



Machine Learning Demo User's Guide

This document describes the available Machine Learning demos from Lattice. These demos operate on Lattice's Embedded Vision Development Kit, featuring the Lattice CrossLink pASSP and ECP5 FPGA.

The implementation of this demo in ECP5-85 consists of 8 Neuro Network engines (NN) engines. The size can be reduced to fit a smaller device with some tradeoffs. The implemented Neuro Network, the so-called LatticeNET1 allows a 90x90 RGB Input with 8 convolution layers..

Two demonstrations are available:

Face Detection

Face Tracking

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Demo Requirements

The following items are required:

Hardware Requirements

- Lattice Embedded Vision Development Kit (LF-EVVK1-EVN)
 - Mini-USB Cable (Included with Kit)
 - 12 V Power Supply (Included with Kit)
- HDMI Cable
- HDMI Monitor (1080p60)
- Micro-SD Card Adapter (this is a customized item, see below for details)
- Micro-SD Card (standard only - less than 2GB, not SDHC/SDXC/etc)

Software and Firmware Requirements

- Diamond Programmer (www.latticesemi.com/programmer)
- Programming files for Embedded Vision Development Kit
 - Dual_Camera_to_Parallel_Crosslink.bit (targets CrossLink)
 - vip_face_box_det_v2_125MHz_agc.bit (targets ECP5)
- Micro-SD card Image writer software (Win32diskimager)
 - **URL link:** <https://sourceforge.net/projects/win32diskimager/>
- Micro-SD card image
 - prog_facebox_v3_0.bin
 - prog_facedet.bin



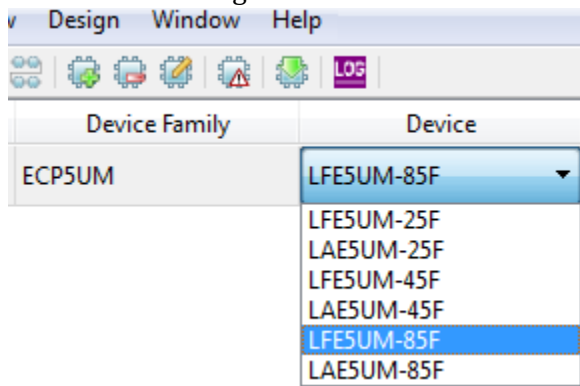
Initial Setup

ECP5 Programming

Erase the ECP5 prior to re-programming

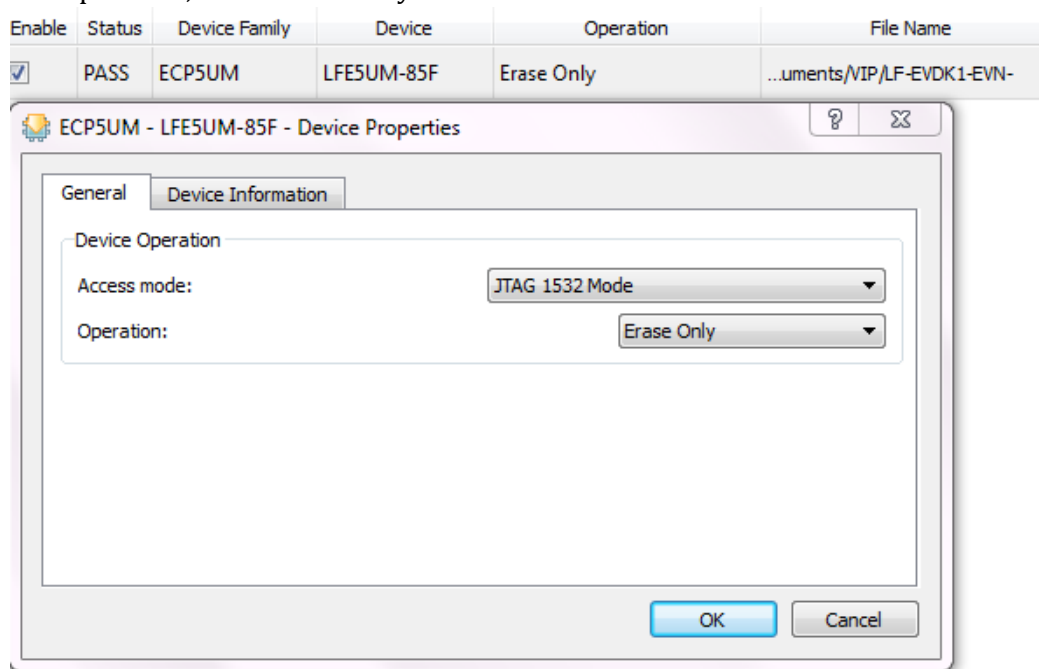
If the ECP5 is already programmed (either directly, or loaded from SPI Flash), you'll need to follow this procedure to first erase the ECP5 SRAM memory, then program the ECP5's SPI Flash in the next section. If you are doing this, keep the board powered when re-programming the SPI Flash in the next section.


