

Creating Applications with the KeilTM C51 C Compiler

nAN-15

Application Note v1.1

Key words

- Development using nRFgo SDK
- Setup of Keil compiler
- Getting started with your first application
- Debugging your application with Keil compiler
- Developing with nRF devices



Contents

1	Introduction	3
2	Theory of operation	4
2.1	Prerequisites to the tutorial	
2.2	Organizing the nRFgo SDK	
3	Developing with nRFgo SDK	
3.1	Step 1: Set up your first Keil project	
3.2	Step 2: Your first application	16
3.3	Step 3: Including files	21
3.4	Step 4: Debug your project	
4	Conclusions	34
	Appendix A - References	35
	Appendix B - Troubleshooting	



1 Introduction

This application note will help you start developing with an nRF device using the nRFgo development platform. This application note contains a step-by-step guide on how to set up your first project in a Keil compiler and explains how to debug using nRFprobe.

The target device for this tutorial is the nRF24LE1, which is a single chip solution for wireless applications. The nRF24LE1 features an ultra low power nRF24L01+ 2.4 GHz transceiver core with an 8051 flash microcontroller, ADC and rich set of digital interfaces.

This tutorial can also be used as reference when developing with other nRF devices with an 8051 microcontroller. In such cases you will need to switch to different nRF devices as shown in <u>Figure 4. on page 7</u>. The setup of the compiler, programming the device and debugger are all carried out in the same way as for the nRF24LE1.



2 Theory of operation

The nRFgo Software Development Kit (SDK) with the Keil C51 C compiler provides a flexible and simple way to develop using an nRF device. By following this guide you will acquire basic knowledge about the Keil compiler and nRFgo SDK so you can create, debug and program your first application.

2.1 Prerequisites to the tutorial

We recommend that you consult the documentation for the nRFgo SDK, nRFprobe and user documentation for the nRFgo Starter Kit while you carry out related development work.

Necessary software and hardware for this application note are listed below in the order you should install them:

Software

- Keil C51 (Version 9.00 or newer)
- nRFgo Studio (Version 1.4 or newer)
- nRFgo SDK (Version 2.2 or newer)
- nRFprobe (Version 1.2.0.5585 or newer)

Hardware

- nRFgo Starter Kit (nRF6700)
- nRFgo Development Kit for nRF24LE1 (nRF24LE1-F16Qxx-DK)

The following steps show how you install the software:

- 1. All nRFgo software is included in the nRFgo kits, but you must download the Keil compiler separately from <u>www.keil.com</u>. For the purposes of this application note the evaluation version of the Keil compiler is sufficient.
- 2. Make sure to download and install the latest software before you follow the instructions in this application note.
- 3. After installing all the software listed above, you must connect the nRFgo Motherboards to the computer and wait for the driver to install.
- 4. Thereafter, start up nRFgo Studio and update the firmware if prompted. Exit the nRFgo Studio application before you continue.
- 5. You can use nRFgo Studio to program nRFgo modules or your own prototypes through the ISP header. For development, use the Keil compiler along with the nRFprobe debugger.

2.2 Organizing the nRFgo SDK

The nRFgo SDK is built up in a tree structure. Here is a short description of the most important folders in the tree structure:

\Docs

This is the documentation for the SDK. It is mandatory reading in order to understand how a project is built up. It contains a description of the functionality for the software modules included in the SDK and of how they interact.

\Precompiled files

This folder includes the precompiled HEX files for the example projects. If you are using the evaluation version of the Keil compiler you will not be able to compile all the projects due to a code size limit, but you can still run the examples by programming the HEX files with nRFgo Studio.



\Source code\gazell

Gazell is a link and pairing library for wireless applications.

\Source code\hal

The Hardware Abstraction Layer (HAL) contains general interface functions to quickly start developing with the hardware modules embedded in an nRF chip. You will use some or all of these files for any project you develop. The path to these files needs to be included in the project.

\Source code\lib

The libraries interface with the HAL to provide more specific functionality. An example of this is the RF test library that can be used to set up different RF test modes.

\Source code\projects

The project folders contain the example projects included in the SDK. This is where you normally will put your own project.

