# Key Phrase Detection on HM01B0 UPduino Shield Demonstration

# User Guide

FPGA-UG-02094 - 1.0

October 2019

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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 Himax HM01B0 UPduino Shield. The design features a Convolution Neural Network (CNN) implementation using our Compact CNN soft IP, which is used in key phrase detection.

# 2. Functional Description

In this demo, an LED indicates when a sample key phrases *Seven*, *Marvin*, *On,* and *Happy* are 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.

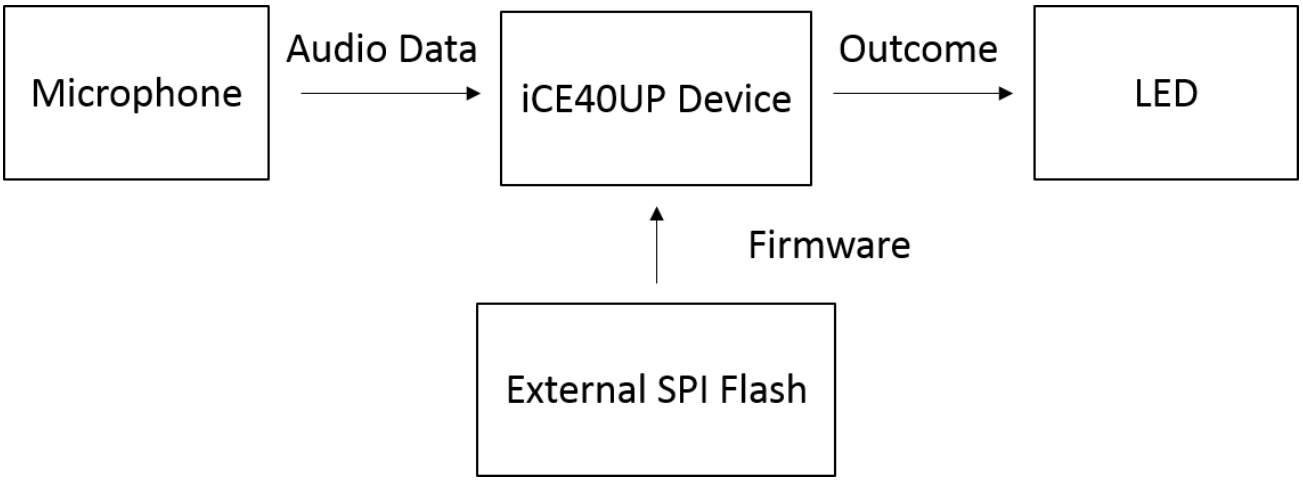


**Figure 2.1. Key Phrase Detection Demo Diagram**

# 3. Demo Setup

Before running the demo, make sure that the two boards are properly connected. A micro USB is required for programming and to turn on the board.

# 4. Programming Key Phrase Detection Demo on iCE40 SPI Flash

This section provides the procedure for programming the SPI Flash on the Himax HM01B0 UPduino Shield Board.

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

- Bitstream
- Firmware

To program the SPI Flash in Radiant Programmer:

1. Connect the Himax HM01B0 UPduino Shield board to the PC using a micro USB cable.

   **Important**: The onboard USB connector is delicate. Handle it with care.
2. Start Radiant Programmer.
3. In the **Radiant Programmer- Getting Started** dialog box, select **Create a new blank project**.
4. Click **OK**.

