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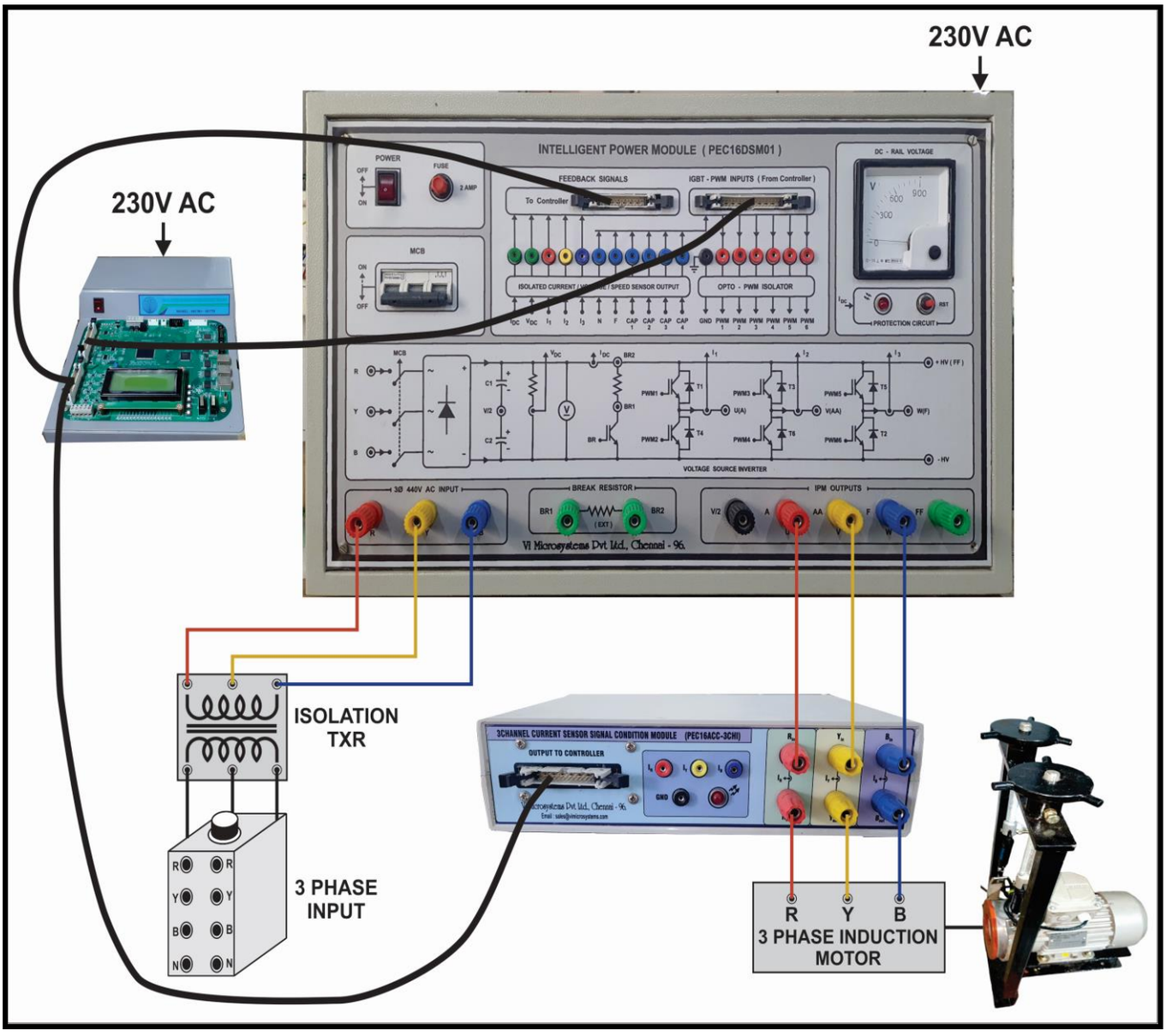
MATLAB FOC & DTC based three ϕ Induction Motor Drive Trainer



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Dear Sir,

Vi Microsystems Pvt. Ltd. is a pioneer for Designing & Manufacturing Engineering Educational Lab Equipment's. We are catering more than 30 Laboratories for MECH, CIVIL, ECE, EEE, EIE, CSE & IT, Branches of ITI, Polytechnic and Engineering Institutions with various ranges of products since last **FOUR DECADES**.

