ECE 529
Utility Applications of Power Electronics
Session 23
Converter fault response

Consider synch generator

\[ i(t) = \frac{\sqrt{2} |E|}{R \left( \frac{1}{X_L} - \frac{1}{x_d} \right)} \left( e^{-\frac{t}{R}} \left( \frac{1}{X_L} - \frac{1}{x_d} \right) e^{-\frac{t}{R}} + \frac{1}{x_d} \right) \cos(\omega t + \theta) \]

Subtransient
Phaser response

Irrefault

Angle of impedance to fault point

Magnitude decreases as fault gets farther away

Fault

Fault near bus

Only if \( I_z \neq 0 \)
Inverter case

Prefault:

\[ I_{load} \rightarrow V_A \rightarrow \text{Bus} \]

Fault: \( m = 0.1 \)

\[ I_{fault} \rightarrow V_A \rightarrow \text{Fault} \]

1.1 pu of \( I_{rated} \) or either 1.2 pu of \( I_{rated} \) or \( I_{prefault} \)

Current magnitude not impacted by location
- Converter fault response
  looks like current source
  not voltage behind a reactance

  → constant magnitude in longer term
    - first few ms could see
      some what larger current
      (1/4 cycle or so)

  → power factor could stay at unity

  - some vendors have leading current
    for deeper voltage sags.
$I_2$ - negative sequence current

1. Regulated to zero...

2. Uncharacteristic with fault type... from ordinary controllers

3. Regulate $|I_2|$, maybe angle

...controller angle of $I_2$ relative to $I_1$
Impact of Inverter Based Generation on Bulk Power System Dynamics and Short-Circuit Performance

PREPARED BY THE
IEEE PES Industry Technical Support Task Force

IEEE/NERC Task Force on Short-Circuit and System Performance
Impact of Inverter Based Generation
Consequence of PLL for power swings

\[ T_i \approx 0.1 \text{ ms to } 0.5 \text{ ms} \]

- Current regulators: \( T_i \approx 2-5 \text{ ms} \)

Synchronous machine

- Fault occurs
- Inertia \( I \)
- \( E_p \) vs. \( \theta \)
- Inverter doesn't do this --
- 3D fault
- Magically goes away after a time