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

# ANALOG & DIGITAL CONFIGURABLE DC-DC CONVERTER STUDY TRAINER

## 1. µC BASED DISCRETE BI-DIRECTIONALCONFIGURABLE DC-DC CONVERTER STUDYTRAINER (VSMPS-13A-16 )

A µc Based Bi-Directional Discrete Configurable DC- DC Converter to study various DC-DC Topology by configuring the MOSFET Switch, DIODE and inductors with provision for Patching the Circuit by students for the maximum hands-on experience for the students. It consists of following 8 Discrete Modules.

i. dsPIC33CH based PWM Controller
ii. CONFIGURABLE POWER CIRCUIT BREAD BOARD MODULE
iii. Opto/Driver with MOSFET Module -2nos
iv. 2 Channel Voltage Current Signal Conditioner Module
v. Load Resistor Module
vi. 1mH Inductor Module
vii. 4mH Inductor Module-2nos
viii. High Frequency Transformer Module
ix. Schottky Diode Module -3nos
x. Capacitance Module – 2nos
xi. Power Converter Circuit Module with Converter Configuration Sheets.

The above Individual Discrete Modules are interconnected by Patch Chards by the student to form one DC-DC Topology, as per Converter Configuration Sheet and can be studied in detail, thus a student will have maximum hands on experience.
This Study Trainer enable the students to configure it for i) Boost Converter (or) Step Up Chopper ii) Buck Converter (or) Step Down Chopper iii) Buck-Boost Converter iv) Bi-directional DC-DC Converter open loop as well as Closed Loop.

v) Forward Converter, vi) Fly back Converter vii) Push pull Converter viii) Interleaved Converter ix) SEPIC Converter x) CUK Converter
PWM generation and Closed loop Control by dsPIC33CH.
Dual Core Embedded Controller

## DIGITAL PWM CONTROLLER for the DC-DC CONVERTER
### dsPIC33CH based PWM Generation

**Based on** dsPIC33CH Dual Core Embedded Controller for PWM Generation.

- 2 Nos. of Isolated High Speed Driver circuits
- 2 Nos. of Current Shunt Sensors for sensing current of the converter at different places.
- 2 Nos. of AD'S Voltage Sensor for sensing the output voltage of the converter for open loop & Closed Loop Application.

**MATLAB-SIMULINK BASED SIMULATION AND DEVELOPMENT OF SOFTWARE BY THE STUDENT**

### DIGITAL PWM CONTROLLER WITH DISCRETE MODULES

## dsPIC33CH TRAINING KIT (NANO -33CH ) MODULE


## DUAL CORE dsPIC33CH BASED PWM CONTROLLER (Nano - 33CH ) MODULE

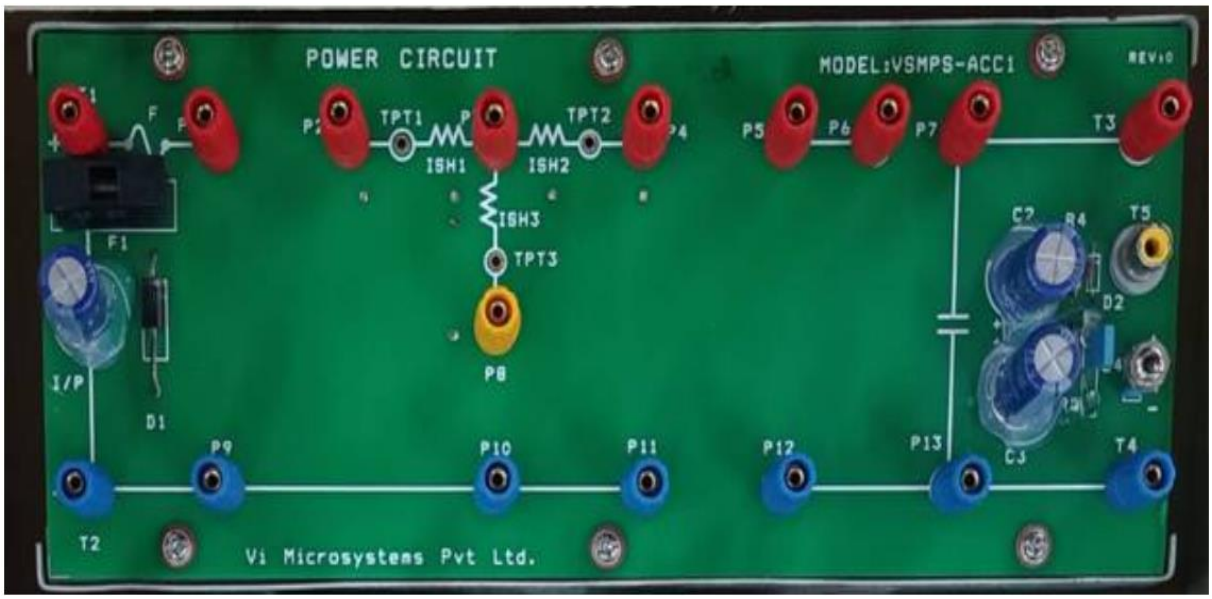
The Nano - 33CH Trainer, based on Dual Core dsPIC33CH DSP Controller, is intended and developed for advanced closed-loop control applications for Power electronics, smart grid etc. It is also focused for students to learn the multi-processor Dual Core- architecture and the inter processor communication mechanisms. The inbuilt intelligent peripherals of this processor lead to complicated design for the developers in the emerging electric applications.

