Vi Microsystems Pvt. Ltd.,
#75, Electronics Estate, Perungudi, Chennai, Tamilnadu, India - 600 096.
Phone : 044 - 2496 0774, 2496 1842, 2496 1852, 2496 3142
E-Mail: sales@vimicrosystems.com | Website: www.vimicrosystems.com
GSTIN: 33AAACV0909J1ZJ | TIN : 33891580314 | PAN : AAACV0909J

9 DSP, FPGA & REAL TIME CONTROLLERS FOR BASIC & ADVANCED DRIVES LAB.

8 latest, based on Arduino, Raspberry, 32 Bit DSP, dsPIC & DSP-FPGA Based Real Time Controllers have been introduced for setting up an open, model based and real time control Lab for Basic & Advanced Variable Frequency Drives using DC, AC, BLDC, PMSM, SR Motors. Based on MATLAB-SIMULINK Model Based Design using our high performance DSP & FPGA PWM Controllers to the EEE UG & PG students and Research scholars of a Engineering College.

These Controllers have unique performance features like

Embedded Power Electronics, Drives applications requiring time-critical response
Offering the simplicity of a microcontroller (MCU)
Offering single-cycle execution
Deterministic interrupt response
Zero overhead looping and fast DMA
Math-intensive Intelligent Blocks like FFT, Trigonometric, Veterbi, FP
Intelligent independent Modules like PWM, ADC, DAC,
Dual Core, additional Accelerators like CLA

We offer many latest DSP & FPGA Based PWM Controllers in this trainer, meant for building products for power electronics, smart grid, Advanced drives, Electrical Vehicles, renewable energy, power system , etc., namely i DUAL CORE DELFINO DSP CONTROLLER (Micro - 28377D), ii. etc. These Real Time Embedded Controllers are specially designed to handle closed loop control Drives, Statcom, FACTs, DFIG, DC-DC Converters, Inverters and many more.

These real time controllers are recently introduced by famous manufacturers like Texas Instruments, Microchip, Xilinx(AMD), Aurdiuno & Raspberry and meant for real time control applications in power electronics, Smart Grid, Renewable Energy, EV et., product building.

For control applications the processor should have many intelligent blocks like ADC, PWM, DSP, FP for implementing DTC, FOC, SPACE VECTOR etc., All these blocks are available in these Embedded Controllers.

Another Controller TMS320F28377D is the most powerful DSP processor, which offers 800MIPS, Dual core, 2 additional CLA processing unit, Trigonometric unit, Veterbi unit,

REAL TIME DSP & FPGA CONTROLLERS

We have introduced 2 new Real Time Controllers based on TMS320F28388D and ZYNQ UltraScale MPSOC with Ethernet Interface to MATHLAB SIMULINK for Real Time Control & Monitoring of many Signals like 3Φ Voltage Current Waveforms, FFT etc,.

1. DUAL CORE F28388D DSP BASED Real Time Controller
   (Micro - 388D)
2. ZYNQ ULTRASCALE MPSOC based FPGA Real Time Controller
   (Micro – XC6)

These 2 Real Time Controllers are compact, versatile real time control prototyping system. Comprising of high-end DSP or FPGA for fast computing and IO, dual core DSP processor and 4 Core Cortex A53- FPGA for control and communication, scalable voltage and current sensors, large number of PWM outputs and high speed IO's. It is coupled with an easy and powerful model-based development environment and a dedicated real time signals software Application Software

