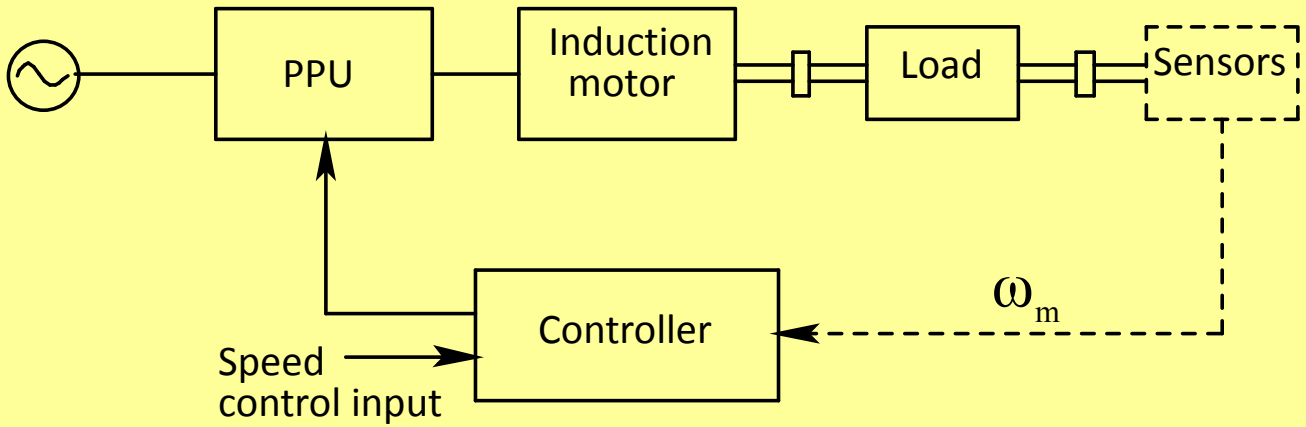
Induction Motors Drive: Other Considerations

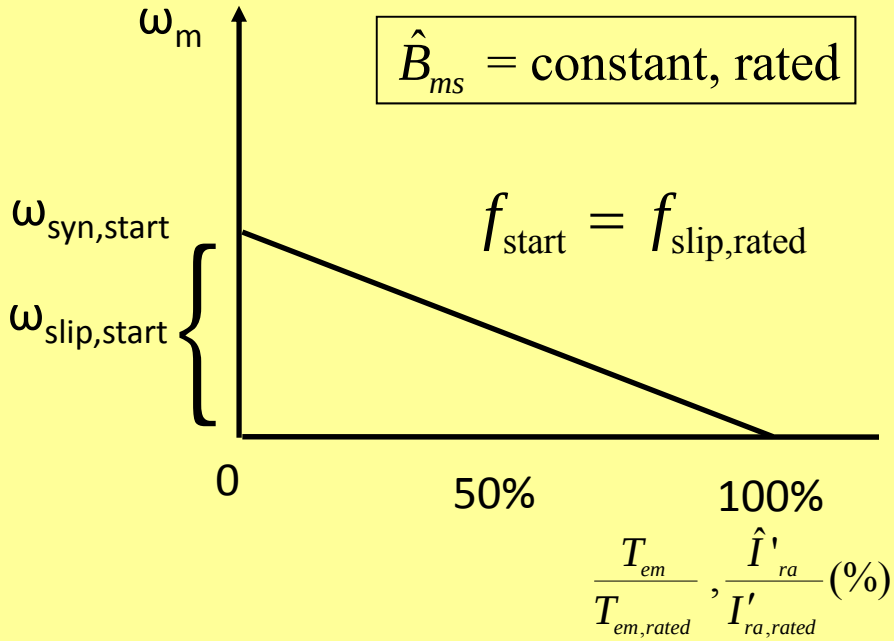
- Start-Up
- Capabilities
- Generator Mode
- Harmonics

