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# MAX V CPLD Development Kit

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## User Guide



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The Altera® MAX® V CPLD Development Kit is a complete design environment that includes both the hardware and software you need to prototype the most common CPLD applications, including I/O expansion, interface bridging, power management control, initialization control, and analog interface control. The RoHS-compliant board, and the license-free Quartus® II Web Edition software provide everything you need to begin developing custom MAX V CPLD designs. The following list describes what you can accomplish with the kit:


- Develop designs for the 5M570Z CPLD.
- Measure CPLD power ( $V_{CCINT}$  and  $V_{CCIO}$ ).
- Bridge between two different I/O voltages (adjustable  $V_{CCIO}$  on CPLD Bank 2).
- Interface to external functions or devices via four connectors.
- Read and write to memories:
  - 8-Kbit (Kb) user flash memory (UFM) available within the 5M570Z CPLD.
  - I<sup>2</sup>C or SPI EEPROMs (user installed).
- Come up to speed quickly with your CPLD design by reusing the example designs provided.
- Re-use the kit's PCB board and schematic as a model for your design.

## Kit Features

This section briefly describes the MAX V CPLD Development Kit contents.

### Hardware

The MAX V CPLD Development Kit includes the following hardware:

- MAX V CPLD development board—A development platform that allows you to develop and prototype hardware designs running on the MAX V 5M570Z CPLD.
  -  For detailed information about the board components and interfaces, refer to the *MAX V CPLD Development Board Reference Manual*.
- A USB cable to power the board.
- Embedded USB-Blaster™ circuitry for CPLD configuration.
- Various user LEDs, push-buttons, and capacitor sense button.
- Standard PC speaker header.
- Two direct-current (DC) motor headers.
- General-purpose I/O connectors to mate with daughtercards.

## Software

The software for this kit, described in the following sections, is available on the Altera website for immediate downloading. You can also request to have Altera mail the software to you on DVDs.


### Quartus II Web Edition Software

The Quartus II Web Edition Software is a license-free set of Altera tools with limited functionality.


-  Download the Quartus II Web Edition Software from the [Quartus II Web Edition Software](#) page of the Altera website. Alternatively, you can request a DVD from the [Altera IP and Software DVD Request Form](#) page of the Altera website.

The Quartus II Web Edition Software includes the following items:

- Quartus II Software—The Quartus II software, including the SOPC Builder system development tool, provides a comprehensive environment for system-on-a-programmable-chip (SOPC) design. The Quartus II software integrates into nearly any design environment and provides interfaces to industry-standard EDA tools.

-  To compare the Quartus II subscription and web editions, refer to [Altera Quartus II Software — Subscription Edition vs. Web Edition](#). The kit also works in conjunction with the subscription edition.

- MegaCore<sup>®</sup> IP Library—A library that contains Altera IP MegaCore functions. You can evaluate MegaCore functions by using the OpenCore Plus feature to do the following:
  - Simulate behavior of a MegaCore function within your system.
  - Verify functionality of your design, and quickly and easily evaluate its size and speed.
  - Generate time-limited device programming files for designs that include MegaCore functions.
  - Program a device and verify your design in hardware.

-  The OpenCore Plus hardware evaluation feature is an evaluation tool for prototyping only. You must purchase a license to use a MegaCore function in production.

-  For more information about OpenCore Plus, refer to [AN 320: OpenCore Plus Evaluation of Megafunctions](#).

- Nios<sup>®</sup> II Embedded Design Suite (EDS)—A full-featured set of tools that allows you to develop embedded software for the Nios II processor which you can include in your Altera designs.

## **MAX V CPLD Development Kit Installer**

The license-free MAX V CPLD Development Kit installer includes all the documentation and design examples for the kit.

Download the MAX V CPLD Development Kit installer from the [MAX V CPLD Development Kit](#) page of the Altera website. Alternatively, you can request a development kit DVD from the [Altera Kit Installations DVD Request Form](#) page of the Altera website.





The remaining chapters in this user guide lead you through the following MAX V CPLD development board setup steps:

- Inspecting the contents of the kit
- Installing the design and kit software
- Setting up, powering up, and verifying correct operation of the CPLD development board
- Running the Board Test System designs

 For complete information about the CPLD development board, refer to the *MAX V CPLD Development Board Reference Manual*.

### Before You Begin

Before using the kit or installing the software, check the kit contents and inspect the board to verify that you received all of the items listed in “*Kit Features*” on page 1–1. If any of the items are missing, contact Altera before you proceed.

### Inspect the Board

To inspect the board, perform the following steps:

1. Place the board on an anti-static surface and inspect it to ensure that it has not been damaged during shipment.



Without proper anti-static handling, you can damage the board.

2. Verify that all components are on the board and appear intact.



The SPI EEPROM (U8) and the I<sup>2</sup>C EEPROM (U6) are not included with the MAX V CPLD Development Kit.