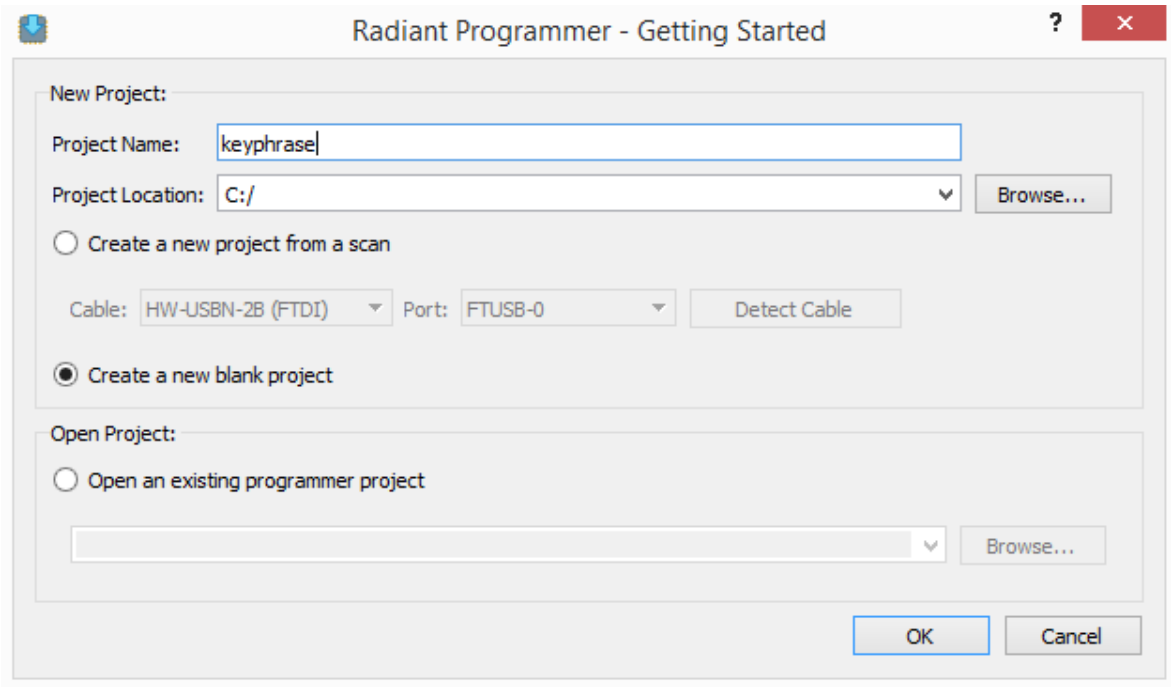


**Figure 4.1. Create a New Blank Project**

Initially, the .xcf has only one option to add a .bin file as shown in Figure 4.2.

