

QuickStart Instructions

KEIL-Kit

nanoMODUL-STM32F103

**Using Keil's ULINK and the Keil Microcontroller
Development Tool Chain**

Note: The PHYTEC Kit CD includes the electronic version of
the English nanoMODUL-STM32F103 Hardware Manual

Edition: August 2009

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1 Introduction to the Rapid Development Kit

The nanoMODUL-STM32F103 module is designed to be plugged into a PHYTEC Carrier Board. The PHYTEC Carrier Board contains the I/O connectors as well as any other interface circuitry not provided on the nanoMODUL module itself. The nanoMODUL module, combined with the PHYTEC Carrier Board, provides a platform to jump start embedded designs and propel concept to prototype and finished product.

Each PHYTEC Rapid Development Kit contains an nanoMODUL-STM32F103 module mounted on an applicable Carrier Board, cables, power supply, printed schematics, applicable evaluation software development tool CDs, and the PHYTEC Kit CD. The PHYTEC Kit CD-ROM provides this QuickStart guide, complete electronic documentation and demo programs.

1.1 Rapid Development Kit Documentation

This Rapid Development Kit (RDK) includes the following documentation on the enclosed PHYTEC Kit CD:

- the PHYTEC nanoMODUL-STM32F103 Hardware Manual
- controller User's Manuals and Data Sheets
- this QuickStart Instruction

1.2 Overview of this QuickStart Instruction

This QuickStart Instruction provides a general kit description, as well as software installation hints and example programs. It is structured as follows:

1. The "*Getting Started*" section describes how to interface the nanoMODUL-STM32F103 target hardware to a host PC and uses the **Blinky** example project to demonstrate the download of user code to the internal Flash using the Keil ULINK and Keil RealView Microcontroller Development Tools.
2. The "*Debugging*" section introduces the main debugging features using a new target within the **Blinky** example project and uses the **Blinky** example project to demonstrate the download of user code to the external SDRAM using the Keil ULINK and Keil Microcontroller Development Tools.
3. The "*Getting More Involved*" section provides instructions for creating a new project with the **Blinky** project as a template.

2 System Description

2.1 Hardware Description

The following PHYTEC hardware components are included in the nanoMODUL-STM32F103 Keil Rapid Development Kit (part number KNM-103-KEIL) and are necessary for completing the instructions in this QuickStart instruction:

- the PHYTEC nanoMODUL-STM32F103 (NM-103)
- the nanoMODUL-STM32F103 Carrier Board (NM-999)
- AC adapter supplying 12V
- Serial cable
- USB Standard A to B cable
- Hard copy schematics
- Keil ULINK2 JTAG-USB adapter¹
- PHYTEC Kit CD
- Keil Microcontroller Development Tools Evaluation CD

2.2 Host System Requirements

- This QuickStart guide will require the installation of Keil ARM/μVision3 software development tool chain
- Operating System: Windows 2000, Windows XP or Windows Vista
- CPU architecture: Any x86 32-bit or 64-bit (x64: AMD64 or Intel EM64T) processor
- 60 MB Free Hard Disk Space
- 128 MB of RAM

¹: The Keil ULINK2 is included in the Rapid Development Kit version with the part number KPCM-044-KEIL.

2.3 The PHYTEC nanoMODUL-STM32F103

The nanoMODUL-STM32F103 is an CORTEX M3 based, small form factor, OEMable module populated with the ST-Microelectronics STM32F103ZE controller. Rich peripherals such as USB Client, make this module the ideal candidate for embedded applications requiring high performance and low power consumption. Other chip-level features include 3 x 12-bit ADCs with up to 16 channels, 2 channels 12-bit DAC, 2 UART's, SPI, I2C, a real-time clock with a separate power domain, and NAND Flash. These features make the devices particularly suitable for automotive and industrial control applications as well as medical systems.

Please refer to the nanoMODUL-STM32F103 Hardware Manual for specific information on board-level features, [jumper configuration](#), [memory mapping](#), [pin layout](#), and Carrier Board features.

