

ABSTRACT

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Title : *Analysis of the Influence of Field Current (I_d) and Torque Current (I_q) on the Speed and Torque Characteristics of a Three-Phase Induction Motor Using the Field Oriented Control (FOC) Method*

Three-phase induction motors are widely used in industry but suffer from control limitations due to their non-linear characteristics. Field Oriented Control (FOC) addresses this challenge by transforming the induction motor's dynamics to resemble a DC motor, allowing for the decoupling of flux and torque control. The effectiveness of FOC relies on the precise regulation of two current components: the field current (i_{ds}) controlling the flux, and the torque current (i_{qs}) controlling the torque. This study aims to analyze the fundamental differences in motor characteristics between the conventional Direct On Line (DOL) method and the FOC method, as well as to investigate the influence of i_{ds} and i_{qs} variations on speed and torque response. An Indirect Field Oriented Control (IFOC) system was designed and validated through MATLAB/Simulink simulation, then empirically implemented on the Lucas-Nuelle Power Electronics and Drives 300 W hardware. The results demonstrate that FOC significantly enhances motor performance. Unlike the DOL method, which experienced torque breakdown at ≈ 2.16 N.m, the FOC method operated stably up to the test limit of ≈ 2.97 N.m, maintaining a higher average power factor (≈ 0.837). The current component analysis validated the decoupling principle: the torque current (i_{qs}) proved to be directly proportional to the generated torque, while the field current (i_{ds}) successfully controlled the flux independently without compromising speed stability. This research empirically validates that FOC provides a superior torque operating range and system stability compared to DOL.

Keywords: *Field Oriented Control (FOC), Induction Motor, Field Current (i_{ds}), Torque Current (i_{qs}), Decoupling, Torque-Speed Characteristics.*

DAFTAR ISI

HALAMAN JUDUL.....	i
HALAMAN PERNYATAAN ORISINALITAS.....	ii
HALAMAN PENGESAHAN.....	iii
KATA PENGANTAR	iv
HALAMAN PERNYATAAN PERSETUJUAN MENYERAHKAN HAK MILIK ATAS TUGAS AKHIR UNTUK KEPENTINGAN AKADEMIS	vii
ABSTRAK	viii
<i>ABSTRACT</i>	ix
DAFTAR ISI.....	x
DAFTAR GAMBAR	xiii
DAFTAR TABEL.....	xvii
BAB I PENDAHULUAN	I-1
1.1 Latar Belakang	I-1
1.2 Rumusan Masalah	I-3
1.3 Tujuan Penelitian	I-3
1.4 Manfaat Penelitian	I-4
1.5 Batasan Masalah.....	I-4
1.6 Sistematika Penulisan	I-4
BAB II LANDASAN TEORI	II-1
2.1 Motor Induksi.....	II-1
2.1.1 Prinsip Kerja	II-1
2.1.2 Rangkaian Ekuivalen	II-2
2.1.3 Konstruksi	II-4
2.1.4 Aliran Daya	II-6
2.1.5 Karakteristik [8]	II-9
2.1.6 Metode <i>Starting Direct On Line</i> (DOL).....	II-11
2.2 <i>Reference Frame Transformation</i>	II-12
2.3 Model Dinamis Motor Induksi.....	II-14
2.3.1 Model Dinamis Kerangka Acuan Stasioner ($\alpha - \beta$)	II-14
2.3.2 Model Dinamis Kerangka Acuan Berputar Sinkron (d-q)	II-15
2.3.3 Model Dinamis Kecepatan Dan Torsi.....	II-17
2.4 <i>Field Oriented Control</i> (FOC)	II-17
2.4.1 <i>Indirect Field Oriented Control</i> (IFOC)	II-20
2.4.2 Hubungan Arus Medan Stator (<i>ids</i>) Terhadap Fluks Medan Magnet (λ_{dr})	II-22