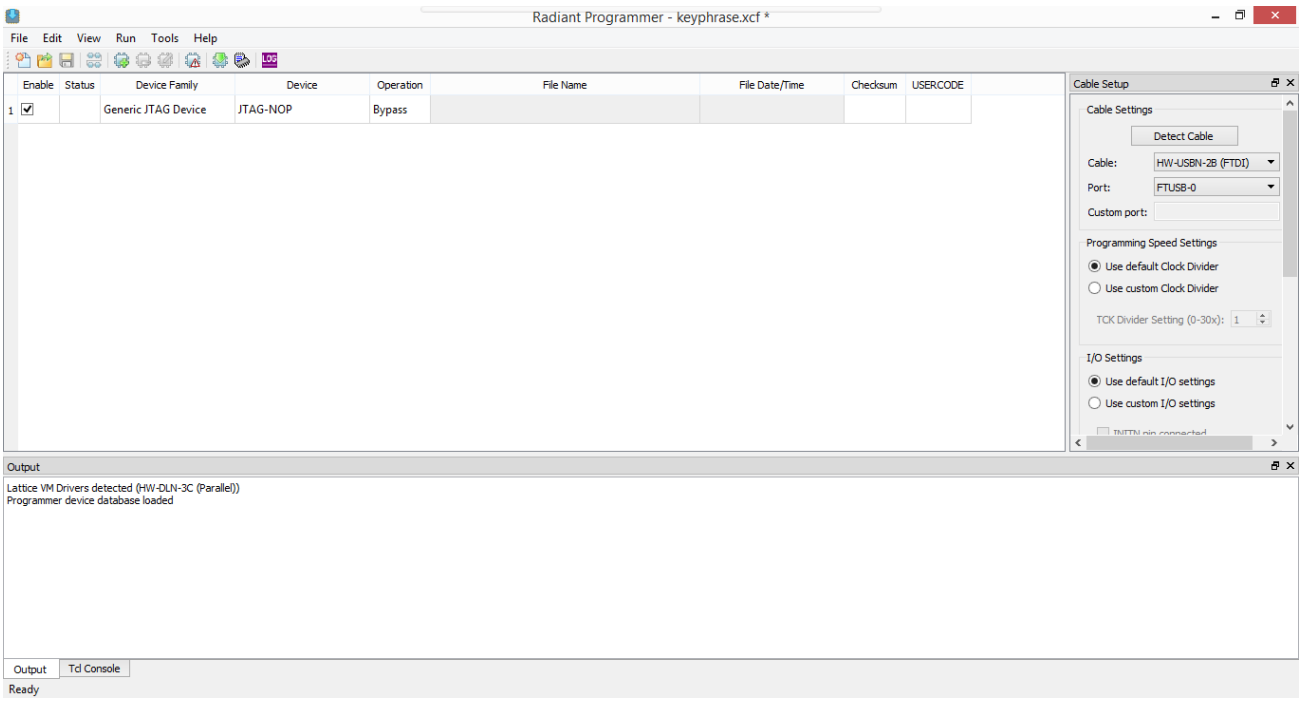


**Figure 4.2. Radiant Programmer – Initial Project Window**

5. To program three .bin files, as needed in this demo, add two more devices by clicking the  button on the toolbar.
6. In the Radiant Programmer main interface, set **Device Family** to **iCE40 UltraPlus** for all three cases as shown in Figure 4.3.

