

## **TECHNICAL REPORT**

### **EC Lab with plugin board**

#### **An open-source Electronics HDL platform- Ekalavya**

*The breakdown of the electronics industry, which started about ten years ago and has shaped the electronics industry structure, favors the transition from a vertically integrated business model to a horizontally integrated business model. In the past, ESS companies maintained complete control over the production cycle, from product definition to final product manufacturing. Today, identifying a new market, defining detailed system specifications, developing the components, assembling those components, and manufacturing the final product are all tasks that are largely outsourced to different organizations. (1)*

*The world of Embedded Systems is relatively large and mainly revolves around the GPG (General Purpose) Processor and Microcontrollers. FPGA (Field-Programmable Gate Array) is commonly used in Processor-Based Embedded Systems to Glue logic or to offload the processor from workloads that require rapid updates. (2) The HDL for FPGA-based signal processing is a significant aspect of Hardware Abstraction Layer efforts. (3)*

*The Ekalavya HDL platform is a convenient and cost-effective pocket HDL platform for Embedded Electronic Design.*

*Ekalavya is an open-source electronics HDL platform that provides seamless implementation with compatible breakout boards and plugins using VHDL/Verilog.*

*Electronic Engineering students, with this Pocket Lab and in combination with various breakout boards, would have the opportunity to conduct a wide range of available experiments based on their current syllabus from the 1<sup>st</sup> to 8<sup>th</sup> semester; these students have an additional appetite for upskilling themselves with hands-on experiments can capabilities in areas of Edge computing for AI, ML, Mechatronics, Robotics and Industrial automation to name a few can choose the appropriate breakout board which in combination with the main EC lab unit will fuel their innovative spark, enable their project initiatives and overall empower them to be better industry prepared. Break-out boards can be considered as a gateway to building edge computing models.*

*From an SI or ML perspective, the Ekalavya architecture:*

*It is designed to integrate shortly into the TensorFlow and TensorFlow Lite framework providing superior ease of use over legacy and alternative platforms.*

*It is designed to serve as a Machine Learning development platform for deploying Convolutional Neural Networks (CNN) on FGGAs in the near future; it includes software scripts needed to convert TensorFlow files and accelerator FPGAIIP.*

#### **Salient Features**

*Built-in IP support for a wide range of Sensors for Quick development of Algorithms that can be implemented.*

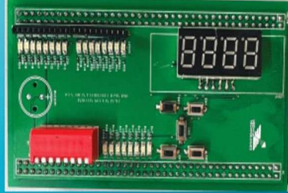
*Robust IP Library for building Applications for AI or ML*

*Designed to work with applications across verticals through specific breakout boards covering the utmost IO*

*User-friendly IDE that works on Windows and Linux.*

### 1. Generic Break-out Board

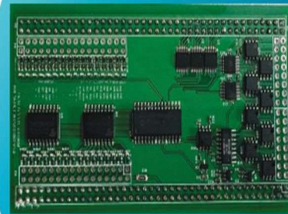
- ▶ Logic Gates (NOR/AND/NAND/XOR/OR)
- ▶ Half Adder and Full Adder
- ▶ Shift Register
- ▶ FSM using Moore and Mealy
- ▶ Arithmetic Logic Unit
- ▶ UP/DOWN counters
- ▶ PWM to control DC/Stepper Motors
- ▶ Interfacing the Solid-State Relays
- ▶ Interface the DOT MATRIX RGB-LED Driver



- Features:**
- ▶ 7 Segment 4 Digit LED Display
  - ▶ 8 Discrete Input (2-60V)
  - ▶ 8 Discrete outputs (2- 60V @100mA)
  - ▶ 8 bit Di Switch
  - ▶ 8 Discrete LED's
  - ▶ 5 Key Switch
  - ▶ 1 buzzer

### 2. Discrete I/O Break-out Board

- ▶ DC Motor Control
- ▶ Encoder Interface
- ▶ Customized PLC Block
- ▶ Driver Control Circuit for Stepper Motor
- ▶ Analog to Digital Converters
- ▶ Drive Pneumatic Valves
- ▶ Interface Sensor with Discrete / Analog input.
- ▶ Interface with Discrete /Analog control (Servo Motors)