1. Connect the 12V power supply to the barrel plug at J4.
2. Ensure SW2 on ECP5 board is ON to power the board. (LEDs should be ON)
3. Connect mini-USB cable from PC to mini-USB connector on ECP5 VIP Processor Board
4. Launch Diamond Programmer with "Create a new blank project"
5. Make the following selections in Diamond Programmer for Device Family and Device





6. For Operation, select Erase Only

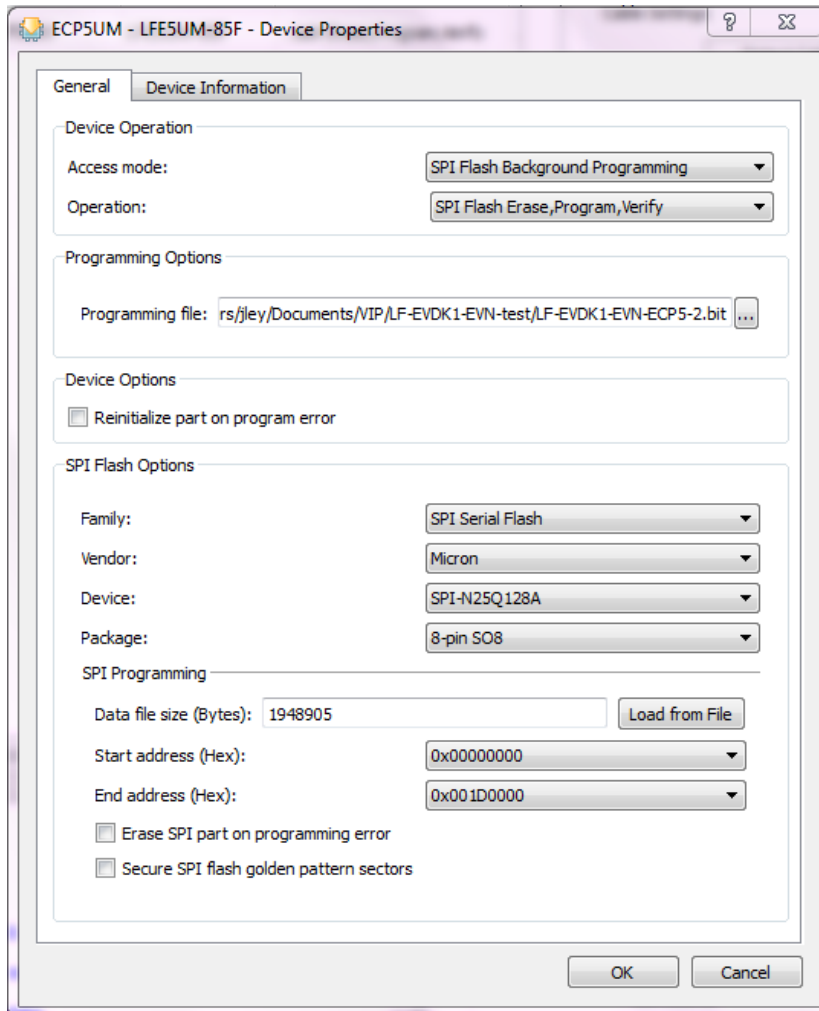


7. Click the Program button  in Diamond Programmer to start the Erase sequence.


(If you power off/on the board, the SPI Flash will program the ECP5 again, and you'll have to repeat steps 1 through 7)

Program the ECP5 VIP Processor Board

8. Double-click the selection in the Operation box and change "Access mode" to SPI Flash Background Programming to bring up the below dialog, make the selections as shown. Noted that in the "Programming File" section, select the file "vip_face_box_det_v2_125MHz_agc.bitbit". Click OK.