- 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 Digital Signal Controller, Master/Slave Core Operation
- Core Frequency: Slave Core :100MIPS @ 200MHz.
- Core Frequency: Master Core: 90MIPS @ 180MHz,
- PROGRAM MEMORY: 512KB - Master, 72KB- Slave
- 4 CAPTURE INPUT SIGNALS at 5 PIN RMC
- PWM, PWM2 – 2 RCA Female Connector Are Used To Provide PWM Signal To The Opto/Driver With MOSFET.
- Adc1,Adc2,Adc3,Adc4 – 4nos Of Rca Female Connector Are Used To Receive The Analog Signal From The 2 Channel Voltage & Current Sensor Signal Conditioner Board.
- Two Pin Phoenix Connector Are Used To Provide The 15v To The Opto/Driver With MOSFET Module.
- Four Pin Phoenix Connector Are Used To Provide The +5V, +12V, -12V For 2 Channel Voltage & Current Sensor Signal Conditioner Board.

**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.

## CONFIGURABLE POWER CIRCUIT BREAD BOARD MODULE




This configurable converter bread board is used to build the different DC to DC converter Topology with the help of configuration sheet.

It consists of input and output terminals, feedback voltage, attenuator circuit, filter capacitor for the output, feedback voltage pole changer switch, input fuse for over current and polarity protection and RCA connector for feedback to the controller. Three numbers of current shunt resistance provided to sense the currents.

## 2. CHANNEL VOLTAGE AND CURRENT SENSOR SIGNAL CONDITIONER (Model no : PEC16DSMO1-ACC5)


- This module is provided to Sense the voltage and current of 2 channels.
- This is used to provide the isolation and attenuation of the signals from the power circuit.
- Isolated by analog isolation amplifier.
- Input maximum voltage: 50VDC,Current: 2A.
- 6 nos. of banana connectors provided for input connections.
- 5 nos. of test points provided to see the signals through DSO
- 4 nos. of RCA connectors provided to give the feedback to the controller.
- One no of 4 pin Phonix connector provided to receive the External DC power supply.
- 6 Nos. of Small banana connector For I/P channel-1 and I/P channel -2 of 2Channel Voltage & Current Sensor Signal Conditioner.
- 4 Nos. of Rca Female Connector for Sensor Output Of2 Channel Voltage & Current Sensor Signal Conditioner.
- Four Pin Phoenix Connector Are Used To Provide The +5V, +12V, -12V For2 Channel Voltage & Current Sensor Signal Conditioner Board.

