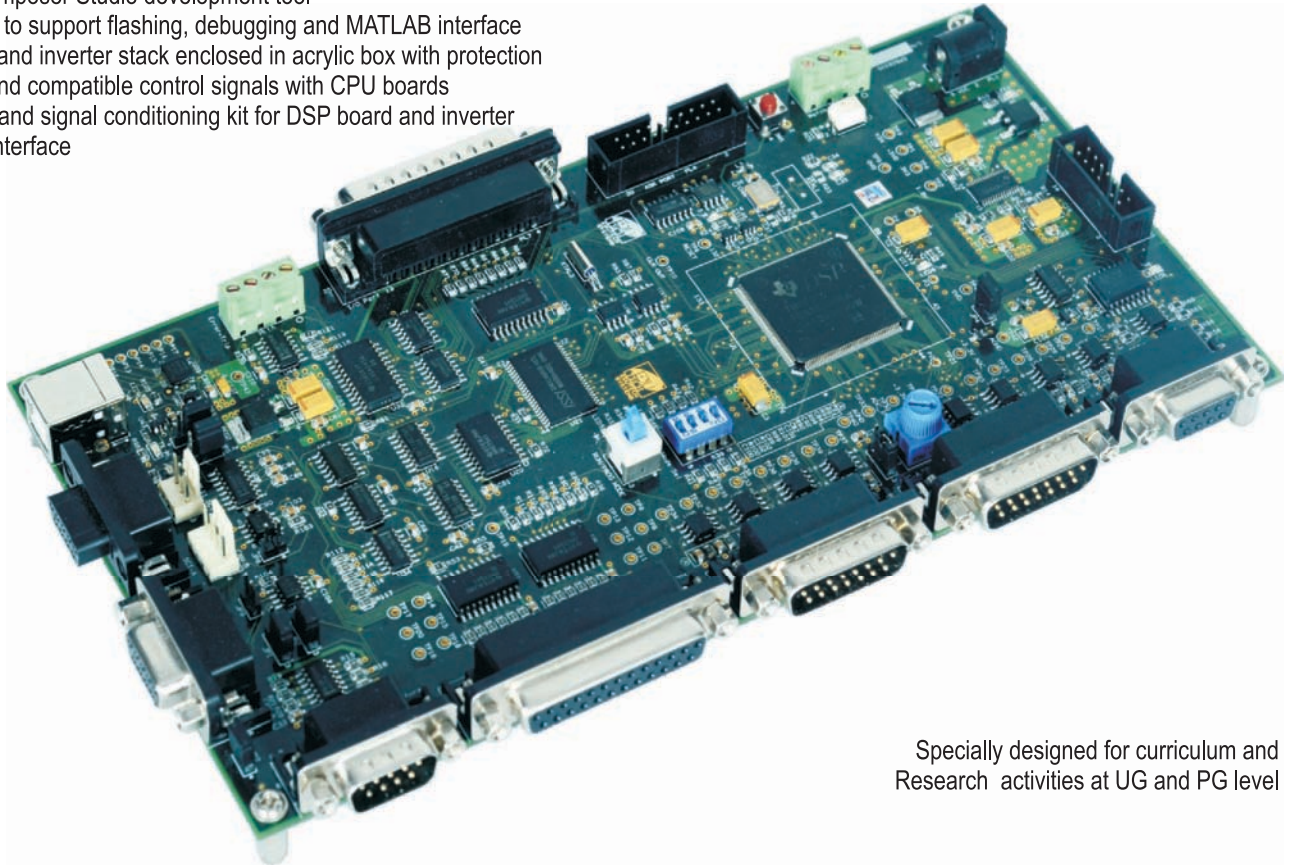


# DSP Lab For Motor Control and Drives

## Features

- Set of DSP CPU target boards featuring TMS320F28335 with on board RAM, +5V signal compatibility, buffered output, USB flashing option, communication ports like UART, CAN, I2C and SPI
- Code Composer Studio development tool
- Emulator to support flashing, debugging and MATLAB interface
- Rectifier and inverter stack enclosed in acrylic box with protection system and compatible control signals with CPU boards
- Isolation and signal conditioning kit for DSP board and inverter module interface