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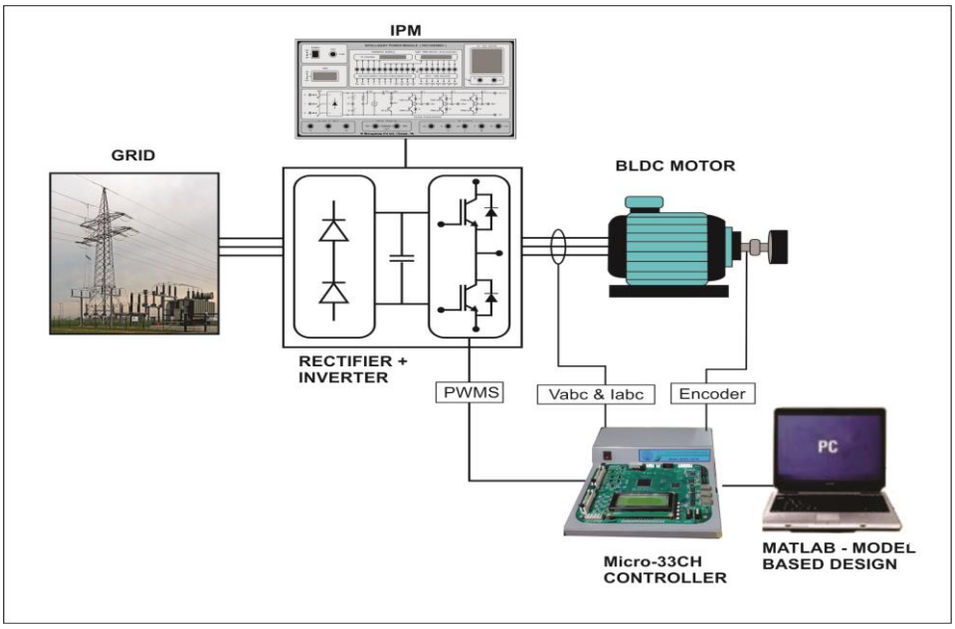
Application Software supports most comfortable and widely used model development flow, strongly harnesed by software for data monitoring, data analysis, control functions and many more

Many purpose-built intelligent peripherals like DMA, ADC , DAC, ePWMS, etc., which are meant to build applications like FOC, SENSORLESS FOC, DTC and any complex algorithms. Separate comparator module for tripping IGBT /SiC. Both processors are supported by MATLAB-SIMULINk

Now, the student can configure their own applications using any one controller in MATLAB-SIMULINK Environment to develop any new applications like V/F, FOC . DTC, STATCOM etc.

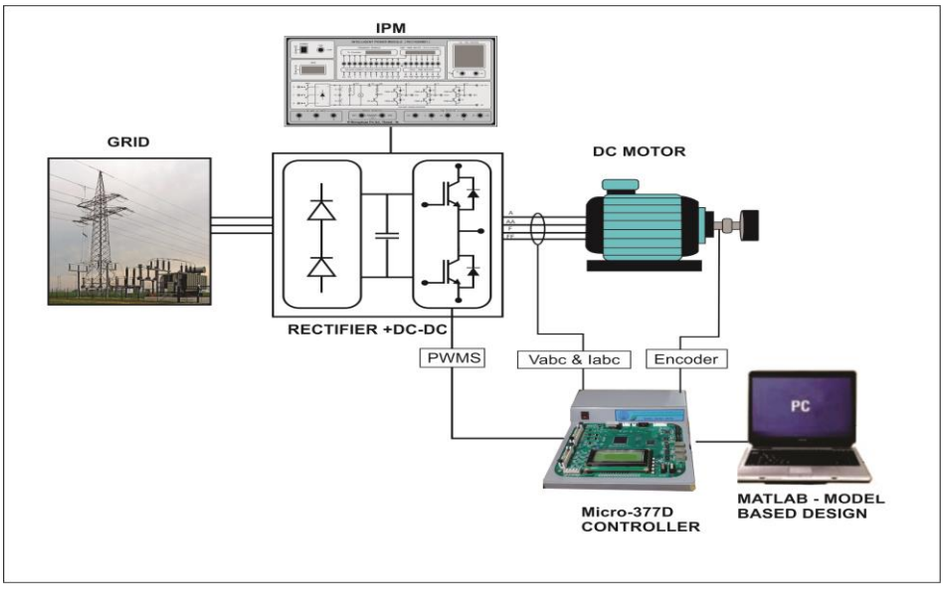
BLDC Motor Drive Trainer.

This Trainer is to study the closed loop control of the most popular Motor, being used in EV, Home appliance, Airconditioner, It consists of a Rectifier+Inverter Power Module, 1hp BLDC Motor with Mechanical Brake, DSP/FPGA/dsPIC Controller. The student can chose any one of the following Controller.