- Features:**
- ▶ 16 Discrete Inputs (2-60V)
  - ▶ Can be configured to read frequency, Period, Duty also
  - ▶ 16 Discrete outputs (max 12V @1000mA)
  - ▶ Can be configured to generate pulse, PWM also
  - ▶ 8 Channels of analog input +/- 10V, 12Bit
  - ▶ 8 channels of Analog output +/-10V, 12Bit, 10mA

### 3. Data Acquisition Plug-in Board

- ▶ FIR Circuits
- ▶ Fixed Floating-point Addition and multiplication
- ▶ Low Pass and High Pass Filters
- ▶ FFT
- ▶ DDS (Digital Direct Synthesis)



- Features:**
- ▶ 8 Channel 12bit Analog input 500kSPS Independent Sampling rate selection
  - ▶ +/- 10V Max voltage input 4-20mA input
  - ▶ 8 Channel 12bit Analog output
  - ▶ 4.5uS refresh rate +/- 10V Max voltage input
  - ▶ 8 Digital Input, 5V compatible
  - ▶ Capture rate 100MHz
  - ▶ Trigger selectable across Analog and Digital inputs
  - ▶ 8 Digital output, 5V compatible
  - ▶ A High speed Analog to Digital (3MSPS, 16bit ) converters Simultaneous acquisition of 8CH
  - ▶ A high-speed DAC (12 bit) for reference generator, waveform generator, control signal

#### 4. Image Processing / Hmi Plug-in Board

- ▶ Customised Algorithms implementation
- ▶ HDMI/DVI Input Designs for Object detection
- ▶ Audio Input Designs for Speech and Sound Detection
- ▶ Camera Input Designs for Object Detection
- ▶ Menu Driver Graphical User Interface
- ▶ Implementation of virtual instruments



- Features:**
- ▶ Camera interface MIPI, CSI, LVDS 8 Channel
  - ▶ HDMI 1 In port & 1out port
  - ▶ LCD interface
  - ▶ Dual channel audio (Stereo) I/O
  - ▶ 128 X 64 graphical OLCD
  - ▶ 5 key Joystick
  - ▶ 1 buzzer
  - ▶ Ethernet port
  - ▶ HDMI output
  - ▶ USB port
  - ▶ UART/TTL

#### 5. Communication Plug-in Board

- ▶ UART application
- ▶ I2C application
- ▶ SPI application
- ▶ Socket programming application (Wired/Wireless)
- ▶ MODBUS protocol
- ▶ Cloud application



- Features:**  
Communication covering Industry standard protocol
- ▶ RS232
  - ▶ RS485
  - ▶ Ethernet
  - ▶ CAN,
  - ▶ Wifi, BLE, NFC
  - ▶ Configurable Protocol driver for MODBUS RTU/ASCII /
  - ▶ TCP IP and other standards.



**EC Lab with Plug-in board**

## Benefits

Breaking down complex digital design

Scalable and affordable based on students' drive to learn

Simple and clear programming environment that supports creation of own microprocessors

Industry aspirants to get hands on working on various experiments/capability options using the VHDL/verilog environment

**Online Community Support:** ([www.vedhyatech.com](http://www.vedhyatech.com))

## References

[1] Platform-Based Design for Embedded Systems Luca P. Carloni a Fernando De Bernardinis a,b Claudio Pinello a Alberto L. Sangiovanni-Vincentelli a Marco Sgroia. In: <http://www.cs.columbia.edu/~luca/research/pbdes.pdf>

[2] Rahul Dubey. (2009). Introduction to Embedded System Design Using Field Programmable Gate Arrays. © 2009 Springer-Verlag.

[3] Ain, M. F, Naghmash, M. S., Chye, Y. H. (2010). Synthesis of HDL code for FPGA design using system generator. *European Journal of Scientific Research*. 45 (1), 111-121.