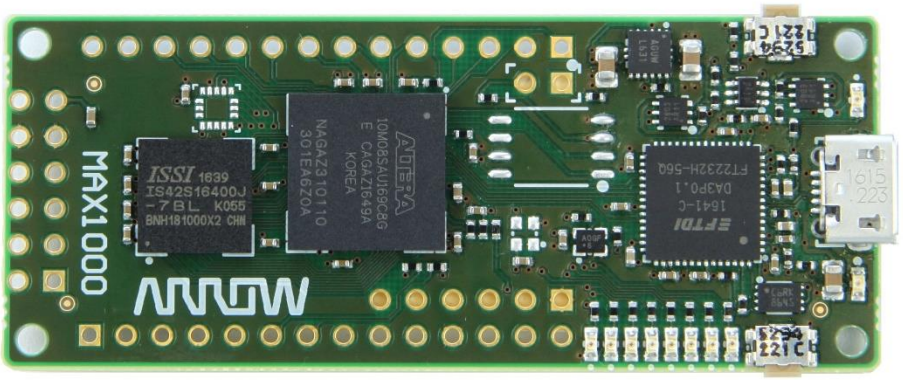


MAX 1000 Tutorial
Expanding a Nios II System

Exercise Manual
Part 2

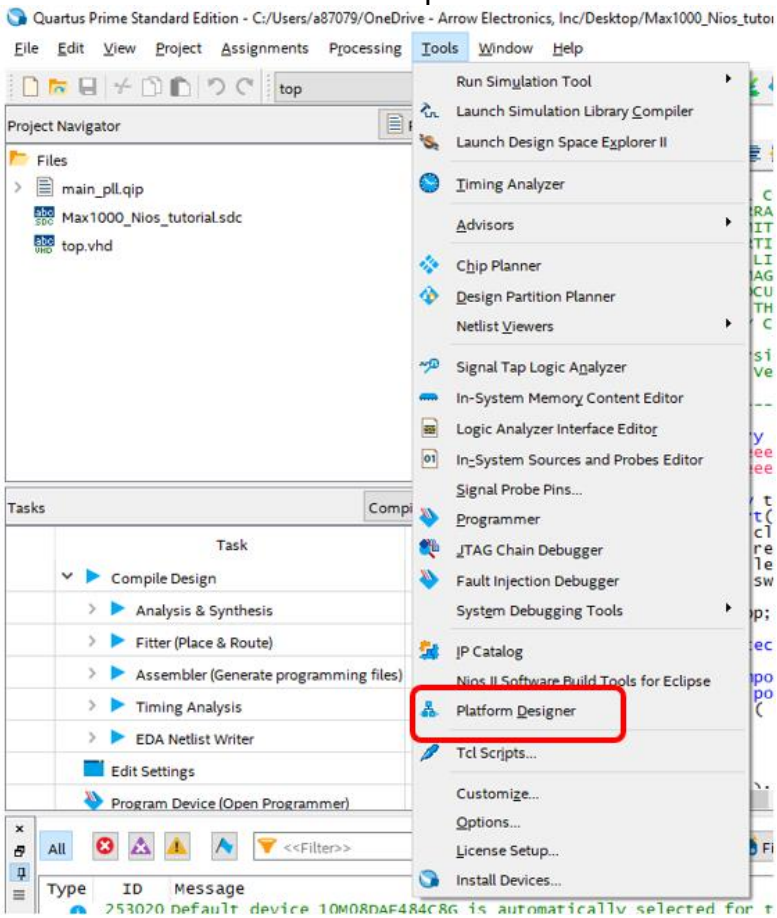
for MAX1000 Board

Quartus Prime 18.1 / Platform Designer

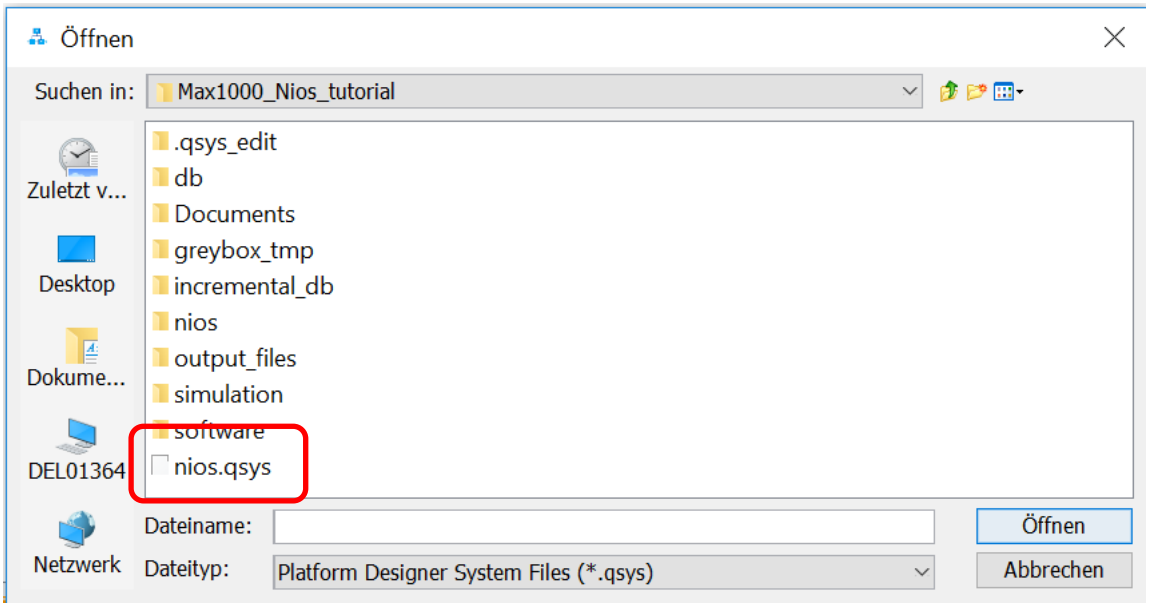
Version 2.0/ 2019-03-04

1. Now we are expanding the NIOSII system

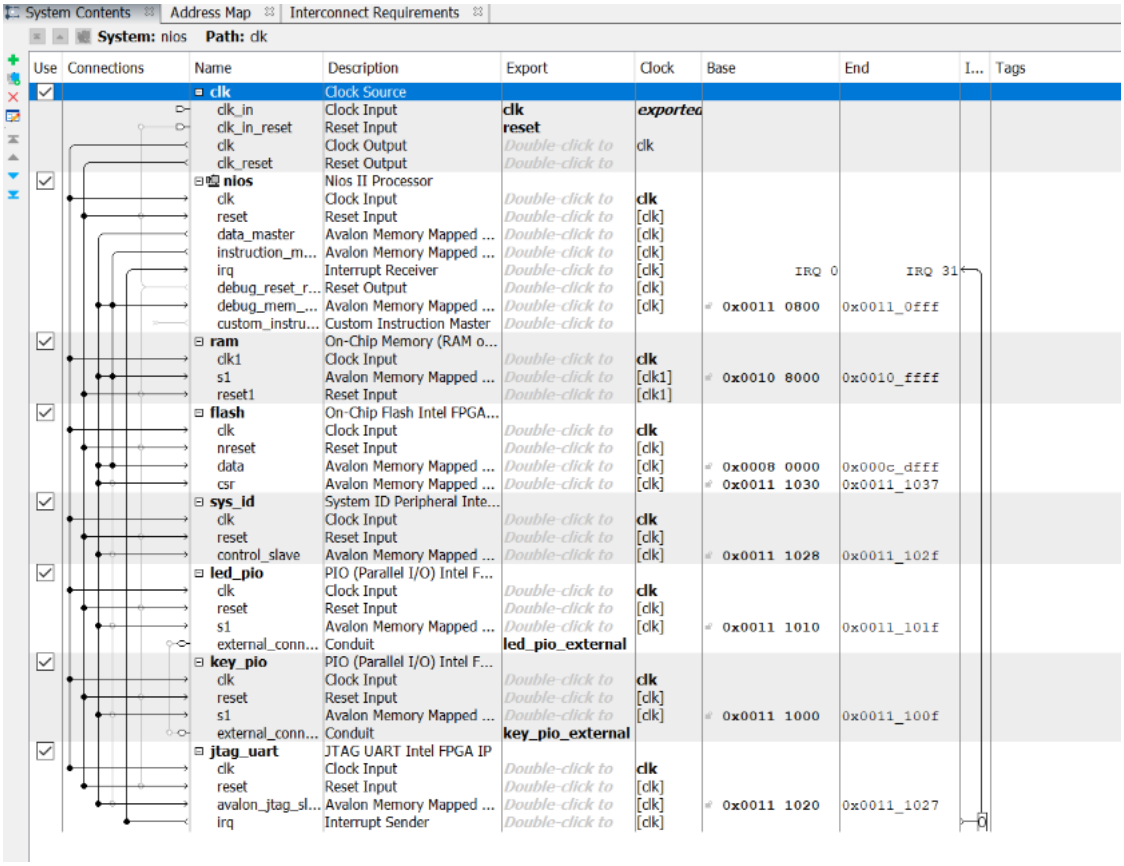
   a. Start Platform Designer from “Tools => Platform Designer” or by clicking the icon  in the line below the top menu.



2. Open the NIOS.qsys from the first lab:

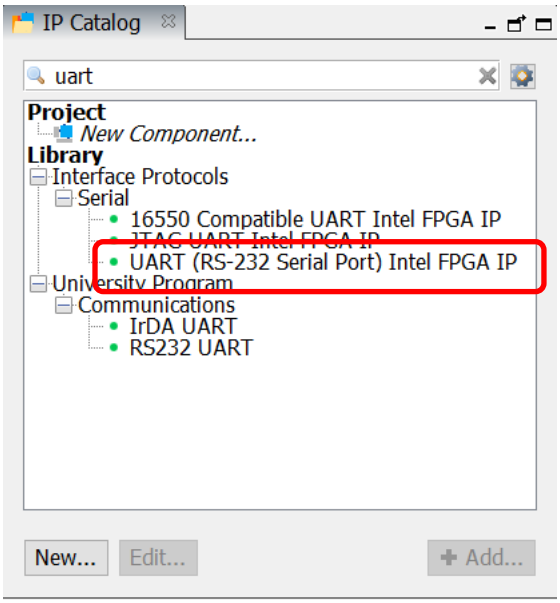


Now You see all components from the first lab:

