Implementation using Field-Oriented Control of 3-Phase Induction Motor with dSPACE and Typhoon HIL 602+

Student name: Omkar Savant (ocsavant_m24@ee.vjti.ac.in)
Supervisors: Prof. N. M. Singh and Dr. S. R. Wagh

VJTI
EED, VJTI

Objective:

Hardware Implementation:

- Controller implemented using a dSPACE system.
- Induction Motor model simulated on Typhoon HIL 602+ for real-time hardware-in-the-loop (HIL) testing.

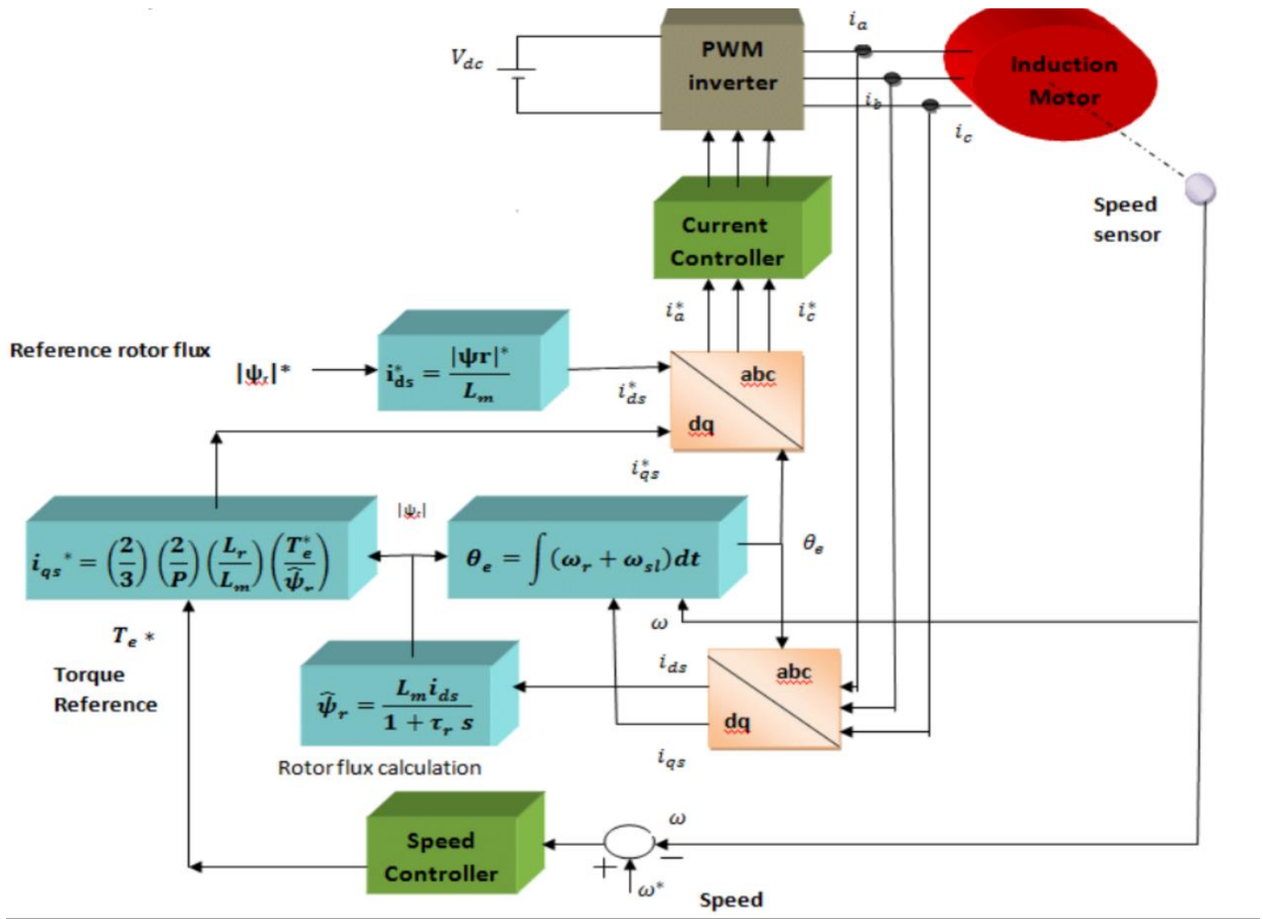
Validation Approach:

- Hardware-in-the-loop (HIL) testing enables evaluation of motor control algorithms without immediate physical hardware.
- Allows for performance tuning and fault testing in a controlled environment.

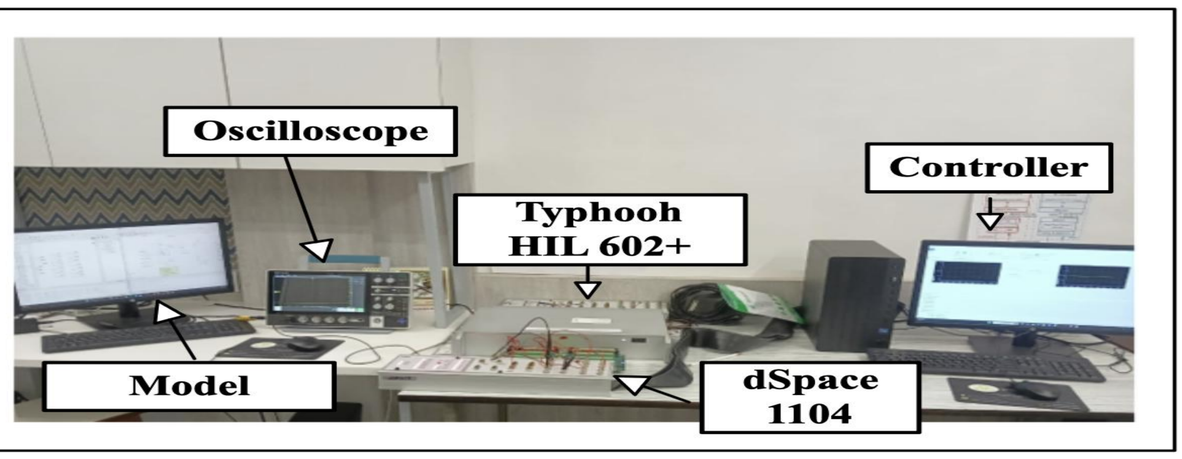
Introduction:

