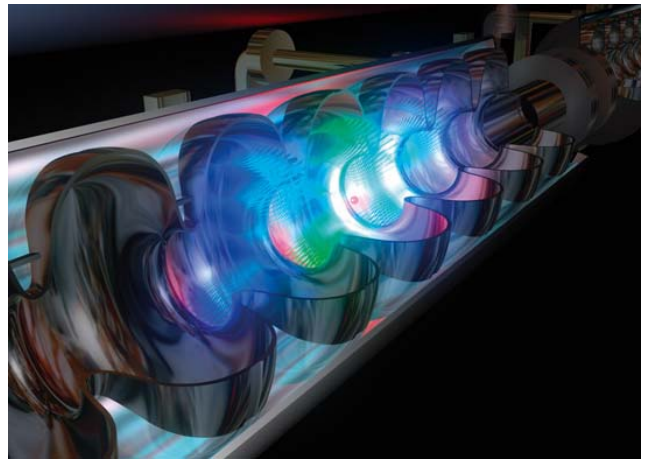
International Linear Collider
at Stanford Linear Accelerator Center



ILC Modulator
Charging supply comments

Richard Cassel SLAC

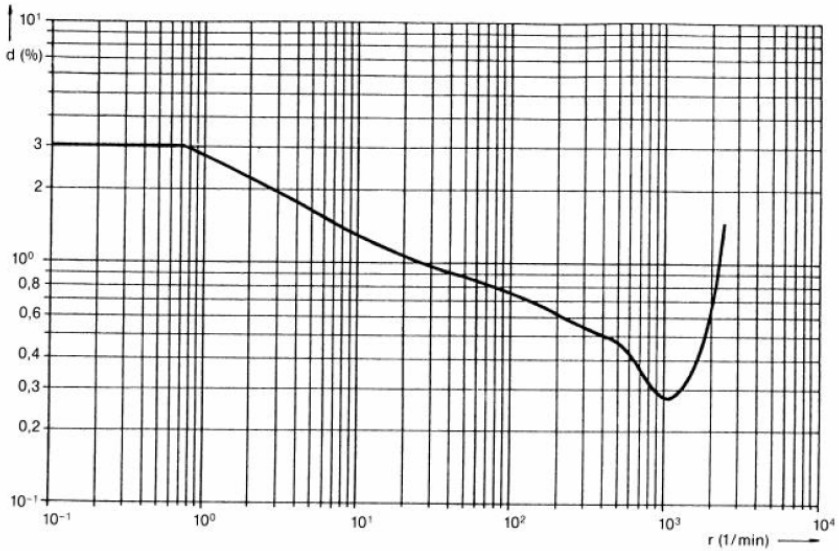
ILC Modulator Power supply Requirements

- Maximum charge Voltage 12 kV
- Pulse Rate 5 Hz
- Average power Per modulator 150kW
- Input line Voltage AC 3 phase 33kV
- Power Factor 94%?
- Harmonic Content unknown?
- Real Power Variation unknown?
- Total line Voltage Variation a 5-10Hz <0.25%?

Power Lines harmonics or waveform distortion

- Harmonic waveform distortion derives from rectifying the AC line.
- Rectified filter must have inductor filter to reduce the unwanted 3rd harmonics on the power line waveform.
- Harmonics can be reused at the source by using a high phase number for the rectifiers
- Although the individual chargers could be 6 phase rectification the total system should have a minimum of 24 phase rectification
- This can be accomplished by phase shifting the step down transformers in groups
- Harmonic filter capacitors may be needed on AC line.
- (Overall phase number must be at least 24 phase Rectification)

Voltage Variations on overall power Lines



From
German standard VDE 0838
Power Supplies for TESLA Modulators
Hans-Jörg Eckoldt, Niels Heidbrook
DESY
TESLA 2000-36

- 3 % Maximum of voltage variation to the public mains Maximum voltage variation allowed at 5-10 Hz < 0.25%
- Actual Variation depends mainly on reactive power and source impedance.
- (Real and Reactive power variation must be minimized)