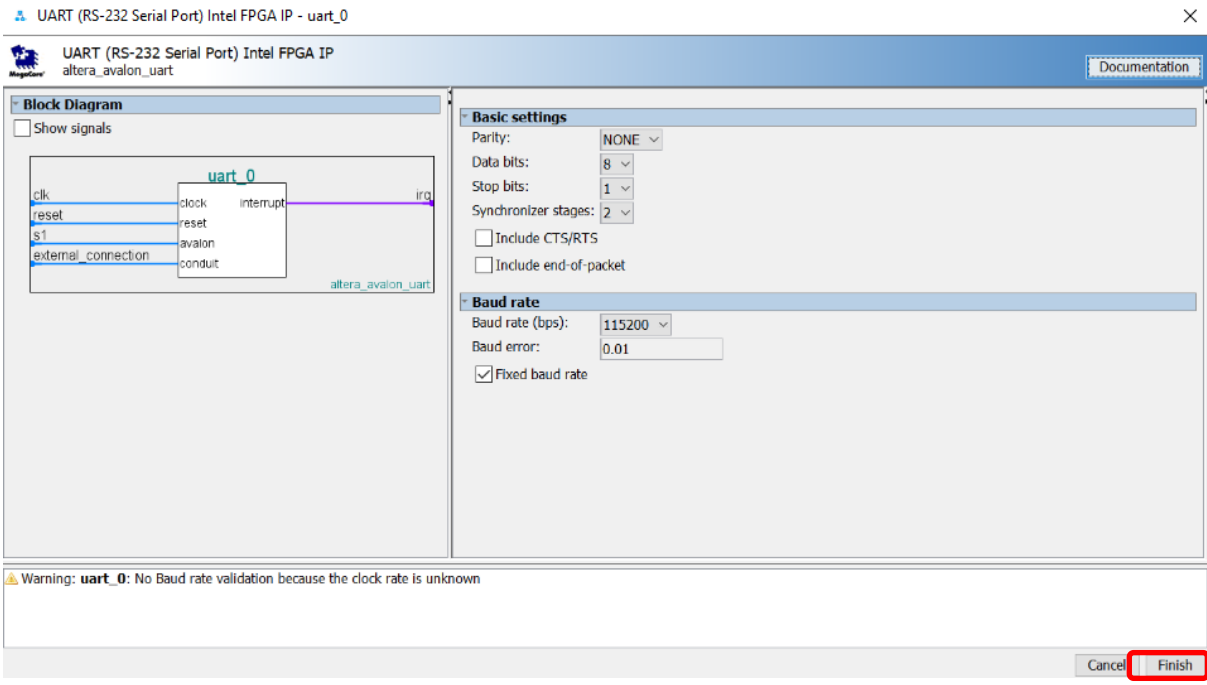


3. Adding a RS232 UART

   a. In the IP Catalog search for “UART” and double click “UART (RS-232 Serial Port) Intel FPGA IP”

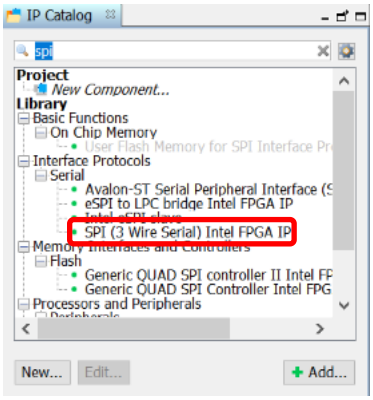


   b. There’s no need to change anything. Here You can find all the settings for Your Terminal-program. Just click finish

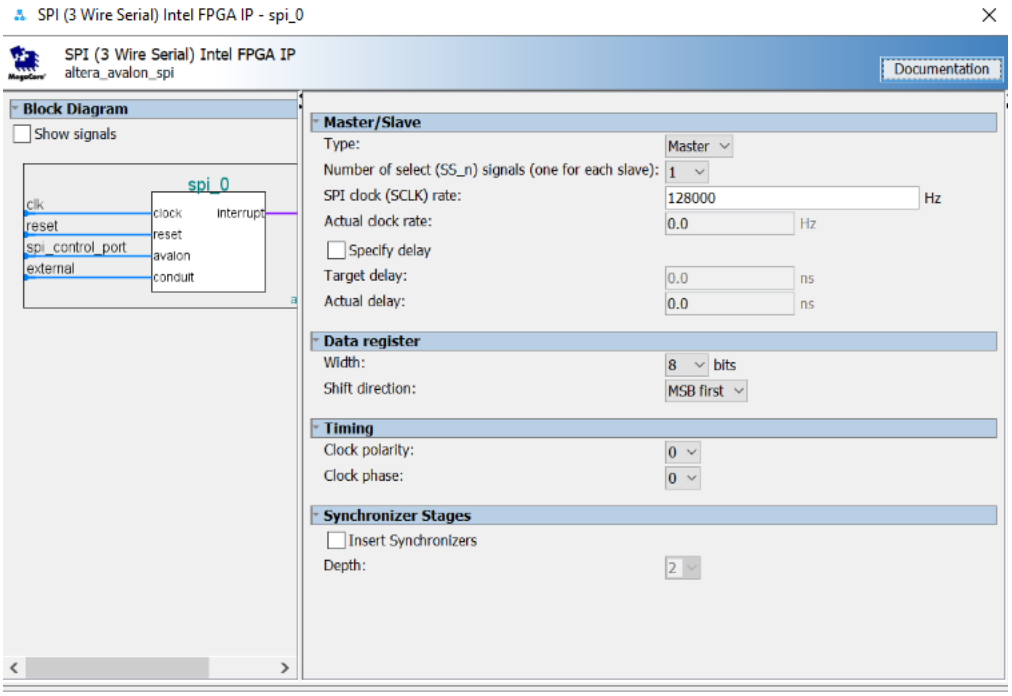


4. Adding the SPI-Interface to connect the Accelerometer:

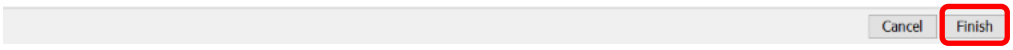
   a. Search for “SPI” and double click “SPI (3 Wire Serial) Intel FPGA IP”



   b. There’s no need to change anything. Just click finish

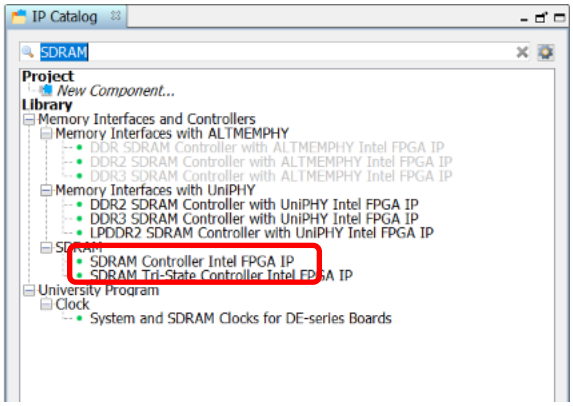


c.



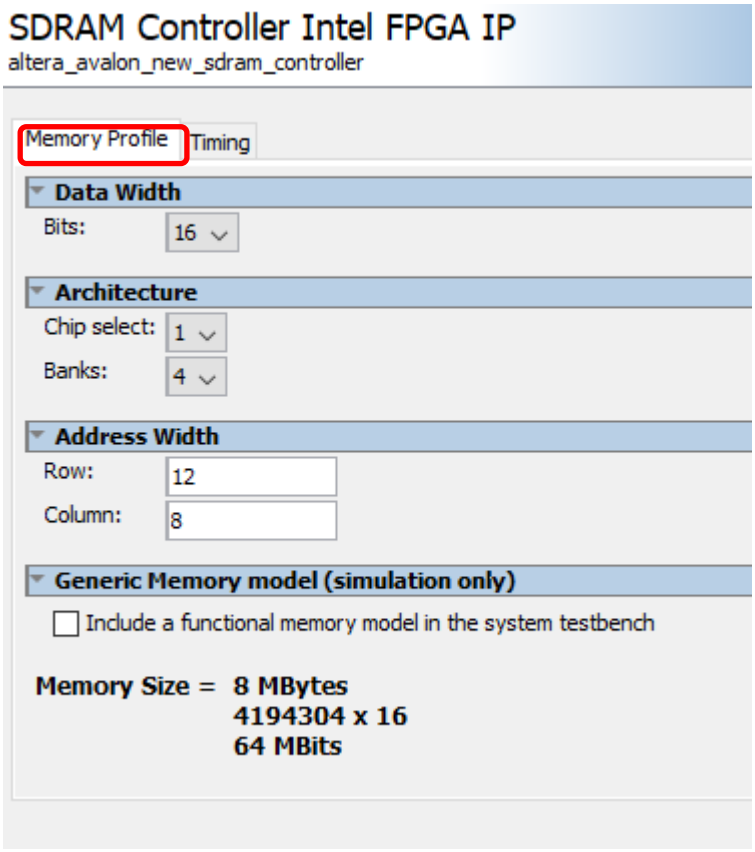
5. Adding the SDRAM

   a. Search for “SDRAM” and double click “SDRAM Controller Intel FPGA IP”



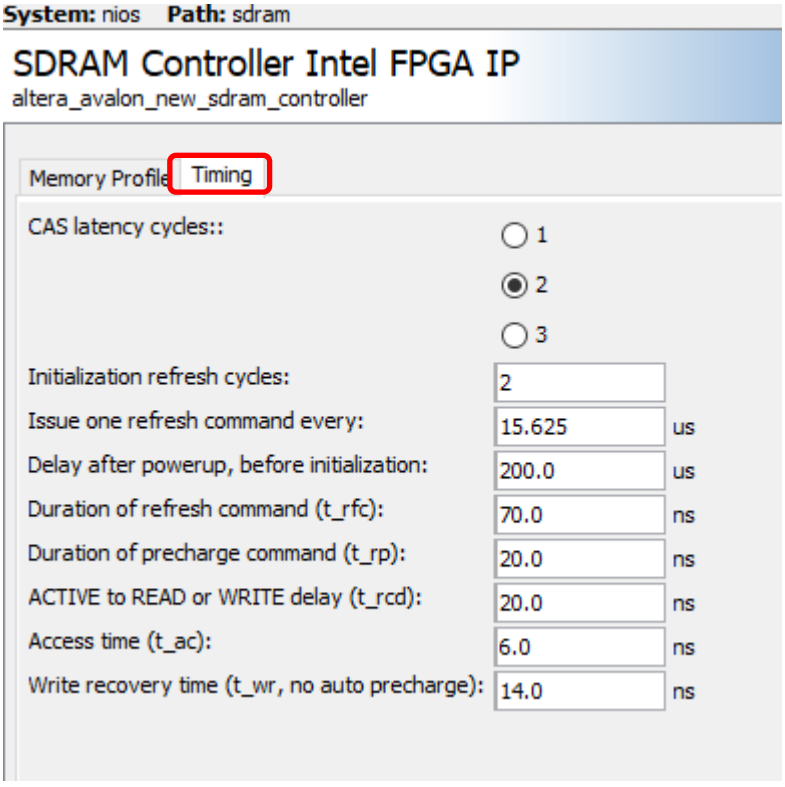
   b. Set “Memory Profile” as shown:

c.



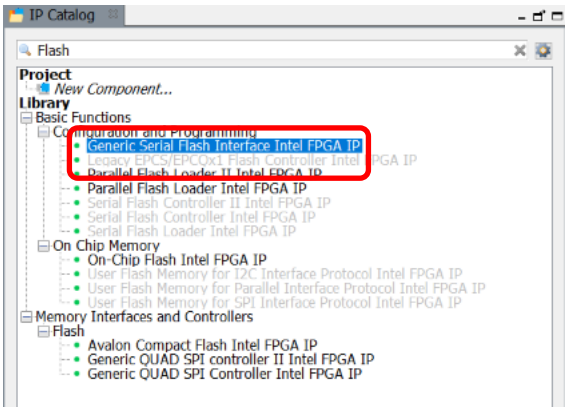
d. And “Timing” to:

e.