Specially designed for curriculum and Research activities at UG and PG level

## Educational Practice Board for TMS320F28335

### Processor

- C2000 Delfino series TMS320F28335 Digital Signal Controller
- 150 Mhz. Max operating speed
- On chip 32-bit floating point unit
- 68K bytes on-chip RAM
- 512K bytes on-chip Flash memory
- On board IEEE 1149.1 JTAG emulation connector with LED indication
- 6 channel DMA controller (For ADC, McBSP, ePWM, XINTF, SARAM)

### On-Board Memory

- 1M bytes (64kx16) off-chip SRAM memory
- 256K EEPROM interface
- USB for Flashing

### On board Data Transfer Interfaces

- USB Connector for UART-A interface
- DB9 connector for UART-A interface
- LED indication for Transmit and Receive data at UART-A
- 3 pin header for UART-B interface

- DB9 connector for CAN-A interface with onboard hardware Loop back mode feature
- 4 pin header for CAN-B interface with onboard hardware Loop back mode feature
- SPI and I2C devices

### Onboard Input/Output Interfaces and other Facilities

- Power-On LED indication
- Connector for Watchdog timer output
- 20 Pin (10x2 header) Connector for 16 GPIO lines
- DB25 Connector for 8 Digital Input and 8 Digital Output interface with +5V compatibility
- Error + Trip +5V compatible connector for Inverter control module
- LED at GPIO Pin as GPIO Test point
- I2C based Off-Chip EEPROM interface
- I2C based Off-Chip RTC interface

### Onboard Special functionality

- MATLAB/SIMULINK compatible

- DB9 connector for 6 channel capture interface
- DB25 connector for 12 channel PWM interface
- DB15 connector for 8 Channel On-Chip ADC-A interface (with 3V protection using OpAmps with unity gain output)
- DB15 connector for 8 Channel On-Chip ADC-B interface (with 3V protection using OpAmps with unity gain output)
- Potentiometer to test On-Chip ADC
- DB9 connector for 4 channels SPI based External DAC interface
- Reset Switch with LED indication
- Switch for Run/Program mode switching with LED indication
- 4-way DIP Switch for 16 different boot mode selection

### General test points

- Test points for All the PWM, ADC and Power supply section

## Development Tools

### Code Composer Studio IDE



Code Composer Studio™ (CCStudio) is an integrated development environment (IDE) for Texas Instruments (TI) embedded processor families. CCStudio comprises a suite of tools used to develop and debug embedded applications. It includes compilers for each of TI's device families, source code editor, project build environment, debugger, profiler, simulators, real-time operating system and many other features.

### JTAG Emulator for TI2000 platform



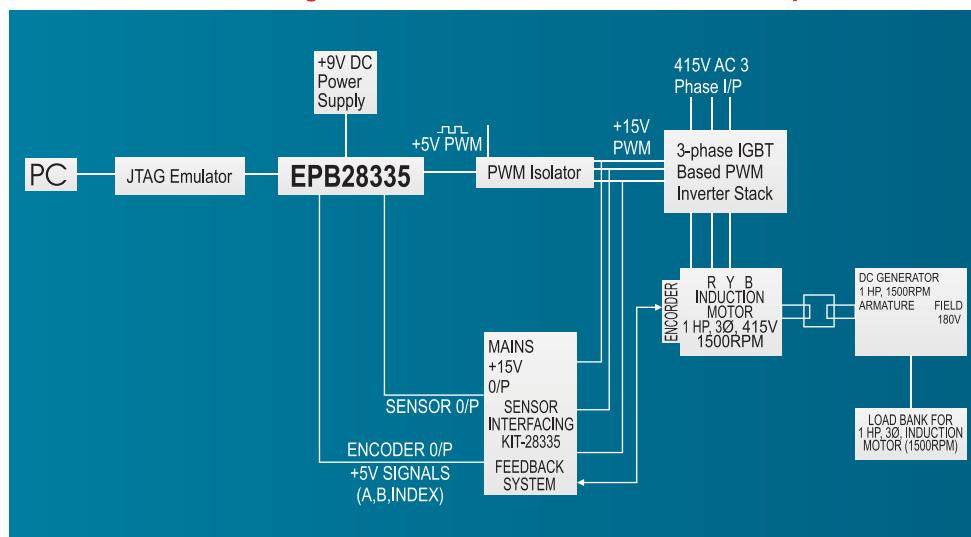
The C2000 Series USB JTAG Emulator allows the user direct access between the host computer and the TMS320C2000™ Platform DSC using the IEEE 1149.1 IEEE JTAG Interface. A JTAG emulation connection is required for debugging software, downloading code, and flash programming Texas Instruments JTAG DSCs. Compatible with Code Composer Studio IDE and supports on chip flash programming.