2.4 Keil RealView Microcontroller Development Kit

The Keil RealView Microcontroller Development Tools for ARM7, ARM9, and Cortex-M3 microcontrollers are easy to learn and use, yet powerful enough for the most demanding embedded applications. The RealView C/C++ compiler supports all ARM-compatible devices including the ST-Microelectronics STM32F103 device. For a complete list of supported ARM derivatives go to:

<http://www.keil.com/arm/chips.asp>

µVision3, the latest version of Keil's popular IDE, combines project management, source code editing, program debugging, and Flash programming in a single, powerful environment. This QuickStart provides an overview of the most commonly used µVision3 features. For more information on Keil ARM/µVision3 tools visit their website at:

<http://www.keil.com/arm/>

For more information and example updates, please refer to the following sources:

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3 Getting Started

What you will learn with this Getting Started example:

- installing Rapid Development Kit software
- interfacing the nanoMODUL-STM32F103, mounted on the Carrier Board, to a host-PC using the Keil ULINK2
- downloading example user code to the nanoMODUL-STM32F103 internal flash.

3.1 Installing Rapid Development Kit Software

3.1.1 Installing Documentation from PHYTEC Kit CD

The PHYTEC Kit CD installs documentation, datasheets, and demo files for the nanoMODUL-STM32F103. When you insert the PHYTEC Kit CD into the CD-ROM drive of your host-PC, the CD should automatically launch a setup program. Otherwise the setup program (setup.exe) can be manually executed from the root of the CD.

1. Insert the PHYTEC Kit CD.
2. On the *Welcome to the nanoMODUL-STM32F103 Product CD Setup* window, select **Next** to continue.
3. Keep **C:\PHYTEC\nanoMODUL-STM32F103** as the installation path and select **Next** to continue.
4. Keep **nanoMODUL-STM32F103** as the Program Folder and select **Next** to install.
5. After the installation process is complete, select **Finish**.

The PHYTEC Kit CD installation path is **C:\PHYTEC\nanoMODUL-STM32F103** and the following five subfolders are located within the nanoMODUL-STM32F103 directory:

AppNotes – This folder is empty.

Datasheets – This folder contains product related datasheets.

extended Files – This folder contains the STMicroelectronics STM32 Function Library.

Keil-Kit – This folder contains this Quickstart Manual and the demo software.

Manual – This folder contains the hardware manual.

3.1.2 Installing Keil Microcontroller Development Tools

When you insert the Keil Microcontroller Development Tools CD into the CD-ROM drive of your host-PC, the CD should automatically launch a setup program that installs the required software. Otherwise the setup program (.exe) can be manually executed from the root folder of the CD.

- Install the Keil ARM Evaluation tools, from the enclosed Keil Microcontroller Development Tools CD, following the steps indicated in the install procedure.
- Alternately, the Keil ARM Evaluation tools can be installed from:

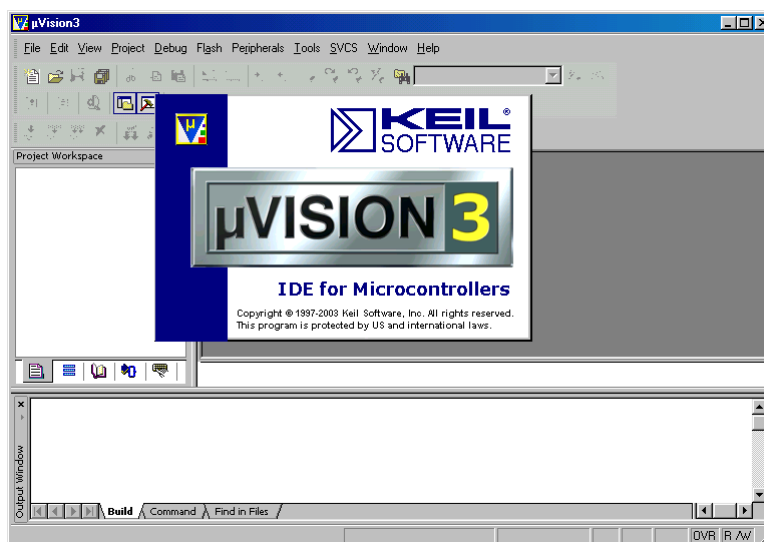
<https://www.keil.com/demo/eval/arm.htm>

3.3 Downloading Blinky Example Code with μ Vision3

The μ Vision3 evaluation software development tool chain should have been installed as described in section 3.1.2.