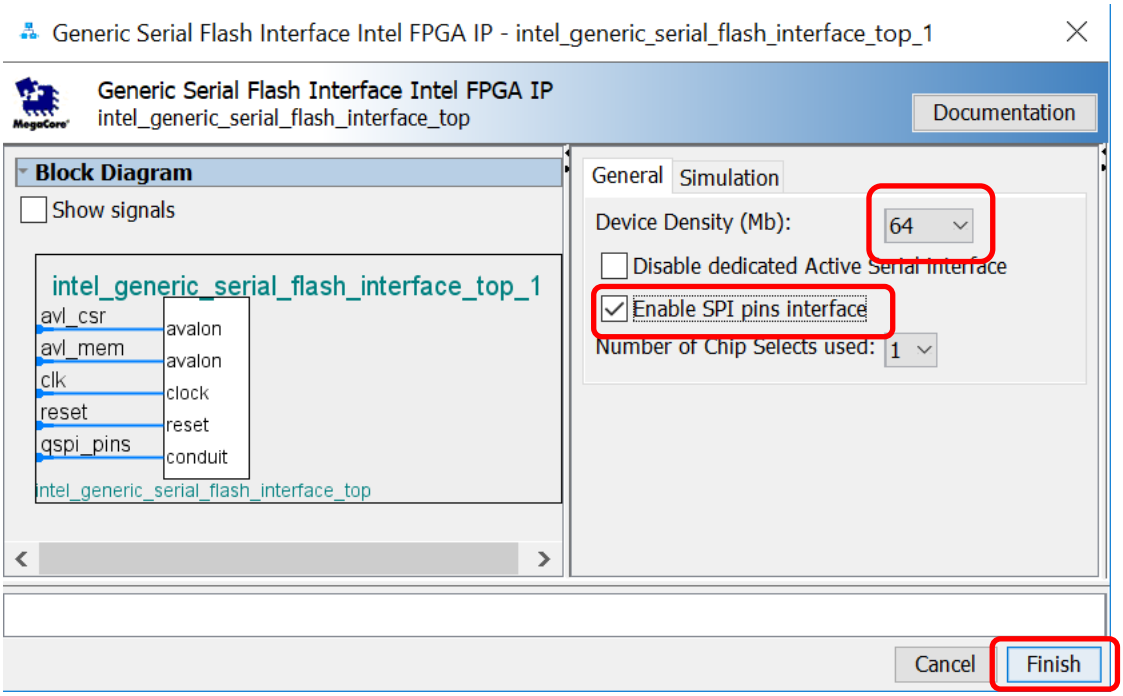


6. Adding External SPI-Flash

   a. Search for “Flash” and double click “Generic Serial Flash interface Intel FPGA IP”

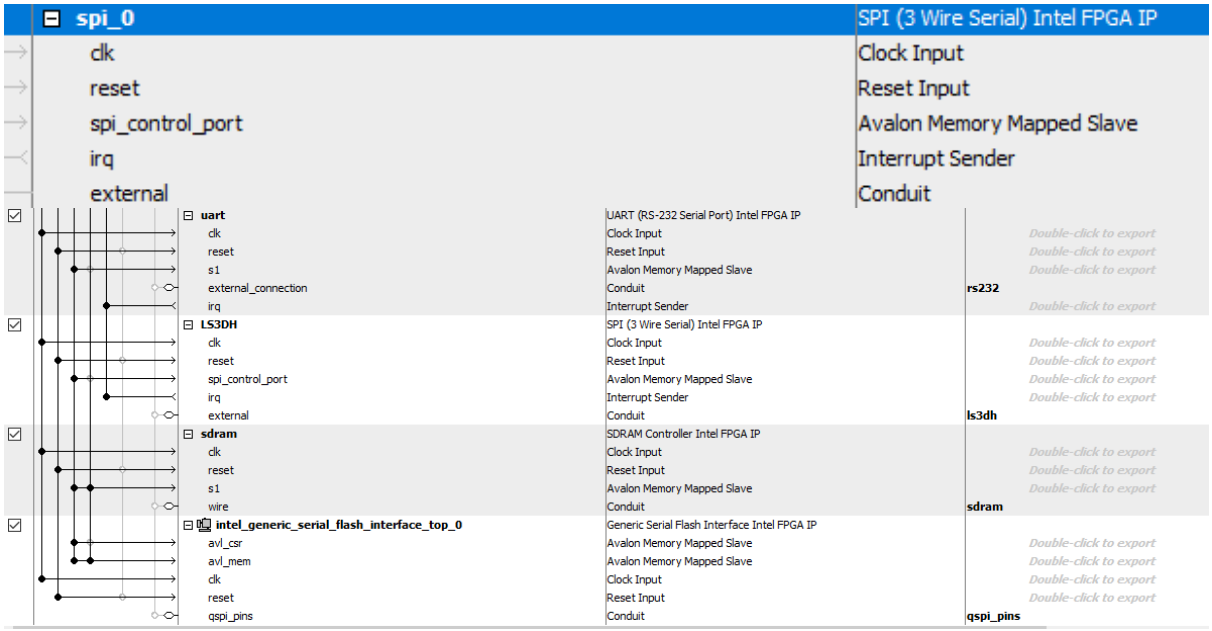


   b. Select 64 Mb Device Density and “Enable SPI pins Interface” and click “Finish”



7. Rename spi_0 to LS3DH by right click on the name and “rename”

8. Connect all buses

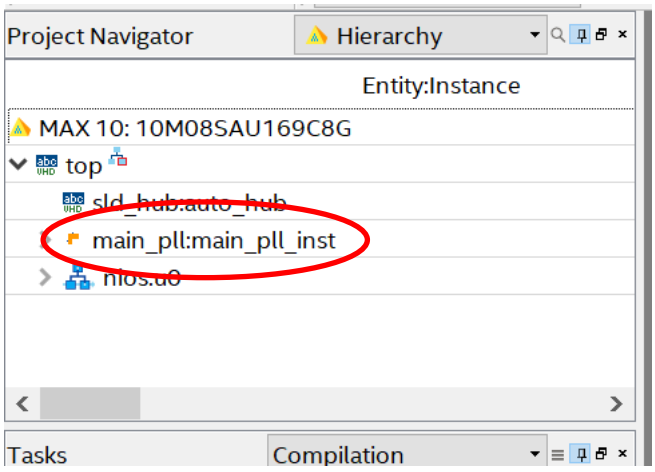


9. Click “Generate HDL”

10. After successful generation click “Finish”

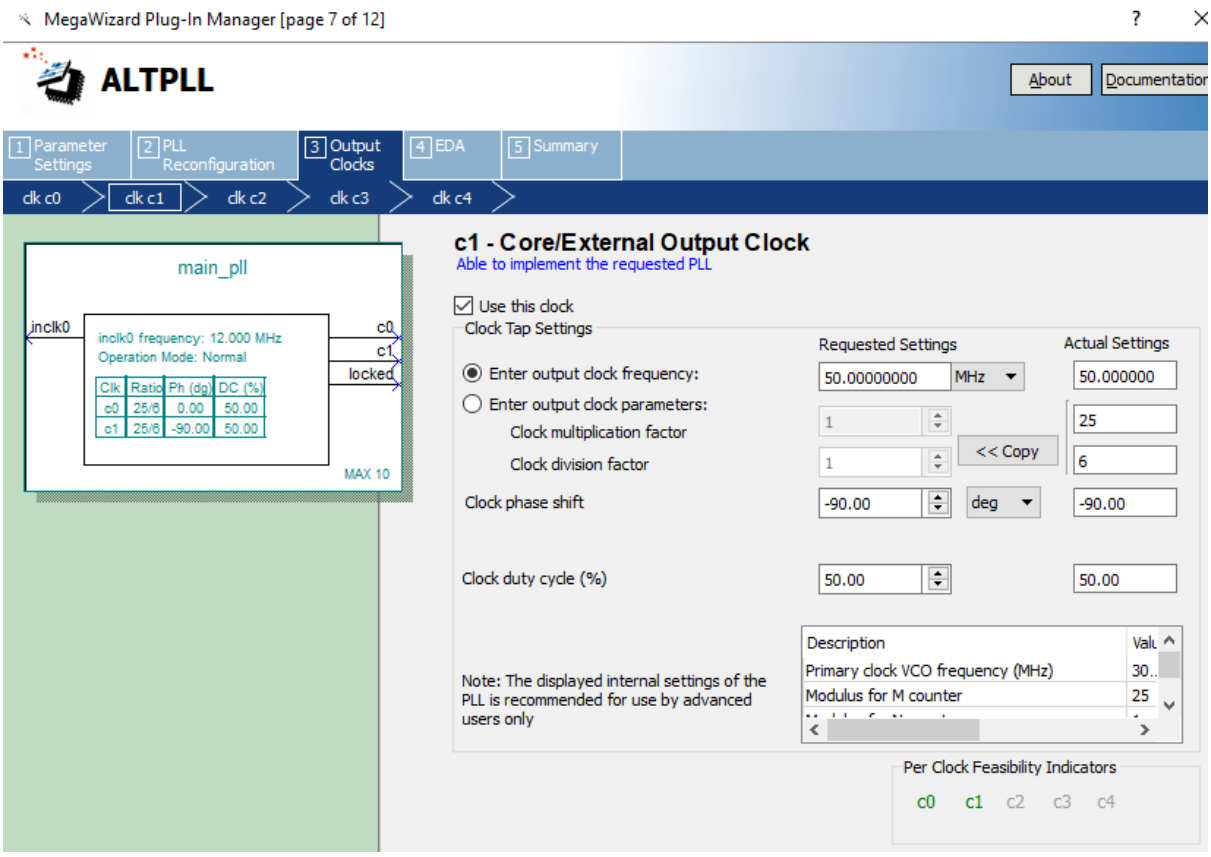
11. Now we need a second clock for the SDRAM

12. In the Project Navigator of Quartus doubleclick “main_pll:main_pll_inst”



13. In the ALTPLL MegaWizard go to “Output Clocks -> clk c1

14. Set check mark at “Use this Clock”, Enter 50.000 MHz as input clk and “Clock phase shift” to -90 degree

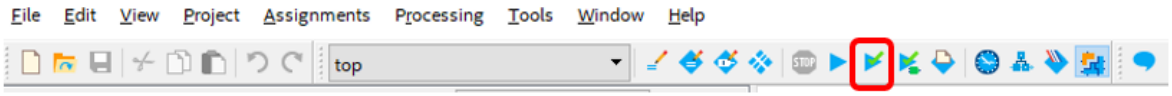
15. 

