## Getting Started with Intel Monitor Program on DE10-Standard

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In this tutorial you will use the Intel Monitor Program to set up an ARM software development project using a pre-defined computer system called the *DE10-Standard Computer*, which includes the ARM Cortex-A9 processor and various peripheral devices. The system is implemented as a circuit that is downloaded into the FPGA device on an Altera DE10-Standard board. This tutorial illustrates how programs written in C can be executed on the DE10-Standard board. The program also supports Assembly programs.

This tutorial is based on the ver. 18.1 of the Monitor program. Please use your best judgement if you use a different version.

Perform the following:

- 1. Connect the DE10 board to your computer using the type A to B USB cable found in the DE10 box; it plugs in next to the power connecton, next to the red on/off button. Turn on the power of the board.
- 2. Open the Intel Monitor Program software.

To develop ARM software code using the Monitor Program, it is necessary to create a new project. Select File > New Project  $\rightarrow$  Give the project a name and indicate the folder for the project (e.g. Lab1). *Do not use spaces when you name folders, projects, files, etc.* Use the dropdown menu of Architecture to set the target architecture to the ARM Cortex-A9 processor. Click Next.

- 3. Now, you can select your own custom computer system (if you have one) or a predesigned (by Altera) system. Choose the DE10-Standard Computer since we are using DE10 in this class and click Next.
- 4. In the next window you can specify the type of application programs that you wish to run. They can be written in either assembly language or the C programming language. Specify that C programs will be used in this tutorial. Click Next. The Altera Monitor Program package contains several sample programs. Check the box Include a sample program with the project. Then, choose the Getting Started program, as indicated in the figure, and click Next.
- 5. Next you specify the source file(s) that contain the application program(s). Since we have selected the *Getting Started* program, the window indicates the source code file for this program. You may also add other relevant files here if any. This window also allows the user to specify additional compiler and linker flags. Click Next.

- 6. The next window indicates some system parameters. Note that the figure indicates that the *DE-SoC* [*USB-1*] cable is selected to provide the connection between the DE-series board and the host computer. This is name assigned to the Altera USB-Blaster connection between the computer and the board. If there is no connection shown, check the connection and status of the board. Click Next.
- 7. The next window displays the memory options that will be used for the program, and allows the user to select a target memory location for each section. The *.text* section corresponds to the program code (and data). By default, the *.text* section is targeted to the DDR3 memory in the DE10-Standard Computer, starting at address 0. You may double click on the memory device column to change it. Click Save to complete the specification of the new project.
- 8. Since you specified a new project, a pop-up box will appear asking you if you want to download the system associated with this project onto the DE-series board. Make sure that the power to the DE-series board is turned on and click Yes. After the download is complete, a pop-up box will appear informing you that the circuit has been successfully downloaded click OK. If the circuit is not successfully downloaded, make sure that the USB connection, through which the USB-Blaster communicates, is established and recognized by the host computer. (If there is a problem, a possible remedy may be to unplug the USB cable and then plug it back in.)
- 9. Select Edit > Enable Source Level Debugging. You will see the source files of this project. When the pop-up opens informing you of new debugging features, click yes. Double click on the c code and add a printf statement before the while loop to print your name in the message window. Add a new line before the message because the first few letters of the message sometimes may get lost in transfer. Don't forget including stdio.h. Save it.
- 10. Having downloaded the DE10-Standard Computer into the Cyclone V SoC chip on the DE10-Standard board, we can now load and run the sample program. In the main Monitor Program window, select Actions > Compile & Load to compile and download the selected sample program into the FPGA chip. Check the Info & Errors window for any warning or errors.
- 11. Run the program by selecting Actions > Continue or by clicking on the toolbar icon . Observe how the patterns displayed on the red LEDs change while you flip some the switches and push a KEY. You should see your printf message in the Terminal window. If you don't see anything in the terminal, pause the execution of the sample program by

clicking on the icon  $\blacksquare$ , and restart the program from the initial address by clicking on the icon  $\blacksquare$ , then  $\blacksquare$ .

12. After you are done, pause the execution of the sample program by clicking on the icon III, and disconnect from this session by clicking on the icon  $\mathbb{N}$ ,