Most of our products are completely designed and manufactured at our In-House Research & Development department, which is recognized by Department of Scientific and Industrial Research (DSIR) , CSIR, Government of India, Ministry of Science and Technology (TU/IV-RD/1448/2022, Dated : 15st March, 2023).

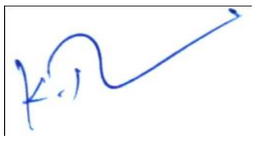
One more Innovative Product from our R&D Department: FOC & DTC control of Induction Motor, implemented on Micro-377D.

As it is very clear from the block diagram, a V/F control is only a scalar control and having lot of disadvantages, whereas FOC & DTC are vector control and it is much better control of torque and speed for Induction Motor. It would be a very useful tool for Research Students.

We are pleased to submit our valuable **proposal for "MATLAB SIMULINK BASED FOC & DTC CONTROL FOR 3 Φ INDUCTION MOTOR" for YOUR EEE DEPARTMENT.** And it would be a ideal set up for Lab Experimentation and Research students, especially for **Power Electronics & Drives lab**.

We sincerely hope that the offer is in line with your requirement and looking forward to receive your valuable order.

Yours faithfully,
For Vi Micro systems Pvt. Ltd.,



AUTHORIZED SIGNATURE

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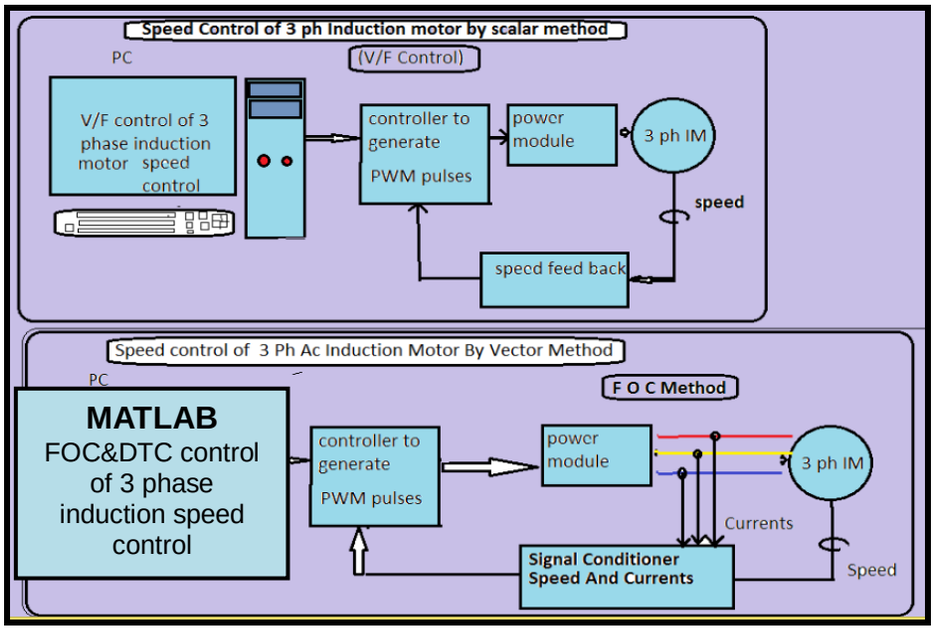

MATLAB BASED FOC AND DTC BASED THREE PHASE INDUCTION MOTOR DRIVE TRAINER

We hereby offer you MATLAB FOC & DTC based Three Phase Induction Motor Drive

Sl.No.	Description of Item	Qty
a	DUAL CORE DELFINO BASED DEVELOPMENT BOARD	1
b	IPM BASED POWER MODULE	1
c	1 HP THREE PHASE AC MOTOR – SPRING BALANCE LOAD SET UP WITH QEP SENSOR	1
d	Three Channel Current Sensor with Signal Conditioner Module	1
e	Field Oriental Control Implementation in MATLAB-SIMULINK	1
f	Direct Torque Control Implementation in MATLAB-SIMULINK	1

OPTIONAL:-

g	EDDY CURRENT LOAD inlieu OF SPRING BALANCE LOAD	1
h	TORQUE SENSOR i. Non-Contact Type Torque Sensor ii. Load Cell based Torque Measurement	 1 1

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a. DUAL CORE DELFINO BASED DEVELOPMENT BOARD (MICRO 28377D)

The Micro-28377D Trainer kit is intended and developed for advanced closed-loop control applications for Power electronics, Smart grid etc.., It is also focused for students to learn the multi-processor architecture and the inter processor communication mechanisms. The inbuilt peripherals of the processor lead to uncomplicated design for the developers in the emerging technology.
The onboard Delta Sigma modulator meant for current measurement of Power electronics, Drives, Smart grid & Power systems