16. Click “finish”

17. Now replace the old top.vhd with the provided new top.vhd.

18. To be able to assign the IO pins to the signal you need to run “Analysis & Elaboration”

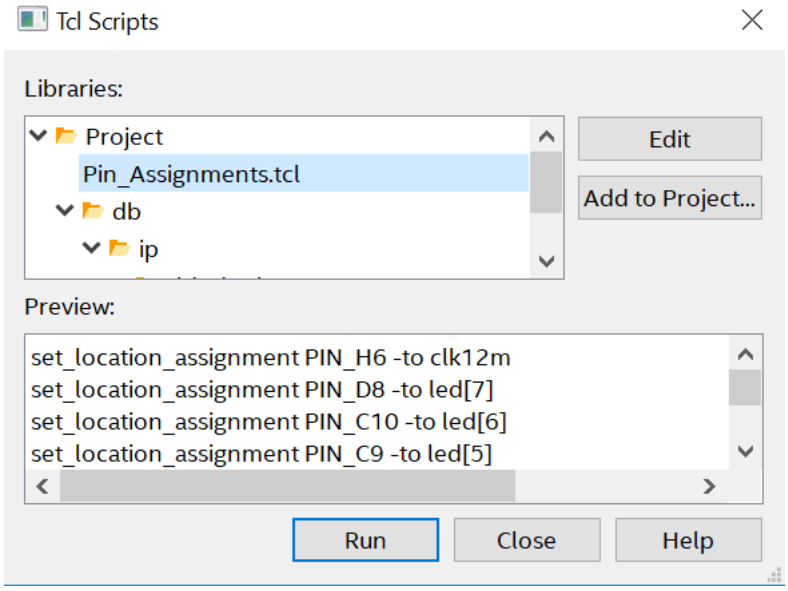
    a. Click the icon for “Analysis & Elaboration” or use “Strg + k”



    b. After the process is finished you can assign IOs. In this tutorial we will use a tcl script.

    c. Copy Pin_Assignments.tcl from the provided USB-Stick to the project-directory

d. In Quartus go to Menu: “Tools -> TCL scripts” select “Pin_Assignments.tcl” and click “Run”



19. Now you need to compile the design to get the needed programming files.

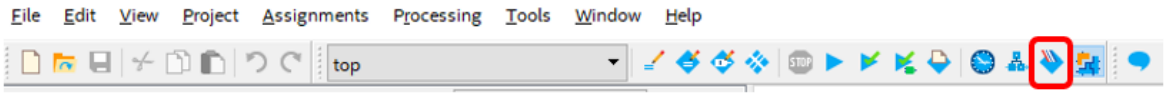
a. Click the “Start Compilation” icon or use “Strg + I”

b. This process will take a while. In the Tasks window you can follow the status

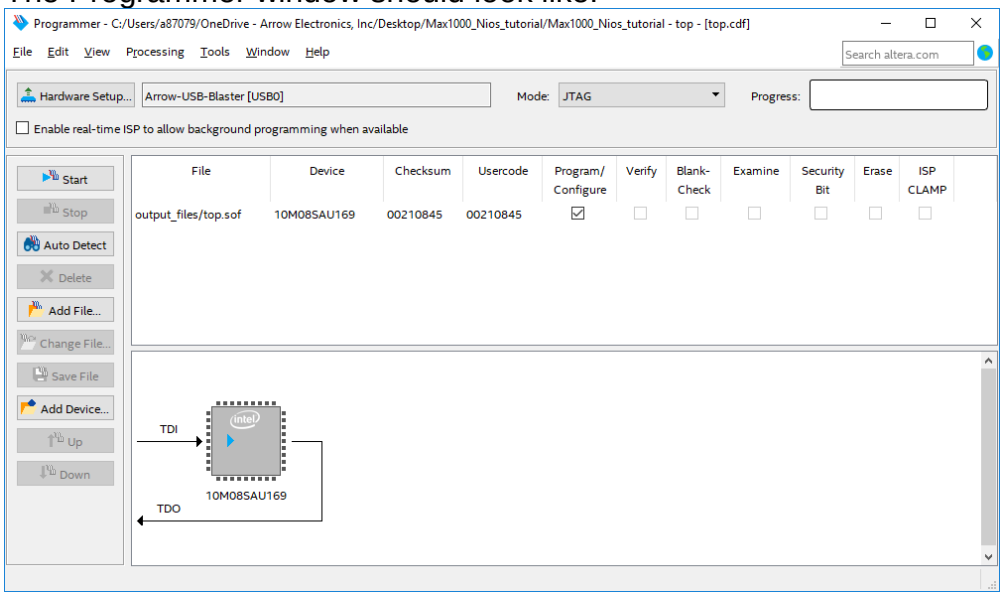
c. After the compilation process has finished successfully the Compilation Report shows the result of the compilation process.

20. To be able to program the SRAM layer of the MAX10 you need to connect the MAX1000 Board via a Micro-USB cable to your computer.

a. Open the Programmer tool by clicking the “Programmer” icon or use the “Tools” menu



b. The Programmer window should look like:



c. The top.sof file is used to program the SRAM layer of the MAX10 device

d. Click “Start” to start the program process

e. After the process has finished you can start the NIOSII Software tutorial.

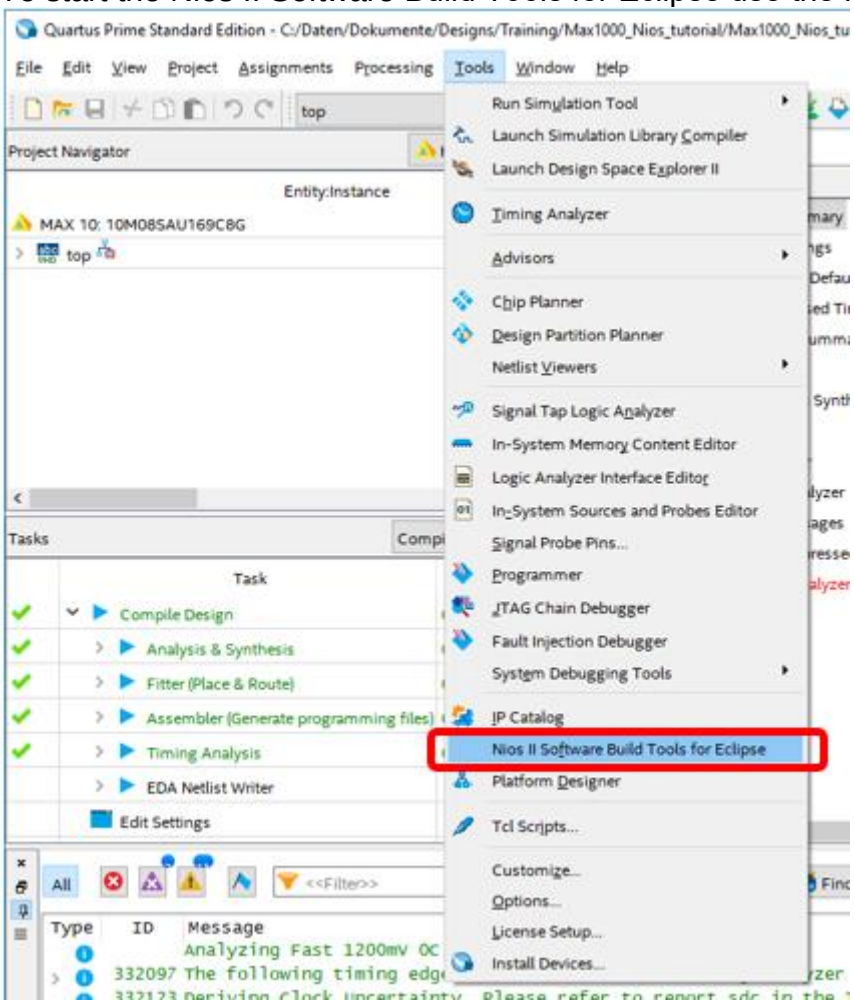
SW-Setup of the Nios II System

In this lab you will generate a C++ based NIOSII program, debug it on the MAX1000 board and generate the HEX file needed to program the UFM.

Hardware setup requirements:

- Micro-USB cable connected between computer and MAX1000 board.
- SOF file programmed to the MAX10 device

1. To start the Nios II Software Build Tools for Eclipse use the Menu “Tools”



2. You need to specify a workspace

   a. Browse to the MAX1000_Nios_tutorial_2 directory and select the directory “**software**”

   b. Click “OK”

c. Nios II – Eclipse starts with an empty window

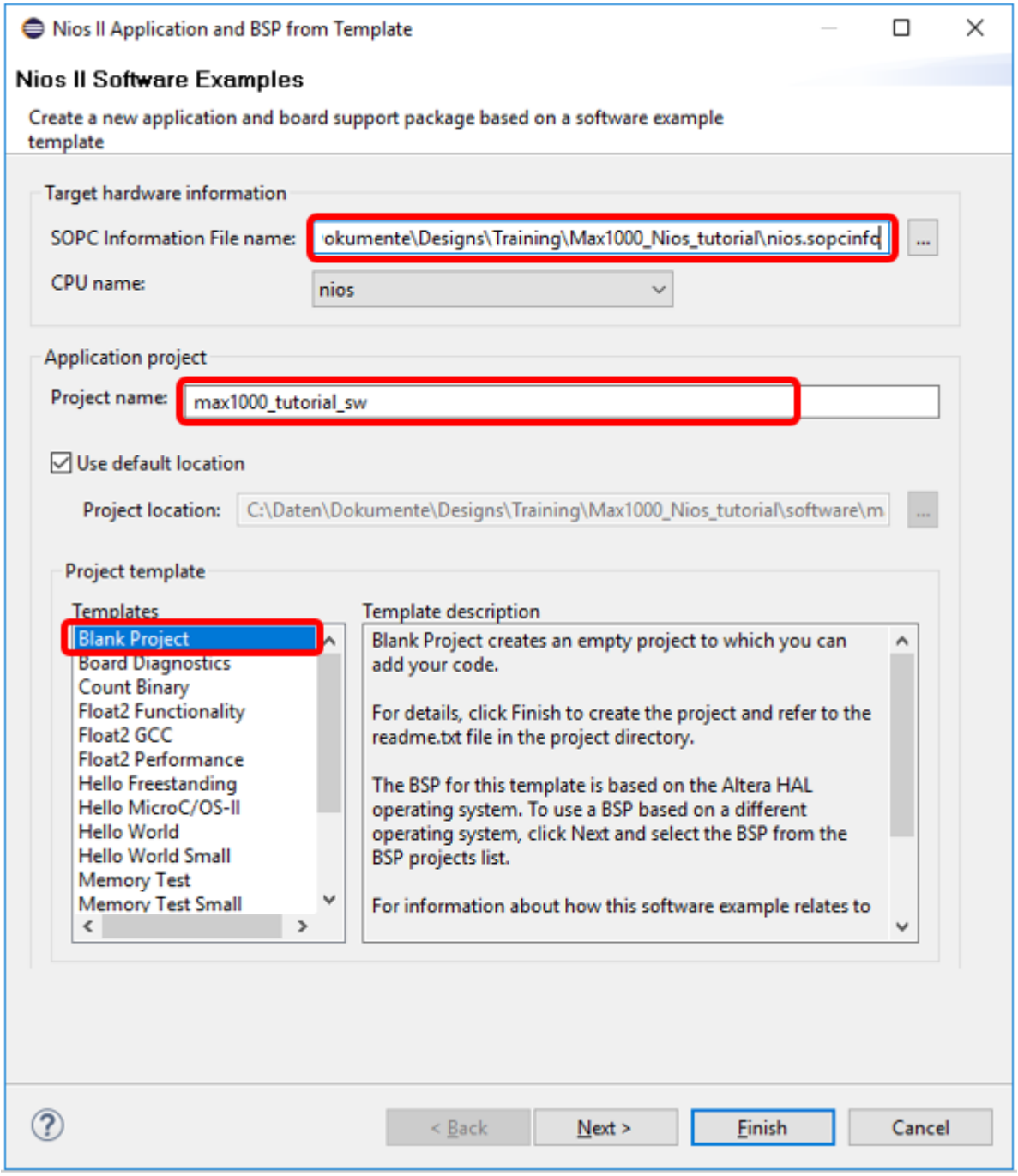
3. Now you generate a new Nios II Application

a. File -> New -> Nios II Application and BSP from Template

b. Select the SOPC Information File name: "**nios.sopcinfo**"