### References

Use the following links to check the Altera website for other related information:

- For the latest board design files and reference designs, refer to the *MAX V CPLD Development Kit* page.
- For the MAX V device documentation, refer to the *Literature: MAX V Devices* page.
- To purchase devices from the eStore, refer to the *Devices* page.
- For MAX V OrCAD symbols, refer to the *Capture CIS Symbols* page.



This section explains how to install the following software:

- Quartus II Web Edition Software
- MAX V CPLD Development Kit
- USB-Blaster™ driver

### Installing the Quartus II Web Edition Software


The Quartus II Web Edition Software provides the necessary tools used for developing hardware and software for Altera devices. Included in the Quartus II Web Edition Software are the Quartus II software, the Nios II EDS, and the OpenCore Plus evaluation IP library. The Quartus II software (including SOPC Builder) and the Nios II EDS are the primary development tools used to create the reference designs in this kit. To install the Altera development tools, perform the following steps:

1. Run the Quartus II Web Edition Software installer you acquired in “Software” on [page 1–2](#).
2. Follow the on-screen instructions to complete the installation process.

 If you have difficulty installing the Quartus II software, refer to [Altera Software Installation and Licensing](#).

### Licensing Considerations

The Quartus II Web Edition Software is license-free and supports MAX V devices without any additional licensing requirement. This kit also works in conjunction with the Quartus\_II Subscription Edition Software, once you obtain the proper license file. To purchase a subscription, contact your Altera sales representative.

 For complete licensing details, refer to [Altera Software Installation and Licensing](#).

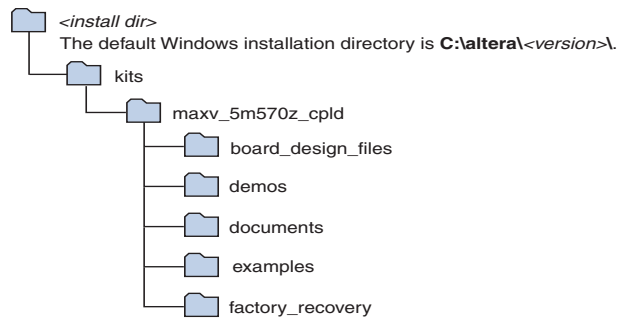
### Installing the MAX V CPLD Development Kit

To install the MAX V CPLD Development Kit, perform the following steps:

1. Run the MAX V CPLD Development Kit installer you acquired in “Software” on [page 1–2](#).
2. Follow the on-screen instructions to complete the installation process. Be sure that the installation directory you choose is in the same relative location to your Quartus II software.

The installation program creates the MAX V CPLD Development Kit directory structure shown in [Figure 3-1](#).

**Figure 3-1. MAX V CPLD Development Kit Installed Directory Structure (1)**



**Note to Figure 3-1:**

(1) Early-release versions might have slightly different directory names.

[Table 3-1](#) lists the file directory names and a description of their contents.

**Table 3-1. Installed Directory Contents**

Directory Name	Description of Contents
<b>board_design_files</b>	Contains schematic, layout, assembly, and bill of material board design files. Use these files as a starting point for a new prototype board design.
<b>demos</b>	Contains demonstration applications.
<b>documents</b>	Contains the kit documentation.
<b>examples</b>	Contains the sample design files for the MAX V CPLD Development Kit.
<b>factory_recovery</b>	Contains the original data programmed onto the board before shipment. Use this data to restore the board with its original factory contents.

## Installing the USB-Blaster Driver

The MAX V CPLD development board includes integrated USB-Blaster circuitry for device programming. However, for the host computer and board to communicate, you must install the USB-Blaster driver on the host computer.

- Installation instructions for the USB-Blaster driver for your operating system are available on the Altera website. On the [Altera Programming Cable Driver Information](#) page of the Altera website, locate the table entry for your configuration and click the link to access the instructions.

The instructions in this chapter explain how to set up the MAX V CPLD development board.

### Setting Up the Board

To prepare and apply power to the board, follow these steps:

1. Ensure that the shunt jumper for J8 (connecting pins 9 and 10) is set to 3.3 V (default setting).
2. To power up the board, plug in the USB cable to the host PC, and plug the other end of USB cable into the board USB type B connector (J4). No other power supply is needed.

When the board is powered up, the blue LED power indicator will illuminate.



It is also possible to power up the board through the BATT+ and BATT- connectors using three 1.5-V batteries in series. However, once you plug in a USB cable, the board disconnects the battery supply and obtains power from the USB cable.



The kit includes a design example and application called the Board Test System to test the functionality of the MAX V CPLD development board. The application provides an easy-to-use interface to alter functional settings and observe the results. You can use the application to test board components, observe performance, and measure power usage. The application is also useful as a reference for designing systems. To install the application, follow the steps in “[Installing the MAX V CPLD Development Kit](#)” on page 3–1.

