



IJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** V **Month of publication:** May 2025

DOI: <https://doi.org/10.22214/ijraset.2025.71772>

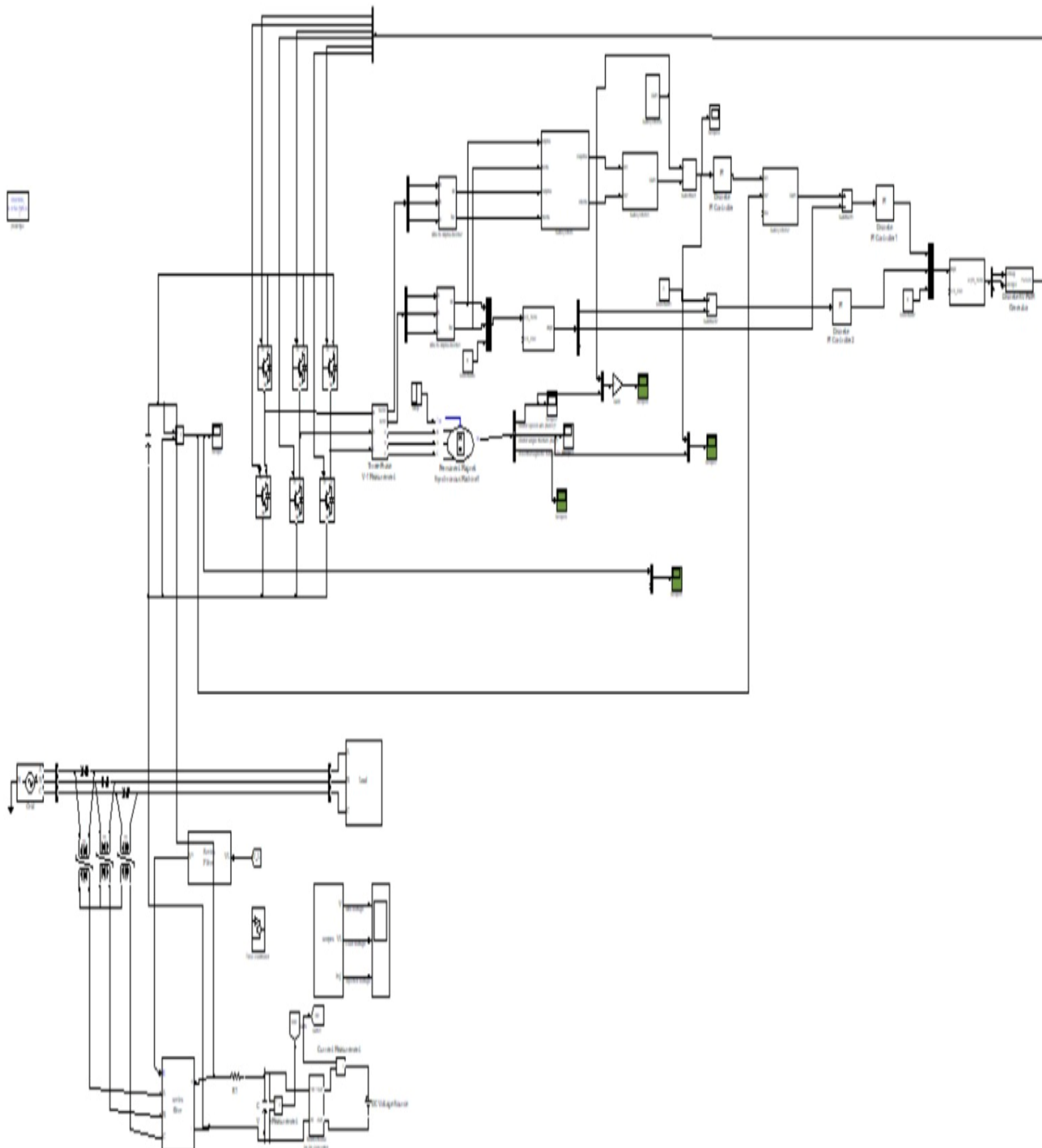
www.ijraset.com

Call:  08813907089

E-mail ID: ijraset@gmail.com

The proposed drive system consists of the following main components:

- * Three-Phase AC Supply
- * Diode Bridge Rectifier
- * DC-Link with Film Capacitor
- * Voltage Source Inverter (VSI)
- * Interior Permanent Magnet Synchronous Motor (IPMSM)
- * Closed-loop Sensorless Controller (MATLAB/Simulink)