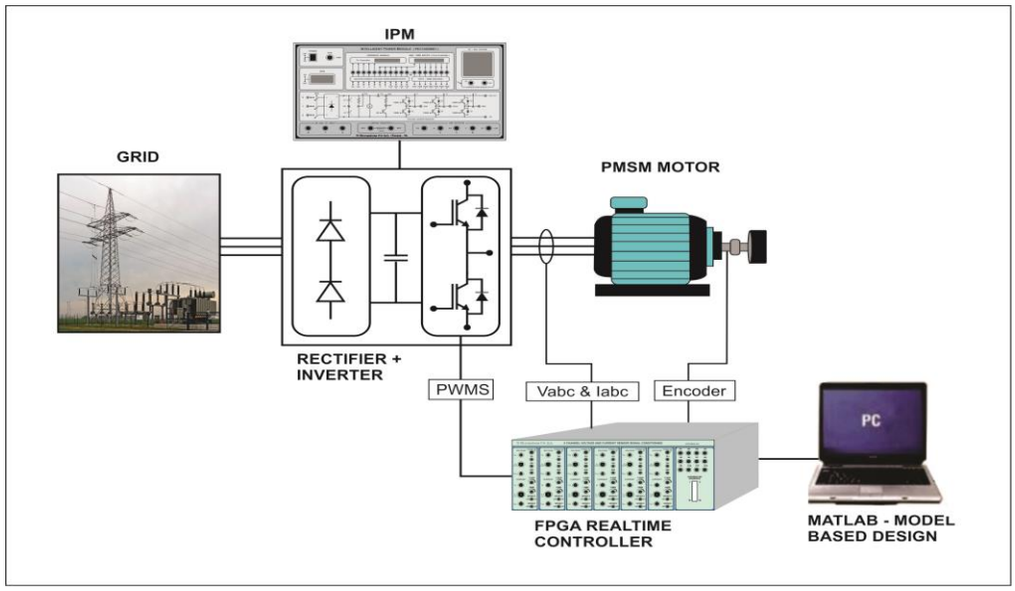
DC Motor Drive Trainer.

This Trainer is to study the closed loop control of the traditional popular Motor, being still used in DRONE, Industries, Control Valves, Dental care, etc. It consists of a Rectifier + Converter Power Module, 1hp DC Motor with Mechanical Brake and a DSP/FPGA/dsPIC Controller. The student can chose any one of the following Controller.



PMSM Motor Drive Trainer.

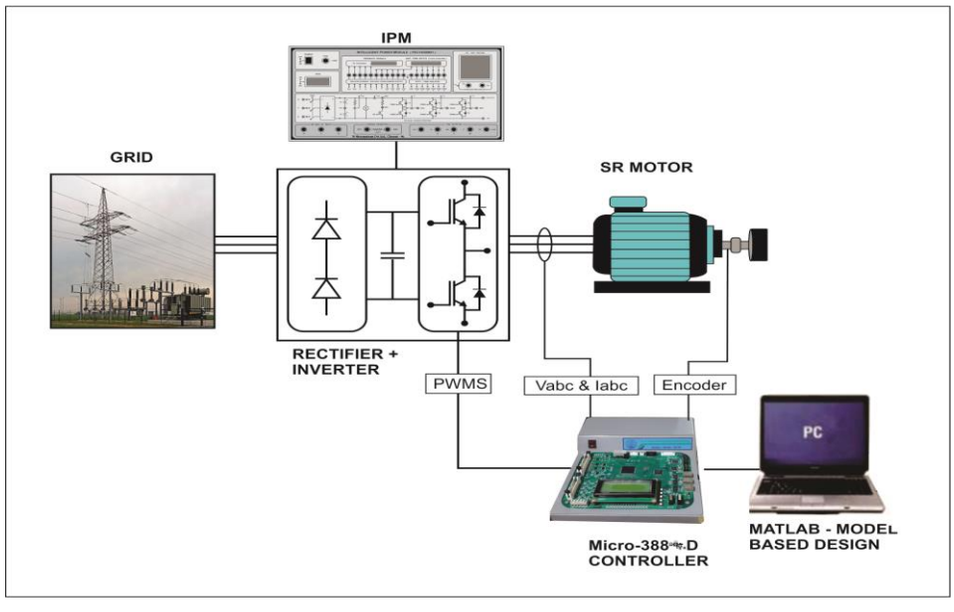
This Trainer is to study the closed loop control of one the most popular Motor, being used in EV, Home appliance, Air conditioner, Servo Motor based Position Control, Robo, Packaging Industries etc. It consists of a Rectifier + Inverter Power Module, 1hp BLDC Motor with Mechanical Brake, DSP/FPGA/dsPIC Controller. The student can chose any one of the following Controller.



SR Motor Drive Trainer.