The application provides access to the following MAX V CPLD development board features:

- General purpose I/O (GPIO)
- User flash memory (UFM)
- Capacitor sense button
- User LEDs and push buttons
- Replaceable oscillator
- Off-chip I<sup>2</sup>C and SPI EEPROM interfaces
- Speaker header
- Two DC motor headers

The application allows you to exercise most of the board components. While using the application, you reconfigure the CPLD several times with test designs specific to the functionality you are testing.

Several designs are provided to test the major board features. Each design provides data for one or more tabs in the application. The Config menu identifies the appropriate design to download to the CPLD for each tab.

After successful CPLD configuration, the appropriate tab appears and allows you to exercise the related board features. Highlights appear in the board picture around the corresponding components.



The Board Test System shares the JTAG bus with other applications like the Nios II debugger and the SignalTap<sup>®</sup> II Embedded Logic Analyzer. When the BTS is connecting to the board, it completely occupies the JTAG bus. If you want to reconfigure the CPLD through the Quartus II Programmer, be sure to close the BTS application first.

### Running the Board Test System

To run the application, navigate to the `<install_dir>\kits\maxv_5m570z_cpld\examples\board_test_system` directory and run the **BoardTestSystem.exe** application.



On Windows, click **Start > All Programs > Altera > MAX V CPLD Development Kit <version> > Board Test System** to run the application.



A GUI appears, displaying the application tab that corresponds to the design running in the CPLD.

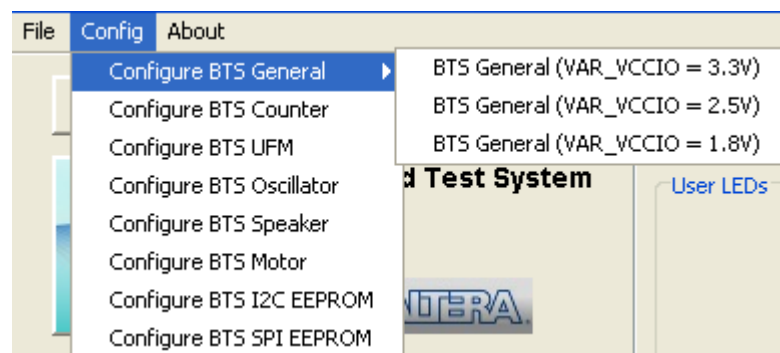
## Using the Board Test System

This section describes each control in the Board Test System application.


### The Config Menu

Each design example tests a different functionality that corresponds to one or more application tabs. Use the Config menu to select the design you want to use. [Figure 5-1](#) shows the Config menu.

**Figure 5-1. The Config Menu**




To configure the CPLD with a test system design, on the Config menu, click the configure command that corresponds to the functionality you wish to test.

 While the configuration is running, a progress bar displays. A message shows when the configuration is completed.

### The GPIO Tab

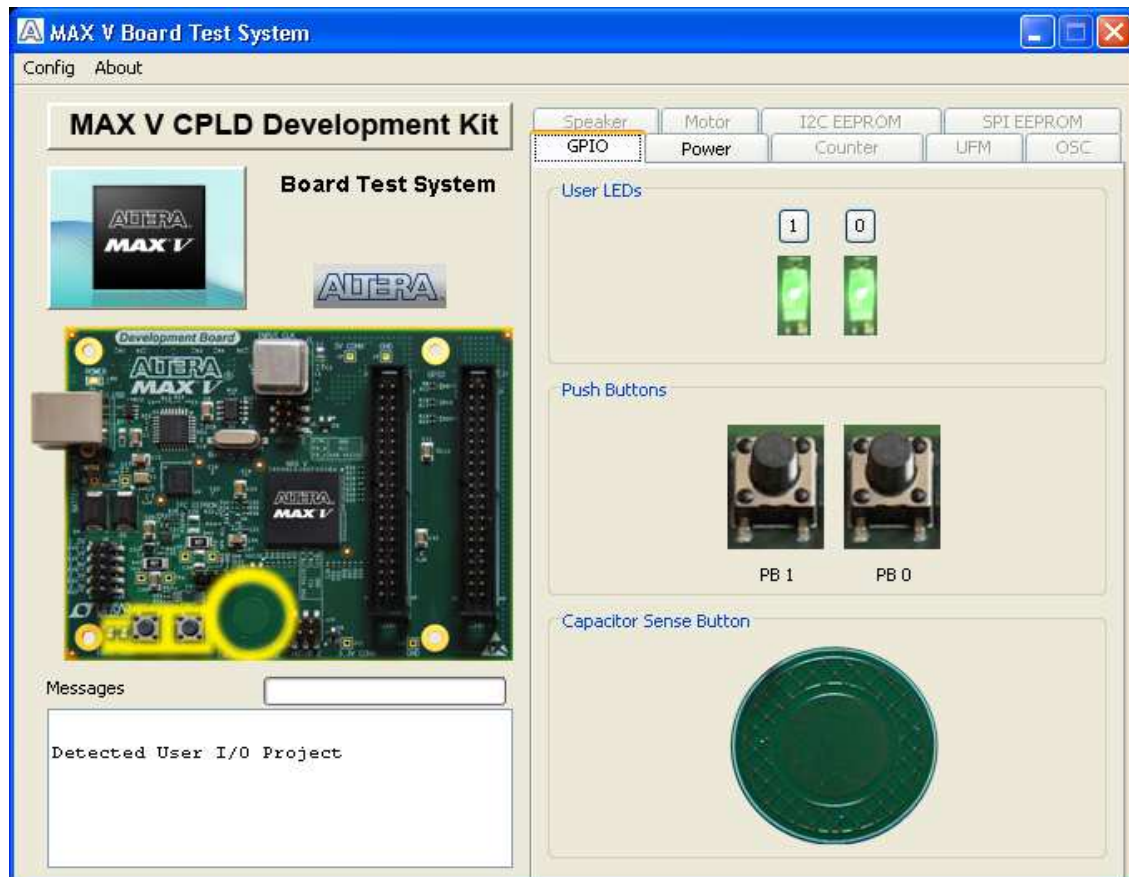
The **GPIO** tab allows you to interact with all the general purpose user I/O components on your board.