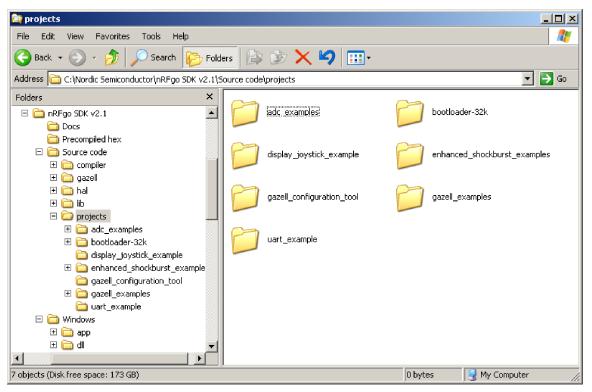


Figure 1. Folder structure for nRFgo SDK



3 Developing with nRFgo SDK

You can break down the development process for nRFgo SDK into four steps. These steps, listed below, range from the setup of the Keil compiler to the debugging of your first project:

- 1. Set up your first Keil project
- 2. Your first application
- 3. Including files
- 4. Debug your project

3.1 Step 1: Set up your first Keil project

Before writing any lines of code you need to create a new project in which you configure the Keil compiler to use the specific nRF device and include the paths that you need in the application.

- 1. Startup Keil uVision from the **Start** menu in Windows.
- 2. Thereafter, select Project, New uVision Project from Keil's menu.
- You are prompted to specify where you want to save your new project. In this case you want to make a new project in *Source code\projects* and you should call the project "my_first_project". (see project folder encircled in Figure 2.)

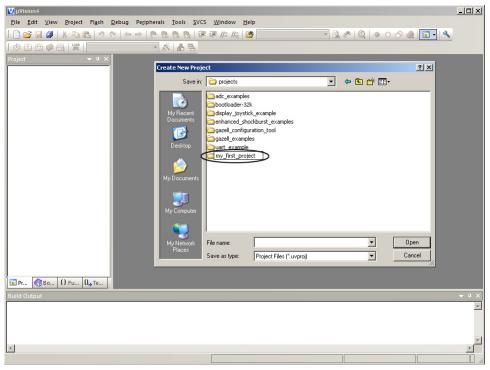


Figure 2. Create a new project



4. Create a new folder in the *Source code\projects* called *"my_first_project"* and then select **Save**. See Figure 3.

Create New Proj	ect			<u>?×</u>
Save jn:	🗀 my_first_project	•	🗢 🗈 💣 🛽	# *
My Recent Documents				
Desktop My Documents				
My Computer				
My Network Places	File <u>n</u> ame: <u>my_first_r</u> Save as <u>type</u> : Project F	project iles (*.uvproj)	•	<u>Save</u> Cancel

Figure 3. Naming the project

Select Device for Target 'Target 1'		×
CPU		
Vendor: Nordic Semiconductor Device: nRF24LE1 Toolset: C51	 Use Extended Linker (LX51) instead of BL51 Use Extended Assembler (AX51) instead of A51 	
Data base	Description:	
MXIC Myson Technology Nordic Semiconductor nRF24E1 nRF24E1 nRF24E1 nRF24E1 nRF24E1 nRF24E1 nRF24E1 nRF1U1P-F16 nRFLU1P-F32 Nvvoton NXP (founded by Philips) OKI	2.4GHz ISM band radio with emhanced 8051 MCU, up to 2Mbps on air data rate, 1.9 to 3.6V supply range, 16-32-bit multiplication-division co-processor (MDU), 16-82-bit multiplication-division co-processor (MDU), 16-82-bit multiplication-division co-processor (MDU), 18-82-bit MULTIPLICATION (MDU), 18-82-bit MULTIPLICATION (MDU), 19-82-bit MULTIPLICATION (MDU), 19-82-bit MULTIPLICATION (MDU), 19-82-bit MULTIPLICATION (MDU), 19-82-bit MULTIPLICATION (MDU), 19-82-bit MULTIPLICATION (MDU), 19-92-bit MULTIPLICATI	•
(OK Cancel	Help

Figure 4. Selecting the correct device

- 5. Choose the device you want to start developing with (see device encircled in Figure 4.). For your project you will use the nRF24LE1. If you are using the full version of Keil uVision PK51 you can also choose to use the extended linker/assembler. However for this project you will use the evaluation version of the Keil compiler.
- 6. Select **OK**.



7. Select **No** when prompted to copy the standard startup code to the project folder. (The startup code can be added later if required.)





