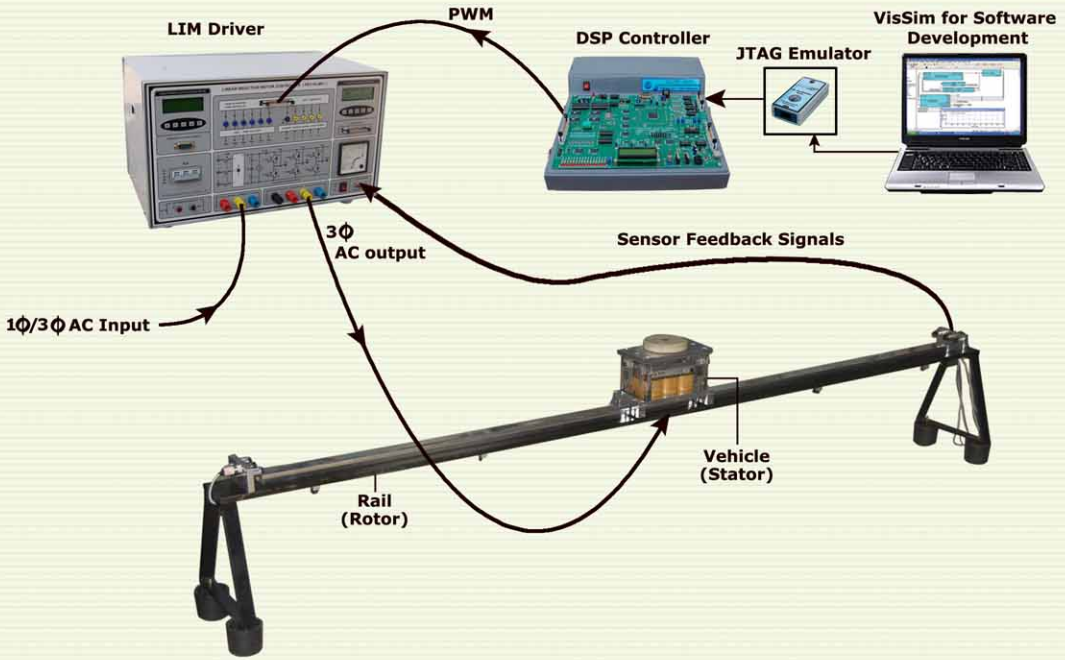

GENERAL DESCRIPTION

The linear motor, model PEC16LM01, is a useful teaching tool to demonstrate the basic principles of magnetism as applied to the operation of linear induction motors. It can also be used by students for determining basic electrical characteristics of a linear induction motor and studying the dynamic behaviour (tractive force, acceleration, top speed) of a linear induction motor.

The linear motor consists of a moveable vehicle and a stationary rail. The moveable vehicle, which is mounted on four bearing rollers, contains what is usually called the stator of a conventional induction motor.

The stationary rail is referred to as the rotor in a conventional induction motor. At both ends of the stationary rail, a cushioned shock absorber and a limit switch (mounted under the stationary rail) allow the direction of motion of the moveable vehicle to be changed.

This is done by reversing the phase sequence of the voltages applied to the motor windings, of the LIM Driver allowing the moveable vehicle to go back and forth over the rail continuously.

The open construction of the moveable vehicle enables students to observe the laminated iron core and windings which form the linear motor. Each winding is independently terminated with 4-mm safety banana jacks mounted on the moveable vehicle frame to allow connection either delta or wye (star) Configuration. Two thumb screws on the moveable vehicle provide adjustment of the air gap between the pole faces and the stationary rail surface.

The linear motor is provided with leads required to connect the stator windings to a three-phase AC power supply of LIM driver which consists of a IGBT-IPM based voltage source inverter, Which Generators 3φ variable voltage and variable frequency AC output so that V/F, vector control, direct torque control technique can be implemented for many research works.

Optical sensors mounted under the stationary rail to measure the motor's tractive force and acceleration. Optionally a quadrature optical encoder can be provided in the vehicle to measure the speed & direction of the vehicle which can also be used as feedback signal for vector / DTC Control implementation.