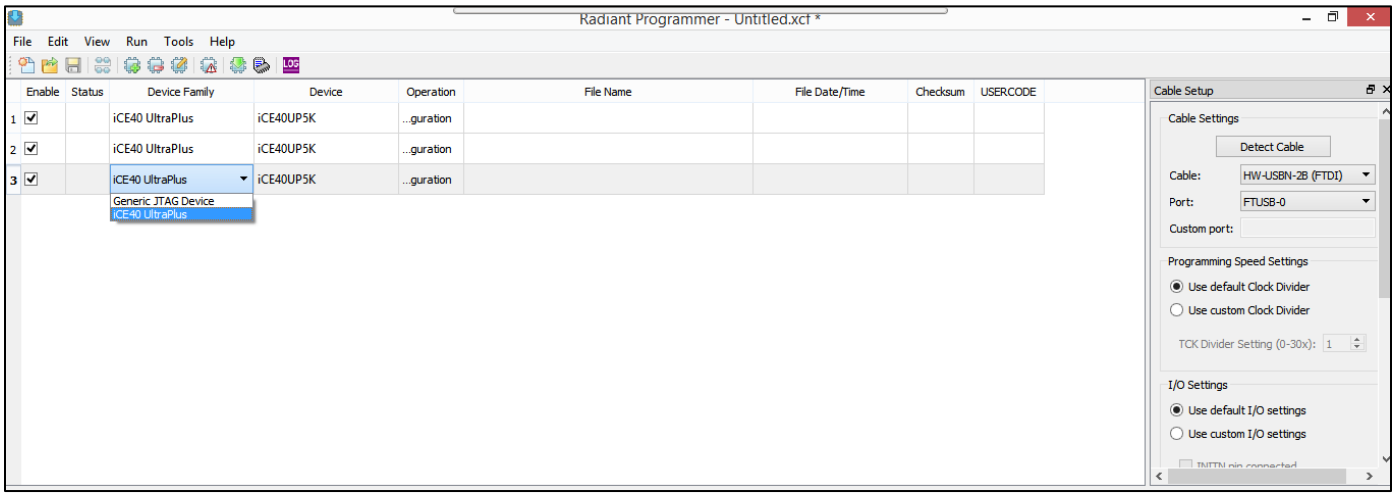


**Figure 4.3. Radiant Programmer – iCE40 UltraPlus Device Family Selection**

7. Set **Device** to **iCE40UP5K** for all three cases as shown in Figure 4.4.

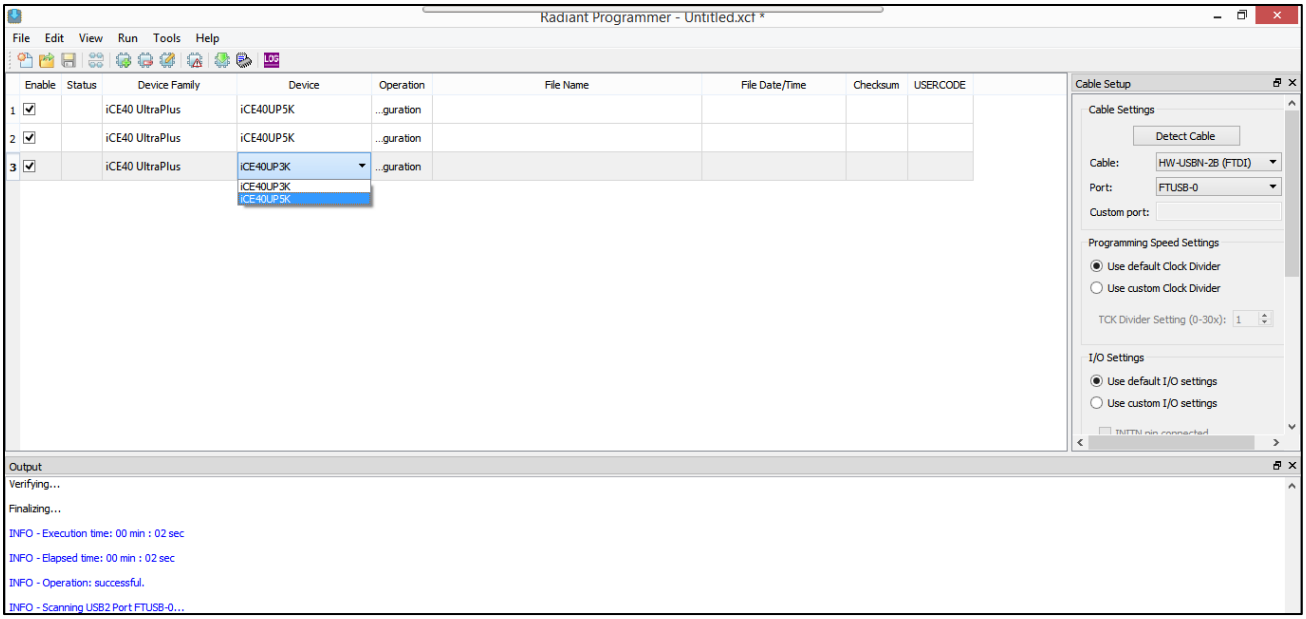


**Figure 4.4. Radiant Programmer – iCE40 UltraPlus Device Selection**

8. Click the iCE40 UltraPlus row and select **Edit > Device Properties**.
9. 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: Winbond**
      - **Device: W25Q32**
      - **Package: 8-pin SOIC**
10. To program the bitstream file, select the options below as shown in Figure 4.5.
    a. Under **Programming Options**, select the key phrase RTL bitstream file 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): 0x00010000**
    d. Click **OK**.