- Start the tool chain by selecting Keil μ Vision3 from within the programs group: *Start \ Programs \ Keil μ Vision3* or by double-clicking on the Keil μ Vision3 icon on your desktop.

After you start μ Vision3, the window shown below appears. From this window you can create projects, edit files, configure tools, assemble, link and start the debugger. Close all projects that might be open by selecting *Project \ Close Project*.

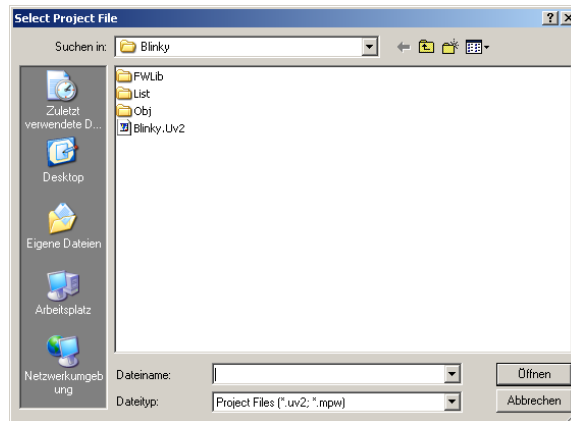


The **Blinky** project, when executed, manipulates a user LED on the nanoMODUL. The **Blinky** example contains one target:

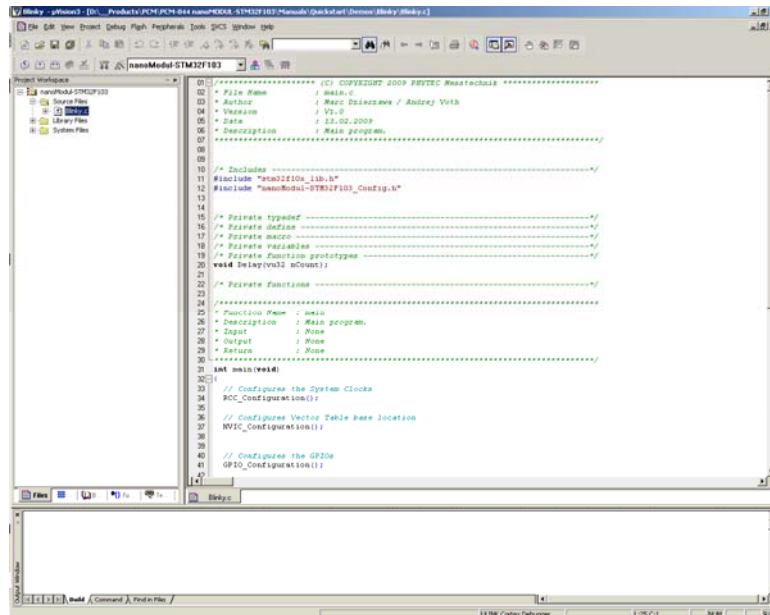
- **nanoModul-STM32F103**: configured for on-chip flash

Open Blinky project by selecting *Project / Open Project* from the μ Vision3 menu and browse to *C:\PHYTEC\nanoMODUL-STM32F103Keil-Kit\Quickstart\Demos\Blinky*


Select the **Blinky.Uv2** projectfile and click *Open*.



If the **Blinky.c** source file is not already visible in the editor window you can open it by double-clicking on its file name in the project workspace:



3.3.1 Build the Project


- Build the target by either selecting the *Build Target* icon  on the build toolbar or by selecting *Project / Build target* in the main menu bar.
- If any source file of the project contains any errors, they will be shown in the **Output Window - Build** tab. You can use the editor to correct the error(s) in the source code, to save the file and to repeat the build.
- If there are no errors, the code is ready to be downloaded into the internal RAM.