### OPTO+DRIVER WITH MOSFET MODULE


| MOSFET DEVICE DETAILS | |
|---|---|
| Drain-source Voltage (VGS =0) | 500V |
| Drain-gate Voltage (RGS=20 kW) | 500V |
| Gate-source Voltage | ±20V |
| Drain Current(continuous)at Tc=25ºC | 8.0A |
| Drain Current(continuous)at Tc=100ºC | 5.1A |

- ❖ RCA female connector are used to receive the PWM pulse from the PWM analog Controller/ Digital Controller.
- ❖ Two pin Phoenix connector are used to provide the +15V power to the TLP250 OPTO/DRIVER WITH MOSFET.

- Drain & Source are terminated at banana connectors for patching to Power Circuit Module

## SCHOTTKY DIODE MODULE

| | |
|---|---|
| crest working reverse voltage | 200 V |
| reverse voltage | 200 V |
| average output current | 10 A |

- 2 Nos. of small banana connector are connected to the Anode and Cathode of the Schottky Diode

## 1mH INDUCTOR MODULE


| | |
|---|---|
| Inductance | 1mH |
| Tolerance(%) | 10% |
| Current Rating (A) | 2A |
| Frequency(Hz) | 20KHz |

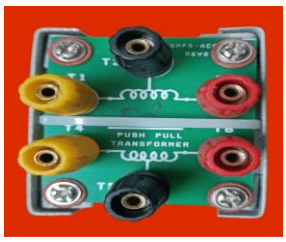
- 1mH Inductor terminals are connected to Banana Connectors for easy patching.

## 4mH INDUCTOR MODULE


| | |
|---|---|
| Inductance | 4mH |
| Tolerance(%) | 10% |
| Current Rating(A) | 1.5 |
| Frequency(Hz) | 20kHz |

- 2 Nos of small banana connector are connected to terminal 1 **T1** and terminal 2 **T2** of the 4mH Inductor

## HIGH FREQUENCY TRANSFORMER MODULE




| | |
|---|---|
| Frequency | 20kHz |
| current rating | 2A |
| Inductance | 4mH |

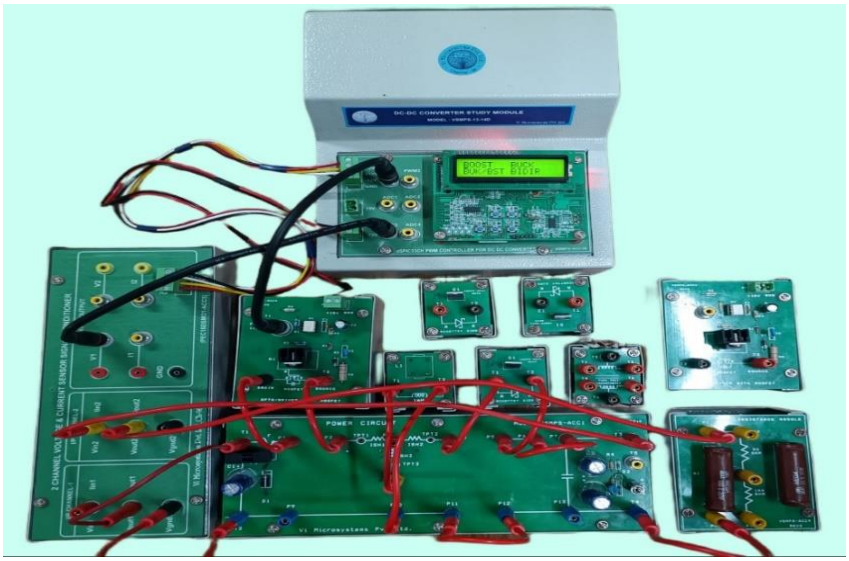
- are connected to 30V-0V-30V Push-pull transformer.
- T1-T2-T3 are one end of the Push-Pull transformer.
- T4-T5-T6 are other end of the Push-Pull transformer.

## LOAD RESISTANCE MODULE

| | |
|---|---|
| Resistance | 100 ohm , 50 ohm And 150 ohm selectable. |
| Power Rating | 20W |

- 5 Nos. of small banana connector are used to select the 3 different value of resistance.
- P2-P4 to select 50 ohm resistance at the load end.
- P4-P5 to select 100 ohm resistance at the load end.
- P1-P3 to select maximum 150 ohm resistance at the load end.

