses at the critical frequency

$$f_{crit} = \frac{P_{cond} + P_{fixed}}{W_{tot}}$$

This can be taken as a rough upper limit on the switching frequency of a practical converter. For $f_{sw} > f_{crit}$, the efficiency decreases rapidly with frequency.

Standard DC/LF/MF Topologies (3-10kW)

- Offline pulse width modulated full-bridge
  - MDX (DC)
  - MDXII (DC)
- Offline phase-modulated full-bridge for greater dynamic range
  - PE (LF)
  - PDX (MF)
- Promising results in the HF range (3-30MHz)



Std form for resonant circuit transfer function

$$\frac{1}{1 + \frac{s}{Q\,\omega_{LC}} + \frac{s^2}{\omega_{LC}^2}} = H(s)$$

$$\omega_{LC} = \frac{1}{\sqrt{L_{eff}C_{eff}}}$$

$$Q = f(Z_{LC}, R)$$

} depend on topology

For next lecture

$$f_{LC} = \frac{1}{2\pi\sqrt{LC}}$$

Read Section 19.1, "Sinusoidal analysis of resonant converters"

$$\sqrt{\frac{L}{C}} = Z_0$$ characteristic impedance (Key to Q scaling)

Z_0 versus R

Load in a resonant circuit can be placed many locations

Excite tank: Sinusoid, □-wave

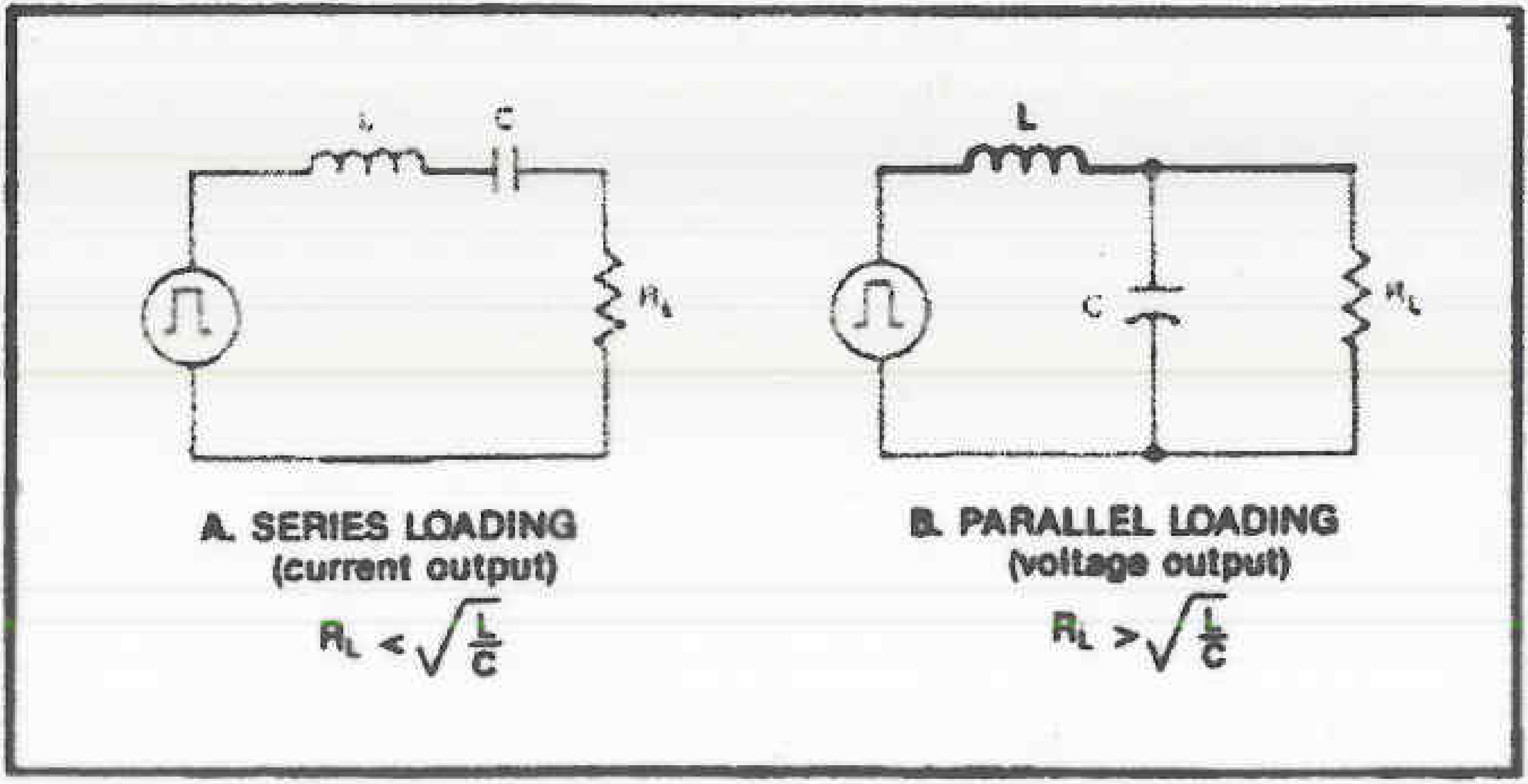


Fig. 9 - Resonant Mode Loading

AEROJET
LOCKHEED MARTIN
Glenn Research Center
Colorado Power Electronics, Inc.

Three-Phase Resonant Converter PPU 10KW Breadboard

Magnetics development

Two magnetic designs are being developed . The candidate with the best combination of efficiency and specific mass will be chosen.

Critical attention is needed for larger magnetic structures due to eddy current losses in the ferrite. The larger structures have an increased volts per turn which causes loss factors not prevalent in lower power magnetic structures.