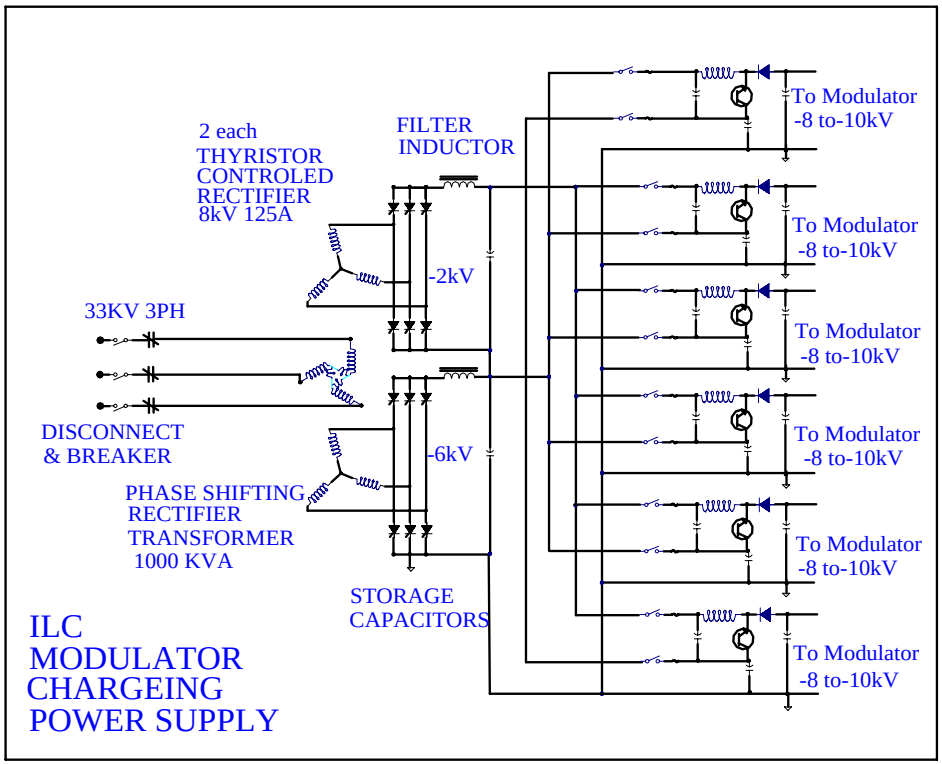
Voltage Variations Control

- Most transformer in the distribution system will have a real impedance of from 1-2% of full load so that means that the real power must not change by more than 13% of full load over the 0.2 second charge time to meet a 0.25%. Voltage variation requirement.
- The reactive power is usually the more sever voltage variation problem because the reactive impedance of most transformer (not oversized) is between 4 to 6 % resulting in a reactive power variation of not more than 4% full load over the 0.2 second charge time.
- (Note even a 94% power factor results in a 34% reactive power component.)
- (Overall power Variation during recharge must be less than 10% of the total load)

Voltage Variations Corrections methods

- Use Switching (Bridge, Buck, or Boost type) supply running in constant power mode.
- Provide switching capacitors or synchronic motor to correct or overcorrect reactive power.
- Use series capacitors to correct reactive power
- Use Constant voltage transformer to correct voltage variation
- Use motor- Generator set to isolate pulsed power from the utility lines
- (Switching supplies use to provide constant real and reactive power is the practical solution)

Proposed power charging system to reduce costs and utility Line problems



- Drive at least 6 modulator from one step down transformer.
- Use SCRs to initially charge capacitors to 80% of voltage
- Use Boost switching supply to charge from 80% to 100%
- Use phase shifting step down transformer for harmonics
- Control as constant power charge (Not constant current)

Conclusions

1) Specification should be determent for power line distortion, and voltage variations for ILC.
2) Pulse number of rectification for total system should be at least 24 to reduce harmonic on utility line.
3) Filter inductors should be use on every supply to reduce third harmonic
4) Switching type supplies should be used to minimize real and reactive power variations during charging of the capacitor banks of the modulators.
5) Supplies should be operated in constant power mode to reduce utility line variations.