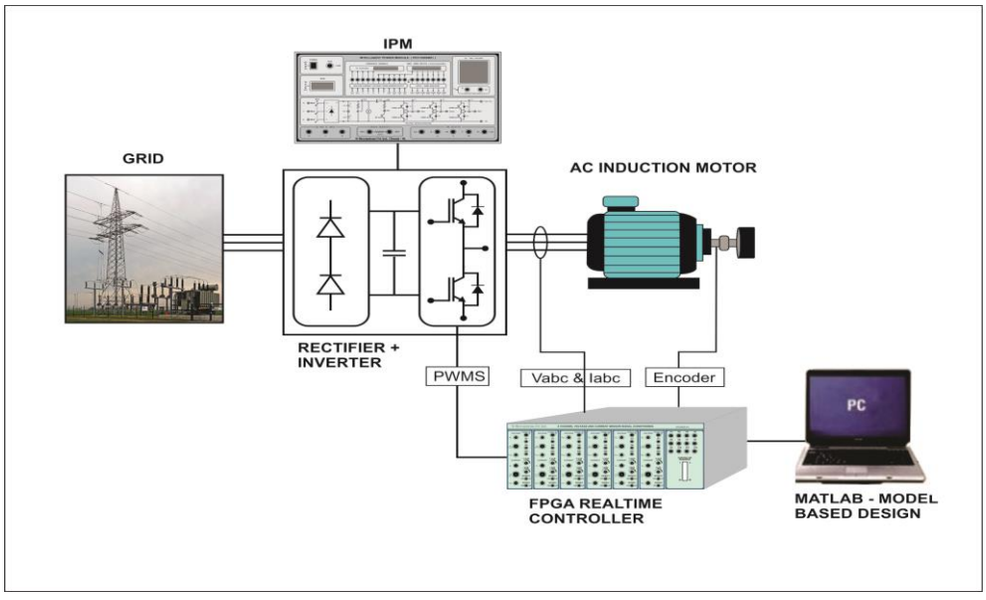
This Trainer is to study the closed loop control of the SR Motor. . Switched reluctance motor works based on the variable reluctance principle. The rotating magnetic field is created with the help of power electronics switching circuit. The rotor does not have winding and stator only carries main field winding,

It consists of a Rectifier + Inverter Power Module, 1hp SR Motor with Mechanical Brake and a DSP/FPGA/dsPIC Controller. The student can chose any one of the following Controller



AC Induction Motor Drive Trainer.

This Trainer is to study the closed loop control of the most popular Motor being introduced in this Century, being used in EV, Pumps, Industries et. It consists of a Rectifier+Inverter Power Module, 1hp AC Motor with Mechanical Brake and a DSP/FPGA/dsPIC Controller. The student can chose any one of the following Controller.



PROPOSAL FOR 8 TYPES OF PWM CONTROLLERS

1. DUAL CORE DELFINO DSP 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, DFIG, etc.., It is also focused for students to learn the multi-processor architecture and the inter processor communication mechanisms. The inbuilt purpose built peripherals of the processor lead to implementation of many POC for the Research Scholars in the emerging technology.

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 onboard 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 Interfaces
- 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
- Software will be provided for
- Wind Emulator
- DFIG Based with Generation

2. DUAL CORE DSP BASED REAL TIME CONTROLLER. (Micro-388D)

The Micro-388D Real Time Controller is intended and developed for advanced closed-loop control applications for Power electronics, Smart grid, DFIG, etc.., It is also focused for students to learn the multi-processor architecture and the inter processor communication mechanisms. The inbuilt purpose built peripherals of the processor lead to implementation of many POC for the Research Scholars in the emerging technology.

Features:

- Dual- Core 32-bit Delfino fixed point Processor
- Operating Speed: 200MHz (For each core)
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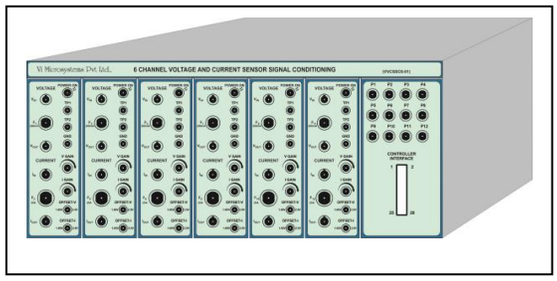
- External memory interface 16/32 bit support
- 192 dedicated PIE vectors
- MCU/DSP balancing code density & execution time

- 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
- Software will be provided for
- Wind Emulator
- DFIG Based with Generation

3. Dual Core dsPIC33CH Based PWM Controller (Micro-33CH)

The Micro-33CH Trainer , based on Dual Core dsPIC33CH DSP Controller, 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 – Dual Core- architecture and the inter processor communication mechanisms. The inbuilt intelligent peripherals of this processor lead to complicated design for the developers in the emerging electric technology.