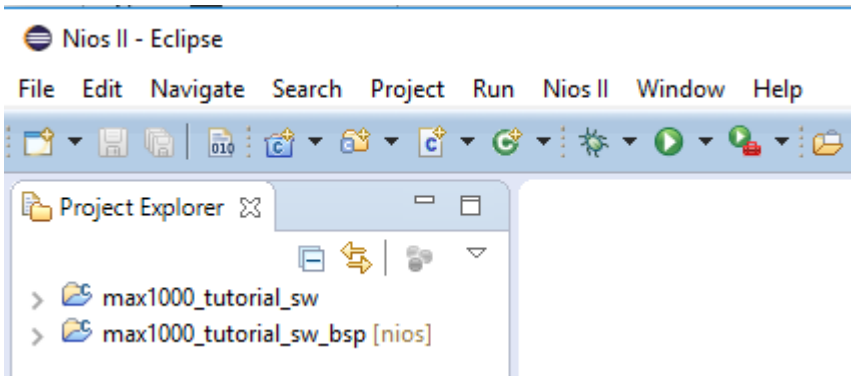
c. Project name: "**max1000_tutorial_2_sw**"

d. Project template: Select "**Blank Project**"



e. Click "Finish

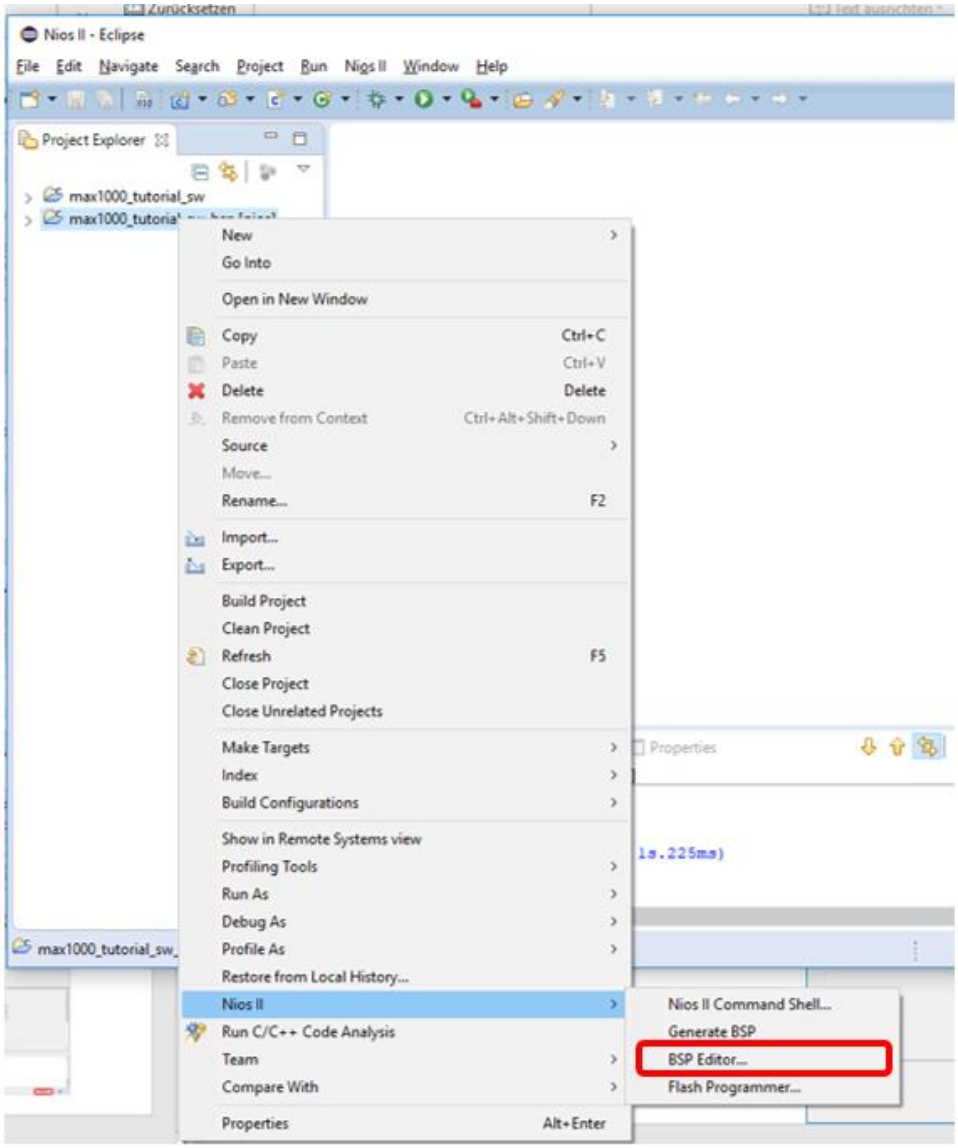
f. In the “Project Explorer” window you now can find two folders



4. Next you need to generate the BSP for the Nios II system

a. Right click the “max1000_tutorial_sw_bsp [nios] folder

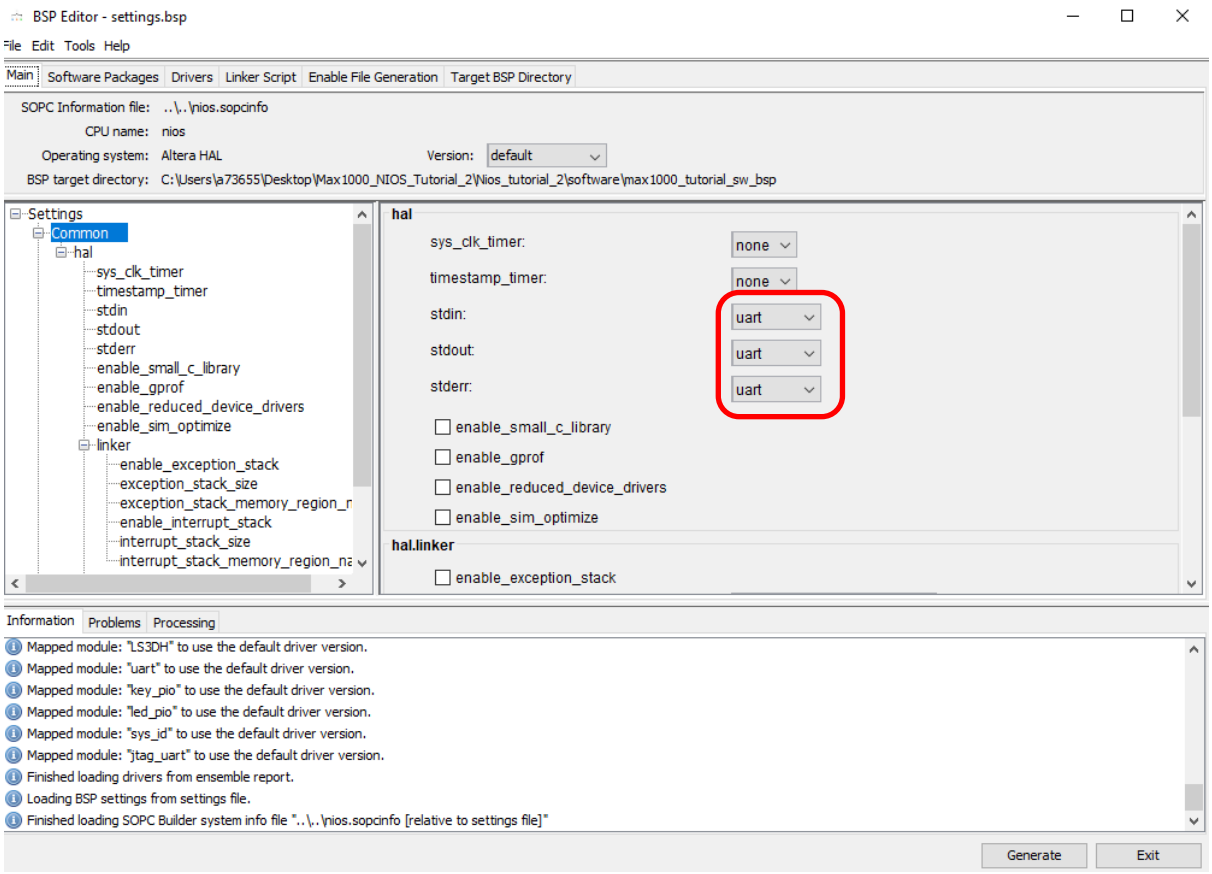
b. Select Nios II -> BSP Editor…



c. You can choose, whether You want to use the integrated console, or use an external terminal program like teraterm or similar.

d. To choose the external terminal-program just select UART for stdin, stdout and stderr.

e.



f. Click “Generate” and “Exit”

5. On the provided USB-Stick is a C file memtest.c .and operation.c. These files must be copied into the Max1000_NIOS_Tutorial_2\software folder.