### USB JTAG Emulator for EPB28335



- The emulator provides JTAG access to Texas Instruments' JTAG based devices
- It is compatible with Code Composer Studio™ V5 development environment
- Debug features (Emulation Connect/Disconnect, Read/Write memory, Read registers, Load program, Run, Halt, Step, Software and Hardware Breakpoint support, Real-Time Mode)
- Support for targets with 1.8v and 3.3v IO voltages
- Support for USB High Speed (480 Mbit/s)
- Supports cable-break detection
- Supports target power loss detection
- Support for multiple FTDI devices
- Adaptive clocking
- LED light to indicate active USB connection

### Block Diagram of DSP Based Motor Control Setup



## Interfacing Kits

### Inverter Stack Module



- The specifications can be configured based on the following parameters
- Stack: Rectifier(optional) + Inverter + Brake Chopper (optional)
- Voltage: Input ac Voltage(optional), DC voltage Vdc, Output AC Voltage (controlled)
- Output Current: 30 A max
- Output Frequency : 50 Hz
- Switching Frequency: 20 kHz max
- Ambient Temperature: 40 deg C.
- Cooling Method: Forced Air Cooled
- Three/Four IGBT gate module (Inverter leg) made up of 3 IGBT with an anti parallel diode
- Inverter module can be made optionally along with Rectifier, Brake Chopper module made up of 1 IGBT with an anti parallel diode
- Optional three phase bridge rectifier module with Blocking voltage of 1600 V and high surge current carrying capability
- Gate Driver module to interfaces and isolates the Control Unit and to control the IGBT's dynamic behavior and its short - circuit protection with Input signal level of 0/15V and Interlocking time between the input signals of 3 $\mu$ s.
- The Gate Driver also monitors the errors: power supply under-voltage (below 13 V), short-circuit between Collector and Emitter and the error reset time is typically 9 $\mu$ s. On detection of error/fault, the Gate Driver switches off the IGBT.
- Optional DC capacitor bank and snubber capacitors
- IGBT modules are mounted on 250 mm heat sink along with the axial fan connected to it to dissipate the heat generated by the IGBTs.
- Normally Closed Thermal contact switch is provided for temperature protection

### Current and Voltage Sensor Interfacing Panel



- The Current and Voltage Sensor interfacing kits are available separately with the following general features
- This kit contains 3 Current/Voltage sensors and encoder interfacing facility
- The board is designed for the 1HP Inverter stack and Motor control application
- Input facility for AC/DC current/voltage sensor from the Inverter
- Current sensor range can be varied using jumper setting.
- Power supply contains input supply of +15VDC, -15 VDC and +5VDC with LED indication
- 0 to 3V sensor output is provided on DB15 female connector which can be directly interfaced with the DSP kit
- Direct interface with EPB28335 for easy experimentation
- Test points are provided for the Encoder input and output signals (A, B, Index, Strobe, GND)

#### Current Sensor Features

Current Measurement range	: 5A, 6A, 8A, 12A, 25A
Fix Offset DC Bias voltage	: 1.5 V
Offset DC Bias voltage range	: 1.0V to 2.0V variable (Using Potentiometer)
Fix Offset AC output voltage	: 3V
Offset AC output voltage range	: 2.5V to 3.5V variable (Using Potentiometer)
Output Current waveform	: Sine wave (Input is pure sine wave is assumed)

(Output sine wave will be above ground line)