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FEATURES

- Ideal for demonstrating the basic principles of linear motor operation.
- Movable vehicle frame made of 18-mm thick PVC blocks for great robustness.
- Movable vehicle mounted on bearing rollers for smooth motion.
- Open construction of the moveable vehicle to facilitate observation of the laminated iron core and windings.
- Automatic direction reversing mechanism to allow continuous back and forth operation.
- Motor windings provided with independent terminals to allow connection in either delta or wye (star) configuration.
- Adjustable air gap between the pole faces and the stationary rail surface.
- User guide providing a step-by-step procedure to operate the Linear Motor.
- Movable vehicle frame made of 18-mm thick PVC blocks for great robustness.
- Movable vehicle mounted on bearing rollers for smooth motion.
- Open construction of the moveable vehicle to facilitate observation of the laminated iron core and windings.
- Automatic direction reversing mechanism to allow continuous back and forth operation.

Linear Induction Motor Driver (PEC16LM01)

This set up is designed to study the Speed control principle of three-phase linear induction motor.
This set up consists of

1. Linear induction motor (LIM) set up
2. Linear Induction Motor Driver
3. DSP Controller

Linear induction motor (LIM) set up:

Linear Motor specification

Model	:	PEC16LM01
Type	:	Three Phase / 50Hz
Power	:	0.5 KW
Voltage	:	415V AC (DELTA /STAR)
Vehicle weight	:	6.2 kg
Track length	:	2 meter
Sensor	:	2 No.(for home & end)4No.for Distance, force measurement with different length
Pole distance	:	47.7mm
Make	:	Vimicro

- V/F control implemented to control the vehicle
- Motor windings provided with independent terminals to allow connection in either delta or wye (star) configuration.
- Ideal for demonstrating the basic principles of linear motor operation.
- Adjustable air gap between the pole faces and the stationary rail surface.
- User guide providing a step-by-step procedure to operate the Linear Motor.
- One LIM driver, consists of IGBT – IPM based voltage source inverter for variable frequency, variable voltage, automatic reversing of the phase sequence of the 3φ voltage applied to the motor windings, braking the vehicle etc.,
- The Voltage source inverter of LIM driver can be controlled by any one of the controller.

  i. TMS320F2407 for standalone/VisSim Control
  ii. TMS320F2812 for standalone/VisSim Control
  iii. DSPIC 4011 controller
  iv. Spartan 3A DSP controller for Matlab control.

- Vissim software can also be used to simulate the experimental setup of LIM and can be run on TMS3202407 or TMS320F2812 controller. This would be a great tool for the researches and final year project student of UG & PG.

The Linear Induction Motor Driver is designed using latest IGBT –IPM module to provide variable voltage & variable frequency three phase power to Linear Induction Motor. Hall effect sensors provided to measure various current as feedback of the control systems, so that many advanced complex research oriented control systems can be established. Many laboratory experiments can be conducted for UG & PF level for Advanced Control System Lab.

It consists of

- One Number of three phase IGBT-IPM Based voltage source inverter power circuit
- 6 Number of PWM Isolated IC provided for PWM isolation
- Built in IGBT driver provided
- 4 Number of Hall effect current sensor provided to measure three phase output currents & DC current with necessary signal conditioner circuit
- One number of three phase diode rectifier circuit with dc filter capacitor provided for DC link side
- One number of dc voltmeter is provided DC link voltage measurement
- One number of over current trip circuit with reset & indication is provided
- One number of three phase AC MCB is provided input side protection
- 8 All input & Outputs are terminated in front panel with terminal identification
- One number of FRC Connector provided for External PWM input.
  4 Optical sensors provided in the LIM rail at various distance for calculating Force & Acceleration of the moving vehicle.
- A Linear Force & Acceleration Meter provided with 20*4 LCD Display to display Force & Acceleration of the vehicles.
- 5 switches provided to select the optical Sensors, Mass value etc.,

SPECIAL FEATURES-1

- One local Digital Controller (Pre-programmed) provided for PWM generation for the LIM Driver for Self-Diagnosis
- Four Number of KEY is provided for varying Frequency & voltage of the 3Φ output voltage to the stator & selecting various mode of operation.
- One number of LCD display provided to display output Frequency, Voltage ratio(M.I), Sensor status, vehicle direction etc.,
- One of FRC Connectors provided to be interfaced with any one Digital controller or to the local controller for self-Diagnosis
- One number of Connectors provided home & end Sensor interface.