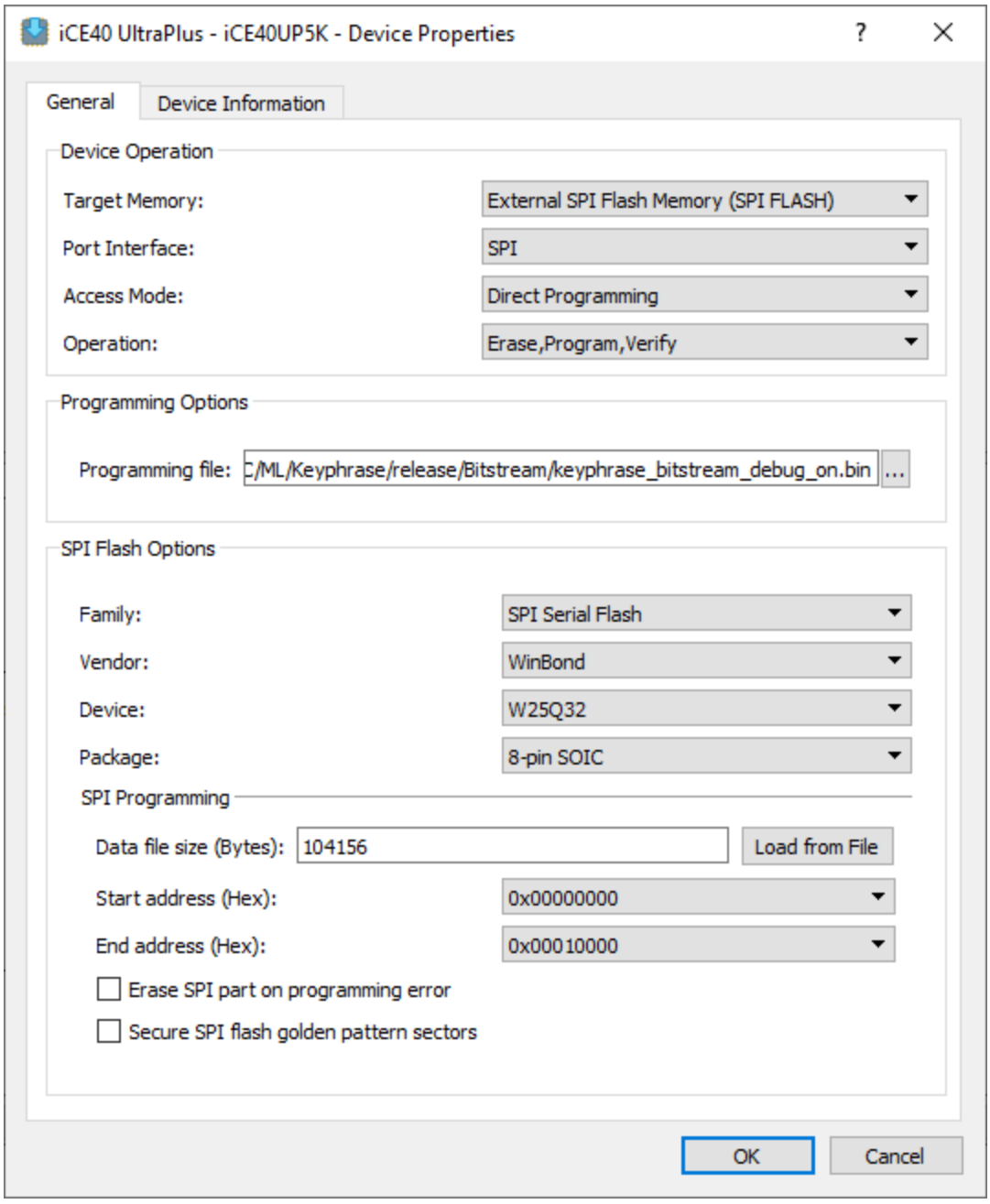


**Figure 4.5. Bitstream File Settings**

11. To program the filter binary firmware for generating spectrogram, select the options below as shown in Figure 4.6.
    a. Under **Programming Options**, select the key phrase filter bin firmware generated by SensAI tool.
    b. Click **Load from File** to update the **Data file size (Bytes)** value. Change the data file size to **32768**.
    c. Ensure that the following addresses are correct:
        - **Start Address (Hex):** 0x00020000
        - **End Address (Hex): 0x00030000**
    d. Click **OK**.