 The MAX V CPLD Development Kit includes three designs examples for the **GPIO** tab ([Figure 5-1](#)):

- **BTS General (VAR\_VCCIO = 3.3V)** runs when I/O voltage is set to 3.3 V (Bank 2).
- **BTS General (VAR\_VCCIO = 2.5V)** runs when I/O voltage is set to 2.5 V (Bank 2).
- **BTS General (VAR\_VCCIO = 1.8V)** runs when I/O voltage is set to 1.8 V (Bank 2).

Figure 5-2 shows the GPIO tab.

Figure 5-2. The GPIO Tab



The following sections describe the controls on the **GPIO** tab.

### User LEDs

The **User LEDs** control displays the current state of the user LEDs. Click the LED buttons to turn the board LEDs on and off.

### Push Buttons

The read-only **Push Buttons** control displays the current state of the board user push buttons. Press a push button on the board to see the graphical display change accordingly.

### Capacitor Sense Button

The inner circle of the **Capacitor Sense Button** on the **GPIO** tab changes to yellow when you put your finger on the actual capacitor sense button on the board.

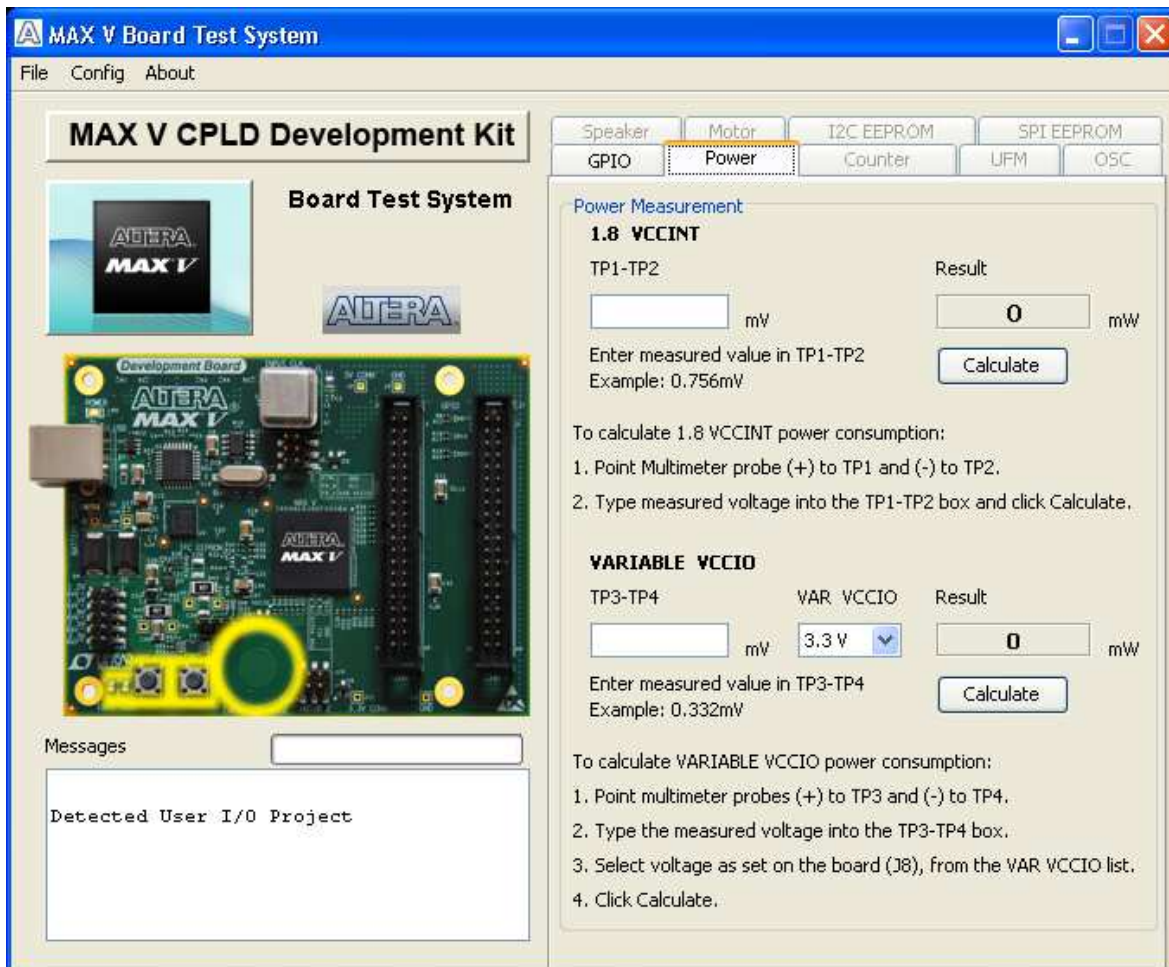
## The Power Tab

The **Power** tab allows you to measure estimated power consumption for the MAX V through test points available on the development board, as specified by the BTS General design you choose from the Config menu (Figure 5-1).

- For more information on the location of the test points and details on MAX V rail voltage, refer to the *MAX V CPLD Development Board Reference Manual*.

Figure 5-3 shows the **Power** tab.

**Figure 5-3. The Power Tab**



- Follow the on-screen instructions for the measurement steps.

