MDP Based Key Phrase Detection Demonstration

User Guide

FPGA-UG-02048 Version 1.1

September 2018

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Acronyms in This Document

A list of acronyms used in this document.

Acronym	Definition
BNN	Binary Neural Network
FPGA	Field-Programmable Gate Array
LED	light-emitting diode
MDP	Mobile Development Platform
SOIC	Small Outline Integrated Circuit
SPI	Serial Peripheral Interface
USB	Universal Serial Bus

1. Introduction

This document describes how to operate the Key Phrase Detection demo on the iCE40™ UltraPlus Mobile Development Platform (MDP) board. The design features a Binary Neural Network (BNN) implementation using our Compact CNN soft IP which is used in key phrase detection.

2. Functional Description

There are four iCE40 UltraPlus devices on the MDP board. The iCE40UP5K_B (U2 on the MDP board) device is used to run this demo.

In this demo, an LED indicates when a sample key phrase *Seven* is detected. When the microphone detects the key phrase, the LED indicator turns ON. When the microphone does not detect a key phrase, the LED stays OFF.

Figure 2.1 shows the diagram of the Key Phrase Detection demo. The microphone captures the audio data and sends it to the iCE40 device. iCE40 then uses the audio data with the firmware file from the external SPI Flash to determine if the key phrase is detected. In addition, there is a RGB driver which each color displays different thresholds of detection of audio data.

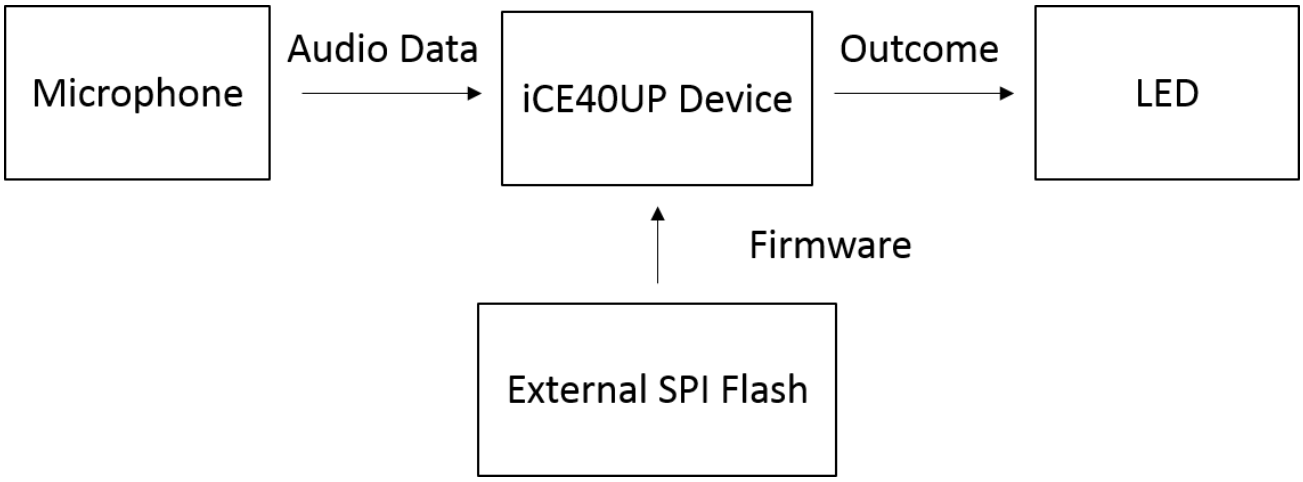

Figure 2.1. Key Phrase Detection Demo Diagram

3. MDP Board Setup

Before running the demo, the MDP board must be configured by setting the switches and jumpers as shown in Figure 3.1.

Note: Figure 3.1 is a default image of the MDP board and the switch/jumper configurations shown here are wrong. The orange rectangles are provided only to help you locate the correct locations of the switches/jumpers. Be sure to read the information in Table 3.1 for the correct configuration settings.

