Point-on-Wave Analysis of Three-Phase Induction Motor Drive Under Fault External to the Power Plant

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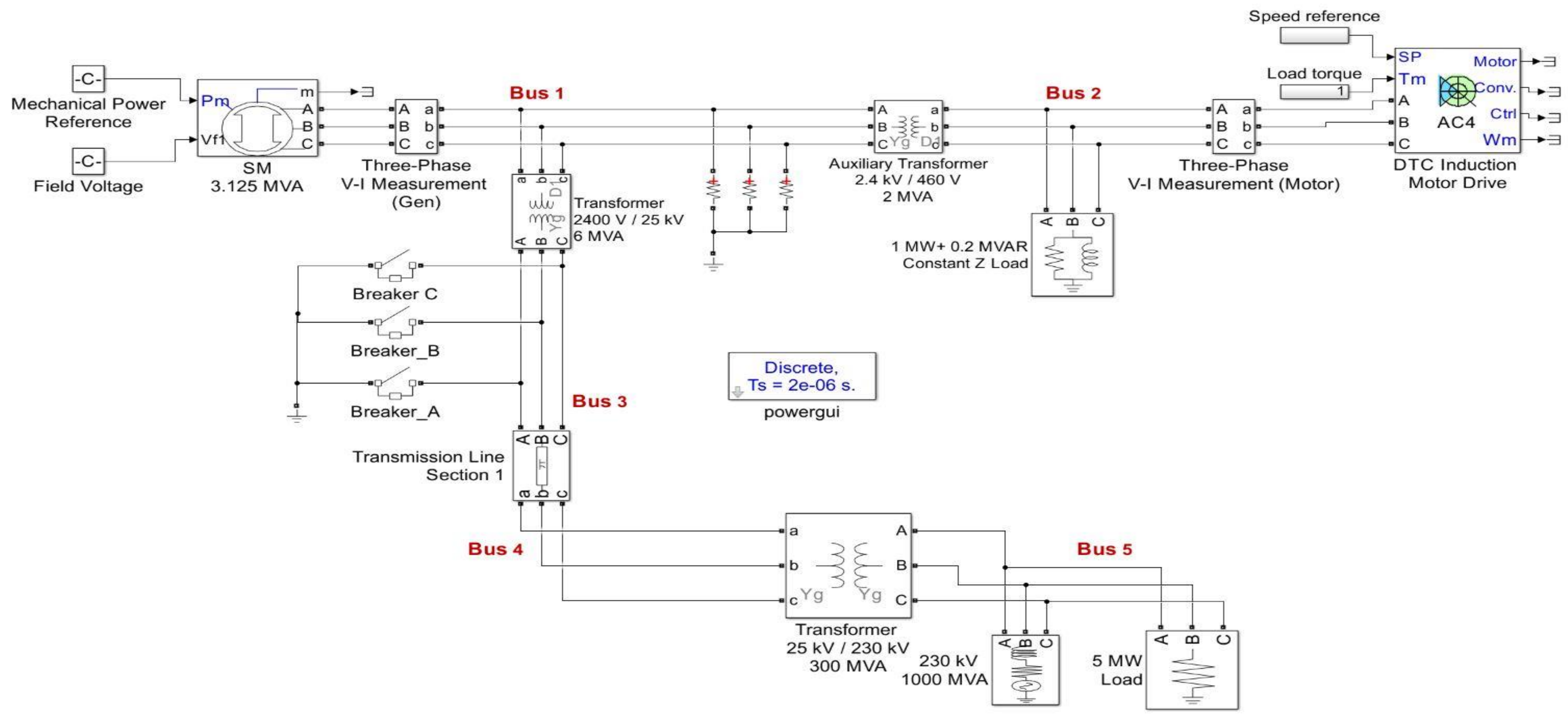
Point-on-wave analysis is used to evaluate the behavior of Adjustable Speed Drives (ASDs) with respect to faults external to the power plant. Faults are simulated for fault type (single-phase to ground and three-phase to ground) and five different fault resistances for each type to ensure similar voltage dip between those two. Results show that power consumption stays constant at a value lower than the steady state value for a single-phase fault that occurs below a threshold voltage of 85%. For a three-phase fault, the ASD works as a constant power load above a threshold terminal voltage of 86%, but under the value the power drops to zero but not linearly as assumed in the dynamic model of an ASD. Results also show that the positive sequence real power absorption profile differs between a single-phase and three-phase fault for the same amount of voltage dip which dictates the importance of including the fault type while deriving a positive sequence model of the drive for dynamic simulation.