Features:

- # Dual- Core 32-bit Delfino fixed point Processor
- # Operating Speed: 200MHz (For each core)
- # 32-bit floating-point unit (FPU) which supports floating point operations
- # Trigonometric Math Unit (TMU) to speed up the execution of trigonometric operations
- # Viterbi, Complex Math, and CRC Unit II (VCU-II) to accelerate the performance of FFT's and communications-based algorithms
- # Two CLA real-time control co-processors that run at the same speed as the main CPU's
- # Parallel processing capability effectively doubles the computational performance
- # 1MB (512KW) of on-board flash memory with error correction code (ECC)
- # 204KB (102KW) of SRAM
- # 16 Channels (16-bit/12-bit at 1.1 MSPS/3.5 MSPS) Successive Approximation ADCs
- # 16 Enhanced PWM outputs, 6 Enhanced Capture Inputs
- # 3 (12-bit) Buffered DACs
- # 2 SDFM with 8 Input Channels and PWM synchronization
- # External memory interface 16/32 bit support
- # 192 dedicated PIE vectors
- # MCU/DSP balancing code density & execution time
- # Single cycle read-modify-write instruction.

ON Board Features:

- 16 Numbers of user LEDs
- 2 Numbers of Limit Switches for user interface
- 4 Numbers of Push-Button Micro Switches
- 1 SPDT Switch for user interface
- 20 × 4 Alphanumeric LCD
- 256MB of SDRAM
- Quadrature Encoder Interface
- Opto-isolated USB Interface
- Opto-isolated USB to Serial Interface
- Opto-isolated on board USB to JTAG Emulator
- PWM Outputs and Capture Inputs are terminated at 34-pin FRC connector
- 16 Channel ADC inputs are terminated at 26-pin FRC connector with buffered and protection
- DAC outputs and sigma Delta ADC inputs are terminated in screw type connector.
- External Emulator facility.
- Compatible with MATLAB SIMULINK