## Power Consumption Calculations

To calculate the estimated power consumption of the **1.8 VCCINT** core power, the **Power** tab uses the following formulas to arrive at the results after clicking **Calculate**:

- Current across  $R_{sense}$  (R44) = Voltage drop across  $R_{sense}$  /  $R_{sense}$  resistance
- Power consumption of  $V_{CCINT}$  = device core voltage ( $V_{CCINT}$ ) × current across  $R_{sense}$

For example:

$$\text{Current across } R_{sense} \text{ (R44)} = (0.756 \text{ mV}) / (0.27) = 2.8 \text{ mA}$$

$$\text{Power consumption of } V_{CCINT} = (1.8 \text{ V}) \times (2.8 \text{ mA}) = 5.04 \text{ mW}$$

You can apply the same formulas to the **VARIABLE VCCIO** power estimation calculation:

$$\text{Current across } R_{sense} \text{ (R47)} = (0.332 \text{ mV}) / (0.27) = 1.23 \text{ mA}$$

$$\text{Power consumption of } V_{CCIO} = (3.3 \text{ V}) \times (1.23 \text{ mA}) = 4.06 \text{ mW}$$

## Power Tab Controls

The following sections describe the controls on the **Power** tab.

### 1.8 VCCINT

- **TP1-TP2**—Allows you to enter the value recorded from the multimeter.
- **Result**—Shows the calculated power consumption after clicking **Calculate**.
- **Calculate**—Performs calculation for estimated power consumption.

### VARIABLE VCCIO

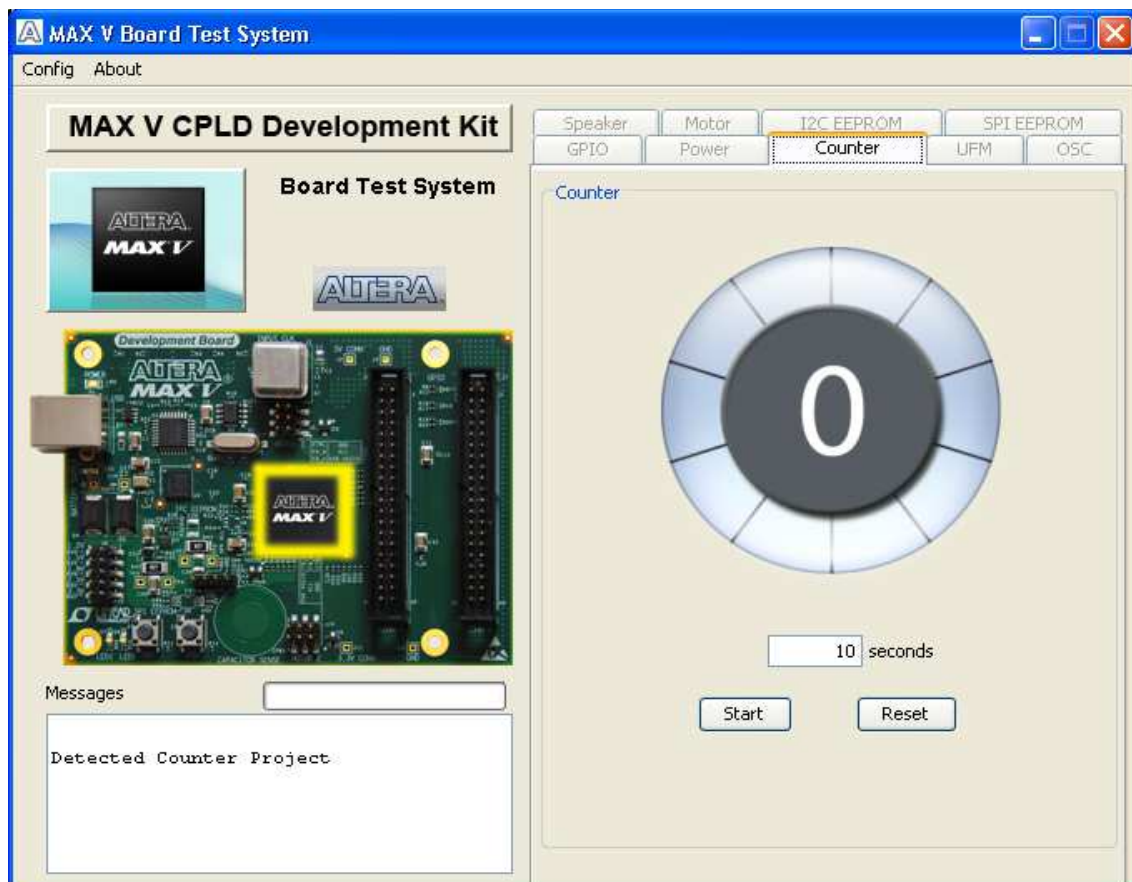
- **TP3-TP4**—Allows you to enter the value recorded from the multimeter.
- **VAR VCCIO**—Allows you to select the voltage level that matches the current setting on J8 on the development board.
- **Result**—Shows the calculated power consumption after clicking **Calculate**.
- **Calculate**—Performs calculation for estimated power consumption.