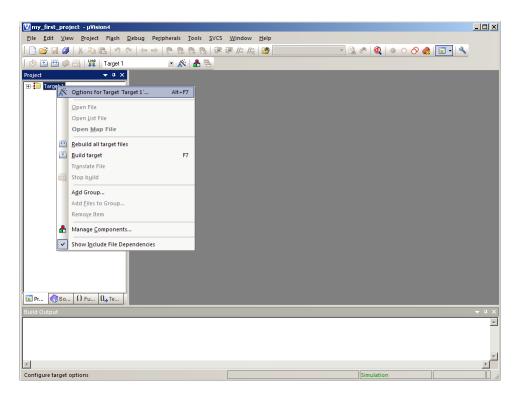


Figure 6. Main window

8. You need to configure the project before you can include files and start to write code. Right-click on "Target 1" in the Project tree view and choose **Options for Target** from the context menu.



9. <u>Figure 7.</u> shows a screenshot of the "Output" tab, where you set up Keil for your project.

Options for Target 'Target 1'	×
Device Targe Output Disting User C51 A51 BL51 Locate BL51 Misc Debug Utilities	
Select Folder for Objects Name of Executable: my_first_project	
Create Executable: .\my_first_project	
Debug Information	
Treate HEX File HEX Format: HEX-80	
🔿 Create Library: .\my_first_project.LIB	
OK Cancel Defaults Help	

Figure 7. Check "Create HEX file"

- 10. Create a HEX file in the "Output" tab (see Figure 7.) to later program the nRF24LE1.
- 11. Next activate the "C51" tab and include some folders where you can later find the files you need for your application.

Options for Target 'Target 1'					
Device Target Output Listing User C51 A51 BL51 Locate BL51 Misc Debug Utilities					
Preprocessor Symbols Define: Undefine: Code Optimization Level: 8: Reuse Common Entry Code Emphasis: Favor speed Global Register Coloring Linker Code Packing (max. AJMP / AGALL)					
Don't use absolute register accesses Enable ANSI integer promotion rules					
Include Paths Misc Controls					
Compiler control string					
OK Cancel Defaults Help					

Figure 8. Selecting to include paths



Folder Setup			<u>?×</u>
Setup Compiler Include Paths:			<u> </u>
			New (Insert)
Г Г	ОК	Cancel	
L	UK	Lancel	

Figure 9. Selecting folders to include

- 12. By default no paths are included, so you need to include four paths for this project, from the "Folder setup" dialog. See <u>Figure 9</u>.
- 13. Use the function buttons to include all the paths as displayed in the screenshots in Figure 10. on page 11.



14. Figure 10. show the paths that contain the files needed for this project.

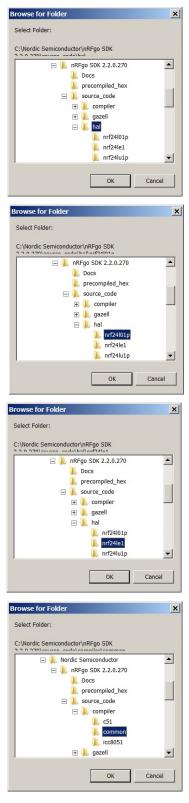


Figure 10. Browse to the folders to include, and repeat for four folders



15. After choosing the folders you want to include, confirm your choice by selecting **OK** in the "Browse for folder" dialog. See <u>Figure 10. on page 11.</u>

Folder Setup		? ×
Setup Compiler Include Paths:	<u>ت ×</u> +	¢
\\.hal \\.hal\nrf24l01p \\.hal\nrf24le1 \\compiler\common		
	OK Cancel	

Figure 11. Confirm by pressing OK

- 16. The folders you now have included contain all the HAL files that you will use later to configure the various hardware modules inside the nRF24LE1. If you are developing with another device, you will need to include the hardware specific files for that device. All devices supported by the HAL have their own folders. Select **OK** in the "Folder setup" dialog as shown in Figure 11. when done.
- 17. Required paths are now included in your project. See Figure 12.

Options for Target 'Target 1'				
Device Target	el Output Listing User C51 A51 BL51 Locate BL51 Misc Debug Utilities			
<u>D</u> efine: U <u>n</u> define:				
<u>E</u> mphasis:	ization ization Warnings: Warninglevel 2 8: Reuse Common Entry Code Bits to round for float compare: 3 Favor speed Global Register Coloring Interrupt vectors at address: 0x0000 Linker Code Packing (max. AJMP / ACALL) Keep variables in order Enable ANSI integer promotion rules			
Include Paths <u>M</u> isc Controls Compiler control string	\\hal\\\hal\.nrf24l01p:\\.\hal\.nrf24le1;\\compiler\common			
	OK Cancel Defaults Help			

Figure 12. Required paths now included in the project



- 18. If you are using the extended linker of Keil you have the option to write 'REMOVEUNUSED' in the "Misc controls" field in This will reduce code space by removing unused functions during compilation.
- 19. When you compile a project with functions that are not used, a related warning message may appear. To disable this warning you can write '15, 16' in the "Disable warning numbers" field. See encircled area in Figure 13.
- 20. Now set up the debugger to use with the Keil compiler. Take care to select the nRFprobe Keil driver as shown in Figure 14. on page 14 and Figure 15. on page 15.
- 21. If you cannot find nRFprobe Keil Driver from the list, then make sure you have installed nRFprobe before you continue.