SPECIAL FEATURES-2

- One number of Digital LCD Displey provided to display FORCE, ACCELERATION of the LIM Vehicle
- Four Number of KEY is provided to select sensors, length etc.,
- One number of Connector is provided for sensor interface

SPECIAL FEATURES-3

- Any one type of Digital Controller (DSP/FPGA/ dsPIC/VisSim/dspace/Matlab + System Generator with FPGA) based control of LIM is Possible
- Can be used for Research Work & Laboratory Experimental purpose.
- Dynamic behaviour of the system can be improved using advanced control techniques and using advanced power modules

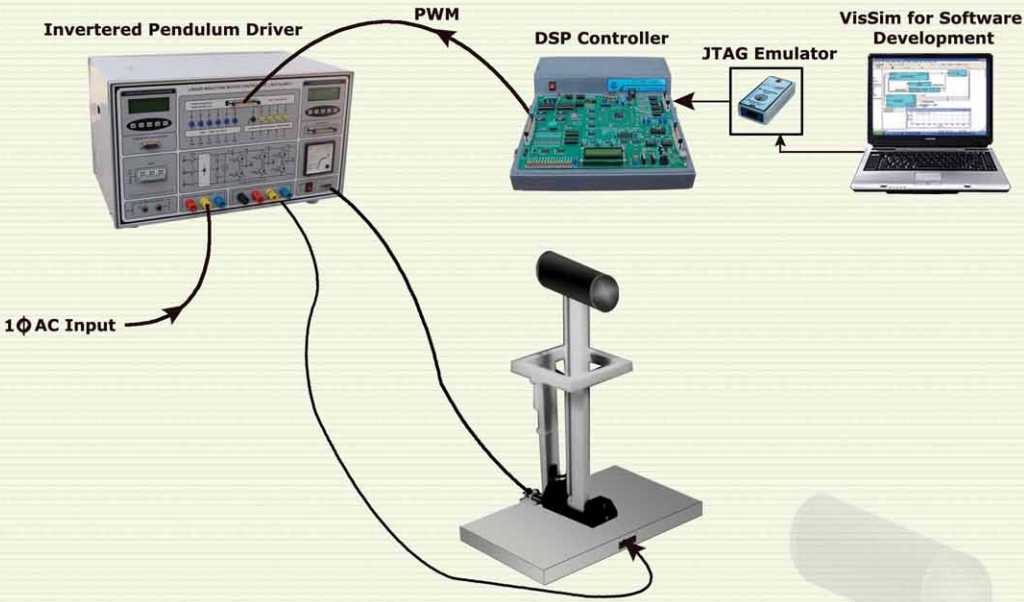
i. Vector control
ii. Space vector modulation.

i) Multilevel Inverter
ii) Matrix Converter

SPECIAL FEATURES-4

- Paper published in IEEE conference using Vi Micro's LIM setup

i) FPGA based Digital Power Controller for Linear Induction motor Drive



Inverted pendulum system is nonlinear unstable system, an ideal experiment platform for teaching control theories and conducting various control experiments. Many abstract control concepts, such as the stability and the controllability of a control system, can all be shown visually through the inverted pendulum system. In addition to educational purposes, an inverted pendulum is also a research area for many researchers of modern control theories. Through the continuous research on new ways of controlling inverted pendulum, researchers have developed new control methods, and apply them to the high tech areas such as aeronautical engineering and robotics, thanks to the characteristics of the system, such as high-order, instability, multi-variables, non-linearity and strong coupling.

The inverted pendulum (PEC16INP01) consists of a pendulum rod, directly driven by a high performance PMDC servo motor, moves in a vertical plane within ±45° from the vertical axis.

At rest, the pendulum rod is stationary and rest on the frame, which is 45° from the vertical axis. One control objective is to move the axis in such a way that the pendulum rod swings and balances vertically. This is obviously a position of unstable equilibrium.