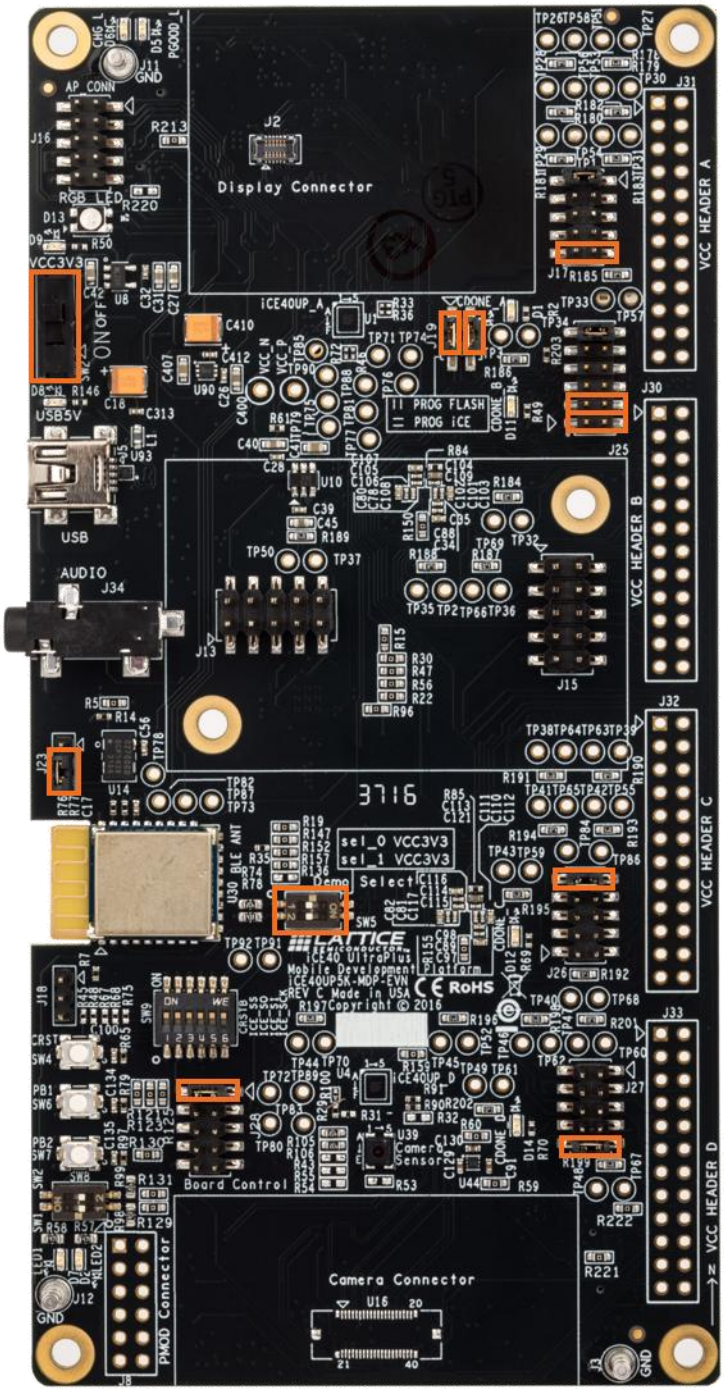

Figure 3.1. MDP Board with Configuration Locations Highlighted

Table 3.1 provides detailed information on the MDP switch and jumper configuration.

Table 3.1. MDP Board Configuration Details

Items	Configuration	Description
J17, J26, J27	Shunt pin 9 - 10	Disable iCE40UP5K A/C/D devices
J25	Shunt pin 1 - 2	Enable iCE40UP5K_B device
J25	Shunt pin 3 - 4	Provide Onboard Mic connection to FPGA
J28	Shunt pin 1 - 2	Board control, for programming SPI Flash
J19	Shunt pin 1 - 3, 2 - 4 (vertical)	Enable programming SPI Flash
J23	Shunt pin 2 - 3	Use Xtal U14 as clock source
SW2	Set to ON	Power Switch, slide down for power-on
SW5 (2,1)	OFF, ON	To select iCE40UP5k_B(U2) as target device

Important: If using Rev C MDP board, check the MDP Revision Guide to ensure that your MDP board has the correct resistor series. The MDP Revision Guide is provided in the Documentation folder of MDP Based Key Phrase Detection Demonstration Bitstream.