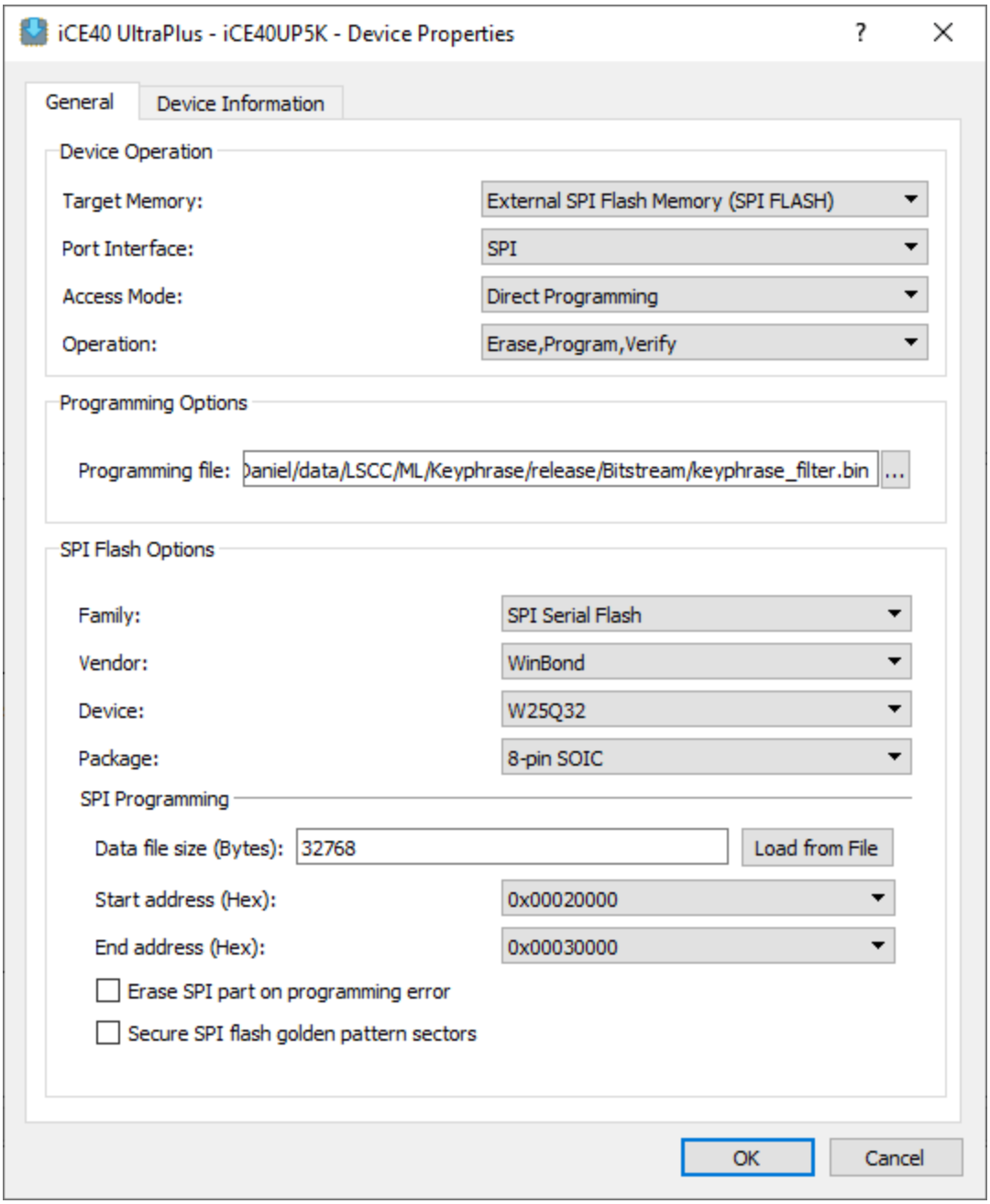


**Figure 4.6. Filter-Firmware Bin File Setting**

12. To program firmware bin that contains model architecture, select the options below as shown in Figure 4.6.
    a. Under Programming Options, select the key phrase firmware binary file generated by SensAI tool.
    b. Click **Load from File** to update the **Data file size (Bytes)** value. Change the data file size to **31048**.
    c. Ensure that the following addresses are correct:
        - **Start Address (Hex): 0x00030000**
        - **End Address (Hex): 0x00040000**
    d. Click **OK**.