2.4.3	Hubungan Arus Beban Stator (i_{qs}) Terhadap Torsi (T_e).....	II-23
2.5	Inverter	II-24
2.6	<i>Sinusoidal Pulse Width Modulation</i> (SPWM)	II-26
2.7	<i>Space Vector Pulse Width Modulator</i> (SVPWM).....	II-27
2.8	Pengenalan Matlab Simulink	II-32
2.9	Modul percobaan <i>Power Electronics and Drives</i> 300 W Lucas-Nuelle	II-34
2.10	Penelitian Terkait	II-34
BAB III METODOLOGI PENELITIAN		III-1
3.1	Tahapan Penelitian	III-1
3.2	Perancangan sistem	III-6
3.2.1	Perancangan Sistem Kendali.....	III-6
3.2.2	Menentukan nilai parameter.....	III-8
3.2.3	Perancangan model motor induksi	III-9
3.2.4	Perancangan model SVPWM.....	III-13
3.2.5	Perancangan model sistem IFOC	III-16
3.2.6	Penerapan rancangan model pada MATLAB/Simulink	III-23
3.3	Pemodelan Unit.....	III-25
3.3.1	Model motor induksi	III-25
3.3.2	Model <i>Space Vector Pulse Width Modulation</i> (SVPWM).....	III-30
3.4	Pengujian Model Unit	III-34
3.4.1	Pengujian Model Motor induksi	III-34
3.4.2	Pengujian SVPWM	III-35
3.5	Pemodelan Sistem <i>Indirect Field Oriented Control</i> (IFOC).....	III-37
3.6	Pengujian Model Sistem <i>Indirect Field Oriented Control</i> (IFOC)..	III-42
3.7	Implementasi Model Sistem Ke Perangkat Keras.....	III-45
3.7.1	Penyesuaian model sistem <i>Indirect Field Oriented Control</i> (IFOC)	III-45
3.7.2	<i>Power Electronics and Drives</i> 300 W Lucas-Nuelle (Perangkat Keras)	III-52
3.8	Pengujian Perangkat Keras	III-57
3.8.1	Konfigurasi Perangkat Keras	III-58
3.9	Pengujian Karakteristik Motor Induksi	III-59
3.10	Waktu dan Tempat Penelitian	III-61
3.11	Matriks Kerja Penelitian	III-62
BAB IV HASIL DAN PEMBAHASAN		IV-1

4.1	Pendahuluan	IV-1
4.2	Hasil Pengujian dan Validasi Model Unit.....	IV-1
4.2.1	Hasil Pengujian Model Motor Induksi.....	IV-1
4.2.2	Hasil Pengujian Model SVPWM	IV-5
4.3	Hasil Pengujian Model Sistem IFOC (Simulasi)	IV-14
4.3.1	Analisa Sinyal Internal Algoritma IFOC	IV-14
4.3.2	Analisa Skenario A: Respons Pelacakan Kecepatan (Simulasi).....	IV-26
4.3.3	Analisa Skenario B: Respons Terhadap Perubahan Arus Medan (Simulasi).....	IV-31
4.4	Hasil Implementasi dan Pengujian pada Perangkat Keras.....	IV-36
4.4.1	Analisa Skenario A: Respons Pelacakan Kecepatan (Perangkat Keras)	IV-38
4.4.2	Analisa Skenario B: Respons Terhadap Perubahan Arus Medan (Perangkat Keras).....	IV-44
4.5	Hasil Pengujian Karakteristik Motor Induksi	IV-50
4.6	Analisa komparatif.....	IV-66
4.6.1	Analisis Pengaruh arus medan (<i>ids</i>) dan arus beban (<i>iqs</i>).....	IV-67
4.6.2	Analisa Perbandingan Karakteristik DOL dan FOC.....	IV-68
BAB V KESIMPULAN DAN SARAN.....		V-1
5.1	Kesimpulan	V-1
5.2	Saran.....	V-3
DAFTAR PUSTAKA		1
LAMPIRAN.....		3