Options for Target 'Target 1'		×
Device Target Output Listing	User C51 A51 BL51 Loca BL51 Misc Debug Utilities	1
<u>Warnings</u> Disable Warning Numbers	a	
use linker control file:		
	<u>Create</u> <u>E</u> rowse <u>E</u> dit	
<u>O</u> verlay		
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Misc		
		-
Linker TO "my_first_project" control RAMSIZE(256)	•	▲ ▼
string ``		
[OK Cancel Defaults	Help
		Пар

Figure 13. Disabling two common warning messages (optional)



Options for Target 'Target 1'	
Device Target Output Listing User C51 A51	BL51 Locate BL51 Mic Debug Uilities
Use Simulator Settings Limit Speed to Real-Time	SettingsSettings
Load Application at Startup Run to main() Initialization File:	Load Application at Startup Run to main() Initialization File: Edit
Restore Debug Session Settings Breakpoints I Toolbox Watchpoints & PA Memory Display	Restore Debug Session Settings Breakpoints Watchpoints Memory Display
CPU DLL: Parameter: S8051.DLL	Driver DLL: Parameter: S8051.DLL
Dialog DLL: Parameter: DP51.DLL -pRF24LE1	Dialog DLL: Parameter: TP51.DLL -pRF24LE1
ОК Са	ncel Defaults Help

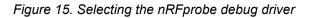
Note: Make sure to check "Use". See the encircled area in the "Debug" tab.

Figure 14. Selecting the nRFprobe debug driver



Options for Target 'Target 1'
Device Target Output Listing User C51 A51 BL51 Locate BL51 Misc Debug Utilities
Configure Flash Menu Command
Use Target Driver for Flash Programming
nRFProbe Keil Driver
Init File: Edit
O Use External Tool for Flash Programming
Command: Infiprog
Arguments: -2 %H -x \$X
E Run Independent
OK Cancel Defaults Help

Note: Make sure to check "Update target before debugging".



22. By selecting the **Settings** button in <u>Figure 15.</u> you can configure the nRFprobe debugger so you, for instance, can program or debug your own hardware. Refer to the documentation for the nRFgo Starter Kit on how to connect your own hardware.

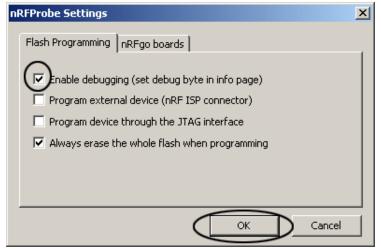


Figure 16. Settings for the nRFprobe driver (optional)



- **Note:** If you want to run the application stand alone, then you need to uncheck "Enable debugging" (see example of this box checked in Figure 16. on page 15) in the "nRFProbe Settings" dialog before programming the device.
- 23. Click the **OK** button in the "nRFProbe settings" dialog to use the changes you have made to the project, and save the project from the **File** menu by selecting **Save All.**
- 24. You can right-click in the Project tree view to add and also rename some of the folders to give them more appropriate names. See encircled area in Figure 17. for illustration.

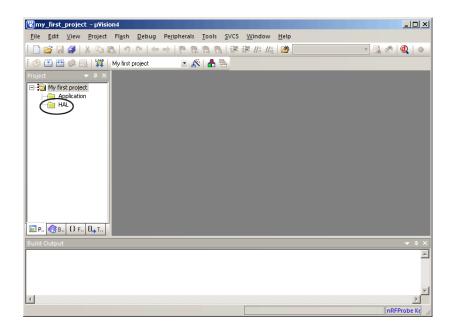


Figure 17. Project set up and ready for source code

You have now completed Step 1 of the tutorial, and the project is ready for you to start writing your first application. This step is outlined in section 3.2 on page 16.

3.2 Step 2: Your first application

The project is now configured, and you can start writing the first few lines of application code in order to compile and program the nRF24LE1. This section explains how you do so.