III. METHODOLOGY

This project involves the simulation of two integrated systems using MATLAB/Simulink: the vector control of an Interior Permanent Magnet Synchronous Machine (IPMSM) and the compensation of voltage sag and swell using a Dynamic Voltage Restorer (DVR). The IPMSM system is modeled to demonstrate precise speed and torque control through Field-Oriented Control (FOC). It begins with a three-phase voltage source supplying power to the IPMSM. The stator voltages and currents are measured and transformed from the three-phase ABC reference frame to the stationary $\alpha\beta$ frame using Clarke transformation, and further into the rotating dq0 frame using rotor angle information generated from sine and cosine functions. These transformations enable independent control of torque and flux. Compared to surface-mounted PMSMs, IPMSMs have saliency (different d-axis and q-axis inductances), which allows for additional torque generation through reluctance torque, making vector control even more effective. The dq components of the current are regulated by Proportional-Integral (PI) controllers, which produce reference voltages. These are then converted back to the $\alpha\beta$ frame and fed into a Discrete Space Vector PWM (SVPWM) generator. The SVPWM block outputs gate pulses to the inverter, which in turn drives the IPMSM with the desired AC voltage. The entire system is monitored using scopes that track rotor speed, torque, and other electrical parameters, while the simulation is managed through a discrete Powergui block with a 5e-5 second sampling time. Step inputs are used to test dynamic performance under varying load or speed conditions. In parallel, a DVR-based voltage compensation system is implemented to mitigate power quality issues such as voltage sag and swell, which commonly occur in power systems. The DVR is connected in series with the grid and load to inject a compensating voltage during disturbances.