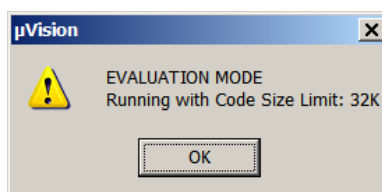


```

x Build target 'nanoMODUL-STM32F103'
compiling Blinky.c...
compiling stm32f10x_gpio.c...
compiling stm32f10x_it.c...
compiling stm32f10x_flash.c...
compiling stm32f10x_hwic.c...
compiling stm32f10x_ttc.c...
compiling nanoModul-STM32F103_Config.c...
assembling stm32f10x_vector.o
  
```

3.3.2 Start the Debugger and Download to nanoMODUL

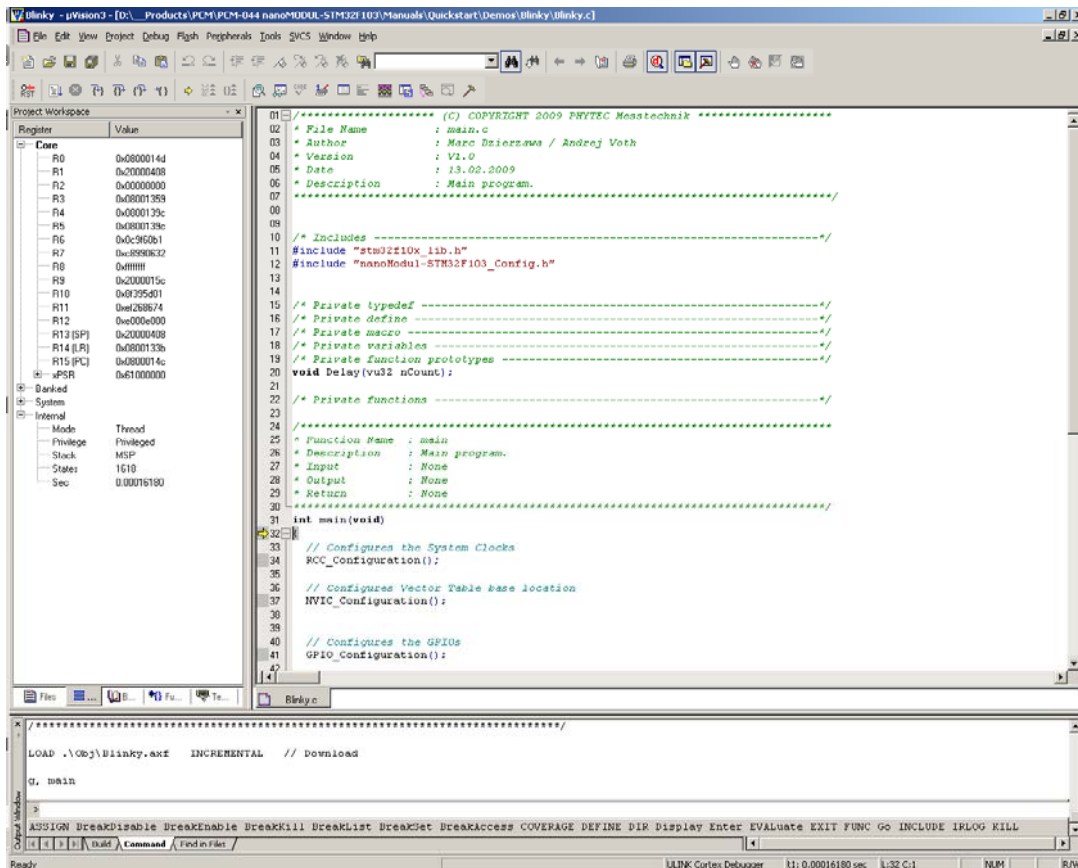
- To start the μ Vision3 debug environment, click the debugger icon  on the μ Vision3 toolbar or select *Debug / Start/Stop Debug Session* from the main menu bar.
- While using the μ Vision3 Evaluation Tools, the following warning will appear. Please select *OK* and continue.



- You will see a blue status bar from left to right at the bottom of your screen indicating the download process of the debug program.