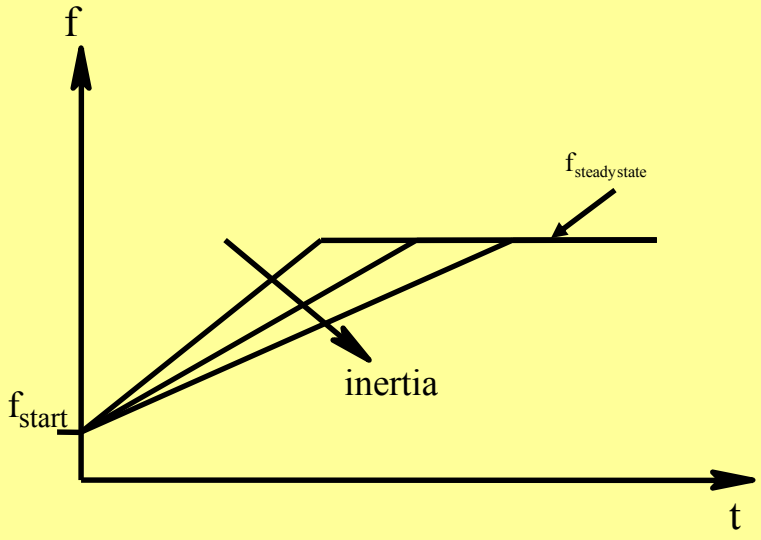
Induction Motor Drives : Speed Control



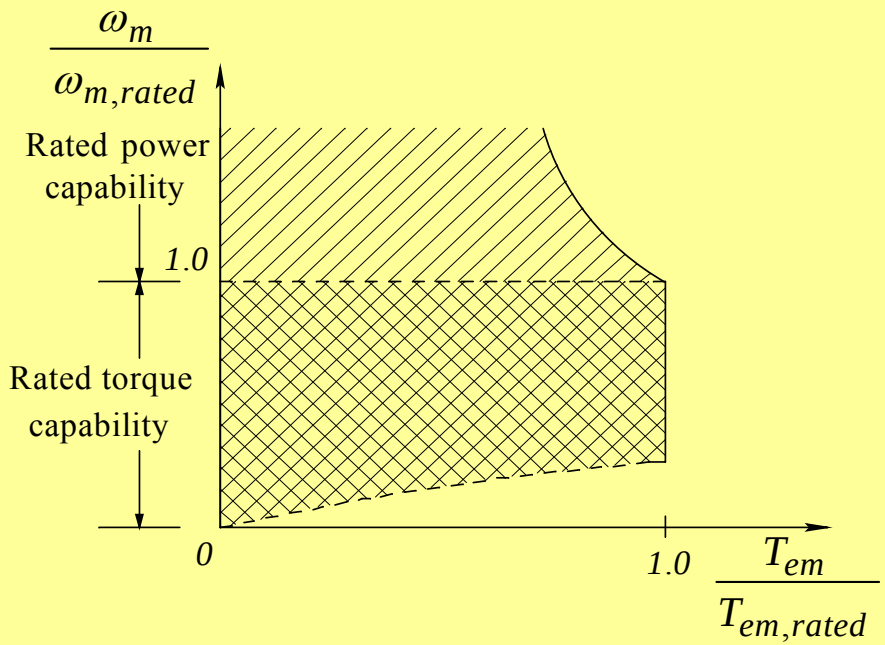
- Efficient speed control over a wide range
  - Reduced voltage control (inefficient)
  - Frequency control (efficient)
- PPU drives induction motor with variable frequency to maintain low slip
- As frequency decreases, voltage must also decrease to avoid magnetic saturation

