ECE 529
Utility Applications of Power Electronics

Session 39
commutation failure

- Device turning on fails to turn on because one turn on doesn't stop conduct
- More common at inverter

- Keep following wrong phase
  A → B
  Stay on A

\[ V_{DC} = 0 \]
\[ AT \ V_{DC_{inv}} \]
\[ P_{DC} \rightarrow 0 \]
HVDC Control

LCC

LCC Reactive power characteristics

- Operates at lagging power factor
- Both rectifier and inverter operation
- Due to phase control
  - Typically reactive power demand = 55% of station real power rating at full load
  - \( Q_{\text{comp}} \): typically 35% of station rating: ac filters plus shunt banks
  - Shunt reactors sometimes used at light load to absorb excess from filters

Rest power system or synchronous condensers

\( Q \) from system

Choose \( Q \) to keep it around this percent

\( Q_{\text{rect}} \approx 180 \)
Simple 11th harmonic filter

\[ \omega L = \frac{1}{\omega C} \]

Phase

-90°

-90°

Inductor

Capacitor 11th

Looks like a capacitor bank at 60Hz

Choose \( L, C \)

1. MVA at 60Hz

2. \( f_0 \)
Short Circuit Ratio

- Commutation performance
- Voltage stability
- Dynamic performance
- Dynamic overvoltage
- Low order harmonic resonance,
- Rule of thumb – ESCR > 2 for LCC
- ESCR = (S_n + S_G + S_SC + Q)/P_DC

Harmonic Characteristics

- AC characteristic current harmonics at f_n = 12n +/- 1
- Short filters: band pass, high pass, double-tuned
- Typical ac filter performance criteria: THD<1.5%, TIF < 45
- DC side voltage harmonics: f_n=12n
- Typically 35% of station rating in installed ac filters
- Harmonic magnitudes diminish with increasing harmonic number
\[ I_{SC} = \frac{V_{SH}}{Z_{OP}} \]

\[ \text{MVA}_{sc \ pu} = \frac{\text{MVA}}{\text{pu}} \]

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\[ I_{St} = \frac{V_{SC}}{Z_{OP}} \]

\[ \text{MVA}_{sc \ pu} = \frac{\text{MVA}}{\text{pu}} \]