If a problem occurs during data transfer, an error message will be displayed. If "No JTAG Devices Found" error should occur, make sure the target hardware is properly connected to a power supply and the host-PC using the Keil ULINK device (*refer to section 3.2*).

If the data transfer was successful, a screen similar to the one shown below will appear. The **Project Workspace** window changes to the **Register** page. The debug toolbar is also displayed. In the lower part of the debug screen you will see the **Command** window.

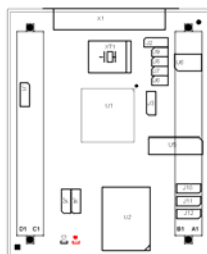


You may need to open, resize and /or move some windows to make your screen look similar to the screen capture. You can open inactive windows by choosing the desired window from the **View** pull down menu.

The debugger will run to the *'main'* function and stop automatically. Notice the yellow arrow pointing to the first command in the *'main'* function. Also notice the program counter R15 (**PC**) within the **Project Window – Register** page showing the start address of the *'main'* function.

- Click on the **Run**  icon and the program will run.

Successful execution of the program will blink LED D1 on the nanoMODUL.



4 Debugging

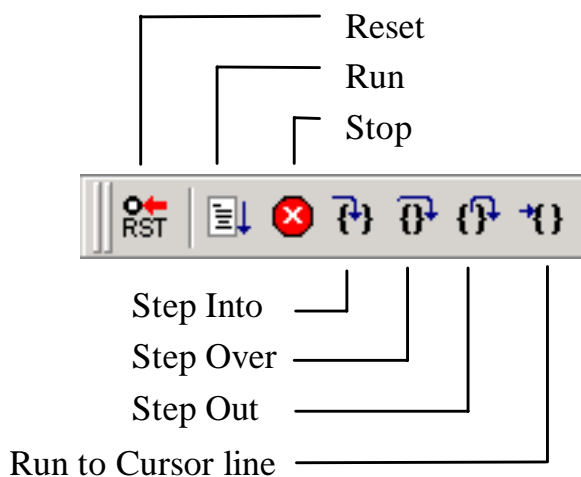
What you will learn with this example:




- familiarizing yourself with simple debug functions provided by the Keil μ Vision3 debug environment
- downloading example user code in the nanoMODUL





This Debugging section provides a basic introduction to the debug functions included in the Keil ARM/ μ Vision3 evaluation tool chain. For a more detailed description of the debugging features, please refer to the appropriate manuals provided by Keil.

4.1 Keil μ Vision3 Debug Features


- The **Debugger** window toolbar gives access to the following debug commands: *Reset*, *Run*, *Stop*, *Step Into*, *Step Over*, *Step Out* and *Run to Cursor line*.

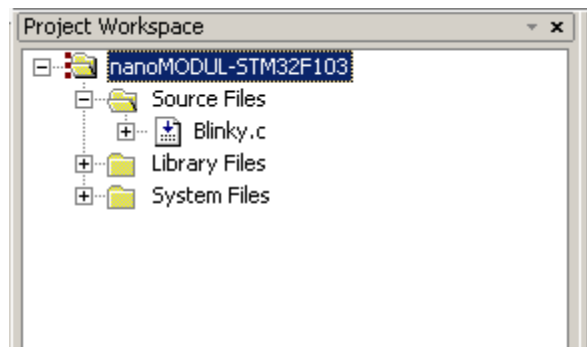


- The first button on the debugger toolbar is the *Reset*  button. The *Reset* command sets the program counter to 0.
- The button to the right of the Reset button starts the *Run*  command. Clicking this button runs the program without active debug functions. To stop program execution at a desired point, a breakpoint can be placed before the *Run* button is pushed.
- The next button on the debugger toolbar is the *Stop*  button. The *Stop* button interrupts and stops the running program at an undetermined location.