Start-up Considerations



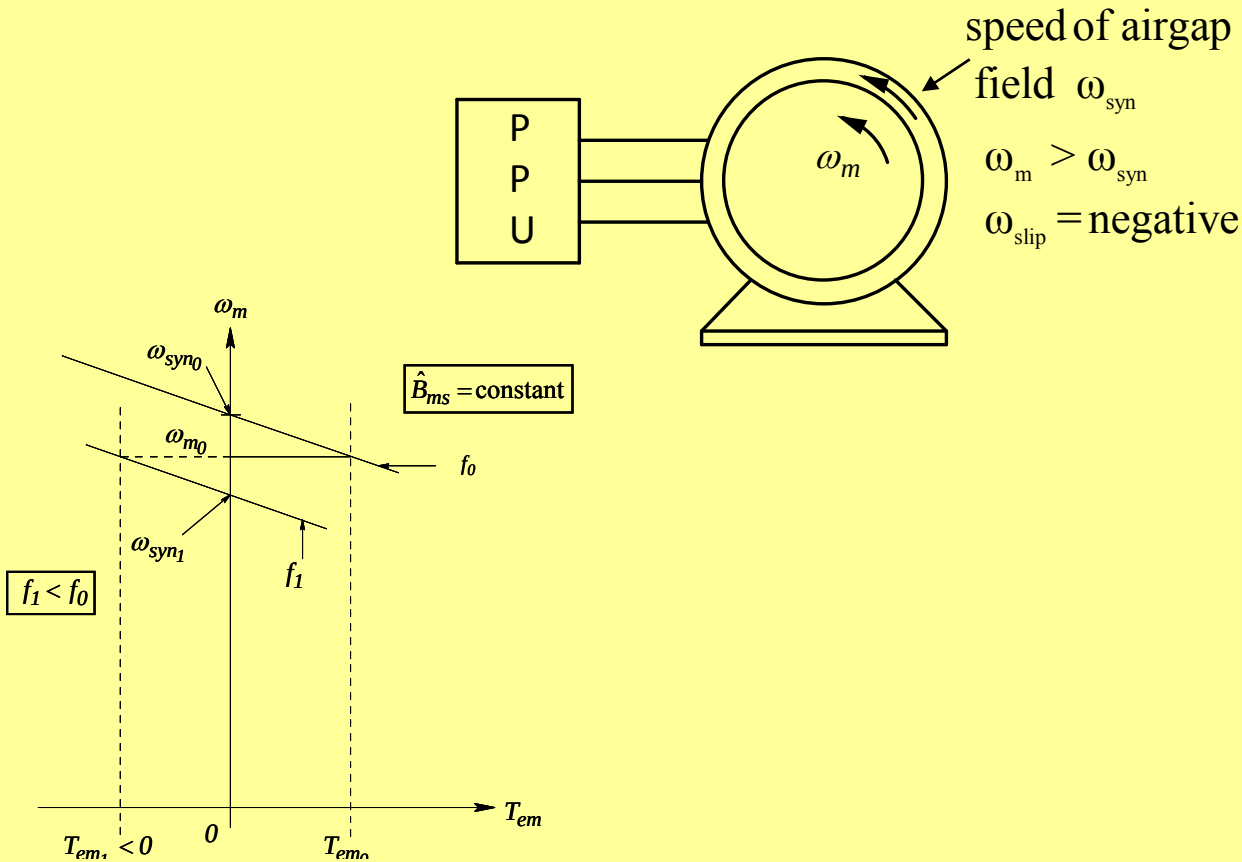


Capability Below and Above Rated Speed



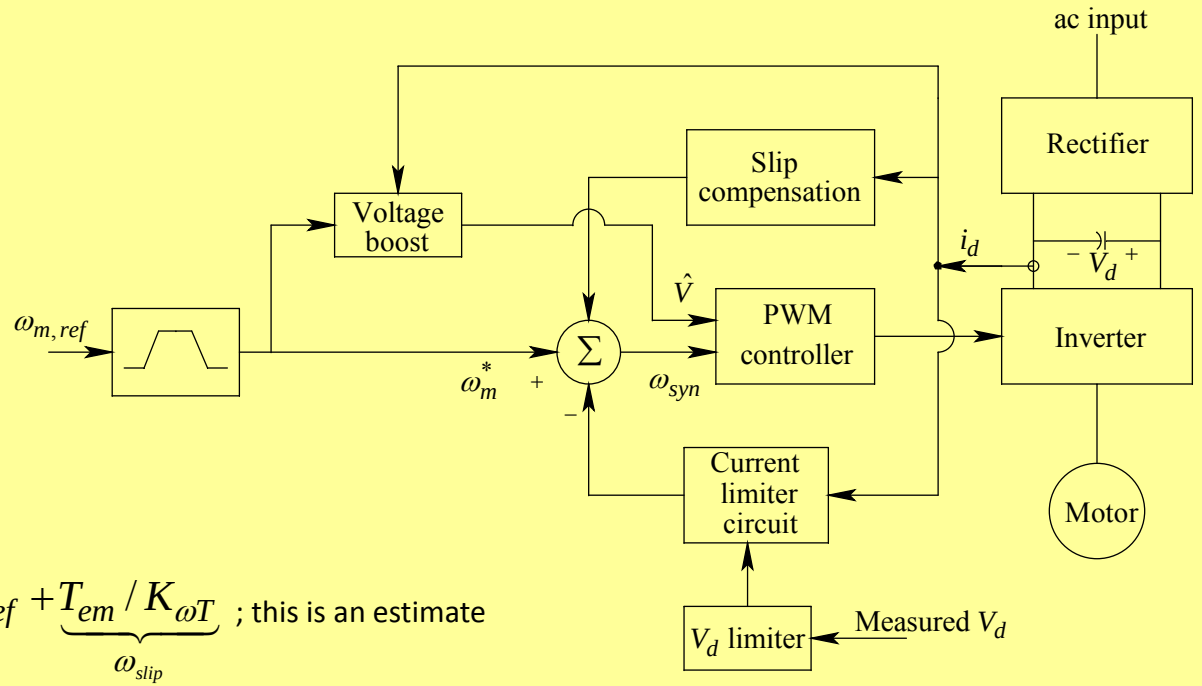
- Voltages limited to rated values, therefore $\hat{B}_{ms}$ declines at higher speeds (Flux Weakening)
- Currents limited to rated values, therefore torque declines when $\hat{B}_{ms}$ declines