4. Programming the Key Phrase Detection Demo

This section provides the procedure for programming the SPI Flash on the MDP Board.

Three different files should be programmed into the SPI Flash. These files are programmed to the same SPI Flash but at different addresses:

- bitstream file
- filter bank coefficient file
- firmware file

To program SPI Flash in Radiant Programmer:

1. Connect the MDP board to the PC using a USB cable and power ON the MDP board.
2. Start Radiant Programmer. In the Radiant Programmer Getting Started dialog box, select **Create a new blank project** as shown in Figure 4.1.
3. Click **OK**.

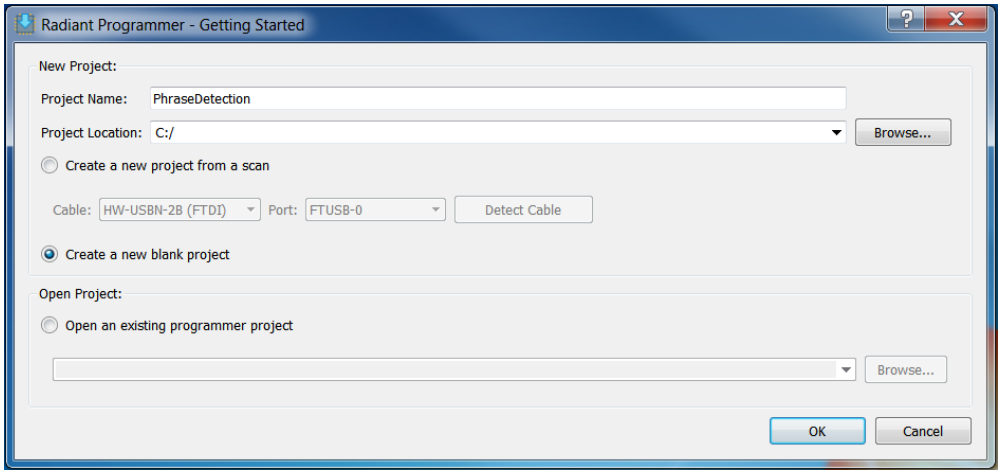

Figure 4.1. Create a New Blank Project

4. In the Radiant Programmer main interface, set Device Family to **iCE40 UltraPlus** and Device to **iCE40UP5K**.
5. Click the iCE40 UltraPlus row and select **Edit > Device Properties**.
6. In the **Device Properties** dialog box, apply the settings below that are common to the three files to program.
   a. Under Device Operation, select the options below:
      - Target Memory: **External SPI Flash Memory**
      - Port Interface: **SPI**
      - Access Mode: **Direct Programming**
      - Operation: **Erase, Program, Verify**
   b. Under **SPI Flash Options**, select the options below:
      - Family: **SPI Serial Flash**
      - Vendor: **Micron**
      - Device: **SPI-M25P80**
      - Package: **8-pin SOIC**
7. To program the bitstream file, select the options below as shown in Figure 4.2.
   a. Under Programming Options, select the bitstream file **Phrase_Detection_Bitstream.bin** in Programming file.
   b. Click **Load from File** to update the Data file size (Bytes) value.

c. Ensure that the following addresses are correct:
   - Start Address (Hex): **0x00000000**
   - End Address (Hex): **0x00020000**

d. Click **OK**.