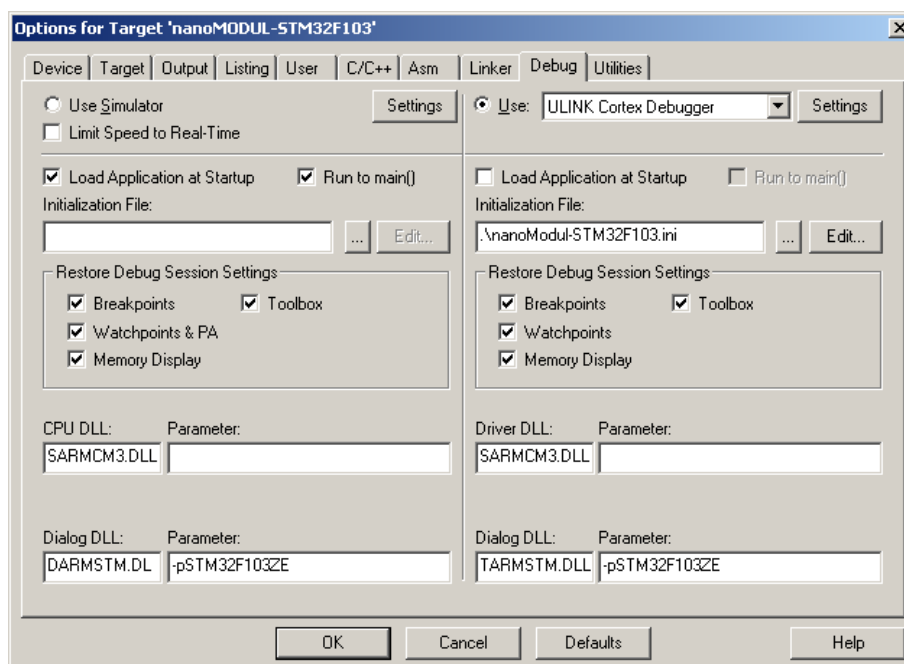
-
- The first button allowing exact control of the program execution is the *Step Into*  button.
The *Step Into* command performs the execution of the command line to which the *Current-Statement Arrow* points. This can be a C command line or a single assembler line, depending on the current display mode. If the command line is a function call, *Step Into* jumps to the C function or subroutine, enabling you to explore the code contained in the accessed subroutine.
 - The *Step Over*  button is next on the debugger toolbar.
The *Step Over* command executes the command line, to which the *Current-Statement Arrow* points. This can be a C command line or a single assembler line, depending on the current display mode. If the command line is a function call, the function will be executed without single stepping into the function.
 - The next button is the *Step Out*  button.
Step Out is used to exit a function you are currently in. *Step Out* is very useful if you find yourself in a function you are not interested in and need to return quickly to your intended function.
 - The last button on the debugger toolbar performs the *Run to Cursor line*  command.
The *Run to Cursor line* command executes the program to the current cursor position within the code window. This allows use of the cursor line as a temporary breakpoint.

4.2 Debugging Modes

If You have still Debug Session active, please stop it by clicking again the debugger icon  on the μ Vision3 toolbar or selecting again Debug / Start/Stop Debug Session from the main menu bar. Be sure that nanoMODUL-STM32F103 is selected in Project Workspace:



The μ Vision3 Debugger offers two operating modes that can be selected in the **Project / Options for Target 'nanoMODUL-STM32F103'** dialog under Tab 'Debug':