Generator Mode



- To initiate braking, lower ω_{syn} to some value less than ω_m
- Braking torque can be adjusted by setting the negative slip frequency

Speed Control of Induction Motor Drives

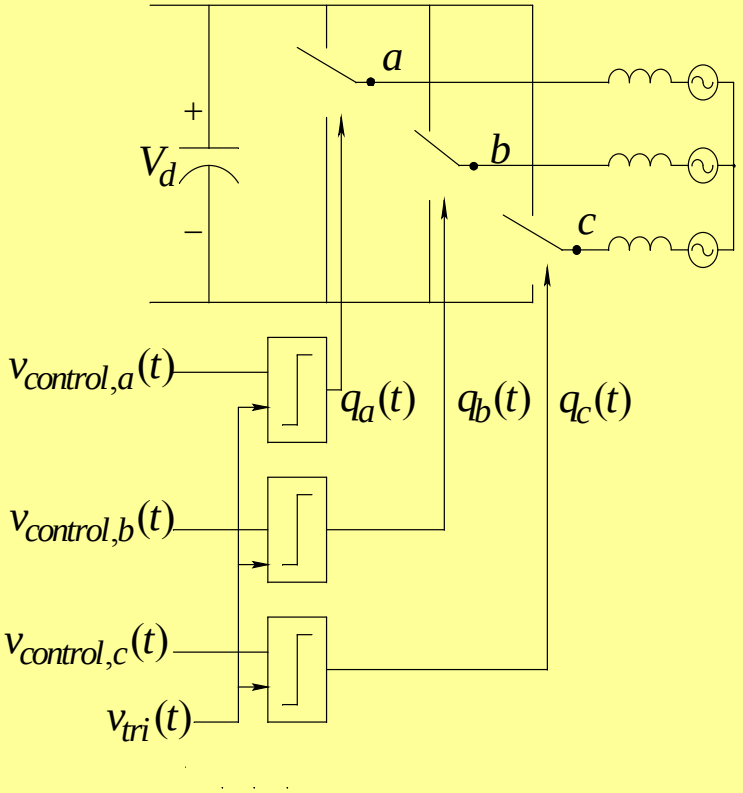


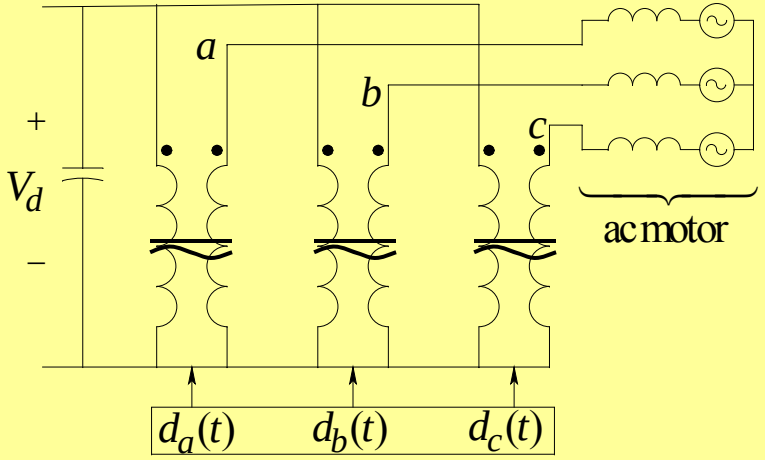
$$\omega_{syn} = \omega_{m,ref} + \underbrace{T_{em} / K_{\omega T}}_{\omega_{slip}}$$; this is an estimate