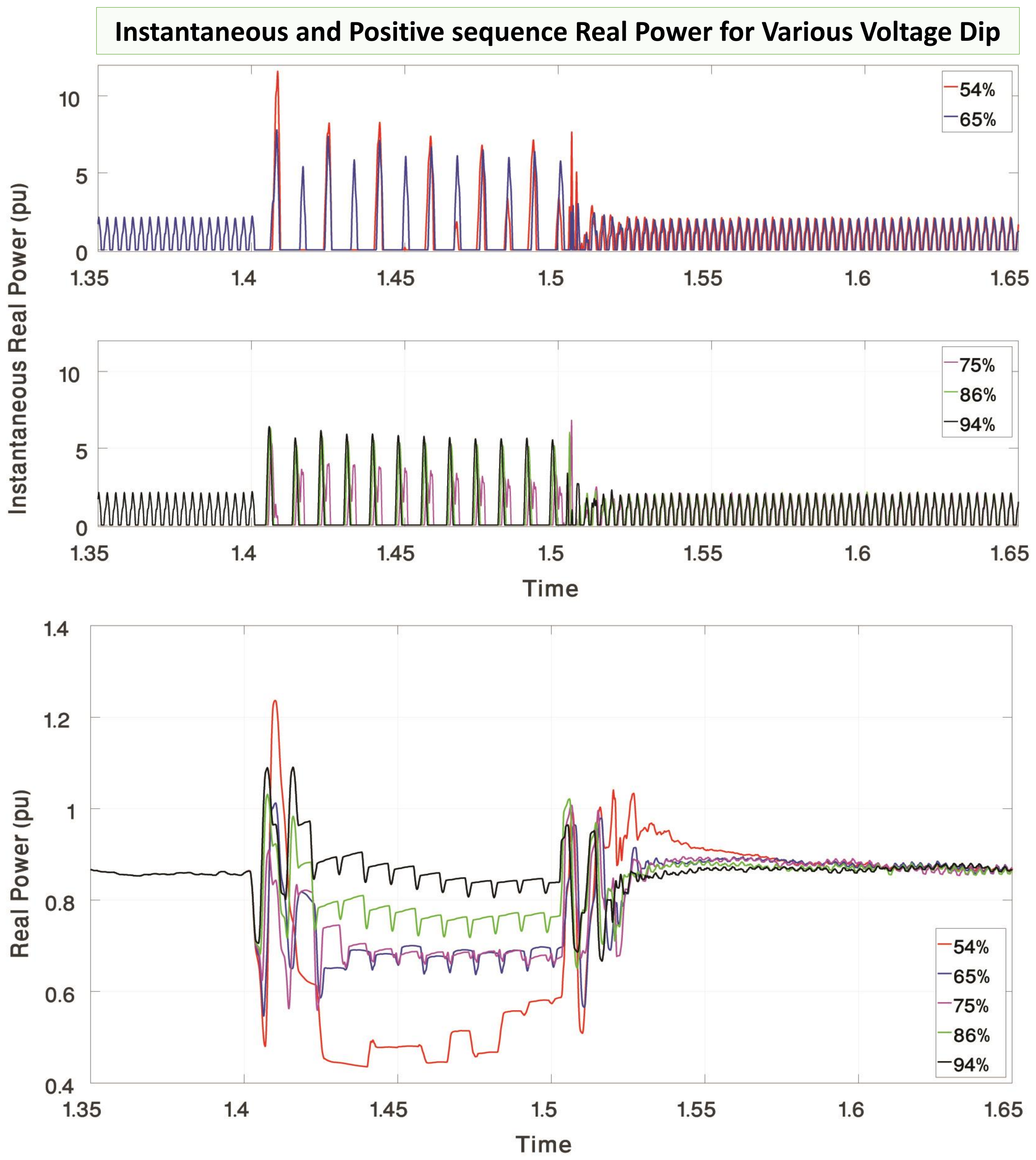
1. System Description and Simulation Approach

- Transient behavior is analyzed for a **150 kVA ASD** running **an auxiliary induction motor** (e.g., fans, pumps, cooling) for a **3.125 MVA** generator. The motor and additional auxiliary load are being run by a **2 MVA** auxiliary transformer. Two **step-up transformers** connect the generator to a **230 kV** infinite bus.
- Disturbances created by a **6 cycle (0.1 second)** fault including **single-phase to ground fault and three-phase to ground fault** are simulated at a bus external to the plant.
- The response of the ASD to different magnitude of voltage dip is analyzed by using **five different fault resistance values** for both the fault types.