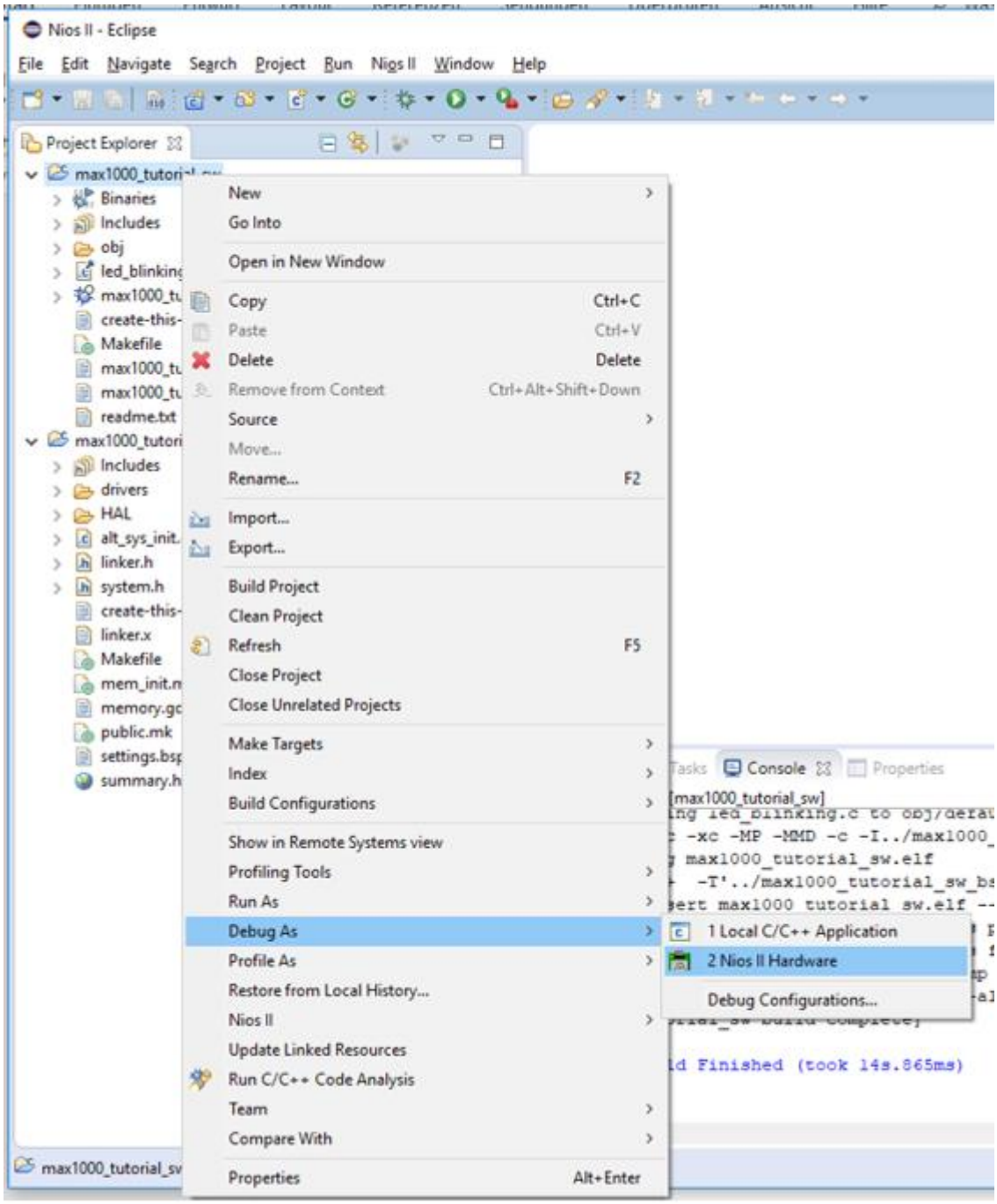
   a. Use a file browser to navigate to the Max1000_Nios_tutorial_2\software and copy the hello_world.c and operations.c files.

   b. In the Nios II – Eclipse window right click the max1000_tutorial_2_sw folder and select “Paste”

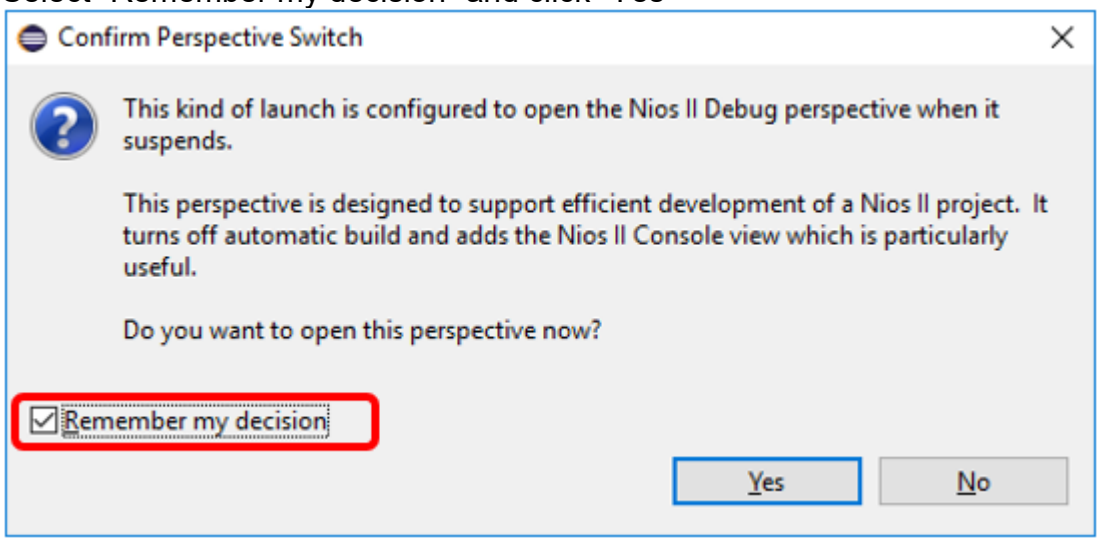
6. To build the project right click the max1000_tutorial_2_sw folder and select “Build Project”

7. Now you can debug the project

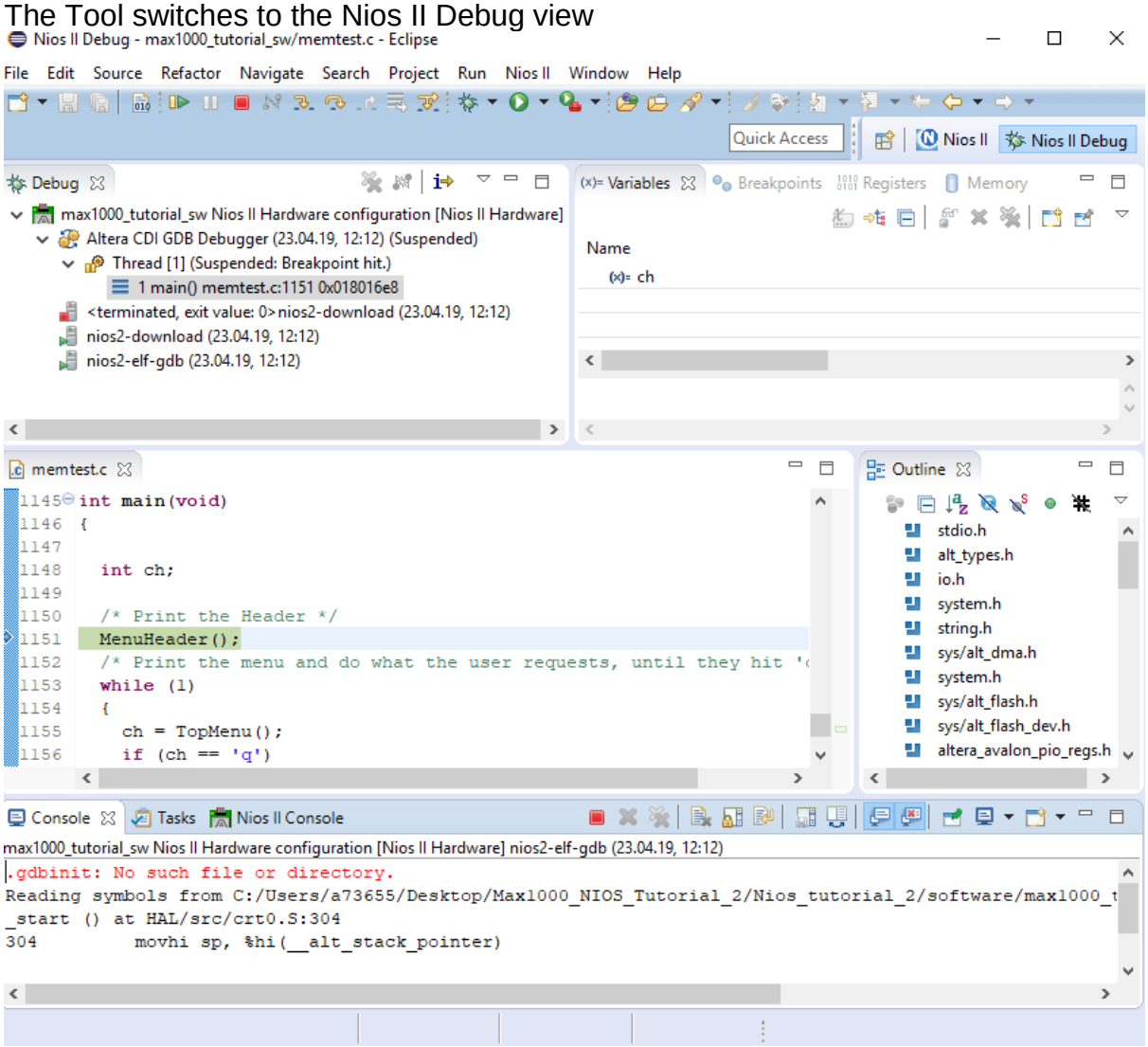
a. Right click the max1000_tutorial_2_sw folder and select “Debug As” -> “2 Nios II Hardware



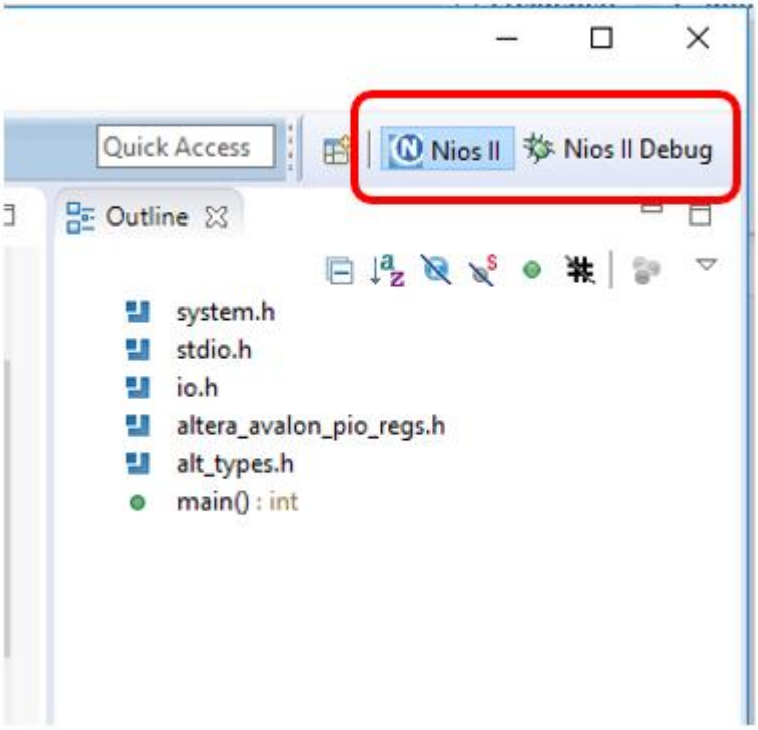
b. Select “Remember my decision” and click “Yes”



