SIMULASI PERBANDINGAN KINERJA MEKANISME *FAULT RIDE THROUGH* BERBASIS KONTROL PI DAN MPC PADA SISTEM PLTS TERHUBUNG *GRID* PADA KONDISI *LOW VOLTAGE RIDE THROUGH*

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ABSTRAK

Gangguan voltage *sag* pada sistem PLTS terhubung grid dapat menurunkan transfer daya aktif, mengganggu kestabilan tegangan *dc-link*, dan menyebabkan inverter gagal mempertahankan operasi apabila tidak dilengkapi mekanisme Fault Ride Through (FRT). Penelitian ini bertujuan menganalisis dan membandingkan kinerja FRT berbasis kontrol Proportional-Integral (PI) dan Model Predictive Control (MPC) pada kondisi Low Voltage Ride Through (LVRT). Sistem PLTS 100 kW, tiga fasa 400 V, disimulasikan menggunakan MATLAB/Simulink dengan voltage *sag* simetris 0,8; 0,6; 0,3; dan 0,07 pu selama 400 ms. Evaluasi dilakukan berdasarkan settling time recovery, overshoot tegangan *dc-link*, injeksi daya reaktif, Total Harmonic Distortion (THD), dan kepatuhan LVRT. Sistem tanpa FRT gagal melakukan recovery pada seluruh skenario. PI-FRT mampu pulih pada *sag* 0,8 dan 0,6 pu dengan settling time 60,40 ms dan 72,42 ms, tetapi gagal pada 0,3 dan 0,07 pu. MPC-FRT mampu melakukan recovery pada seluruh skenario dengan settling time 51,01; 62,46; 692,19; dan 744,97 ms. Rata-rata THD MPC-FRT hanya 0,20%, dibandingkan PI-FRT sebesar 3,04%. MPC-FRT juga menunjukkan overshoot *dc-link* lebih rendah pada tiga dari empat skenario dan kemampuan LVRT yang lebih konsisten. Dengan demikian, MPC-FRT lebih andal dalam meningkatkan ketahanan sistem PLTS terhadap voltage *sag*.

Kata kunci : *Fault Ride Through*; *Low Voltage Ride Through*; *Model Predictive Control*; PLTS Terhubung *Grid*; *Voltage sag*.

PERFORMANCE COMPARISON SIMULATION OF A FAULT RIDE THROUGH MECHANISM BASED ON PI AND MPC CONTROL IN A GRID-CONNECTED PV SYSTEM UNDER LOW VOLTAGE RIDE THROUGH CONDITIONS

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ABSTRACT

Voltage sag disturbances in grid-connected photovoltaic (PV) systems can reduce active power transfer, destabilize the dc-link voltage, and impair inverter operation when adequate Fault Ride Through (FRT) capability is not implemented. This study analyzes and compares the performance of Proportional–Integral (PI)- and Model Predictive Control (MPC)-based FRT strategies under Low Voltage Ride Through (LVRT) conditions. A 100-kW, three-phase, 400-V grid-connected PV system was modeled and simulated in MATLAB/Simulink under symmetrical voltage sags of 0.8, 0.6, 0.3, and 0.07 p.u., each lasting 400 ms. Performance was evaluated in terms of recovery settling time, dc-link voltage overshoot, reactive power injection, Total Harmonic Distortion (THD), and LVRT compliance. The system without FRT failed to recover under all sag conditions. PI-FRT recovered at 0.8 and 0.6 p.u. with settling times of 60.40 and 72.42 ms, respectively, but failed at 0.3 and 0.07 p.u. MPC-FRT successfully recovered under all scenarios with settling times of 51.01, 62.46, 692.19, and 744.97 ms, respectively. MPC-FRT also achieved a lower average THD of 0.20% compared with 3.04% for PI-FRT and exhibited lower dc-link overshoot in three of the four scenarios. Therefore, MPC-FRT provides more consistent and reliable LVRT performance for grid-connected PV systems.

Keywords: *Fault Ride Through; Low Voltage Ride Through; Model Predictive Control; Grid-Connected PV System; Voltage sag.*