MATLAB – SIMULINK based Model Based Design of Drives, Power Electronics, Power System, Electric Vehicle etc, makes it easy for the students to build any Applications in this field.

- PROCESSOR: dsPIC33CH512MP508 dual core, 16-bit DSP device 80-Pin Dual Core, 16-Bit Digital Signal Controllers Master/Slave Core Operation
- OPERATING SPEED: 200MHz, Slave Core @ 100MIPS
- OPERATING SPEED: 180MHz, Master Core @ 90MIPS
- PROGRAM MEMORY: 512KB - Master, 72KB- Slave
  4 CAPTURE INPUT SIGNALS AT 5 PIN RMC

ON Board Features:

- 4 Numbers of user LEDs,
- 4 Numbers of Push-Button Micro Switches
- 4 GPIO Terminated at 5pin FRC Connector
- 20 × 4 Alphanumeric LCD
- Integrated On-Board Isolated Pickit3 programmer/debugger.
- 2 nos 6 pin Header for External Pickit3 Programmer/debugger
- Provided for Master & Slave Devices.
- Opto-isolated USB PORT, Quadrature Encoder Interface
- Opto-isolated USB to UART Serial Interface (COM PORT)
- 8 PWM Outputs and 4 Capture Units with Differential Signal Inputs are terminated at good quality 34-pin FRC connector for easy use for the students.
- 8 Channel ADC inputs & 4 DAC/Analog Compare outputs are terminated at good quality 26-pin FRC connector with buffered and protection
- 12 BIT RESOLUTION, 3.5 MSPS SAMPLING RATE
- 2 nos of SPI Interface Terminated at 6 pin RMC Connector.
- 1 no of I2C Interface Terminated at 4 pin RMC Connector.
- 1 no of CAN Interface Terminated at 3 pin RMC Connector.

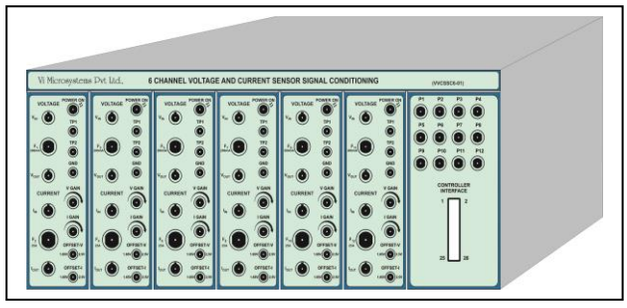
4. ZYNQ ULTRASCALE MPSOC based FPGA Real Time Controller. (Micro – XC6)

This FPGA Dev Board is a powerful, versatile real time control prototyping System for Power Electronics, Advanced Drives, Smart Grid, Power Systems, Building DFIG, FACTS, DQ Based Grid Connected Inverters etc,. Comprising of high end FPGA for fast computing and IO, Quad core A53 processor for control and communication sensors, large number of PWM outputs and high speed IO. It is designed to address today's complex problems. Coupled with an easy and powerful Mat lab model- based development environment, push button device , Powerful Application software, it forms a complete control prototyping solution. . It provides an embedded processing system (PS) with tightly integrated programmable logic and a rich set of configurable I/O capabilities.

This **Real Time Controller** is an ideal solution for Building Power Electronics applications, DFIG, Advanced Drives, Electrical vehicles Etc. Based on Quad core A53Procesor with logical Cells, DSP Slices and many on board features.