## The Counter Tab

The **Counter** tab allows you view and control the CPLD counter in a visual display. By using logic design and the internal oscillator as a counter, this design example shows the time delay before turning on an LED. (CPLDs are frequently used to monitor and control power IC's, such as switchers and regulators.)

Figure 5-4 shows the **Counter** tab.

**Figure 5-4. The Counter Tab**



The following sections describe the controls on the **Counter** tab.

**Counter display**—Shows number count and highlights a section around the circumference.

**Seconds**—Allows you to enter the number of seconds for the counter from 1 to 10.

**Start**—Begins counter test.

**Reset**—Sets counter to zero.

## The UFM Tab

The **UFM** tab displays sector 0 of the user flash memory content (4,096 bits per sector), and allows you to write, read, and erase the sector 0 address space. Figure 5-5 shows the **UFM** tab.


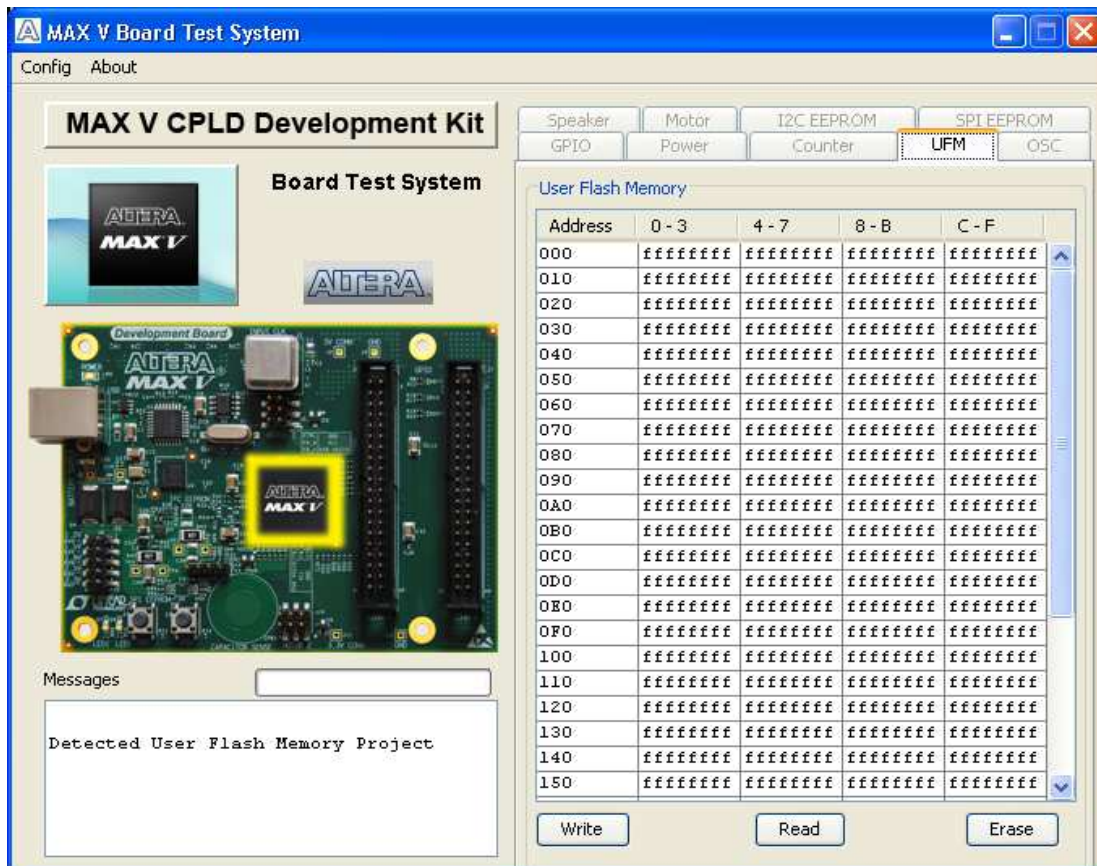
 MAX V devices feature a single UFM block, which can be used like a serial EEPROM for storing non-volatile information up to 8,192 bits.