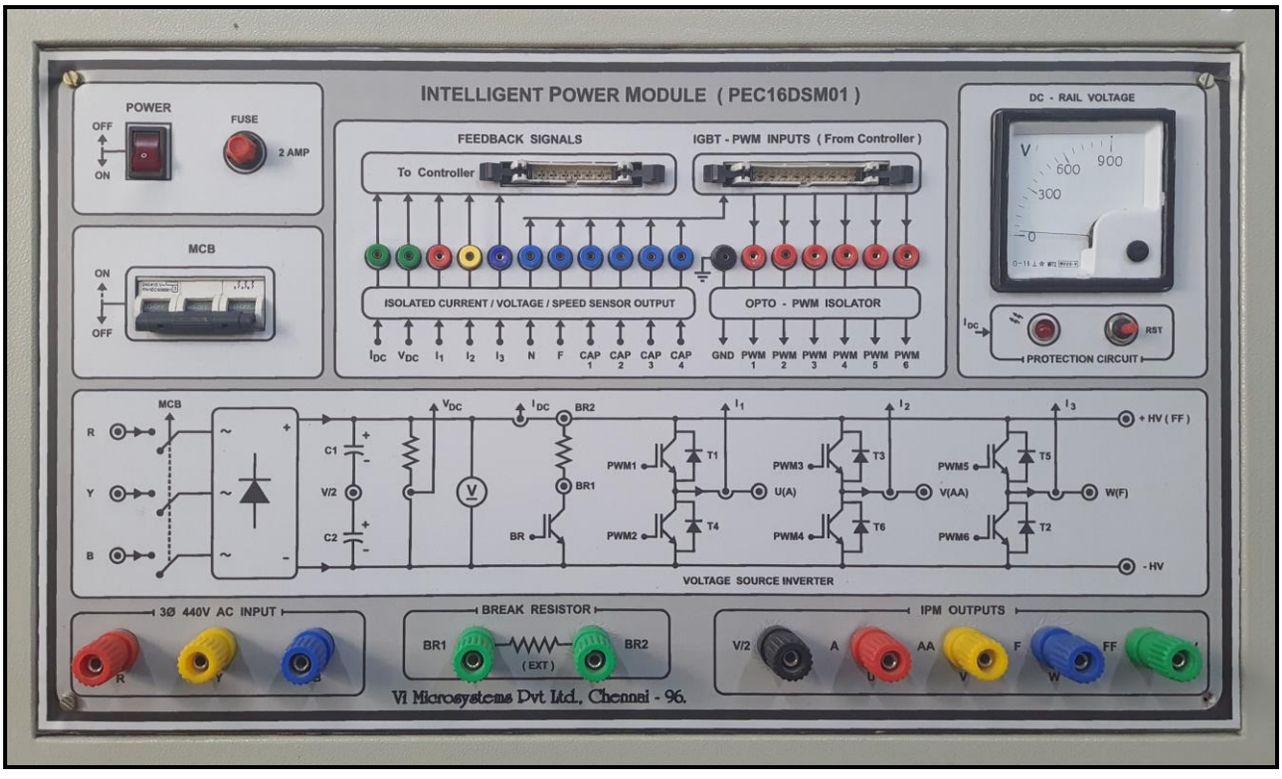
b. IPM BASED POWER MODULE

MAKE : VI MICROSYSTEMS
MODEL : [PEC16DSMO-1]

* Power Module is designed for Motor control Applications upto 3 HP by using the 3rd Generation IGBT & DIODE Technology Based IPM.
* Input : 1 Phase /3 phase 50 Hz AC.
  Output : 400V/10A (MAX), AC/DC on each Leg of 3 phase Bridge

IPM (INTELLIGENT POWER MODULE)

* 1200V, 25A, 3 Phase IGBT Inverter Bridge
* 1200V, 10A IGBT for over voltage Breaking
* Built - in over voltage, under voltage, over current & over Temperature Protection



ADDITIONAL FEATURES

* 1200V, 25A Converter Bridge for AC-DC power conversion
* 4 Nos of Hall Effect current sensors to sense the DC Link current & 3 output current of the Inverter Bridge
* 1 No of Hall Effect Voltage sensor to sense DC Link voltage
* All the PWM signals are isolated using Opto Isolator
* Protection circuit for over current with LED indication
* Optically Isolated Fault signal from the IPM is given to the Embedded/DSP controllers for protection.
* Independent Power supplies for all Isolated circuits.
* 0-900V Voltmeter to Indicate the DC Link Voltage
* FRC Connectors are provided to Interface with the Embedded/DSP controllers
* All the Input/ Output Lines are terminated at Banana sockets.

c. 1 HP THREE PHASE AC MOTOR – SPRING BALANCE LOAD SET UP WITH QEP SENSOR

MAKE : VI MICROSYSTEMS
MODEL : [PEC165ACSQ1]

This set up consists of one number of (1) Three phase AC motor coupled (2) Mechanical spring balance load set-up (3) Quadrature Optical encoder (512 PPR)

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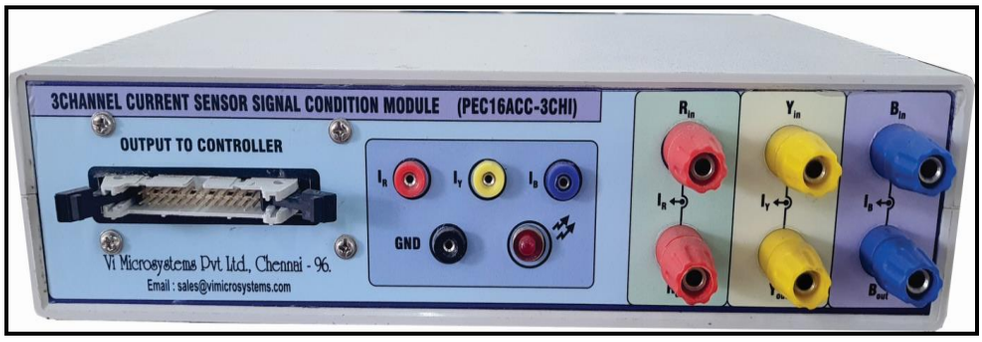
AC MOTOR SPECIFICATIONS :

Three phase squirrel cage induction motor.
Power : 1Hp (.75kw)
Current : 2 A, star connection
Three phase 230VAC : 50Hz input
Speed : 1390 rpm
Make : Siemens
Quadrature Optical encoder for Speed /position feedback

d. 3 Channel Current Sensor & Signal Conditioner Module. (PEC16DSMO ACC-01)

This Module consists of 3 Hall Effect Current Sensors to measure 3 phase currents upto 25A (AC/DC) and signal conditioners to provide 3.3V/5V to the ADC input of the DSP/FPGA Controller. Signal Conditioner outputs are terminated at 26 Pin FRC Connector.