- ZYNQ ULTRASCALE MPSOC
  - 28848 Logic Elements
  - 4 GB 64-bit wide, 2400 Mb/s memory
  - System logic cells : 256.2K, CLB flip-flops : 234.2K, CLB LUTs : 117.24K66
  - Distributed RAM : 3.5MB, DSP slices : 1248
  - 20 Nos of Global clock Networks
  - 8 User I/O Banks
  - 328 User I/O lines and 124 LVDS lines
- Integrated non-volatile memory devices 512 Mb QSPI. 16 GB eMMC, 64 Kb EEPROM
- On-Board Isolated USB-Blaster used to configure the flash memory & FPGA device

- Bipolar input ADC Modules – 1nos.
  - Resolution : 18 bit
  - No of ADC : 4
  - No of Channel : 8
  - Simultaneous sampling : 8
  - Sampling Rate : 2Msps
  - Input Range : +/-2.5V, +/-5V, +/-10V
  - Inputs are buffered with OPAMP and protected with TVS diode
  - ADC inputs are terminated in 26pin FRC connector for easy interface



- Bipolar output DAC
  - Resolution : 16 bit
  - 30MHz Operation
  - No of Channel : 4
  - Settling time : 100ns
  - Simultaneous data updating for all DACs
  - Output Range : +/-2.5V, +/-5V
- On-Board Isolated UART communication used to communicate with PC via USB
- Totally 80PWM signals
- 34pin header for IPM interface
  - 16 PWM outputs at 5V level using level converter and protection using TVS diode
  - 8 capture inputs / Quadrature encoder interface are protected with TVS diode
  - PWM outputs and capture inputs are terminated in 34 pin FRC for easy interface
- 80 PWM outputs at 5V level using level converter and protection using TVS diode and terminated in two 50pin FRC connector for easy interface
- 20MHz onboard oscillator
- JTAG header for external configuration
- 2 limit switches are provided for General purpose usage in the software Factory configured as Increment, Decrement switches)
- 8 Nos. of User LEDs
- 8 Nos. of Slide switches for user
- 4 Nos. of Push button switches for user
- On board Isolated USB interface with TMC protocol for Data acquisition
- 3 Nos. of 20pin header with extra user I/Os at 3.3V level and protected using TVS diode.

ARDUINO COMPATIBLE PWM CONTROLLERS

5. RP2040 Dual Core Based PWM Controller. (Nano – RP40)

As Raspberry based embedded Controllers become more and more awareness among students, Vi Micro has designed another innovative PWM Controller, based on Raspberry RP2040 Processor, which provides Dual Core Cortex M0+ Microcontroller, 16 PWMs, ADC, etc, to build many Power Electronics Applications.

The **RP2040 Dual Core** Processor is used to build this PWM Controller, which consists of Dual Core Cortex M0+ Microcontroller with Flash Ram, PWM, ADC and many on board features.

Features:

- Based on Raspberry RP2040 Dual Core Cortex M0+ MCU
- Digital I/O Pins: 22 headers
- UART, SPI, I2C
- Memory: Flash :2 MB, SDRAM: 264KB
- Clock Speed: up to 133 MHz
- Microcontroller: Dual Core Cortex-M0+ 32bit ARM MCU
- Digital I/O Pins: 8 nos.
- PWM Pins: 6nos.
- Analog Inputs: 6no, 12bit

Carrier Board Features:

- 3-nos of Analog Inputs are terminated at P2 connector
- 12bits, 350Ksps
- 1-no of Digital to Analog is terminated at P5 connector
- 6 PWM Signals terminated at P3 connector.
- 3-nos of Capture are terminated at P4 connector for Proximity sensor and Quadrature Encoder Sensor interfacing.
- Buffer Provider for the PWM and Capture signals
- RS232 - Com Port interface with PC
- 20X4 Alphanumeric LCD Display
- 4 Push Button switches for user applications and its expansion available in P8 connector.
- PMOD connector provided for Hardware expansion.