$$V_a = k_f\ f + k_{vT}\ T_{em}$$

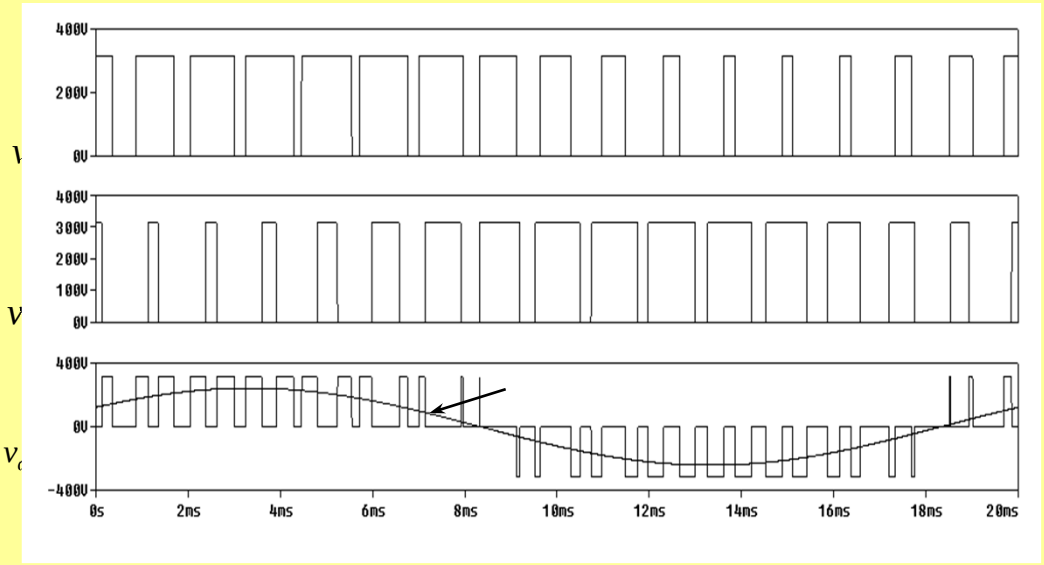
- $\omega_{m,ref}$ is passed through a rate limiter to avoid over driving the motor
- This method does not give precise speed control

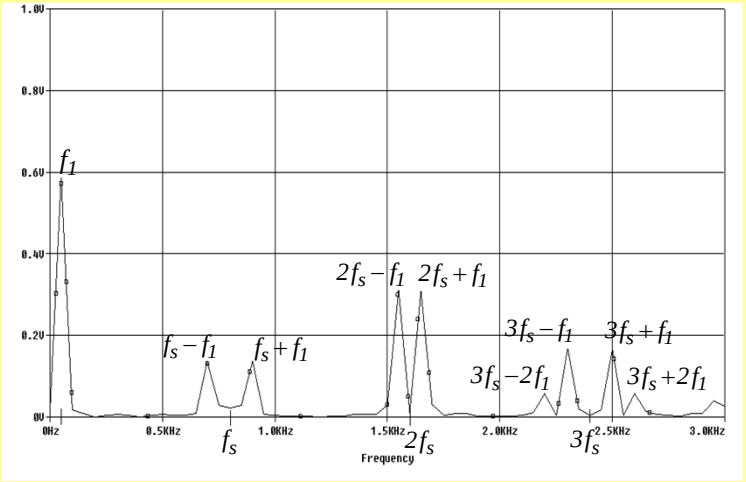
Pulse-Width-Modulated Power Processing Unit