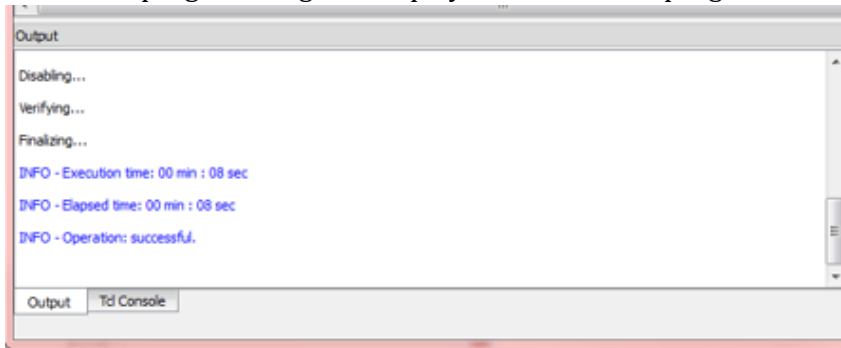


Note: instead of entering the Data file size, click “Load from File”.

9. Click the Program button  in Diamond Programmer to start the programming sequence.



10. Successful programming will display as below in the programmer output console



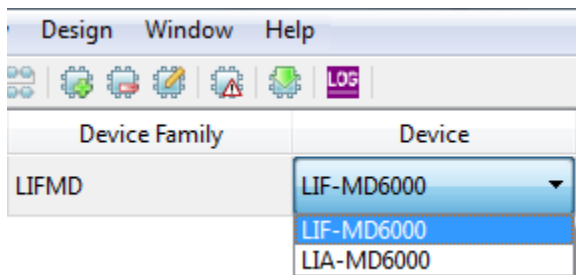


Programming Crosslink

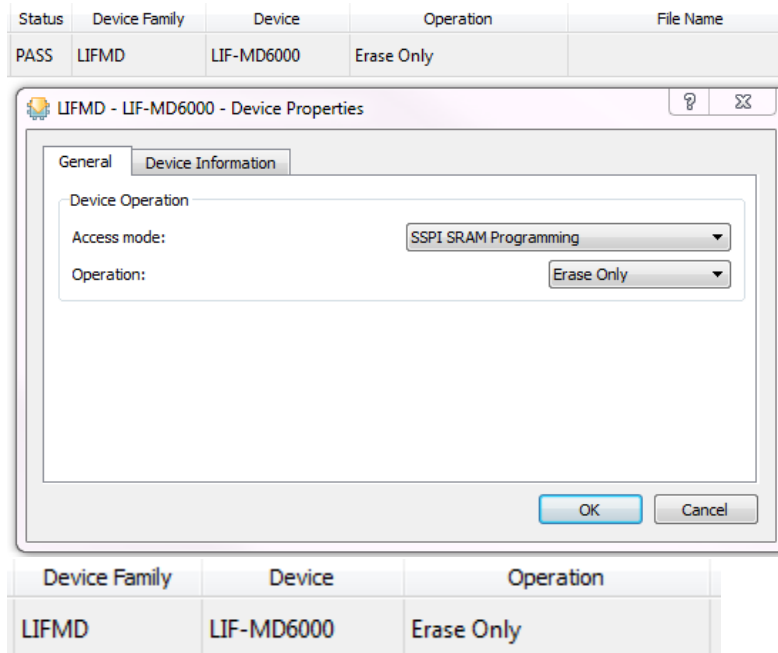
Erase the CrossLink prior to re-programming

If the CrossLink is already programmed (either directly, or loaded from SPI Flash), you'll need to follow this procedure to first erase the CrossLink SRAM memory before re-programming the CrossLink's SPI Flash. If you are doing this, you need to keep the board powered when re-programming the SPI Flash (so it doesn't re-load on re-boot).