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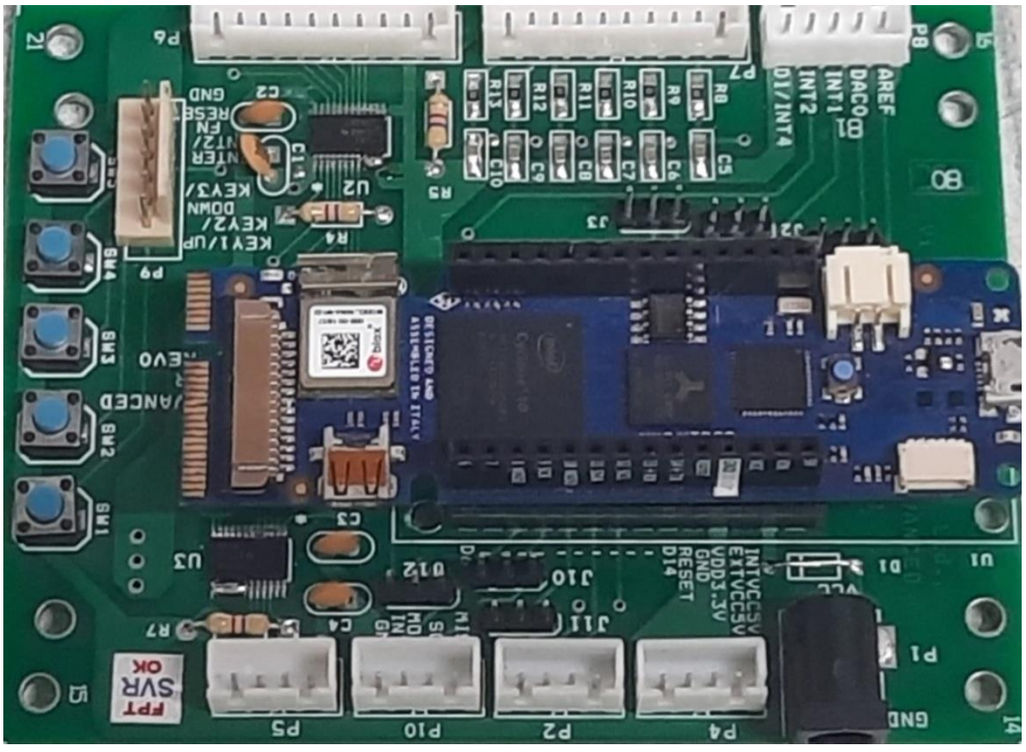
6. ARDUINO Based FPGA CYCLONE 10 PWM Controller. (Nano – ACY10)

As Arduino based embedded Controller become more awareness among students, Vi Micro has designed another innovative PWM Controller based on Arduino Vidor 4000 Controller, which provide a Cortex M0+ Microcontroller and a Cyclone 10 FPGA to build many Power Electronics Applications.



The Arduino Vidor 4000 is used to build this PWM Controller, which consists of one Cortex M0+ Microcontroller and Intel Cyclone10 FPGA.

Features:

- Based on Arduino Vidor with FPGA & Cortex M0+
- FPGA: Intel Cyclone 10CL016
- Digital I/O Pins: 22 headers + 25 Mini PCI Express
- UART, SPI, I2C
- Memory: Flash :2 MB, SDRAM: 8MB
- Clock Speed: 48 MHz - up to 200 MHz
- Microcontroller: Cortex-M0+ 32bit ARM MCU
- Digital I/O Pins: 8 nos.
- PWM Pins: 6 nos.
- Memory: Flash: 256KB, SDRAM: 32KB
- Analog Inputs: 6 no, 12bit
- Analog Outputs: 1 no, 10bit
- Clock Speed: 48MHz

Carrier Board Features:

- 6-nos of Analog Inputs are terminated at P2 connector
- 12bits, 350Ksps
- 1-no of Digital to Analog is terminated at P5 connector

- 6 PWM signals terminated at P3 connector.
- 3-nos of Capture are terminated at P4 connector for sensor interfacing.
- Buffer Provider for the PWM and Capture signals
- RS232 - Com Port interface with PC
- 20X4 Alphanumeric LCD Display
- 4 Push Button switches for user applications and its expansion available in P8 connector.

7. TMS320F28049 DSP Based PWM Controller Module (Nano-49).

As DSP based Controllers become more and more awareness among students, Vi Micro has designed another innovative PWM Controller, based on Texas Instrument TMS320F28049 Processor, which provides 32Bit F2812 DSP Core , 16 PWMs, fast ADC, Specialised Peripherals Like CLA, ADC, etc, to build many Power Electronics Applications.

Hardware Features

- TMS320F280049C: 100 MHz C28x CPU with FPU and TMU, 256 KB Flash,
- 3x 12-bit ADC, CAN, encoder, FSI, UART, and more
- Programmable Control Law Accelerator (CLA)
- 3.45-MSPS, 12-bit Analog-to-Digital Converters

* Power domain isolation for real-time debug and flash programming
* CAN transceiver
* Two encoder interface connectors
* 3-nos of Analog Inputs are terminated at P2 connector

- 1-no of Digital to Analog is terminated at P5 connector
- 6 PWM Signals terminated at P3 connector.
- 3-nos of Capture are terminated at P4 connector for Proximity sensor and Quadrature Encoder Sensor interfacing.
- Buffer Provider for the PWM and Capture signals
- RS232 - Com Port interface with PC
- 20X4 Alphanumeric LCD Display

- 4 Push Button switches for user applications and its expansion available in P8 connector.