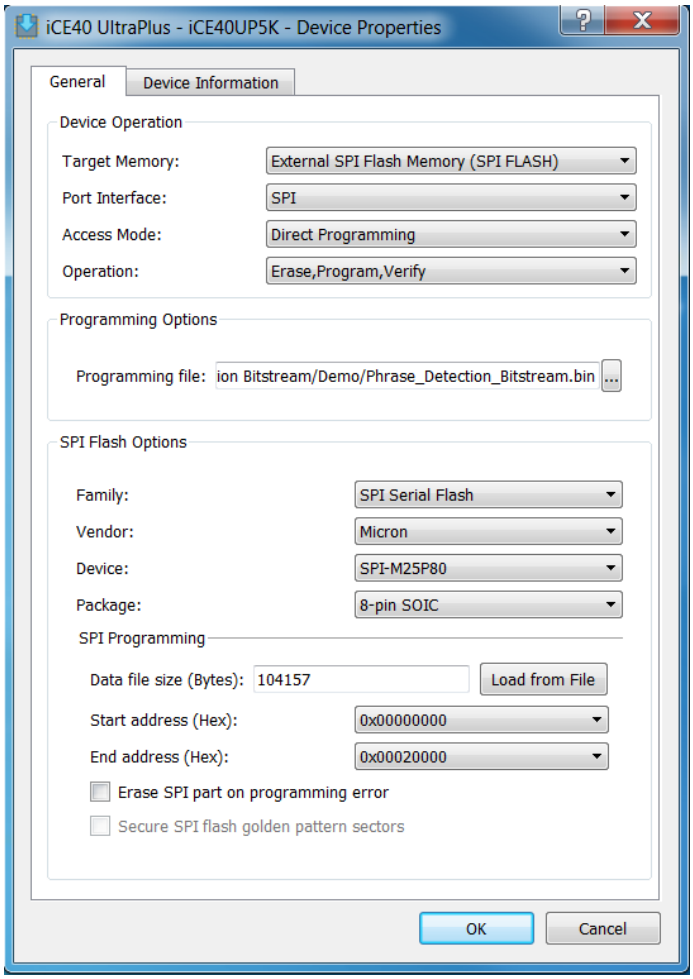

Figure 4.2. Bitstream File Settings

8. In the main interface, click **Program Device** to program the bitstream file Phrase_Detection_Bitstream.bin.
9. To program the filter bank coefficient file, select the options below as shown in Figure 4.3.
   a. Under Programming Options, select the binary file **FilterBank.bin** in Programming file.
   b. Click **Load from File** to update the Data file size (Bytes) value. The default data file size does NOT default to 8192. Manually change the value to **8192**.
   c. Ensure that the following addresses are correct:
      - Start Address (Hex): **0x00020000**
      - End Address (Hex): **0x00030000**
   d. Click **OK**.