Figure 5-5. The UFM Tab



The following sections describe the controls on the **UFM** tab.

The table control allows you to type hex values in any cell.

**Write**—This control writes sector 0 of the UFM.

**Read**—This control reads sector 0 of the UFM.

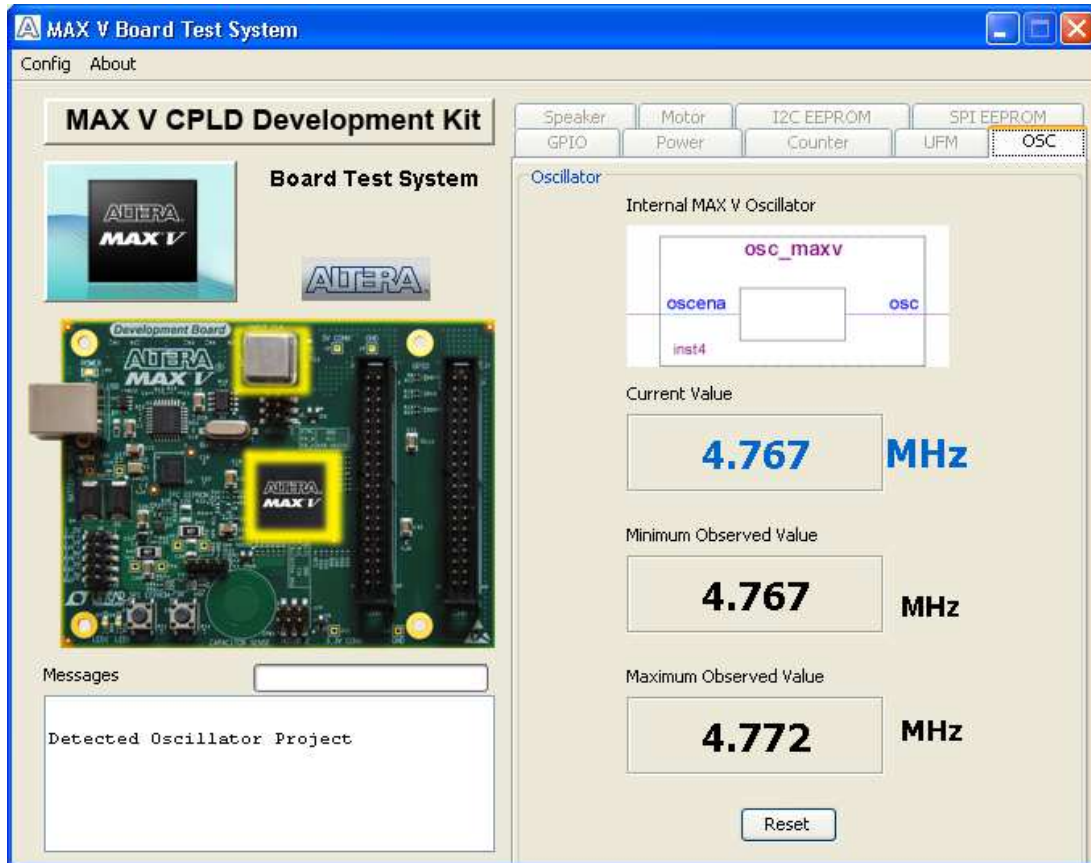
**Erase**—This control erases sector 0 completely.

 For detailed information on UFM storage, refer to the *MAX V Device Handbook*.

## The OSC Tab

The OSC tab allows you to monitor the current frequency of the MAX V internal oscillator. Figure 5-6 shows the OSC tab.

Figure 5-6. The OSC Tab



The following sections describe the controls on the OSC tab.

### Internal MAX V Oscillator

This diagram shows an internal oscillator symbol from the Block Editor of the Quartus II software.

### Current Value

This control shows the current frequency of the internal oscillator since the test has been running or since clicking the **Reset** button. This value is somewhere between 3.3 to 5.3 MHz.

### Minimum Observed Value

This control shows the minimum frequency of the internal oscillator since the test has been running or since clicking the **Reset** button.

### **Maximum Observed Value**

This control shows the maximum frequency value since the test has been running or since clicking the **Reset** button.

### **Reset**

This control allows you to set the minimum and maximum frequency to the same value, which is equivalent to starting the test.