c. The Tool switches to the Nios II Debug view

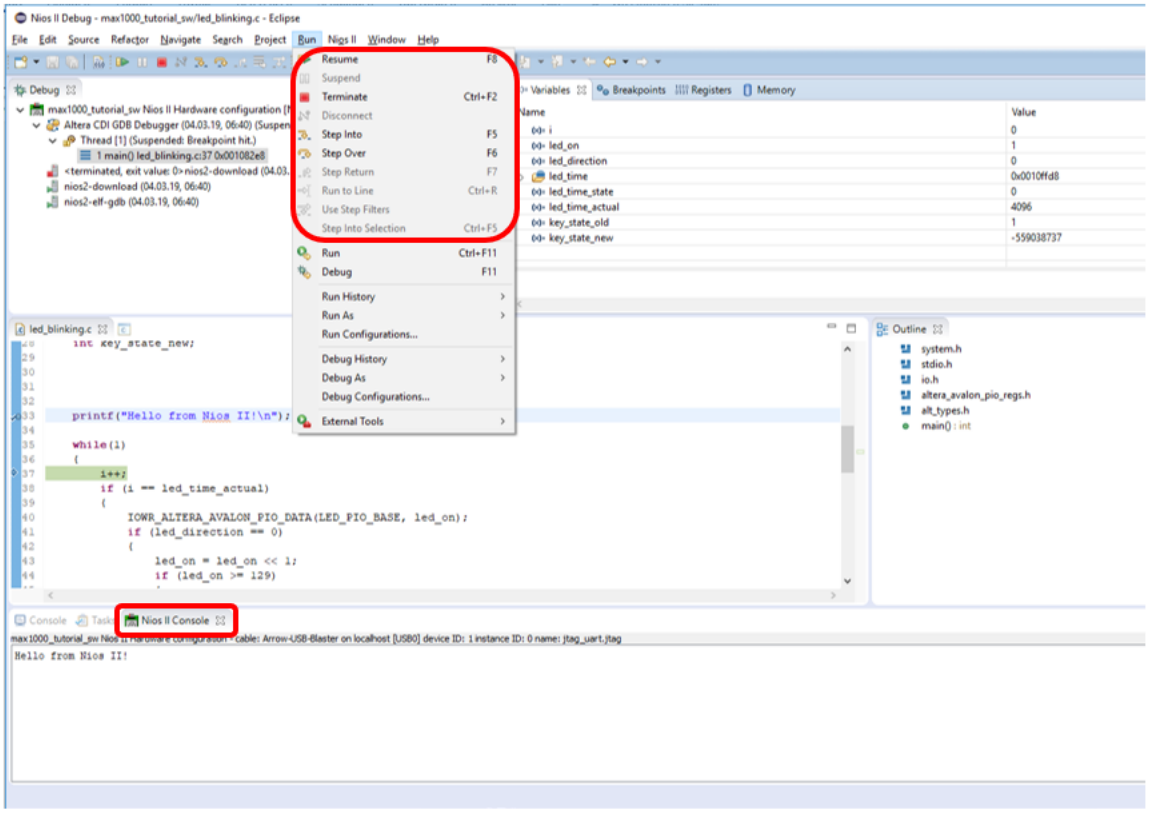


d. Switching between the two views can be made with the two buttons on the top right corner of the Nios II Eclipse window



e. After loading the ELF File to the hardware, the program stops at the first executable line of code.

f. In the menu “Run” you can find the controls to step through the code:

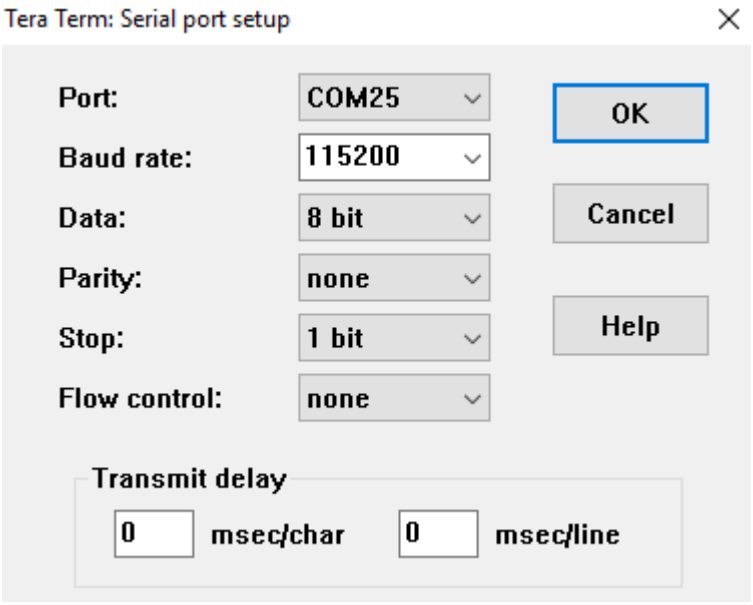


With “Step Over” or F6 the code is executed line by line

With “Step Into” or F5 you will also see the subroutines of every line
With F8 the whole code is executed until the next breakpoint (if there is any)
By double clicking on a line number in the code window you can set and delete breakpoints

g. In the “Nios II Console” you will find the outputs of printf commands, if You have selected JTAG-UART for stdin, stdout and stderr.

h. Otherwise You have to open the terminal program and setup the serial connection via the virtual-com-port (in this example COM25).

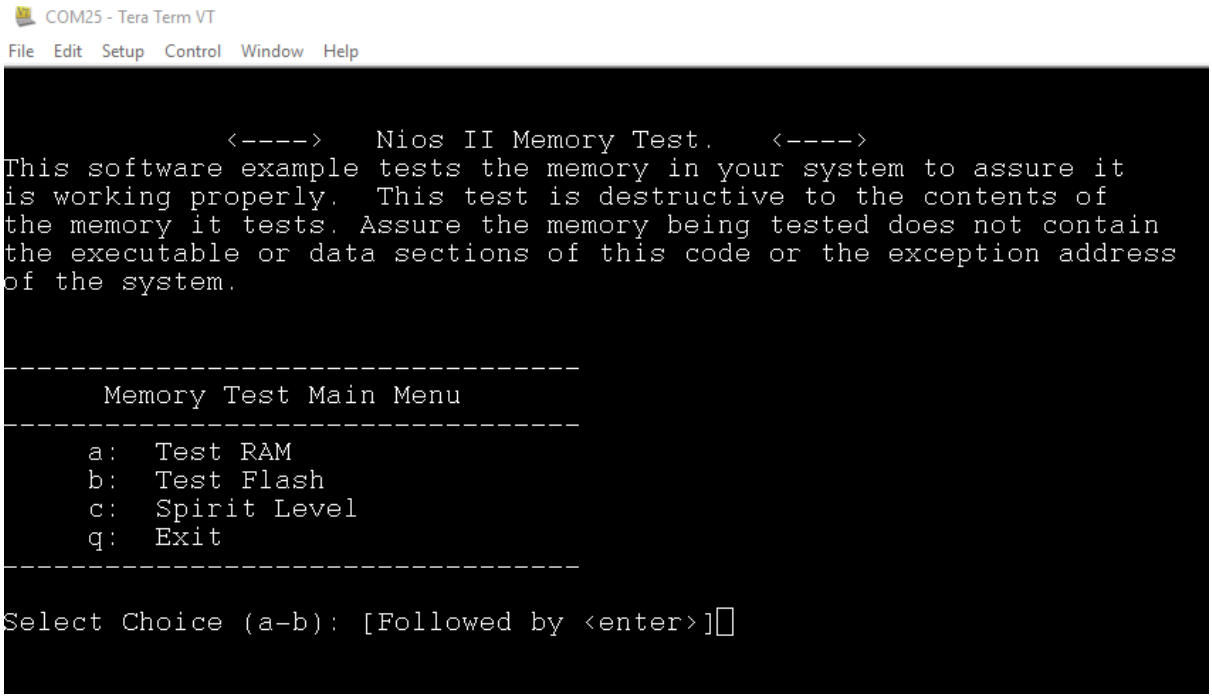
i. 

j. Press F8 in Eclipse to let the program run.

k. Important: If you need to reprogram the MAX10 you need first to terminate the “Debug” or “Run” session

l. In the terminal window (or the eclipse console) now You have a selection choice to test the onboard SDRAM, SPI-Flash and Accelerometer:

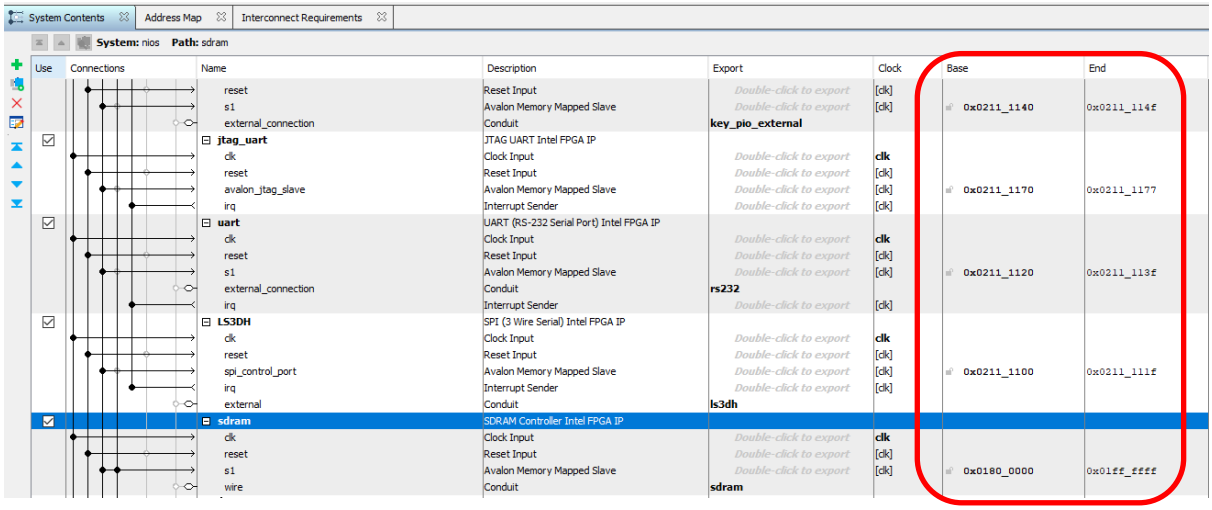
m.



n. To test Parts of the SDRAM enter a and “Return”

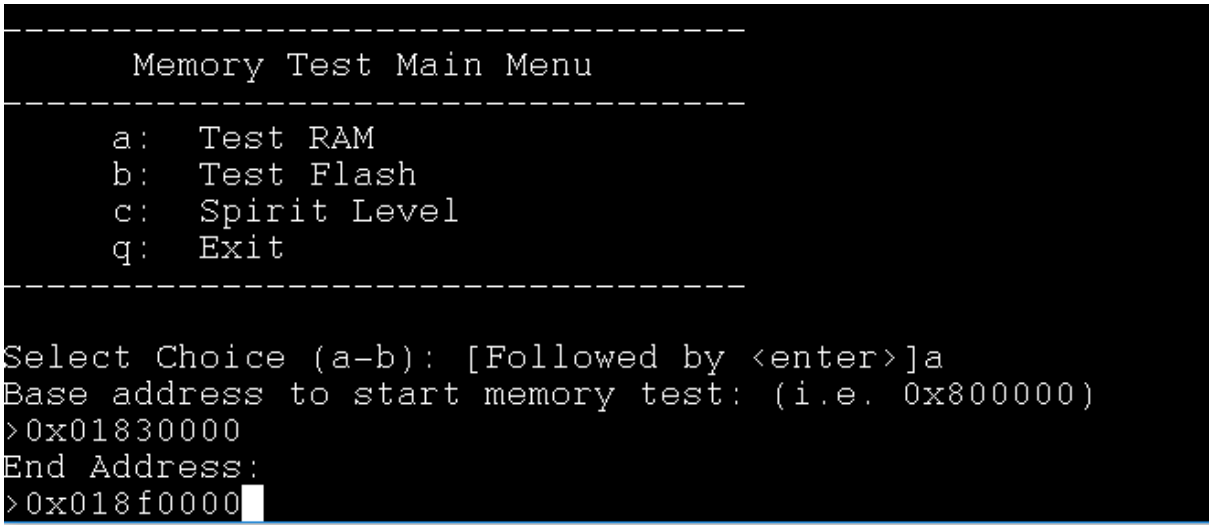
o. Now enter Start- and End-Address for the test. The Base address of the SDRAM You can find in the Platform-Designer:

p.