- 1. Before you can start writing code you must add an empty source file called **main.c** in the project folder.
- 2. From the Project tree view's context menu, select **Add files to group "application"...** as shown in Figure 18. on page 17 The "Add files to group 'application" dialog appears.



3.

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		Tr <u>a</u> nslate File	
		Stop b <u>u</u> ild	
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Add Files to current	Proje	ect Group	nRFProbe Ke

Figure 18. Adding the first file to the project

Add Files to G	roup 'Application'						? ×		
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my_first_project.plg									
my_first_p	roject.uvproj								
🗐 main.c									
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File <u>n</u> ame:	main.c					Ado			
Files of <u>type</u> :	All files (*.*)			-		Clos	•		
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							11		

Figure 19. Creating a new file called main.c

4. Create a text file by right-clicking in the folder view and choosing **New text document** and renaming the created file to main.c. See <u>Figure 19</u>. This file will work as an entry point for your application.



5. Double-click on the main.c in the Project tree view to edit the file.

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Figure 20. Main window with empty main.c file

- 6. Add the empty main.c to the project, write some lines of code and compile it.
- 7. You can copy Code example 1 from <u>Figure 21.</u> into the space for writing code below the main.c tab for your first application. See <u>Figure 22. on page 19</u>.
- 8. The example code will continuously toggle Port 0 pin 0. If Port 0 pin 0 doesn't toggle on your development kit module, then you should check the header on the module is not connected to the 32 kHz XO.

```
/* My first application */
#include <Nordic\reg24le1.h>
// Main routine
void main()
{
    // Set P0 as output
    PODIR = 0x00;
    while(1)
    {
        // Toggle a GPI0
        P00 = !P00;
    }
}
```

Figure 21. Code example 1



9. After writing the code example into the main.c you can compile the program by selecting **Rebuild**. See Figure 22.

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Project Rebuild main.c	▼ ×
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	-
Build Output	▼ # ×
compiling main.c linking	_
Program Size: data=9.0 xdata=0 code=22 creating hex file from "my_first_project" "my first project" - 0 Error(s), 0 Warning(s).	_
Rebuild all target files	nRFProbe Ke 🏼 🎢

Figure 22. Example code with build of HEX file (shortcut F7)

- 10. After compiling the code you can program the nRF24LE1 module plugged into the nRFgo Motherboard by selecting **Download**. See encircled area in Figure 23. on page 20.
- 11. If you want to run the application without the debugger you need to deselect "Enable Debugger" (see Figure 16. on page 15).
- 12. The first time you attempt to program an nRFgo module you will be prompted about which nRFgo Motherboard you want to use. See <u>Figure 24. on page 20</u>. Make sure that an nRFgo Motherboard and an nRF24LE1 module are plugged into the computer.



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Project	▼ X					
Download code to flash memory						
main.c 03 // Register file for the nRF24LE1 minc 04 #include <nordic\reg24le1.h></nordic\reg24le1.h>						
HAL 05 06 // Main routine 07 void main() 08 (09 // Set PO as output 10 PDPDP 0 00 00 00 00 00 00 00 00 00 00 00 00						
10 PODIR = 0x00; 11 while(1) 12 (
13 // Toggle a GPI0 14 P00 = !P00; 15 > 16 >						
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compiling main.c linking Program Size: data=9.0 xdata=0 code=22 creating hex file from "my_first_project" "my first project" - 0 Error(s), 0 Warning(s).						
The second secon	▼ 					
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Figure 23. Programming the nRFLE1 module from Keil

13. The board you use depends on the number of boards connected to the computer. You can have several projects open at the same time and program boards individually. Boards can be programmed from their own project. Each nRFgo Motherboard has a small status LED that indicates the board number.



Figure 24. Selecting which nRFgo board to use for your project



You have now successfully compiled and programmed your first application, and the next step outlined in <u>section 3.3</u> will help you include files to make more complex applications.

3.3 Step 3: Including files

Writing source code from scratch can be time consuming, since you will have to study in detail all the registers in the datasheet to set up the device. To shorten development time there are ready-made software modules that can be included and re-used for several projects. Each module contains the functionality for a specific hardware module.

For this project you want to use the ADC within the nRF24LE1, so you will include the HAL for the ADC.

1. Select the HAL folder in the Project tree view and activate the context menu by right-clicking. Select **Add Files to Group 'HAL'...** from the context menu. See <u>Figure 25</u>.