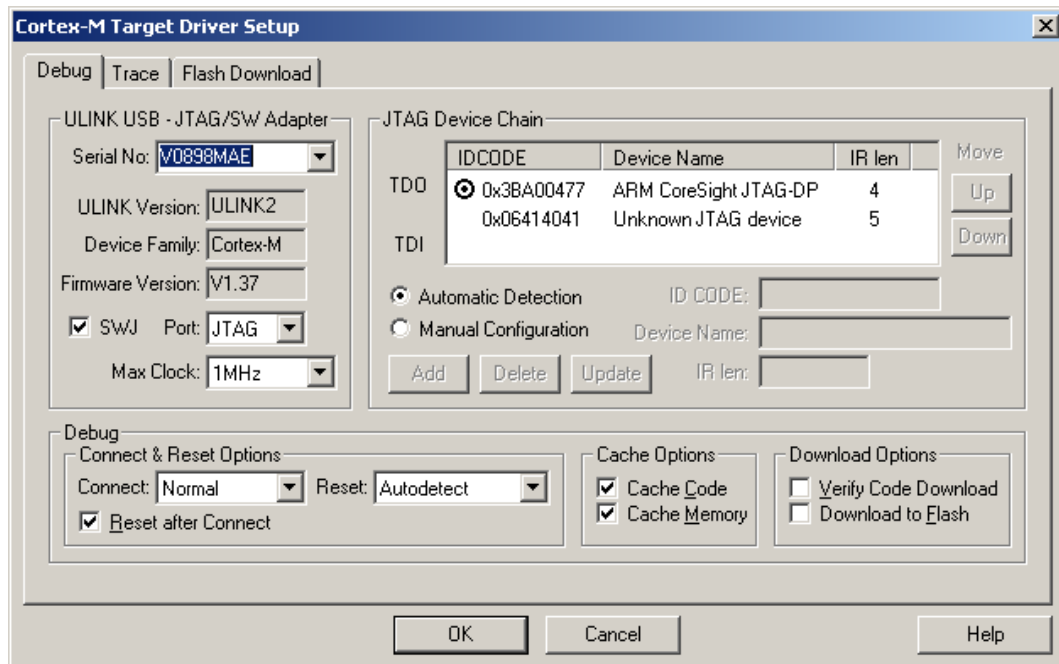
- The **Simulator** allows PC-based simulation of most features of the STM32F103 microcontroller without actually having target hardware. You can test and debug your embedded application before the hardware is ready. μ Vision3 simulates a wide variety of peripherals, including external

I/O and timers. The peripheral set is configured when you select a CPU from the device database for your target.

- USB-JTAG debugging interface adapters such as the **Keil ULINK** allow target-based debugging. With the ULINK interface you may connect directly to the target hardware using the JTAG interface. Debugging on the target hardware also enables the testing of peripheral components of the application and real-time program execution.

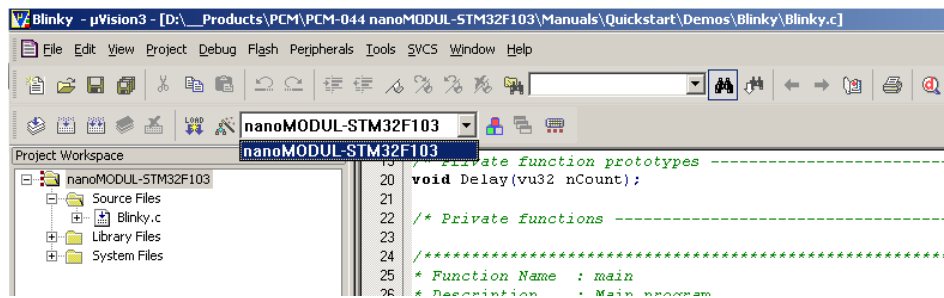
The **Blinky** demo in this section utilizes the **ULINK Cortex Debugger** environment.



- The **ULINK Cortex Debugger** settings can be viewed by selecting the *Settings* button:



4.3 Starting the Debugger

- Open the **Blinky** project as described in section 3.3
- In the **Select Target** pull-down menu select the *nanoMODUL-STM32F103* target.



- To start the ARM/µVision3 debug environment, click on the debugger icon  on the µVision3 toolbar.
- Click on the **Run**  icon and the program will run.

Successful execution of the program will blink LED D1 on the nanoMODUL.