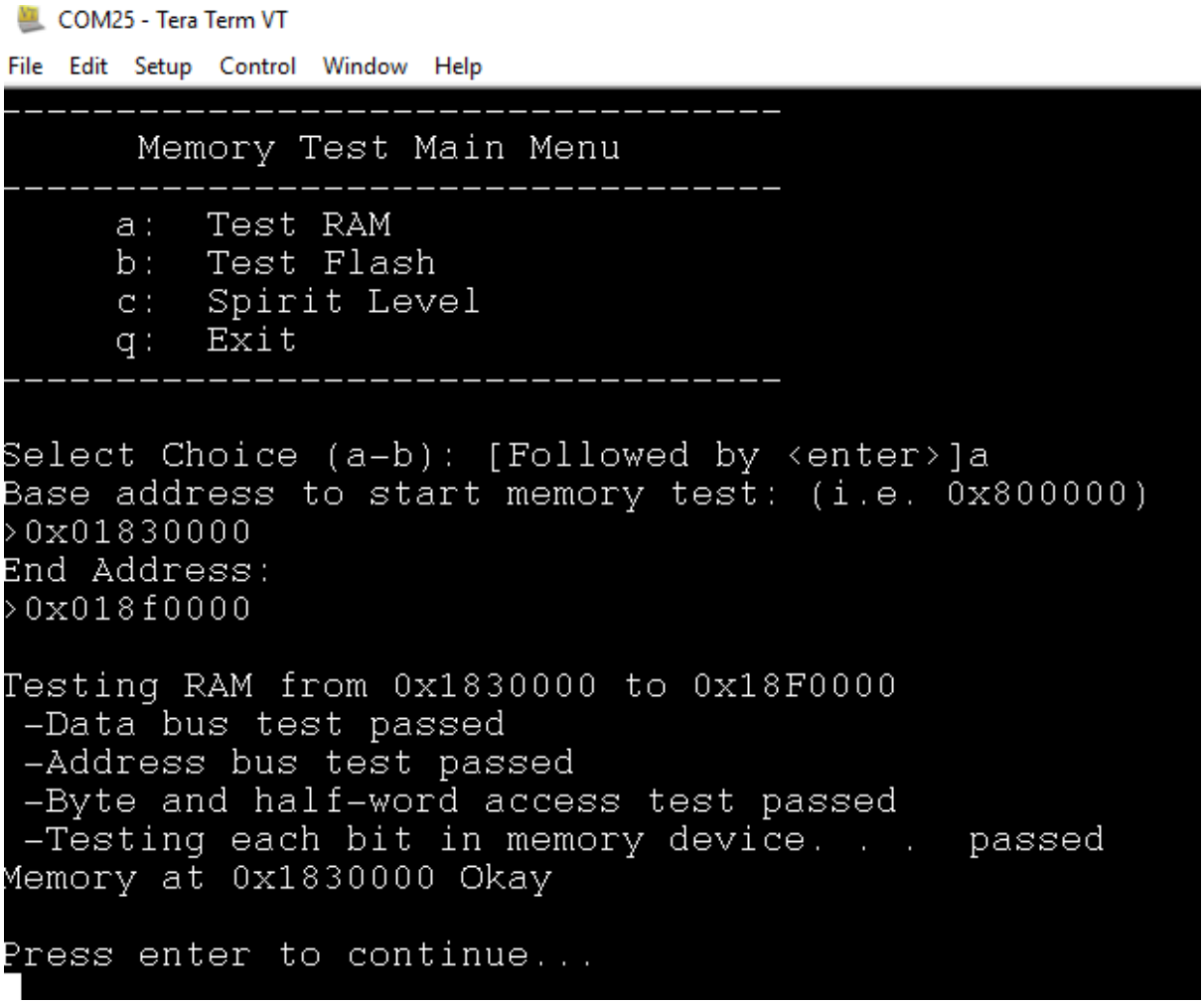
q. Due to the program, that resides in the SDRAM, you should set the Start-Address higher, than the end of the program. This program needs about 130KB. In this example start address is set to 0x01830000. Otherwise the test will destroy the program, and the debug session is interrupted.

r.



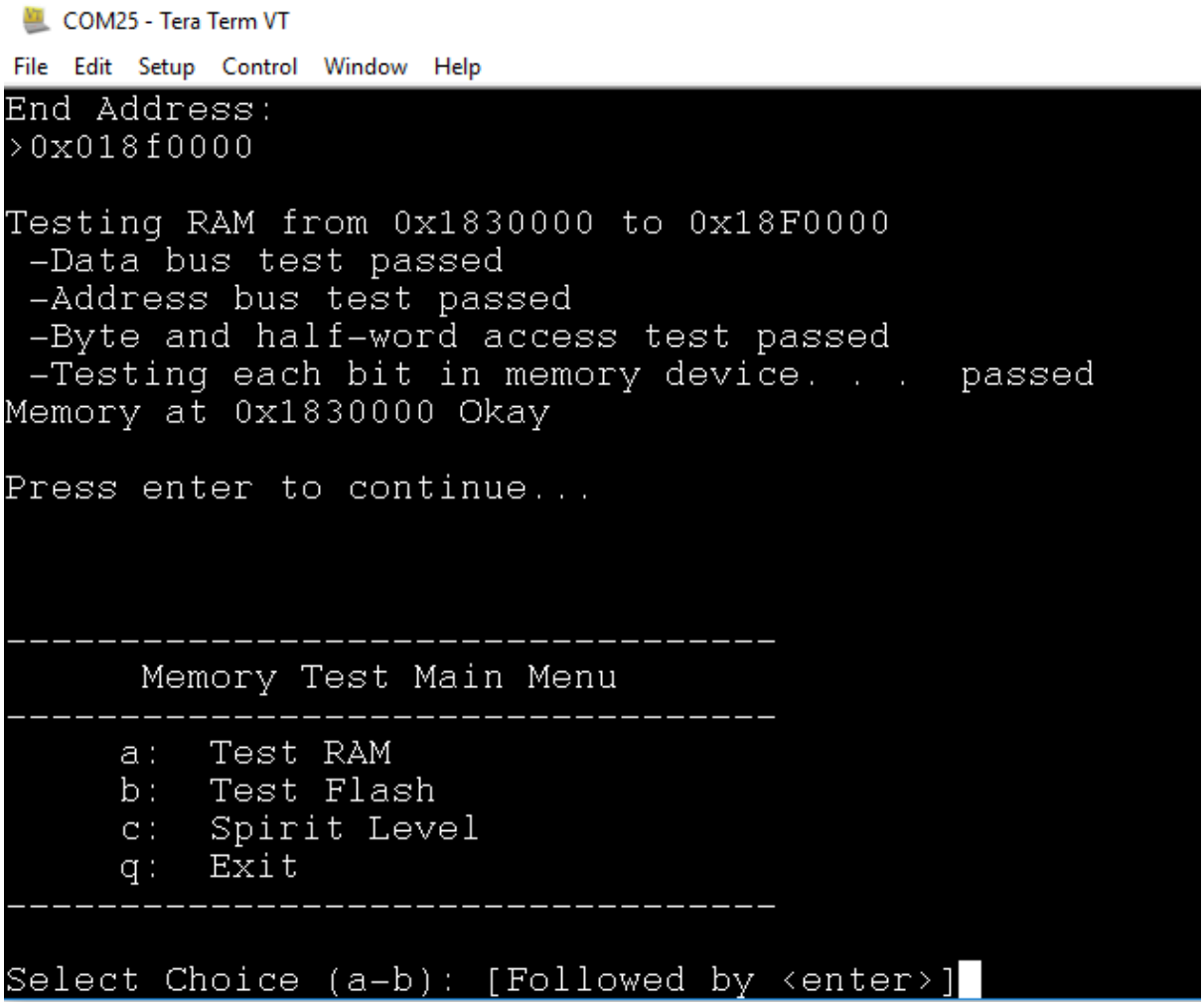
s. Click Enter to start the test and view the results:

t.



u. Pressing enter brings you back to the menue:

v.



w. For testing the W74M… SPI Onboard Flash type b followed by enter.

x. There will be done some read, write, protect, unprotect, sector-erase and chip-erase tests.

```
Onboard flash W74M.. device will be tested.
>Flash Device found: Winbond flash W74M64FS
Device ID: 1740ef
Reading data at address 0...
Memory content at address 0: ffffffff
Address 0 not containing data...
Writing flash-ID to address 0...
Reading data at address 0...
Memory content at address 0: 1740ef
All sectors in this configuration device is not protected
Now performing sector protection...
Write register for sector protect in progress.....
All sectors in this configuration device is now successfully protected
Trying to erase sector 0...
Reading data at address 0...
Memory content at address 0: 1740ef
Now perform sector unprotect...
Sector unprotect successfully! :)
Trying to erase sector 0...
sector erase in progress...........
Reading data at address 0...
Memory content at address 0: ffffffff
Address 0 not containing data...
Writing data to address 0...
Current memory in address 0: 100
Current memory in address 1: 101
Current memory in address 2: 102
Current memory in address 3: 103
Current memory in address 4: 104
Current memory in address 5: 105
Current memory in address 6: 106
Current memory in address 7: 107
Current memory in address 8: 108
Current memory in address 9: 109
Current memory in address 10: 10a
Current memory in address 11: 10b
Current memory in address 12: 10c
Current memory in address 13: 10d
Current memory in address 14: 10e
Current memory in address 15: 10f
Read data match with data written. Write memory successful.
Trying to erase chip
.....................................................
Reading data at address 0...
Memory content at address 0: ffffffff
Chip erase successful.

Press enter to continue...
```

y.

z. At last, there is a spirit level application to test the accelerometer. Type c followed by enter to start this. The onboard LEDs show the level of the board. By tilting the board, you can see the LEDs lighting accordingly. You can finish the test, by tilting the board more than 50° in one direction (USB port down).

Congratulation, you have successfully finished the second Part of MAX1000 tutorial.