11. Launch Diamond Programmer with "Create a new blank project"
12. Make the following selections in Diamond Programmer for Device Family and Device



13. Make the following selections in Diamond Programmer:

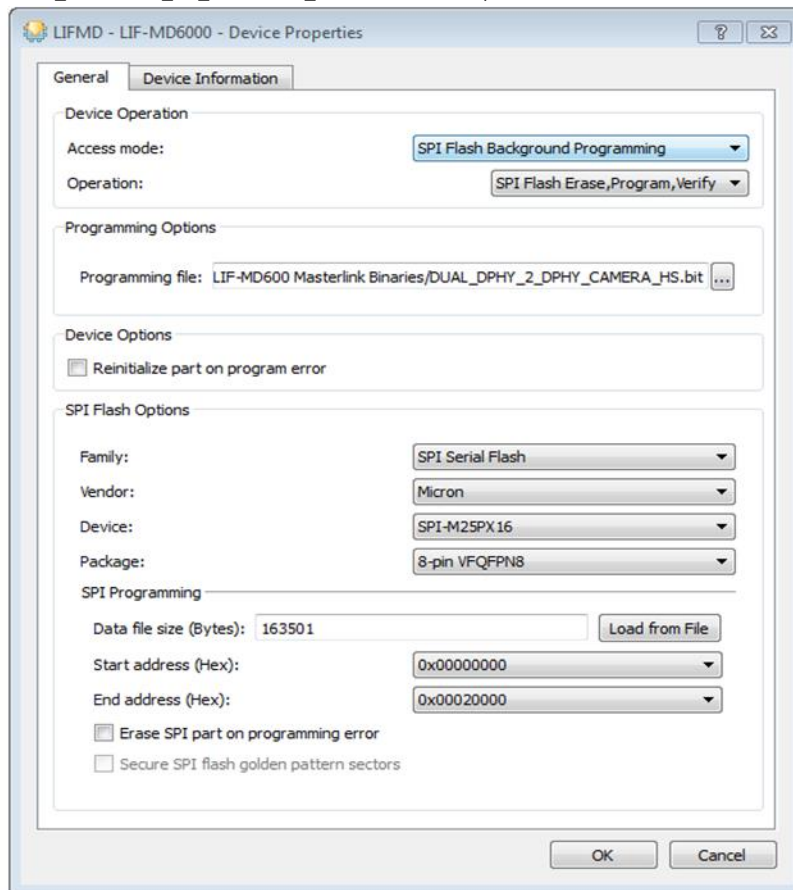





14. Click the Program button  in Diamond Programmer to start the Erase sequence. (If you power off/on the board, the SPI Flash will program the ECP5 again, and you'll have to repeat steps 11 through 14).

Program the CrossLink VIP Input Bridge Board

15. Double-click the selection in the Operation box and change “Access mode” to SPI Flash Background Programming to bring up the below dialog, make the selections as shown. Noted that in the “Programming File” section, select the file Dual_Camera_to_Parallel_Crosslink.bit”, Click OK.

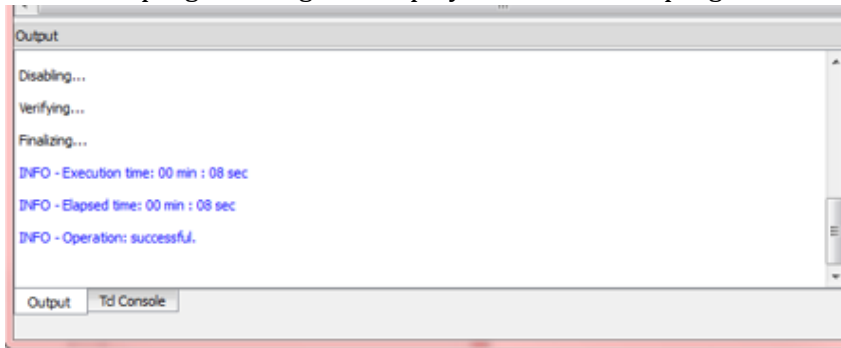


Note: instead of entering the Data file size, just click “Load from File”.