8. Dual Core dsPIC33CH Based PWM Controller Module (Nano - 33CH)

The Nano - 33CH Trainer , based on Dual Core dsPIC33CH DSP Controller, 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 – Dual Core- architecture and the inter processor communication mechanisms. The inbuilt intelligent peripherals of this processor lead to complicated design for the developers in the emerging electric technology.

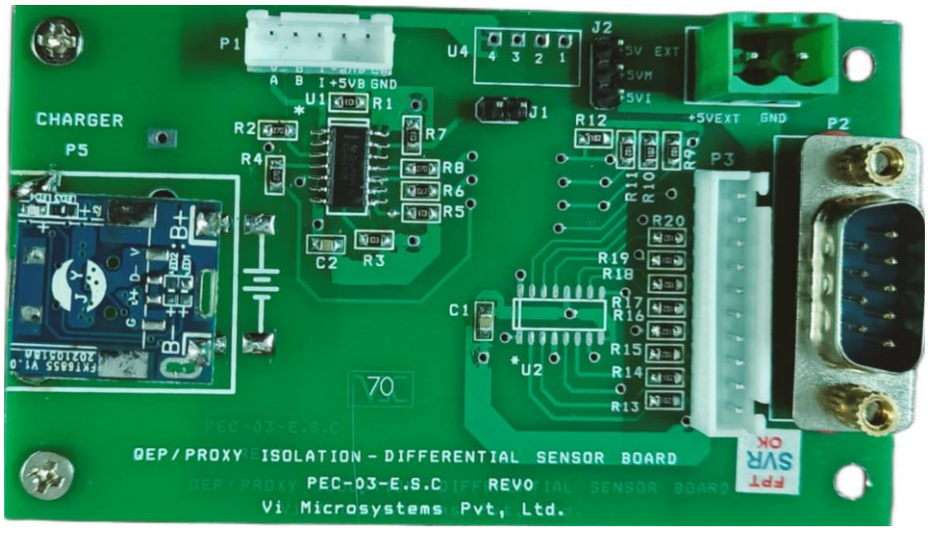
MATLAB – SIMULINK based Model Based Design of Drives, Power Electronics, Power System, Electric Vehicle etc, makes it easy for the students to build any Applications in this field.

- PROCESSOR: dsPIC33CH512MP508 dual core, 16-bit DSP device
  80-Pin Dual Core, 16-Bit Digital Signal Controllers
  Master/Slave Core Operation
- OPERATING SPEED: 200MHz, Slave Core @ 100MIPS
- OPERATING SPEED: 180MHz, Master Core @ 90MIPS
- PROGRAM MEMORY: 512KB - Master, 72KB- Slave
  4 CAPTURE INPUT SIGNALS AT 5 PIN RMC

ON Board Features:

- 4 Numbers of user LEDs,
- 4 Numbers of Push-Button Micro Switches
- 4 GPIO Terminated at 5pin FRC Connector
- 20 × 4 Alphanumeric LCD
- External Pickit3 programmer/debugger.
- Opto-isolated USB PORT, Quadrature Encoder Interface
- Opto-isolated USB to UART Serial Interface (COM PORT)
- 8 PWM Outputs and 1 Capture Units with Differential Signal Inputs are terminated at good quality connector for easy use for the students.
- 8 Channel ADC inputs & 2 DAC/Analog Compare outputs are terminated at good quality connector with buffered and protection
- 12 BIT RESOLUTION, 3.5 MSPS SAMPLING RATE
- 1 nos of SPI Interface Terminated at 6 pin RMC Connector.
- 1 no of I2C Interface Terminated at 4 pin RMC Connector.

9. QEP/PROXY ISOLATED SIGNAL CONDITIONER BOARD (PEC-03)



A Signal Conditioner Board for QEP or Proximity Sensor for speed measurement of Motor.

- To be fixed at the Motor Side
- QEP or Proximity Sensor Signal Outputs are Isolated
- Isolated Single Ended Signals are Converted to Differential Outputs and Terminated at RMC Connector for better notice immunity, using AM26C31.

* 5V,1A,Isolated DC-DC Converter Provided using CRE130
* 500mAH Li-ion Battery Provided for Battery Operation
* USB Li-Ion Battery Charger Provided.