PEC16INP01 is equipped with sensors to detect the angular position and velocity of the pendulum rod as well as the angular position of the pendulum.

SPECIFICATIONS

Dimensions :-

Pendulum	:	9 mm (W), 30 mm (D), 330 mm (H)
Base and Support	:	240 mm (W), 150 mm (D), 170 mm (H)

Weight :-

Pendulum	:	0.5 kg
Base and Support	:	1.75 kg

Motor control : Four-quadrant Uni-polar PWM Chopper control with Forward, Reverse & Brake operation.

Motor Specification : 24V PMDC servo motor - 1kg/cm Torque-speed 1500 rpm

Feed back Sensor : QEP Encoder (A, B & Z (TTL compatible signals, 512 lines) or Servo Potentiometer.

Measurement : Pendulum Angle, Motor speed & Direction

Supply Voltage : 230V AC @ 50Hz

Number of AXES : One

Controller : Standalone Digital Controller built in with the Inverter Pendulum Driver. Optionally any one type of Digital Controller (DSP / FPGA / dsPIC / VisSim/dspace / Matlab + System Generator with FPGA) based control of Inverted Pendulum is Possible

i) TMS320F2407 DSP CONTROLLER

ON CHIP FEATURES:

* 16 PWM outputs
* Auto sequenced 10 bit ADC with dual sequencer (8 channels in a sequencer) with conversion time350ns)
* 40 GPIO lines.
* 6 Capture Inputs /2 QEP.

MEMORY:

* 48K x 16 bit EPROM for monitor assembler and Disassembler
* 16K x 16 bit RAM for program memory
* 32K x 16 bit RAM for data memory

ii) TMS320F2812 DSP CONTROLLER

ON CHIP FEATURES:

* OPTO isolated port terminated with 9 pin D-male connector upto 38K boud rate.
* 3 switches are provided for user applications like. (Increment, Decrement etc.,)
* RF EMI rejection
* ADC inputs are protected by zener diodes.
* 16 leds provided to indicate the various statusof user program
* 8 I/O lines are protected by zener diodes which is used as Input lines.

MEMORY:

* 48K x 16 bit EPROM for monitor, Assembler and Disassembler
* 16K x 16 bit RAM for program memory
* 32K x 16 bit RAM for data memory

iii) VDAD-12 FPGA CONTROLLER

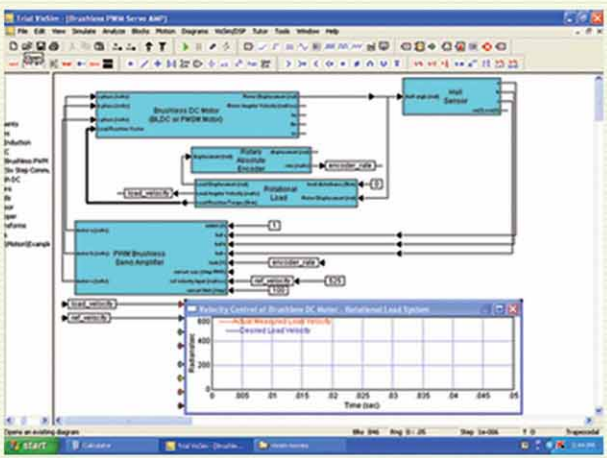
ON CHIP FEATURES:

* 2 no of FPGA Xilinx Spartan3 Device XC3S400-4PQ208
* 288K Block RAM
* 8064 logic cells
* USB interface
  a. One Spartan3 of 400K gates used to interface 4 nos of AD7266.
  b. 8 channel,12 bit serial ADCs at 2 MSPS
     (i) 4 nos of AD7266, each AD7266 has dual 12 bit ADC
     (ii) 2 MSPS throughput for each ADC, and a total of 16 MSPS throughput is possible
* 8 channel 12 bit serial DAC (AD5328)

VisSim

The simulated Motion Control GUI block available in VisSim can be immediately downloaded to DSP Controller through JTAG Emulator and tested with Real Time Advanced Control System Setup. This will be an ideal tool for Researchers in Linear Induction Motor & Interter Pendulum.