IV. SIMULATION RESULTS

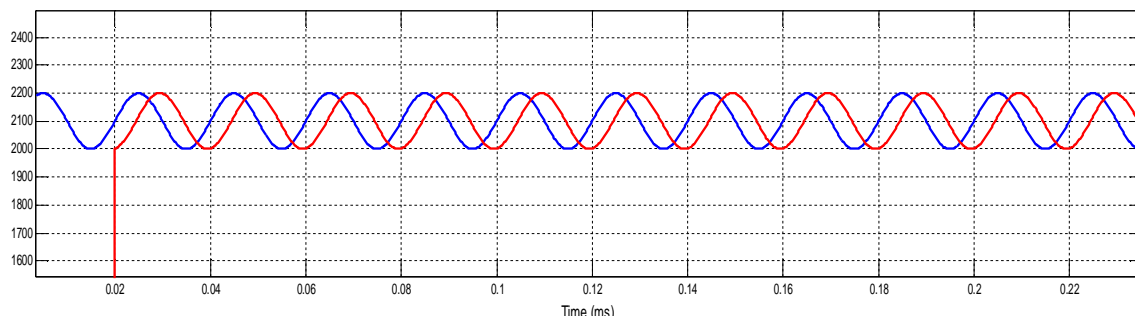


Fig:Speed Estimation in IPMSM

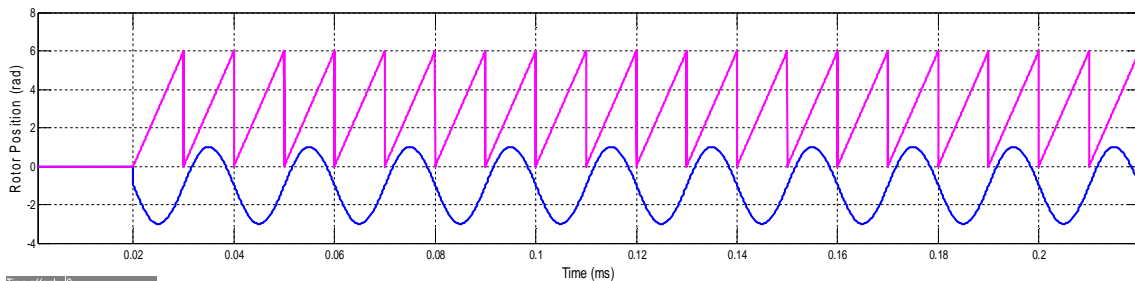


Fig: Rotor Position

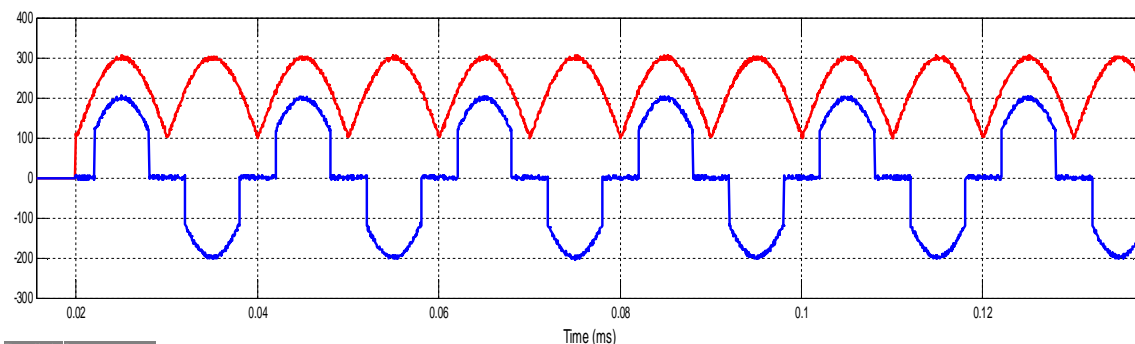


Fig:Voltage & Current Waveforms

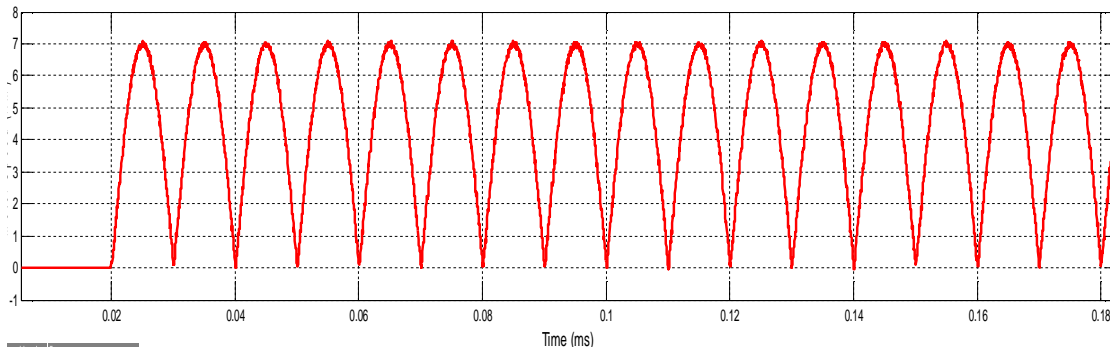


Fig:Motor Torque

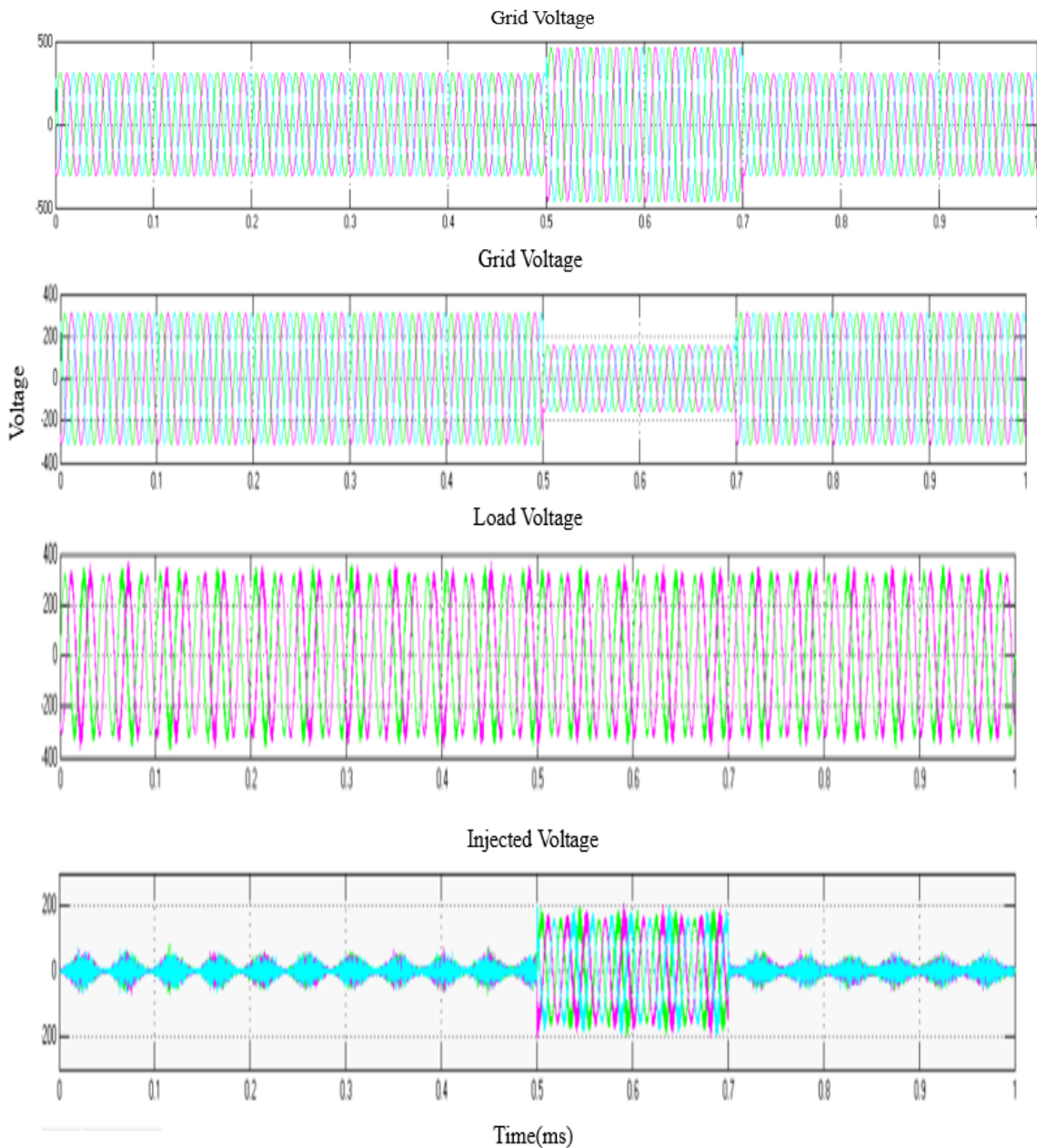


Fig:Voltage Swell and Sag Condition

The above graphs illustrate the results obtained from simulating the system in MATLAB/Simulink. These results demonstrate several key performance aspects:

1) *Stable Speed and Torque Performance Under Varying Load Conditions:*

The simulation results show that the system maintains a consistent and stable speed as well as torque output, even when the load on the motor changes. This indicates robust control capabilities and reliable performance in dynamic operating environments.

2) *Accurate Rotor Position Tracking Using Sensor less Feedback:*

The system effectively tracks the rotor position without relying on physical sensors. This sensor less feedback method ensures precise estimation of the rotor's angular position, which is crucial for the control and operation of the motor

3) *Effective Compensation During Voltage Sags and Swells:*

The system is able to detect and compensate for voltage fluctuations, such as sags (drops) and swells (increases), in the power supply. This compensation helps to sustain normal motor operation and protect it from potential damage caused by these disturbances.