**External Variable power Supply of 0-30V / 2 A Provided to supply Variable DC Voltage with Current Control to the input of Configured Converter.**



## 2. ANALOG DISCRETE CONFIGURABLE DC- DC CONVERTER STUDY TRAINER ( VSMPS -13-15 )

An Analog PWM generator Based Discrete Configurable DC- DC Converter to study various DC-DC Topology by configuring the MOSFET Switch, DIODE and inductors with provision for Patching the Circuit by students for the maximum hands-on experience for the students. It consists of following 8 Discrete Modules.

i. TL494 based PWM Controller with Voltage Sensor Module
ii. CONFIGURABLE POWER CIRCUIT BREAD BOARD MODULE
iii. Opto/Driver with MOSFET Module -2nos
iv. Load Resistor Module
v. 1mH Inductor Module
vi. 4mH Inductor Module -2nos
vii. High Frequency Transformer Module
viii. Schottky Diode Module -3nos
ix. Capacitance Module – 2nos
x. Power Converter Circuit Module with Converter Configuration Sheets, (Optional) 2 Channel Voltage Current Signal Conditioner Module

The above Individual Discrete Modules are interconnected by Patch Chards by the student to form one DC-DC Topology, as per Converter Configuration Sheet and can be studied in detail, thus a student will have maximum hands on experience.

This Study Trainer enable the students to configure it for i) Boost Converter (or) Step Up Chopper ii) Buck Converter (or) Step Down Chopper iii) Buck-Boost Converter iv) Forward Converter, v) Fly back Converter vi) Push pull Converter (Only open loop)

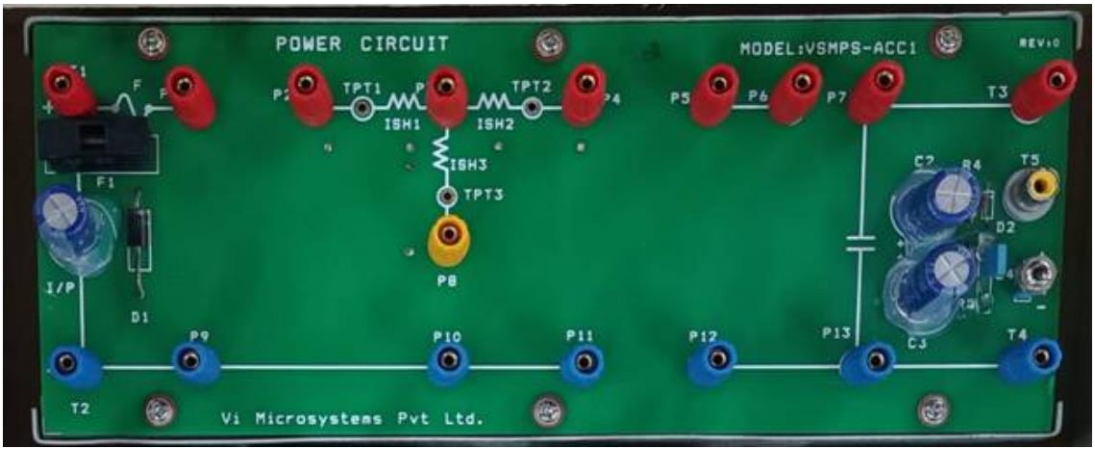
## PWM generation and Closed loop Control by TL494 Module

**TL494BASED PWM GENERATOR WITHVOLTAGE SENSOR MODULE**

| | |
|---|---|
| Control mode opec | Voltage |
| Duty cycle (max) (%) | 60 |
| Switching frequency (max) (kHz) | 18 TO 25 |
| Features | Adjustable switching frequency, Dead time control, Error amplifier, Multi-topology |
| Voltage Sensor with Signal Conditioning | For Closed Loop |

- SW1- SPDT Switch to select the single or dual pulse from PWM CONTROLLER.
- SW2- SPDT Switch to select the Inverted or Non-Inverted pulse from PWM CONTROLLER.
- SW3- SPDT Switch to select the open loop or closed loop operation from PWM CONTROLLER.
- P7 and P8 – 2 Nos. of phoenix connector for providing +15V power supply to the OPTO/DRIVER WITH MOSFET.
- PWM1- RCA Female connector terminated for PWM pulse to the OPTO/DRIVER WITH MOSFET 1.
- PWM2- RCA Female connector terminated for PWM pulse to the OPTO/DRIVER WITH MOSFET 2.
- VOUT- RCA Female connector provided for give the feedback from the o/p voltage.
- 12 Nos. of unisolated socket or test point to check the signal from the TL494CN PULSE CONTROLLER IC.