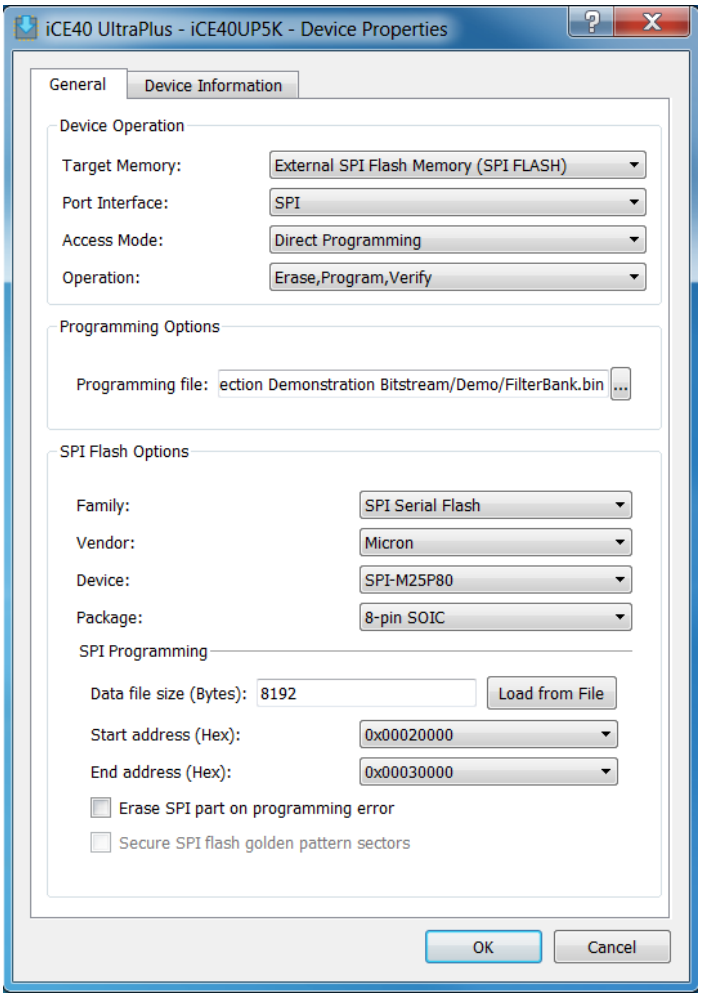

Figure 4.3. Filter Bank Coefficient File Settings

10. In the main interface, click **Program Device** to program the bitstream file **FilterBank.bin**.
11. To program the binary firmware file, select the options below as shown in Figure 4.3.
    a. Under Programming Options, select the binary file **Phrase_Detection_Firmware.bin** in Programming file.
    b. Click **Load from File** to update the Data file size (Bytes) value. The default data file size does NOT default to 20016. Manually change the value to **20016**.
    c. Ensure that the following addresses are correct:
        - Start Address (Hex): **0x00030000**
        - End Address (Hex): **0x00040000**
    d. Click **OK**.

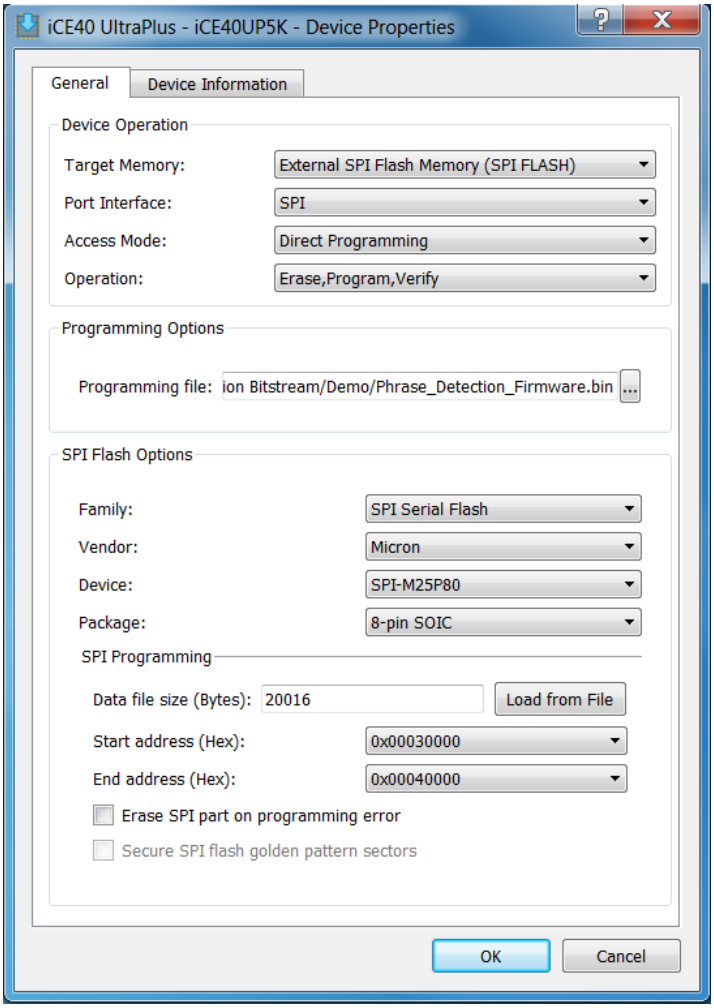

Figure 4.4. Binary Firmware File Settings

12. In the main interface, click **Program Device to** program the bitstream file **Phrase_Detection_Firmware.bin**.
13. After programming the files, perform a power cycle to start observing the demo.