V. CONCLUSION

This paper demonstrates a sensorless vector control system for IPMSM drives with power-saving features and voltage disturbance handling. The model-based estimator provides accurate rotor information without mechanical sensors. The power optimization strategy and sag/swell compensation increase system efficiency and robustness, making it suitable for industrial applications requiring high reliability and compact design.

REFERENCES

- [1] Zhang, G.; Wang, G.; Xu, D.; Yu, Y. Discrete-time low-frequency-ratio synchronous-frame full-order observer for position sensorless IPMSM drives. *IEEE J. Emerg. Sel. Top. Power Electron.* 2017, 5, 870–879.
- [2] Liang, D.; Li, J.; Qu, R.; Kong, W. Adaptive second-order sliding-mode observer for PMSM sensor-less control considering VSI nonlinearity. *IEEE Trans. Power Electron.* 2018, 33, 8994–9004.
- [3] Quan Yin¹, Haichun Li, Hui Luo, Qingyi Wang and Chendong Xu. An Improved Sensorless Vector Control Method for IPMSM Drive with Small DC-Link Capacitors. School of Automation, Huazhong University of Science and Technology, Wuhan 430000, China. 2 January 2020; Accepted: 22 January 2020; Published: 26 January 2020.



10.22214/IJRASET



45.98



IMPACT FACTOR:
7.129



IMPACT FACTOR:
7.429



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089  (24*7 Support on Whatsapp)