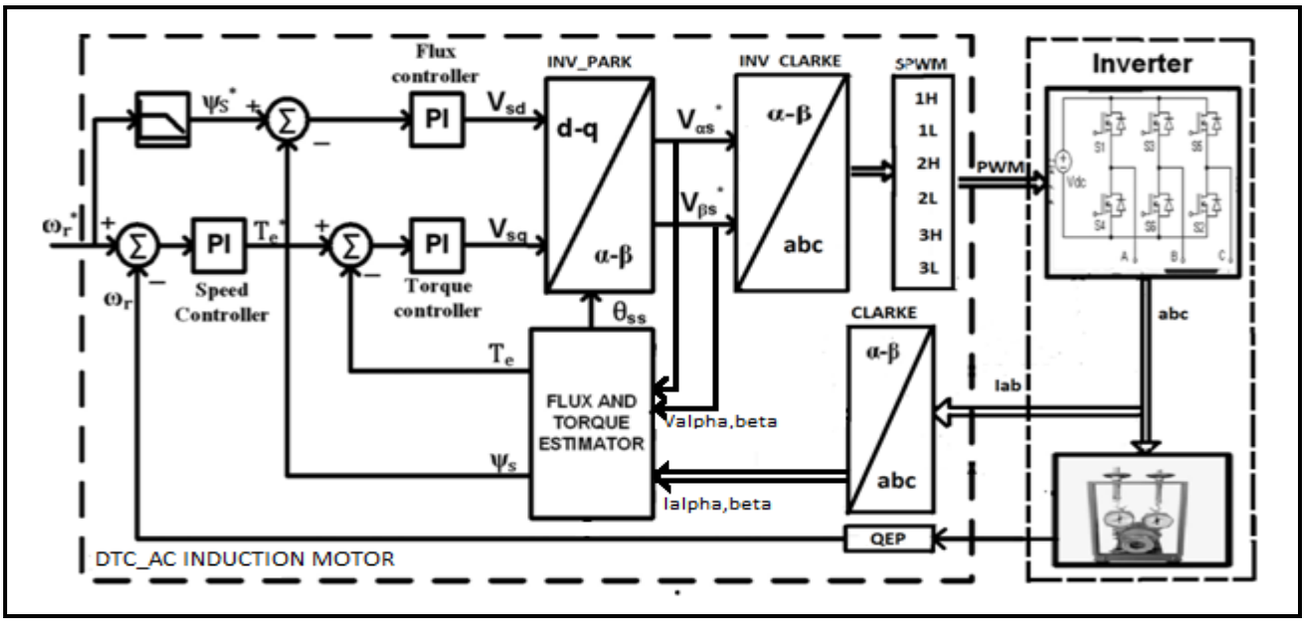


* Number of channels : 3 channel current.
* 3 number of current sensor with current rating of 25 Ampere AC/DC.
* All current sensor signal inputs are terminated at 26 pin FRC Connecter to interface with DSP/FPGA Controller
* Total 4 numbers of test points are provided, 3 for current and 1 for Ground.
* Power on switch as well as power input connecter provided in back side of panel.
* Can be used to measure 3 number of Currents of Inverter Output to the motor.