5. Running the Key Phrase Detection Demo

To run the basic demo and observe results on the board:

1. Power ON the MDP board.
2. Say the word *Seven* over the microphone.
3. When the phrase is detected, LED D11 turns ON. If the phrase is not detected, LED D11 remains OFF.
4. (Optional) In order to enable the RBG LED (D13), connect:
   - J30 pin 18 to J32 pin 9
   - J30 pin 19 to J32 pin 11
   - J30 pin 21 to J32 pin 13
   - J26 pin 3 to 4

Refer to Figure 5.1 for the location of LED D11. The microphone is located at the back of the MDP board.

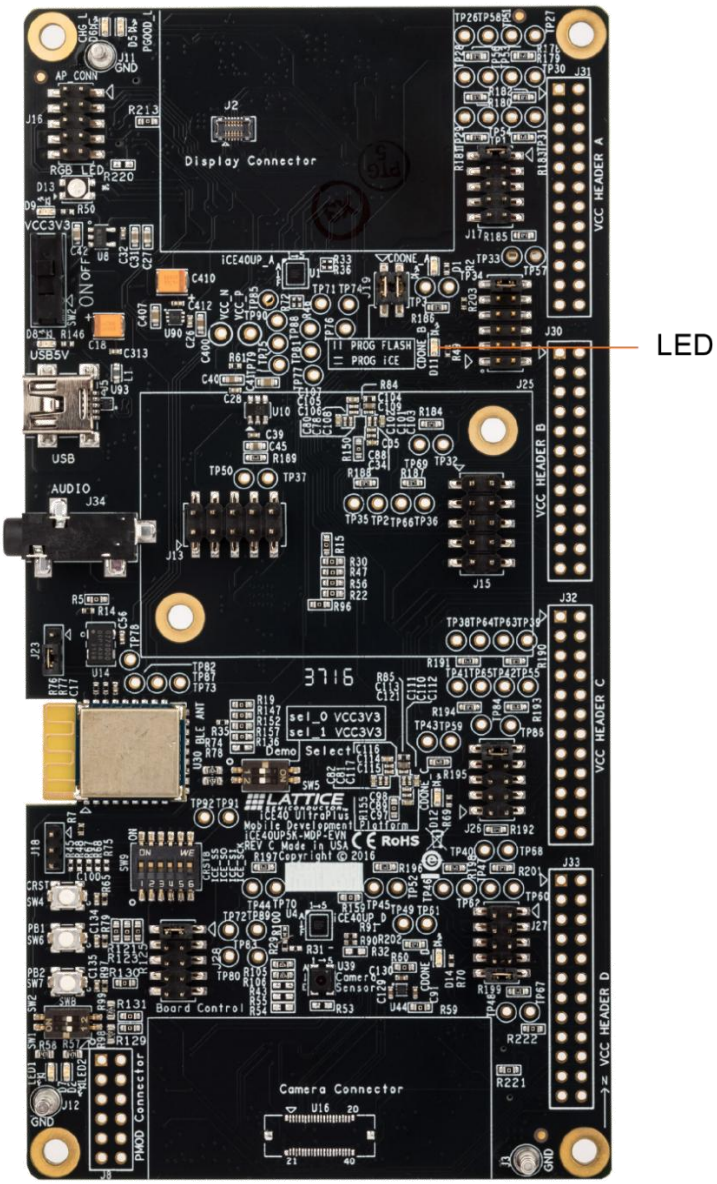

Figure 5.1. LED Location

Technical Support

For assistance, submit a technical support case at www.latticesemi.com/techsupport.

Revision History

Revision 1.1, September 2018

Section	Change Summary
All	General update.
Revision History	Updated revision history table to new template.

Revision 1.0, May 2018

Section	Change Summary
All	Initial release.

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