## CONFIGURABLE POWER CIRCUIT BREAD BOARD MODULE




This configurable converter bread board is used to build the different DC to DC converter Topology with the help of configuration sheet.

It consists of input and output terminals, feedback voltage, attenuater circuit, filter capacitor for the output, feedback voltage pole changer switch, input fuse for over current and polarity protection and RCA connector for feedback to the controller. Three numbers of current shunt resistance provided to sense the currents.

## OPTO+DRIVER WITH MOSFET MODULE


| | |
|---|---|
| Drain-source Voltage(VGS =0) | 500V |
| Drain-gate Voltage(RGS=20 kW) | 500V |
| Gate-source Voltage | ±20V |
| Drain Current(continuous) at Tc=25ºC | 8.0A |
| Drain Current(continuous) at Tc=100ºC | 5.1A |

- RCA female connector are used to receive the PWM pulse from the PWM analog Controller/ Digital Controller.
- Two pin Phoenix connector are used to provide the +15V power to the **TLP250 OPTO/DRIVER WITH MOSFET**.

  2 Nos. of small banana connector are used to connect the drain and source terminal for drive the power to the power circuit Board.

## SCHOTTKY DIODE MODULE

| | |
|---|---|
| crest working reverse voltage | 200 V |
| reverse voltage | 200 V |
| average output current | 10 A |

- 2 Nos. of small banana connector are connected to the Anode and Cathode of the Schottky Diode

## 1mH INDUCTOR MODULE


| | |
|---|---|
| Inductance | 1mH |
| Tolerance(%) | 10% |
| Current Rating (A) | 2A |
| Frequency(Hz) | 20KHz |

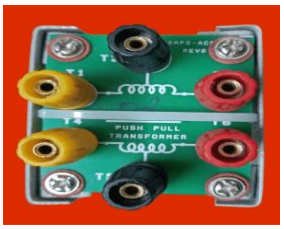
- 2 Nos. of small banana connector are connected to terminal 1 **T1** and terminal 2 **T2** of the **1mH** Inductor.

## 4mH INDUCTOR MODULE


| | |
|---|---|
| Inductance | 4mH |
| Tolerance(%) | 10% |
| Current Rating(A) | 1.5 |
| Frequency(Hz) | 20kHz |

- 2 Nos. of small banana connector are connected to terminal 1 T1 and terminal 2 T2 of the 4mH Inductor

## HIGH FREQUENCY TRANSFORMER MODULE



| | |
|---|---|
| Frequency | 20kHz |
| current rating | 2A |
| Operating Temperature | +125C |
| Inductance | 4mH |

- 6 Nos of Small banana connector are connected to **30V-0V-30V Push-pull transformer.**
- T1-T2-T3 are one end of the Push-Pull transformer.
- T4-T5-T6 are other end of the Push-Pull transformer.

## LOAD RESISTANCE MODULE

| | |
|---|---|
| Resistance | 100 ohm , 50 ohm And 150 ohm selectable. |
| Power Rating | 20W |

- 5 Nos. of banana connector are used to select the 3 different value of resistance.
- P2-P4 to select 50 ohm resistance at the load end.
- P4-P5 to select 100 ohm resistance at the load end.
- P1-P3 to select maximum 150 ohm resistance to the load end.

**External Variable power Supply of 0-30V / 2 A Provided to supply Variable DC Voltage with Current Control to the input of Configured Converter.**

**A fully patched Experimental Set Up.**

## 3.ANALOG PWM BASED CONFIGURABLE DC-DC CONVERTER STUDY TRAINER (VSMPS -13A-14)

A Configurable DC- DC Converter to study various DC-DC Topology by configuring the MOSFET Switch DIODE and inductors with Parching by students for the maximum hands on experience for the students.
This Study Trainer enable the students to configure it for i) Boost Converter (or) Step Up Chopper ii) Buck Converter (or ) Step Down Chopper iii) Buck-Boost Converter iv) Fly back Converter v) Push pull Converter (Only open loop) vi) Forward Converter, open loop as well as Closed Loop.