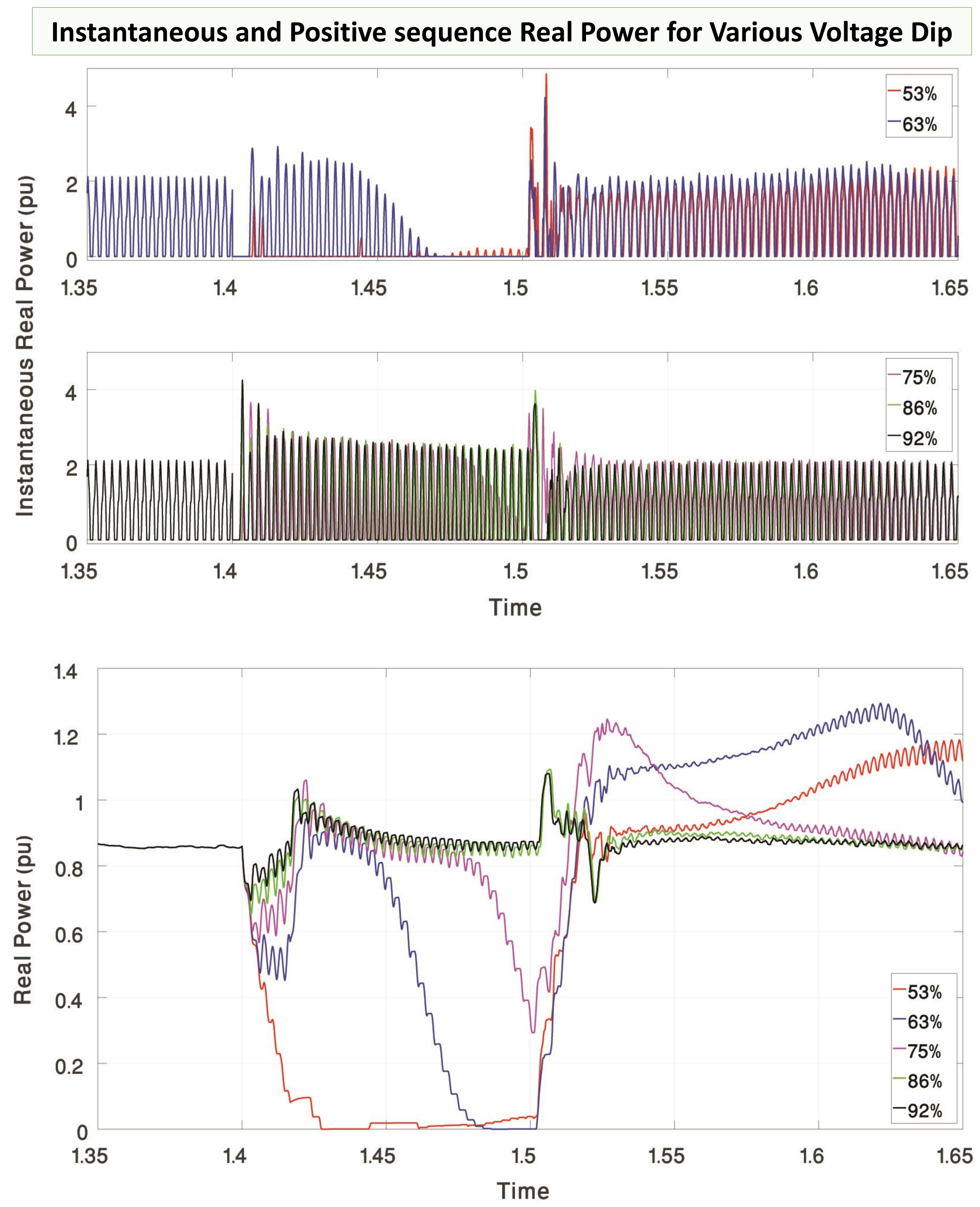
2. Simulation Results for Single-Phase to Ground Fault

- Lower voltages reduce the positive sequence real power absorbed by the drive.
- In **54% and 65% of terminal voltage dip**, power drops off rapidly and then holds nearly constant for the fault period.
- The other two phases remain active (as the fault is simulated at phase A) and charge the DC link capacitor. The capacitor voltage is sufficient to drive the motor during the fault period.