## The Speaker Tab

The **Speaker** tab allows you to play sounds through a standard 4-pin PC speaker, once the recommended speaker is installed.

-  A speaker is not included with the MAX V CPLD Development Kit.
-  For more information on the PC speaker header and manufacturing information, refer to the *MAX V CPLD Development Board Reference Manual*.

Figure 5-7 shows the **Speaker** tab.

**Figure 5-7. The Speaker Tab**



The following sections describe the controls on the **Speaker** tab.

### Volume

The **Volume** control allows you to adjust the volume in three steps.

### Music Notes

The **Music Notes** control allows you play the notes in a single octave through an external 4-pin speaker.

## The Motor Tab

The **Motor** tab allows you to control and monitor DC motor speed once the recommended motor is properly installed.



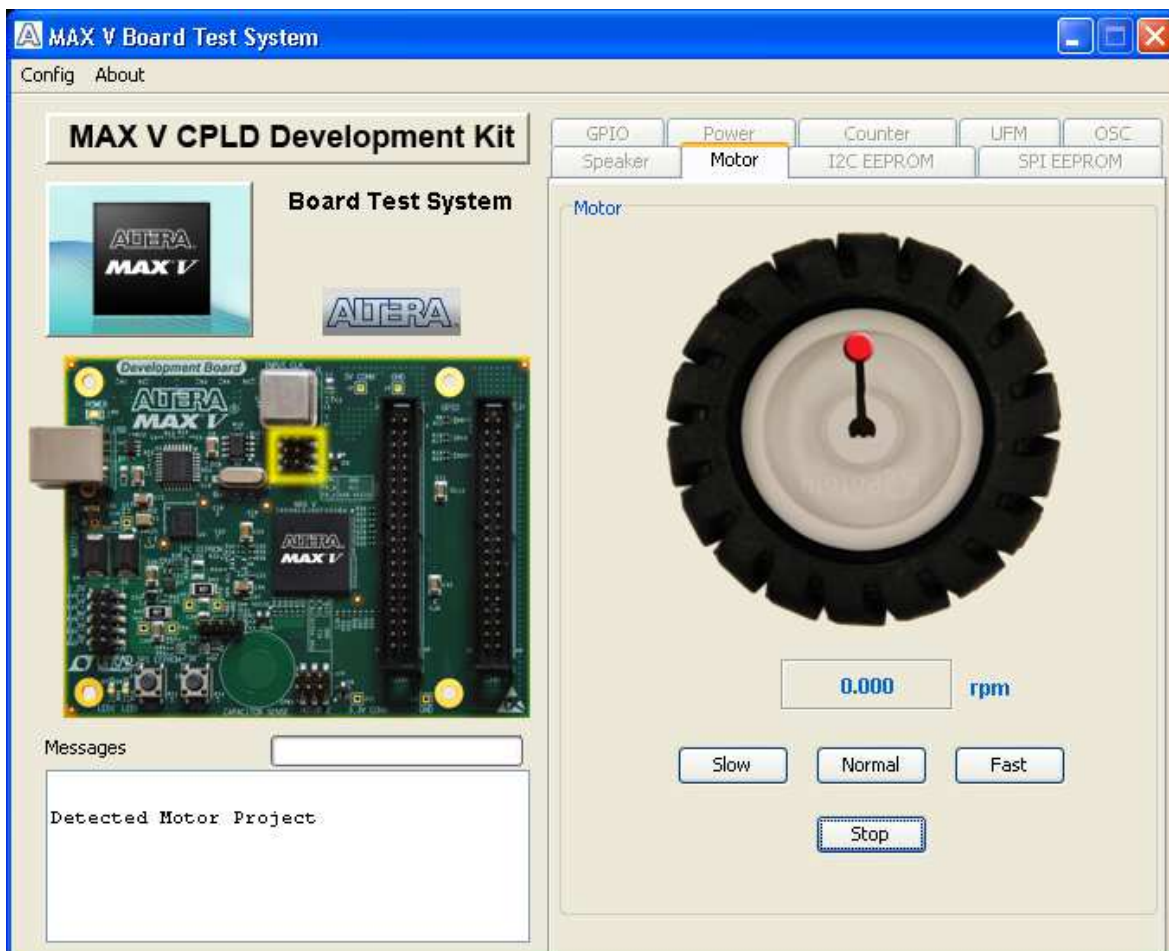
-  A motor is not included with the MAX V CPLD Development Kit.
-  For more information on the recommended DC motor and manufacturing information, refer to the *MAX V CPLD Development Board Reference Manual*.

Figure 5-8 shows the **Motor** tab.

**Figure 5-8. The Motor Tab**



The following sections describe the controls on the **Motor** tab.

**rpm**—Shows the actual rotor speed in rpm as effected by the following buttons:

**Slow**—Slows the rotor speed to between 65 and 75 rpm.

**Normal**—Sets the rotor speed to between 130 and 140 rpm.

**Fast**—Increases the rotor speed to between 190 and 200 rpm.