PWM generation is Based on Analog PWM Controller TL494

**This module consists of (i) Analog PWM controller circuit ( TL494 based )(ii)PWM Opto Isolator with Driver circuit (iii)Feedback Isolator and signal conditioner Circuit (iv)Configurable power circuit (v) Power circuit components with Configurable Sheets.**

### (i) PWM Control circuit

- TL494 Based PWM Generator
- 2 Nos. of High Speed MOSFET
- 2 Nos. of Isolated High Speed Driver circuits
- 2 Nos. of Current Shunt Sensors for sensing current of the converter at different places.
- Voltage Sensor for sensing the output voltage of the converter for Closed Loop Application.

### (ii) PWM OPTO Isolator and Driver circuit

- Two nos. of high speed opto couplers with Driver Provided.

### (iii) Feedback circuit

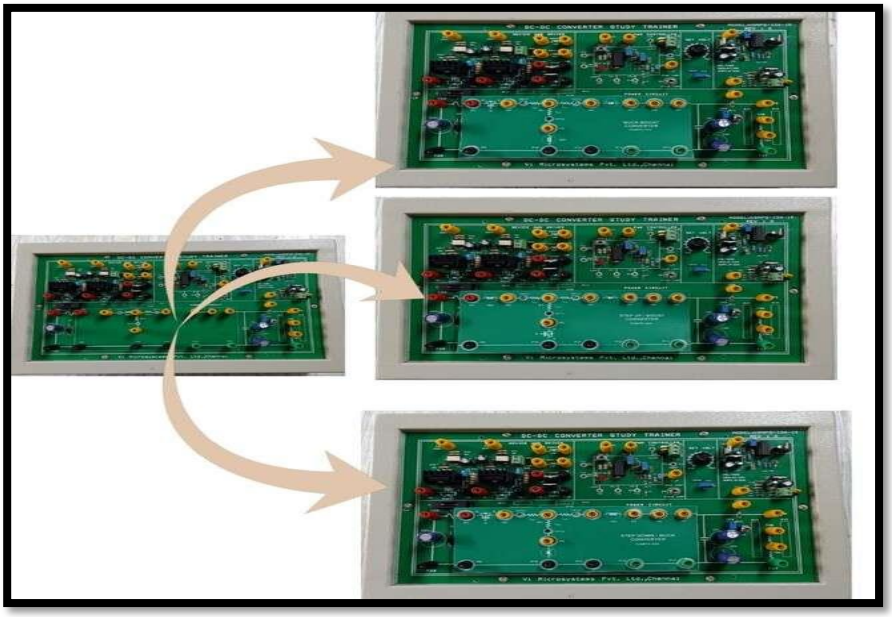
- Hall Effect Voltage Sensor Provided for sensing the output voltage of the Converter for closed loop operation.

### Modes of operation:

- In Boost mode I/P is 15V and O/P is 30V DC
- In Buck mode I/P is 30V and O/P is 15V DC
- In Fly back Mode I/P is 30V and O/P is 5V DC
- In Push pull Mode I/P is 30V and O/P is 5V DC
- Power Rating is 5 - 15Watts
- Output Current : 1 Amp
- dv/dt protection is available for all MOSFET (Snubber Circuit)
- Test points provided in control section for wave form measurement in DSO
- Power Circuit Configuration PAD provided for easy connection of various power supply.
- Patch Cards provided in various length to interface easily.

### iv) Configurable power circuit

- It consists of power circuit i/p and o/p connection with configurable converter patching connections.
- Components for the Power Circuit : MOSFET, DIODE and Inductors are Provided



## (v) Power circuit components

- It consists of Two nos. of MOSFETs, Two nos. Diodes and Two nos. of Inductors.

**(vi)External Variable power Supply of 0-30V / 2 A Provided to supply Variable DC Voltage with Current Control to the input of Configured Converter.**


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