16. Click the Program button  in Diamond Programmer to start the programming sequence.



17. Successful programming will display as below in the programmer output console





Micro-SD Card Adapter

This demo requires a Micro-SD Card Adapter. This is a custom item for use with the Lattice Embedded Vision Development Kit.

If you do not have this item, contact your local Lattice representative, or follow the below instructions to build your own.

Materials Required

You will need the following materials to make your own Micro-SD Card Adapter

- Adafruit Micro-SD Card Breakout Board+ <http://adafru.it/254>
- 2x5 female header
- Short wire

Assembly instructions

Solder the header to the Micro-SD Card Breakout Board+ as shown in the image; connecting one side of the header to Micro-SD Card Breakout Board+ in the following locations:

CS, DI, DO, CLK, GND.

Solder the wire as shown, connecting the pin shown closest in the photo to 3v on the Micro-SD Card Breakout Board+





Write the image to the Micro-SD Card

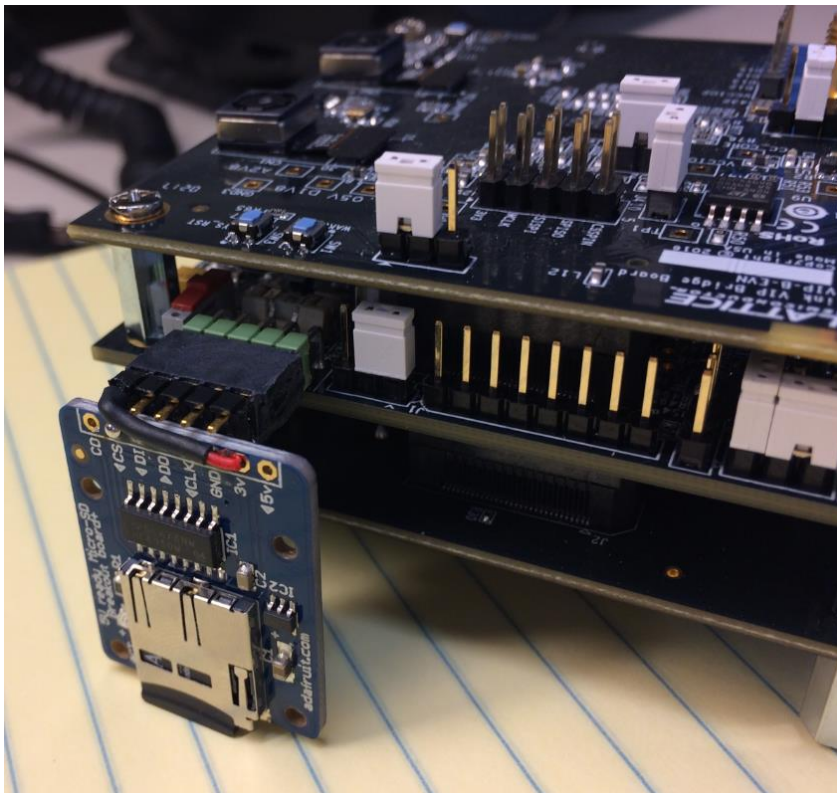
Download and install the Win32diskimager Image Writer software from the following link:

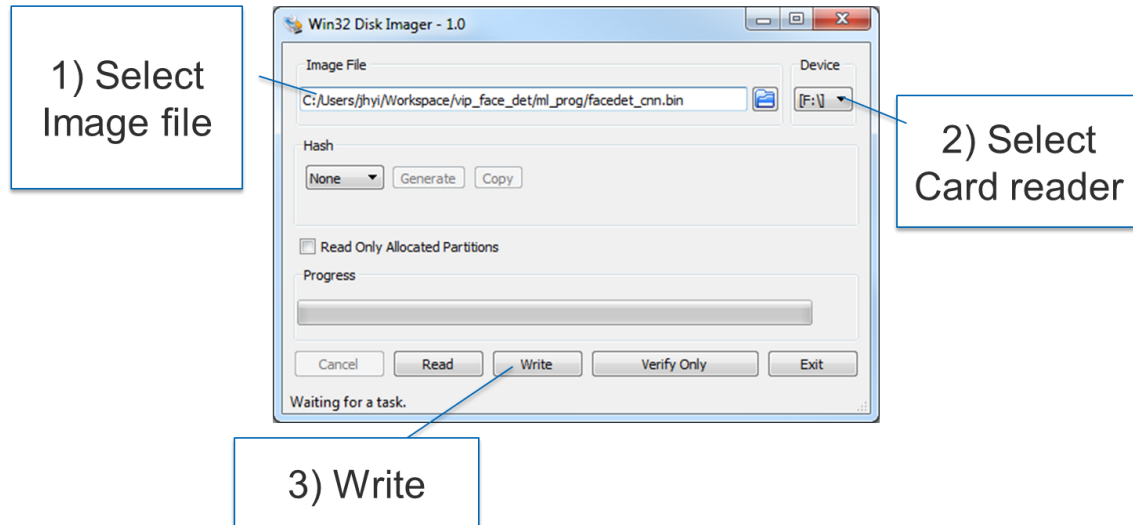
<https://sourceforge.net/projects/win32diskimager/>

Use Win32diskimager to write the appropriate flash image file to the SD memorycard. Depending on your PC, you may need a separate adapter (not described in this document) to physically connect to the card. See Demo section below to determine which file to use for the demo you want to run.

Connect the Micro-SD Card Adapter

Connect as shown in the picture







Demo Operation

There are two demos available. Both demos use the same bitstream files for ECP5 and CrossLink. The NN are reconfigured through the content in the Micro-SD card. In addition, the Micro-SD card also stores the learning data.

Procedure to run either demo:

1. Write the appropriate file to the Micro-SD card:
 - a. Face Detection / Demo 1 = prog_facedet.bin
 - b. Face Tracking / Demo 2 = prog_facebox_v3_0.bin
2. Insert the configured Micro-SD Card into the Micro-SD Card Adapter, and connect to the Embedded Vision Development Kit.
3. Cycle the power on Embedded Vision Development Kit to allow ECP5 and Crosslink to be reconfigured from Flash.
4. Connect the Embedded Vision Development Kit to the HDMI monitor. Camera image should be displayed on monitor.
5. Depending on the selected demo the output should be visible.

Note: As all demo firmware/information is written to non-volatile Flash memory, either demo will run at power-up.

Demo 1 / Face Detection

Demo 1 provides an example of object/facial detection. A green box will appear around an objects and indicates if a human face is detected in the image. Two green bars on the left indicate the propability that a face is either detected or not detected in the image.



Green box indicates
face detected

Bars indicates probability
Left bar = no face detected
Right bar = face detected

The demo 1 operates at 7 fps but it is possible to increase the frame rate to 200fps with a 32x32RGB input. The ECP5 consumes approximately 0.85W of power.

Demo Face Tracking

Demo 2 provides an example of object/facial tracking application. A green box will appear around an objects and indicates if a human face is detected in the image. This green box will follow the human face in the image and track the movement.



Green box indicates
location of the face

FAQ

Question: Object/facial recognition does not work all the time.

Answer 1: The human face needs to consume 30% to 100% of the image height. Ensure that you are close enough to the image sensor.

Answer 2: 50% or more of the face needs to be in the image for proper detection.

Answer 3: Detection is sensitive to rotation of the camera. We recommend that rotation on all axis relative to the face is maintained to less than 25%.

Answer 4: Lighting needs to be neutral. In particular avoid large differences in lighting across the image.



Question: My board was working first but when I cycle the power it does not work anymore.

Answer: There is a known warm issue caused by a boot from flash.

Problem description: Some boards are failing to configure from SPI Flash after the board has been running for a period of time and has become warmer. Once the board cools down, the configuration is successful.

Workaround: The problem is believed to be caused by the loading on the SPI interface. Removing the connection to the downstream board appears to solve the issue. On the ECP5 board, remove pins 27 (SCLK) and 31 (MISO) from the inside of connector J12.



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