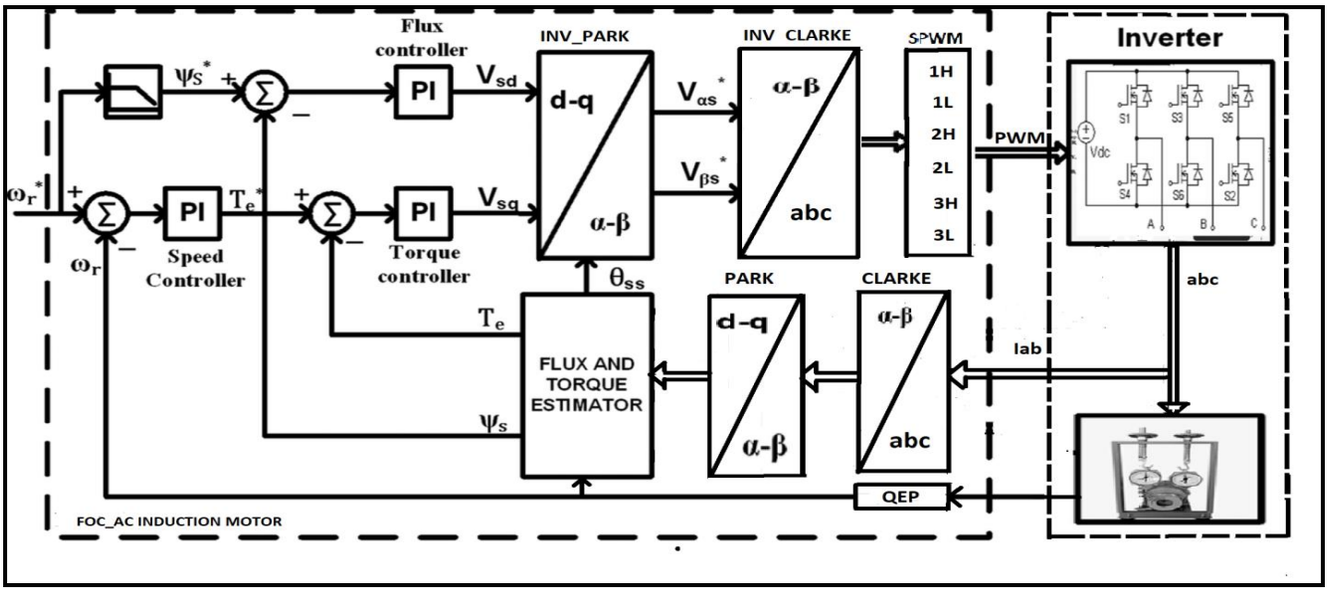
e. Direct Torque Control Implementation

* Flux and torque estimated using voltage model
* To sense the speed & position QEP 512 ppr sensor used
* Minimum running speed : 100rpm

* Motor can run in both direction
* V_d,V_q, I_d, I_q speed flux theta and Torque parameters will be displayed in PC
* User can give Ref speed command from PC
* Speed, Torque and flux regulation done with PI controller
* Set Speed, Actual Speed and Torque are made available at 3 DAC Outputs for Monitoring on DSO.
  * A set speed profile can be set using SIGNAL FILTER of MATLAB for the Research Scholars to test the performance of DTC implementation



f. Field Oriental Control



* Algorithm based on Rotor-flex-oriented control
* Sensored control utilizing a voltage source inverter
* Dynamic independent control of speed and torque
* Having minimum running speed of 100 RPM
* Four Quadrant operations.
* The 3-phase stator currents are measured. This measurement provides ia, ib and ic. The rotor velocity is also measured.
* The 3-phase currents are converted to a 2-axis system. This conversion provides the variables iα and iβ from the measured ia, ib and ic values. iα and iβ are time varying quadrature current values as viewed from the perspective of the stator.
* The 2-axis coordinate system is rotated to align with the rotor flux using a transformation angle information calculated at the last iteration of the control loop. This conversion provides the Id and Iq variables from iα and iβ. Id and Iq are the quadrature currents transformed to the rotating coordinate system. For steady state conditions, Id and Iq will be constant.
* Error signals are formed using Id, Iq and reference values for each. The Id reference controls rotor magnetizing flux. The Iq reference controls the torque output of the motor. The error signals are input to PI controllers. The output of the controllers provide Vd and Vq, which is a voltage vector that will be sent to the motor.
* The Vd and Vq output values from the PI controllers are rotated back to the stationary reference frame using the angle. This calculation provides quadrature voltage values Vα and Vβ.
* The Vα and Vβ values are transformed back to 3-phase values Va, Vb and Vc. The 3-phase voltage values are used to calculate new PWM duty cycle values that generate the desired voltage vector.
* The entire process of transforming, PI iteration, transforming back and generating PWM is Illustrated in the Figure.

OPTIONAL: -

g. EDDY CURRENT LOAD inlieu of SPRING BALANCE LOAD SETUP

1hp rating
0-80V,3A current rating
1500 rpm speed
Electronic DC voltage controller provided for load/torque variation

h.Torque Sensors

i. NON CONTACT TORQUE SENSOR

This Torque Sensor is contactless constructed upto 10,000 rpm and the torque is recorded by the torsion of the shaft using the strain gauge principle and due to the inductive and optical transmission of the signals. The sensor is maintenance-free, the signals are digitized directly on the shaft and made available by the evaluation electronics as a voltage signal or via USB.

* Measurment Range : 0…. 1Nm to 0…100Nm
* Output Signal : 0…. +- 10 V / USB

ii. LOAD CELL BASED TORQUE MEASUREMENT

used for Eddy Current Load
2 Load Cell Fixed on 2 arms of Spring Load.
Signal Conditioners provided
Load Cell Readings are used to calculate the Torque.

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