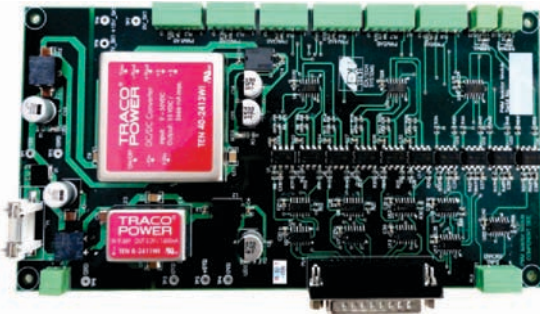
#### Voltage Sensor Features

Voltage Measurement range	: 10V- 500V Fixed
Fix Offset DC Bias voltage	: 1.5 V
Offset DC Bias voltage range	: 1.0V to 2.0V variable (Using Potentiometer)
Fix Offset AC output voltage	: 3V
Offset AC output voltage range	: 2.5V to 3.5V variable (Using Potentiometer)
Output Current waveform	: Sine wave (Input is pure sine wave is assumed)

(Output sine wave will be above ground line)

# DSP Lab For Motor Control and Drives

## PWM Isolator Kit



- General purpose PWM Isolator kit for direct connection with DSP board to generate fully isolated and amplified PWM signals
- It converts the 5V DC PWM signals generated from the DSP board to 15V DC level which can be further given to the power module under study.
- PWM isolator outputs 12 channel isolated +15 V PWM signals
- PWM input signal voltage is of +5 V
- Input Power supply range is from +9V DC to +36V DC
- Thermal Trip facility provided
- Capable to capture errors signal available from inverter module
- Microcontroller interface for Error signal and Thermal trip
- On board LED indication for Thermal Trip and Error signals
- On board Power On LED, test points for signal testing and fuse for protection

## Experiments:

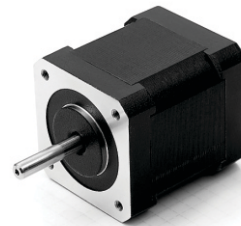
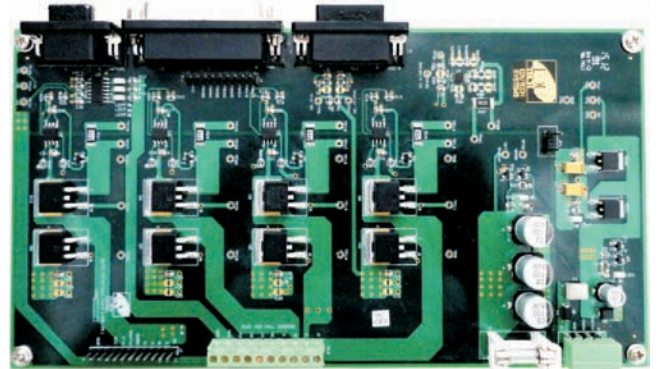
### DSP board based experiments

- Exploring different communication protocols like UART, CAN and I2C based devices like EEPROM, RTC
- Experiments to explore data converters like ADC and DAC
- Experiments to generate PWM signals
- Experiment to generate a pair of complementary 1 KHz signal
- Practical to generate a dead band unit on EPWM1A/1B
- Practical to generate HRPWM for PWM-A and PWM-B
- Experiment to capture signal using pooling and interrupt methods
- Practical to explore timer peripheral
- Writing and reading data on external and internal RAM

### Inverter Stack based experiments

- Experiment to interface inverter module with 28335 target board with variable frequency and variable dead band
- Experiment to interface inverter module with 28335 target board with variable frequency and variable dead band taking care for error signal as well as thermal trip
- Practical based on three phase bridge inverter

## BLDC Interfacing Kit



- The BLDC28335 is a general-purpose power stage board able to drive brushless DC motor.
- Flexible platform for developing motor control applications.
- All required power and control signals needed for controller interface are available on the board
- Can drive BLDC motor upto +24V DC/ 6A
- Power supply input voltage range is between 12V DC to 14V DC , 6/8 A
- PWM connector of 8 channel PWM input of +5V
- ADC connector is to read motor voltage, shunt voltage and supply voltage
- Capture connector is to read the hall sensors positioning and speed
- Test points for input PWM signals
- Test points for U, V, W, X Motor input signals
- Test points for input voltage, Motor voltage and Hall sensor voltage and +5V DC voltage is available
- On board Status LEDs to read the Hall sensor positioning
- On board Power On LED and test points for signal testing
- On board fuse for protection at high current and high voltage

Hands-on Training Program on DSP available