* Drag and drop block diagram construction
* 135 + linear and nonlinear blocks
* Toolbox functions for control, Electromechanical design, Hydraulics and Signal processing
* Components libraries for DSP, Dynamic, Electromachanical, Electrical, Hydraulics, Process, chemical, thermal and turbines
* Spectrum display of amplitude of vector elements
* Visual diagram comparisons
* Customisable toolbar
* Windows clipboard support



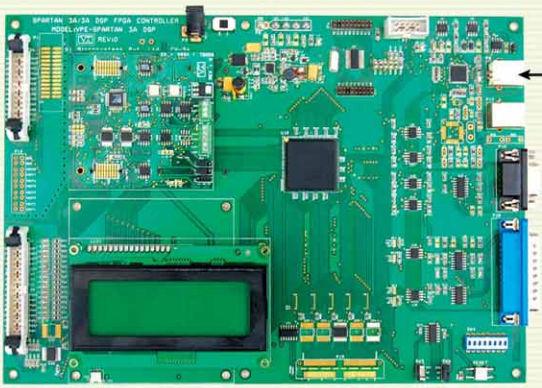
Many Sample Programs for

1. Linear Induction Motor
2. Inverter Pendulum

Sample Programs for

1. V/F Control
2. SV PWM Control
3. Vector Control
4. BLDC Control

iv) FPGA - System Generator Development System
(for Linear Induction Motor & Inverter Pendulum Controller)

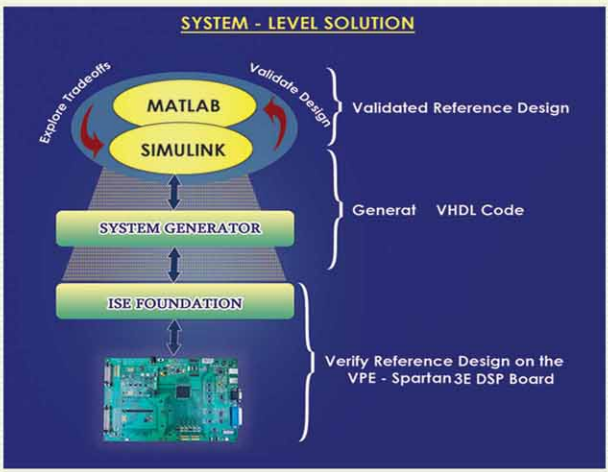


Spartan 3A DSP FPGA Controller

A novel Hardware in Loop system for MATLAB and System Generator Environment for Linear Induction Motor & Inverter Pendulum Controller

SPECIFICATION

* Based on Spartan 3A DSP FPGA Device.
* XILINX 3SD1800A-FG676 FPGA
* Memory : 2 Nos of 32MB SDRAM
* One isolated RS232 Serial port
* One isolated Full speed USB port
* One high speed (480 Mbit/sec) USB port
* On board JTAG programmer
* 50 PWM outputs
  - # 16 PWM outputs are terminated at PE standard 34 pin FRC connector
  - # 34 PWM outputs are terminated at a connector
* 8 capture inputs, 8 digital I/O
* Input & output Devices
  - # 16 User LEDs, 8Dip switches
  - # 2 limit switches, One reset switch
  - # 16 × 2 alphanumeric LCD
* 8 channel 12-bit 2MSPS ADC
* 4 Channel 14 bit 2MSPS DAC
* FPGA based high-performance DSP for various hardware in Loop applications.
  - # 250 MHz XtremeDSP DSP48A Slices.
  - # Dedicated 18-bit by 18-bit multiplier.



DRIVER FOR LINEAR INDUCTION MOTOR & INVERTED PENDULUM

* One Number of three phase IGBT-IPM Based voltage source inverter power circuit
* 6 Number of PWM Isolated IC provided for PWM isolation
* Built in IGBT driver provided
* 4 Number of Hall effect current sensor Provided to measure three phase output currents & DC current with necessary signal Conditioner circuit
* One number of three phase diode rectifier circuit with dc filter capacitor provided for DC link side
* One number of dc voltmeter is provided DC link voltage measurement
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