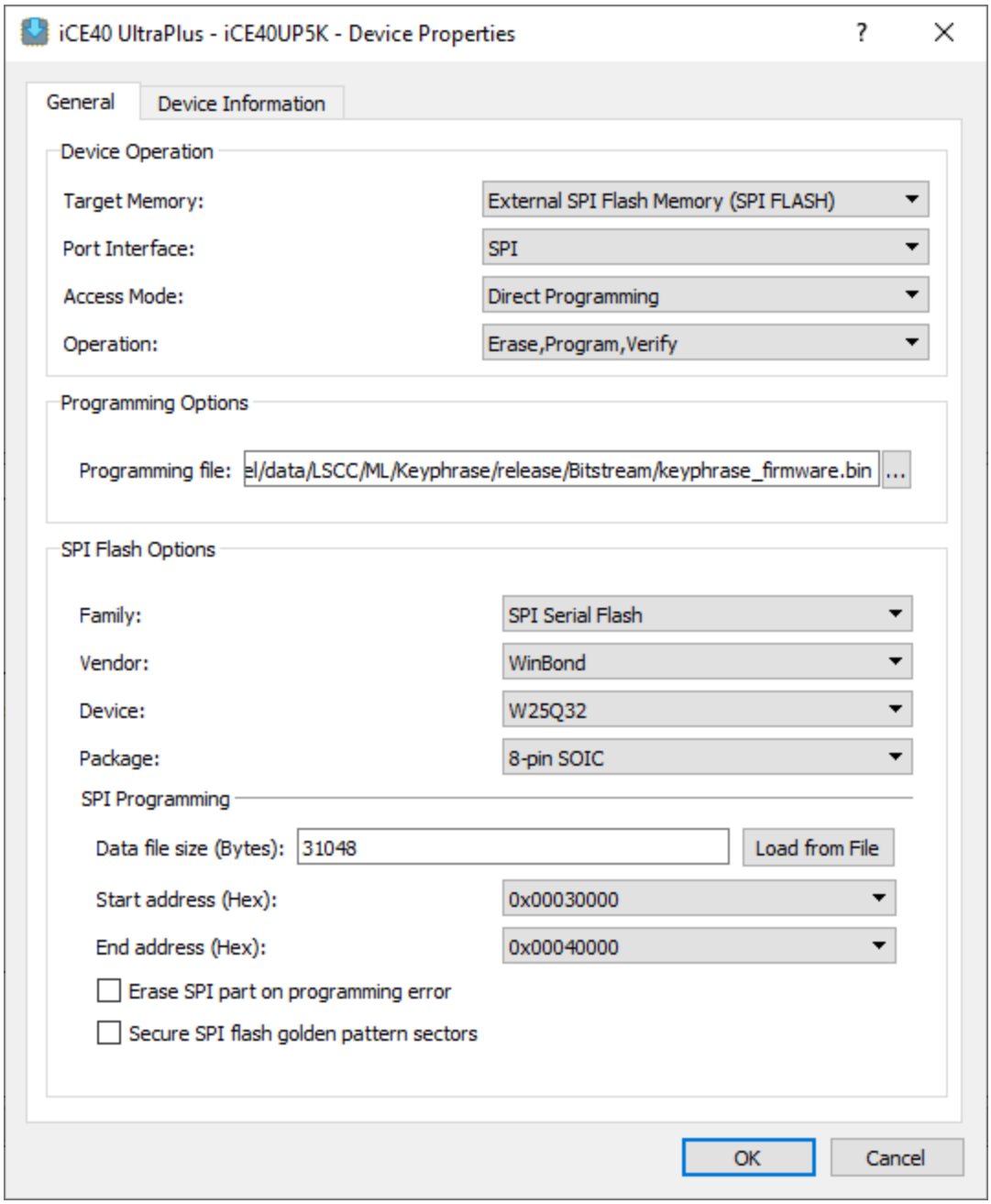


**Figure 4.7. Firmware Bin File Settings**

13. In the main interface, click **Program Device** to program the binary file.

# 5. Running the Key Phrase Detection Demo

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

1. Power ON the Himax HM01B0 UPduino Shield board.
2. State the keyword in front of the board. LEDs turn on. Refer to Figure 5.1 for the LED information.

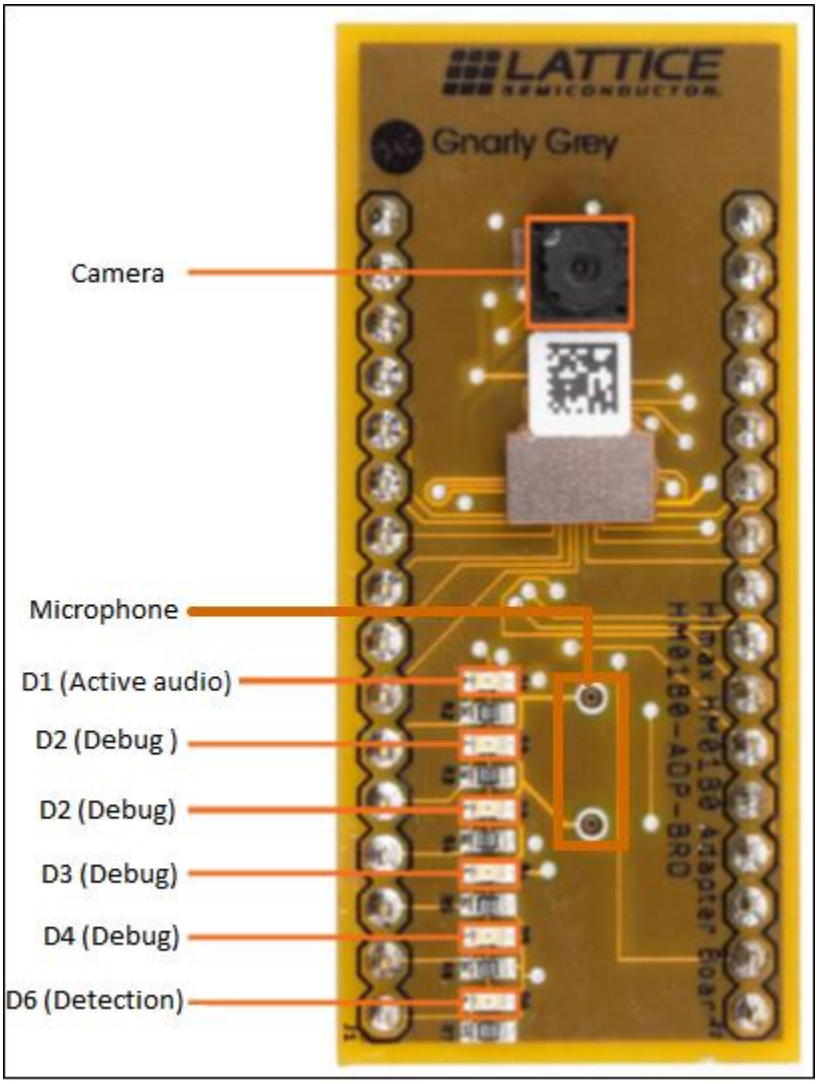


**Figure 5.1. Microphone and LED Location**

D1 turns ON if an active audio is detected including noise. It is OFF when silence is detected.

D2-D4: These are debug LEDs.

D6 turns on when the keyword is detected.

# Technical Support

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

# Revision History

**Revision 1.0, October 2019**

| Section | Change Summary |
|---|---|
| All | Initial release. |


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