- 3-Phase Induction Motor(IM): A widely used electrical motor for industrial and commercial applications.
- Field-Oriented Control (FOC): A vector control technique that decouples torque and flux control to improve efficiency and dynamic response.
- MATLAB Simulation: Designed for real-time system validation and optimization.
- dSPACE Integration: Used to implement and control the FOC algorithm on a real-time controller.
- Typhoon HIL 602+: Provides hardware-in-the-loop (HIL) simulation of the plant model for real-time testing and validation.

Block Diagram:



Field Oriented Control of IM



Typhoon and dSPACE simulation

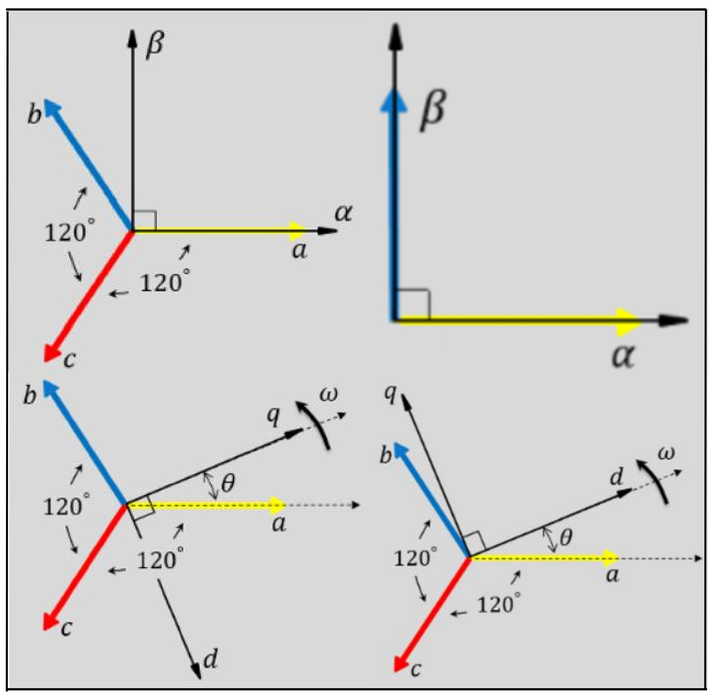
Mathematical Calculation:

Clarke Transformation (abc-αβ)

$$\beta = \frac{1}{3}(a + 2b)$$

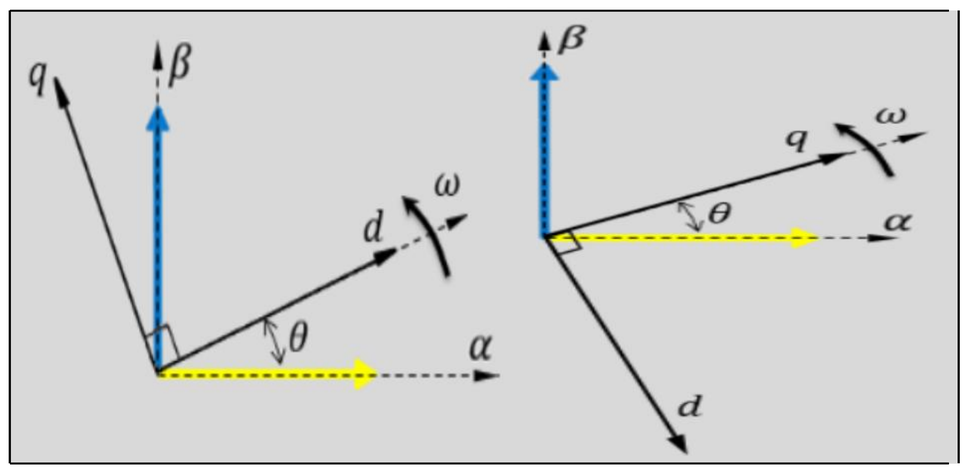
Park Transformation (αβ - dq)

$$d = \alpha\cos(\theta_e) + \beta\sin(\theta_e)$$
$$q = \alpha\sin(\theta_e) + \beta\cos(\theta_e)$$



Inverse Park Transformation (dq - αβ)

$$\alpha = d\cos(\theta_e) - q\sin(\theta_e)$$
$$\beta = d\sin(\theta_e) + q\cos(\theta_e)$$



References:

- T. Gallah, A. Khedher, M. F. Mimouni & F. M'sahli, Theoretical comparison between Field Oriented and Generalized Predictive Control for an Induction Motor , International Journal on Sciences &Techniques of Automatic control, IJ-STA, Vol. 1, No.1, pp 43-60, June 2007.
- M. Jemli , H. Ben Azza and M. Gossa, «Real-time implementation of IRFOC for Single-Phase Induction Motor drive using dSpace DS 1104 control board ». Simulation Modelling Practice and Theory 17, pp.1071–1080, March 2009.

Expected Results:

- FOC implementation in MATLAB under various loads.
- MATLAB+dSPACE+Typhoon HIL 602+ enabled seamless motor control validation.
- Future-ready approach for EVs, industrial drives, and renewable energy.