with option 1, easier to handle Δ-Y transformer
- refer to V & i to LV side
  include 30° shift

- Voltage transformation ratio

- If looking at fault cases need
to include zero sequence removal term...

\[ \text{VSC} - \Delta Y \rightarrow \text{Grid} \rightarrow \sqrt{3} \text{L6} \]

will be in Park's transform

\[ \frac{1}{3} \left[ \begin{array}{ccc} 2 & -1 & -1 \\ -1 & 2 & -1 \\ -1 & -1 & 2 \end{array} \right] \left[ \begin{array}{c} i_a \\ i_b \\ i_c \end{array} \right] \]
- Leading power factor operation
  - Converter is leading $\Rightarrow$ consuming $Q$
    from system

  System reference
  - $P + jQ$
    - Inductive $Q$
  - Supply power

  $|V|$
  - Describes voltage stability
  $P$
Current regulators

$K_i, K_p$ calculated based on $R, L$ between terminals & POI

$\omega_L$ - cancel cross-coupling in $id, iq$ control loops

$V_{FE}$

1. Regen of $R, L$ and $V_{meas} \pm $ Inves to LV side of transformer

2. Regen $R \& L$ to HV side of $\text{And Scale}$

Take $V_{meas} \pm $ Inves there $V_{dc}/2$
Thyristor Converter Applications

-> Non-voltage source converter cases.

NPNP

15-30A

Turn off like a diode

Latch device on
Thyristor Controlled Reactor

- Two options for inductor models
  » Little impact on digital simulation
- Average susceptance with firing delay angle, $\alpha$

$$B_L(\alpha) = \frac{1}{\omega \cdot L} \cdot \left(1 - \frac{2 \cdot \alpha}{\pi} - \frac{\sin(2 \cdot \alpha)}{\pi}\right)$$

TCR Power Circuit

- Built-in thyristor models
- Switch resistance of $0.001 \Omega$ for loss approximation
- Series connected devices and associated circuits not modeled
- Reactor $R_L$ for application
- Numerical snubber if needed
a. Static VAR Compensators

- HVDC transmission
- A. Line commutated converters (LCC)
- B. VSC