5 Internal Flash Programming

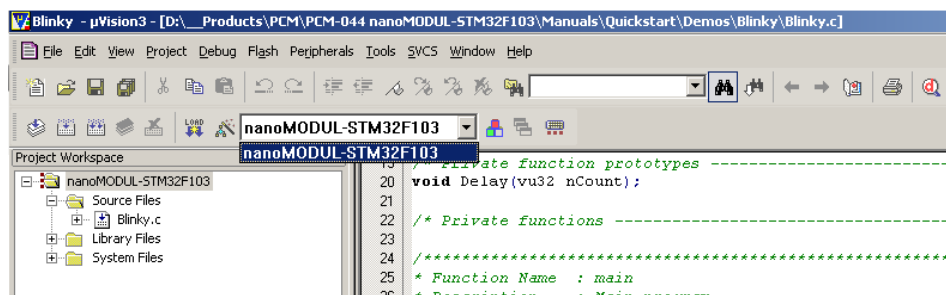
What you will learn with this example:


- downloading example user code to internal Flash memory using ARM/ μ Vision3 tools

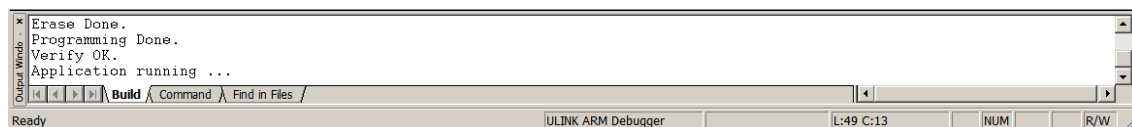
5.1 Loading the Blinky Application to internal Flash

This section shows how to download the *Blinky* executable into internal Flash of nanoMODUL

- Open the **Blinky** project as described in section 3.3
- In the **Select Target** pull-down menu be sure that the *nanoMODUL-STM32F103* target is selected.



- Download the code into Flash memory by either selecting the *Download to Flash Memory* icon  on the build toolbar or in the main menu bar select *Flash / Download*.
- The individual steps of the Flash download procedure can be viewed at the bottom of the μ Vision3 **Output Window - Build** tab.
- Wait until the programming is complete. This is indicated by the "**Verify OK**" message. The download utility will perform a reset and code will execute without further user interaction.



Successful execution of the program will blink LED D1 on nanoMODUL.

6 Getting More Involved

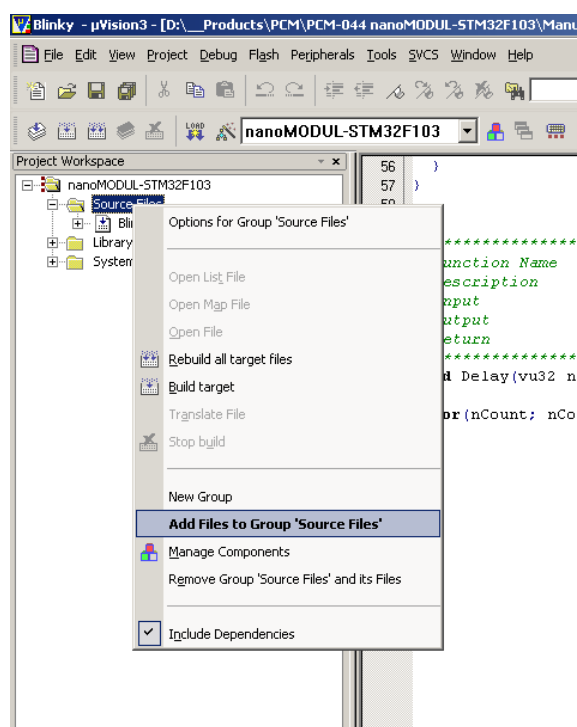
What you will learn within this example:


- how to create a new project with the **Blinky** project as template

6.1 Creating a New Project

For ease of creating a new project for the nanoMODUL-STM32F103 it is recommended that the given **Blinky** project is used as a template. The **Blinky** project already has the target, linker, compiler, debugger, and startup code correctly configured for the nanoMODUL-STM32F103 target. Here are some suggestions for getting started:

- Create a new directory for your project and copy the contents of **Blinky** into the new directory.
- From the **Project Workspace** you can manage components of your project and add or remove source files, add code libraries, etc... For example, add source code from the **Project Workspace** window by right-clicking on the *Source Code* folder and selecting *Add Files to Group 'Source Code'*.



- Advanced users can modify the target, compiler and linker settings from the Options for Target area by selecting the Options for Target icon  on the build toolbar or from the main toolbar menu select Project / Options for the Target 'nanoMODUL-STM32F103'.

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