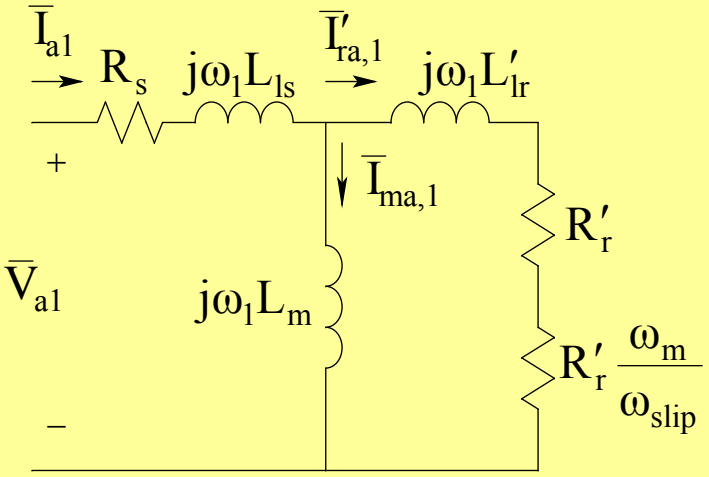
Harmonics in PPU



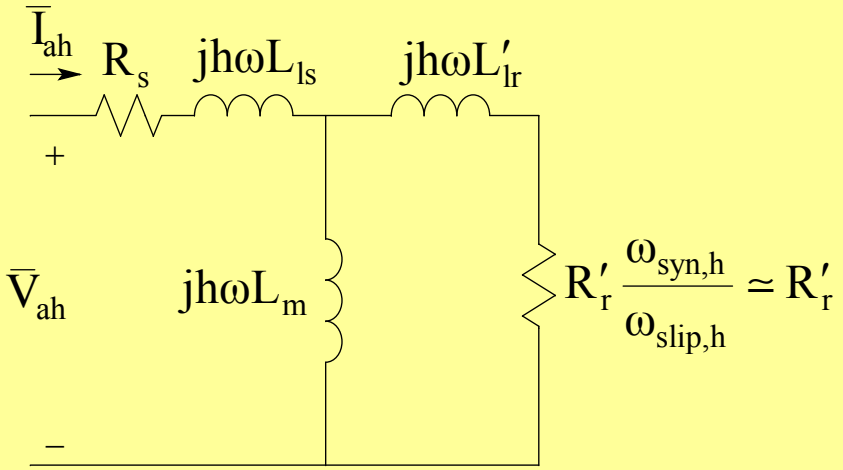


- PPU with switching frequency of 800 Hz generating a fundamental sine wave of 50 Hz
- Frequency spectrum shows large 50 Hz component and smaller components at higher frequencies due to switching
- These higher frequency components add to the losses in the motor

PPU – Supplied Induction Motor



Fundamental Frequency Model

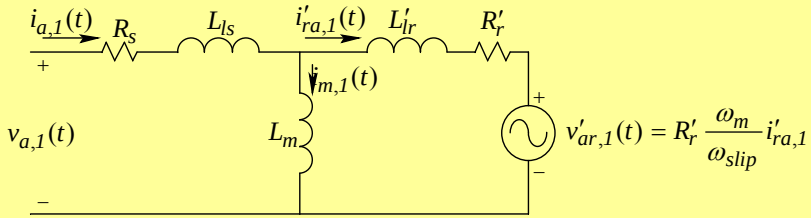


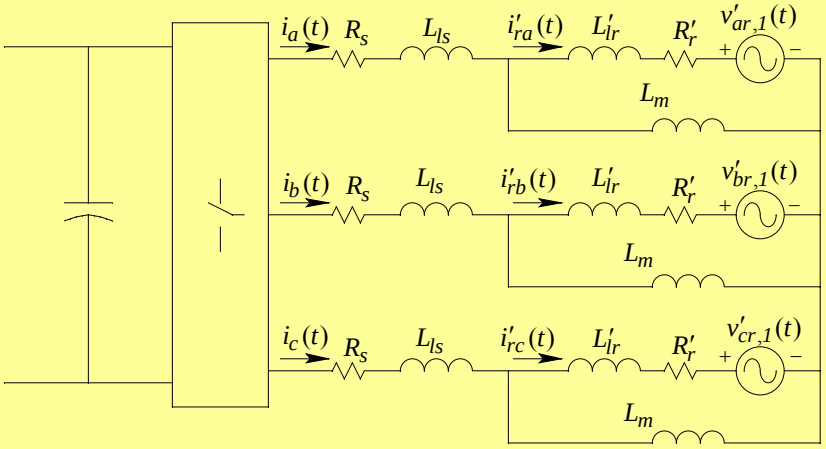
Harmonic Frequency Model

- At harmonic frequencies $R_{eq} \simeq R'_r$
  Magnetizing inductance can be ignored
  Harmonic currents controlled by leakage inductance

$$\hat{I}_{ah} \simeq \frac{\hat{V}_{ah}}{(X_{ls,h} + X'_{lr,h})}$$

PPU – Supplied Induction Motor Model





- Fundamental frequency drop across resistor replaced with AC voltage source

Summary

- Start-Up
- Capabilities
- Generator Mode
- Harmonics