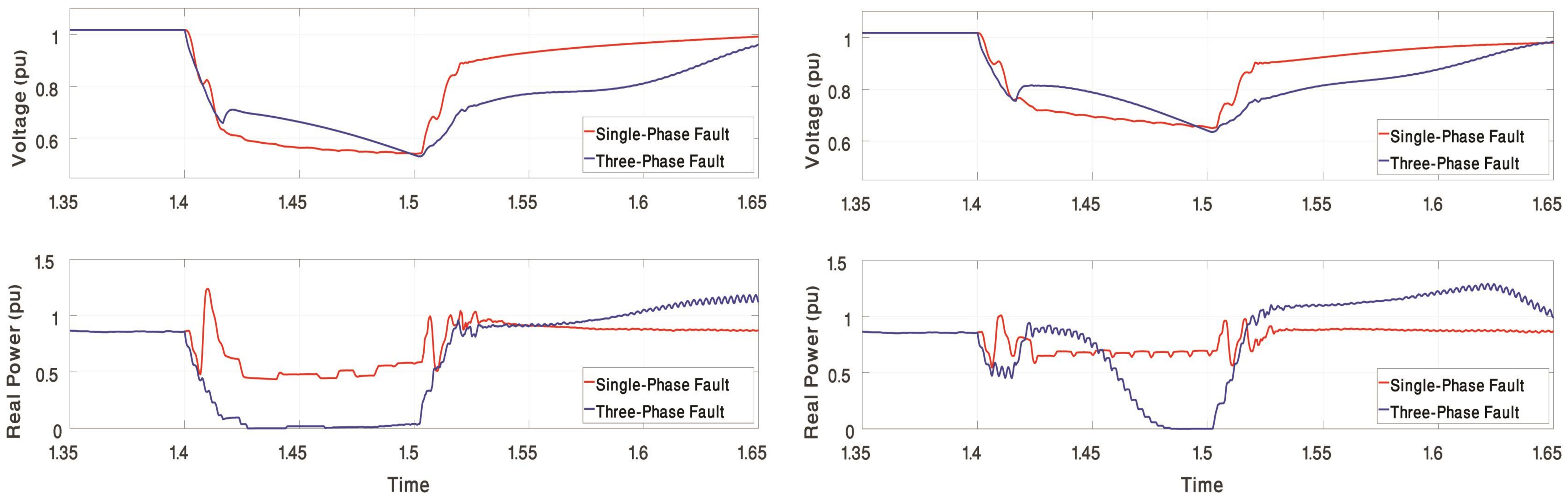


3. Simulation Results for Three-Phase to Ground Fault

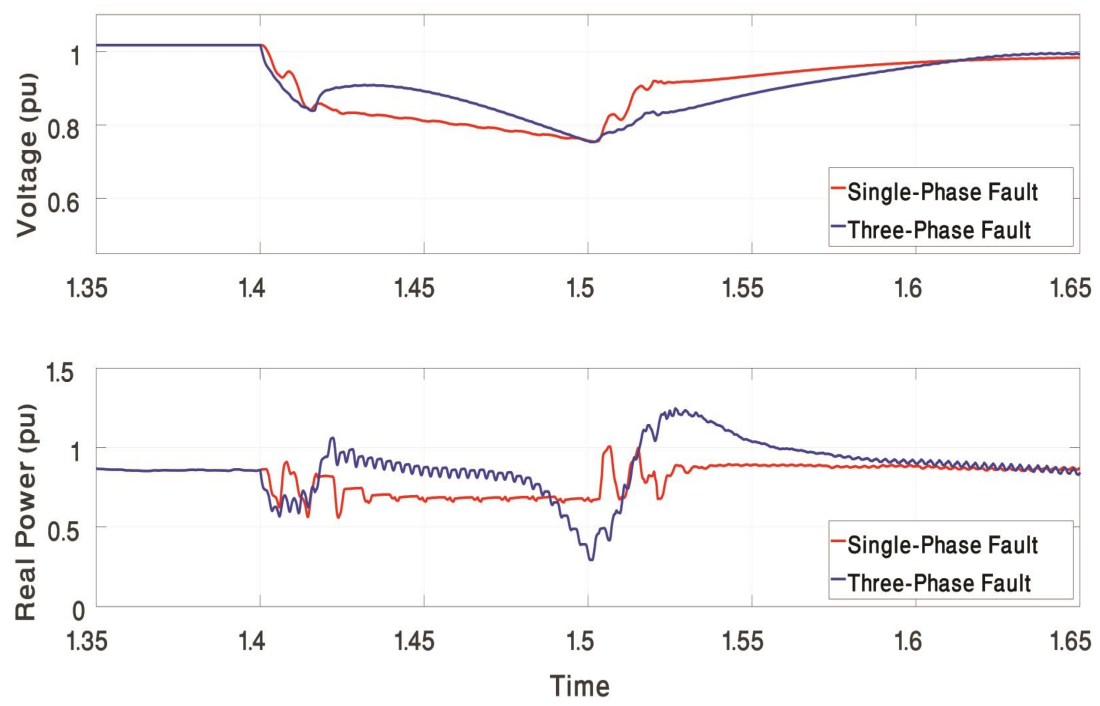
- **A voltage dip of 53%** creates the fastest drop in real power absorption and then holds steady near zero.
- A **voltage dip of 63% and 75%** indicates that positive sequence power drops briefly before increasing to steady state levels for a few cycles, and then decreases again towards zero as fault time increases.
- Results contrast the conventional assumption that power absorption of the drive decreases linearly until a threshold value of the terminal voltage is reached.



4. Comparing Single-Phase and Three-Phase Fault Cases



- For a single-phase fault, the drive continued to absorb power from the source even at the greatest voltage dip.
- For a three-phase fault, the positive sequence power dropped immediately to zero for the case **with the greatest voltage dip (53%)** and decreased slowly to zero for smaller voltage dips as fault duration increased.



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