# RINGKASAN

## PERANCANGAN DAN ANALISIS PROTOTYPE H-BRIDGE VOLTAGE SOURCE INVERTER (VSI) PWM TERHUBUNG JALA-JALA LISTRIK

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Perkembangan sistem pengisian kendaraan listrik berbasis *hybrid* mendorong kebutuhan inverter *grid-connected* yang mampu menyalurkan daya ke beban sekaligus berinteraksi dengan jaringan listrik secara terkendali. Salah satu solusi yang dapat memenuhi kebutuhan tersebut adalah adanya inverter *grid-connected* yang mampu mengonversi energi DC menjadi AC yang terintegrasi dengan jaringan sehingga proses penyaluran daya dapat berlangsung secara terkendali.

Penelitian ini difokuskan pada perancangan dan analisis prototipe *H-bridge Voltage Source Inverter* (VSI) berbasis modulasi *Sinusoidal Pulse Width Modulation* (SPWM) unipolar yang terhubung jaringan dengan metode *Phase Locked Loop* (PLL) digital. Metode penelitian meliputi studi literatur, perancangan dan simulasi menggunakan PSIM dan Proteus, serta implementasi prototipe berbasis mikrokontroler Arduino Uno sebagai sistem kendali.

Hasil simulasi menunjukkan karakteristik sinkronisasi dan kualitas gelombang yang ideal. Namun, pada implementasi prototipe, inverter belum mampu beroperasi sebagai sistem *grid-connected* secara optimal. Tegangan grid berada pada kisaran 7,8–9,2 V dengan arus inverter 0,382–0,418 A, serta daya aktif inverter 2,7–3,5 W yang lebih rendah dibandingkan daya grid sebesar 9,7–13,6 W. Keterbatasan sinkronisasi fase dan kendali arus menyebabkan faktor daya hanya sebesar 0,83 dan nilai THD melampaui batas IEC 61727, sehingga pengujian prototipe merepresentasikan validasi prinsip kerja dasar inverter dan keterbatasan implementasi nyata.

Kata kunci: Inverter terhubung jaringan, Inverter sumber tegangan, H-bridge, SPWM unipolar, kontrol arus, *Phase Locked Loop* (PLL)

## *SUMMARY*

### *DESIGN AND ANALYSIS OF A PROTOTYPE GRID-CONNECTED H-BRIDGE VOLTAGE SOURCE INVERTER (VSI) USING PWM*

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*The development of hybrid electric vehicle charging systems has driven the need for grid-connected inverters capable of delivering power to loads while interacting with the electrical grid in a controlled manner. One solution to meet this requirement is the use of grid-connected inverters that convert DC energy into AC power integrated with the grid, enabling controlled power transfer.*

*This research focuses on the design and analysis of a prototype H-bridge Voltage Source Inverter (VSI) based on unipolar Sinusoidal Pulse Width Modulation (SPWM) and connected to the grid using a digital Phase Locked Loop (PLL) method. The research methodology includes a literature study, circuit design and simulation using PSIM and Proteus, as well as prototype implementation based on an Arduino Uno microcontroller as the control system.*

*Simulation results show ideal synchronization characteristics and waveform quality. However, in the prototype implementation, the inverter was not able to operate optimally as a grid-connected system. The grid voltage was in the range of 7.8–9.2 V with inverter current of 0.382–0.418 A, while the inverter active power of 2.7–3.5 W was lower than the grid power of 9.7–13.6 W. Limited phase synchronization and current control resulted in a power factor of only 0.83 and THD values exceeding the IEC 61727 standard, indicating that the prototype testing mainly validated the basic operating principles of the inverter and revealed practical implementation limitations.*



*Keywords: Grid-connected inverter, Voltage Source Inverter (VSI), H-bridge, unipolar SPWM, current control, Phase Locked Loop (PLL)*