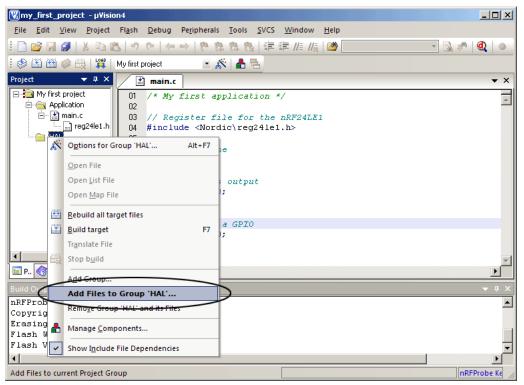


Figure 25. Including the HAL for the ADC



2. The HAL can easily be included by right-clicking on the HAL folder in the Project tree view and then selecting "Add the hal_adc.c to the project" as shown in Figure 25. on page 21. See Figure 26.

Add Files to Group 'HAL'	<u>? ×</u>
Look in: 🔁 nrf24le1 💽 🗢 🖻 📸 🖽 -	
<pre>hal_adc.c hal_aes.c hal_aes.c hal_ancmp.c hal_flash.c hal_nrf_hw.c hal_pof.c hal_rng.c hal_rtc.c hal_spi.c hal_wdog.c hal_wdog.c</pre>	
File name: hal_adc.c Add Files of type: C Source file (*.c) Close	
	11.

Figure 26. Browse to \Source code\hal\nrf24le1 and include hal_adc.c

3. The HAL for the ADC is now included in the project, and to use the functionality of the HAL you can include it in the main.c by writing #include <hal_adc.h>. See encircled area in Figure 26.



Wimy first project - μVision4	
<u>File Edit V</u> iew <u>P</u> roject Fl <u>a</u> sh <u>D</u> ebug Peripherals <u>T</u> ools <u>S</u> VCS <u>W</u> indow <u>H</u> elp	
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reg24le1.h 04 #include <hal_adc.h></hal_adc.h>	
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X	Þ
Rebuild all target files nRF	Probe Ke 🏑

Figure 27. Rebuilding target

4. After including the file in the project you can **Rebuild** the application. See Figure 27. You can use a project with an empty main routine. The compiled code space is now 191 bytes, the reason for this is that you have included all the functionality of the ADC to your project, but not used it yet. If you are using the extended linker, then unused functions are not compiled and there is no increase in code size.



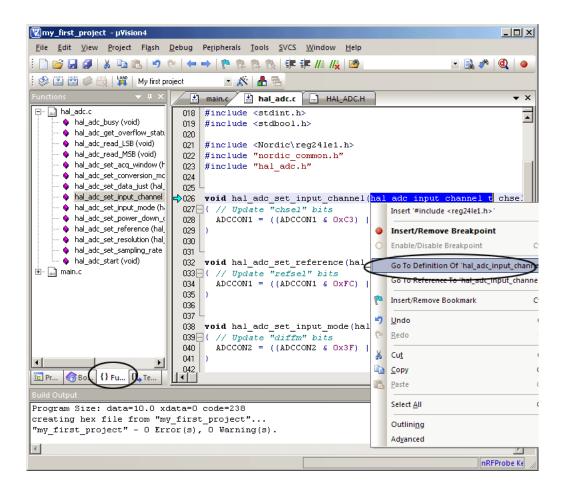


Figure 28. Available functionality of the HAL ADC with source code

- 5. Optionally you can browse the functions in the hal_adc.c by selecting the "Function tab". See the encircled area to the left in Figure 28. Click on one of the functions to see the argument for the functions and the source code for it. All parameters for the functions are enumerators that can be used in the function call.
- 6. You can also list up all available enumerators by using the **Go To Definition of** menu option (see <u>Figure 28.</u>) for each function call (see <u>Figure 29. on page 25</u>).



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Figure 29. Available parameters used as input for specific function

7. By using the functions listed in the hal_adc.c you can easily build an application that can initialize and read an analog input, and there is no need to study the datasheet in detail. Similar HAL are available for all modules inside the nRF24LE1.



8. For now you can copy the content from Figure 30. (Code example 2) below into your the main.c.

```
/* My second application */
#include <Nordic\reg24le1.h>
#include <hal_adc.h>
void main()
{
  // Init a variable for the ADC measurement
 uint8 t adc measurement = 0;
  // Configure ADC
 hal_adc_set_input_channel(HAL_ADC_INP_AIN0);
 hal adc set reference (HAL ADC REF VDD);
 hal adc set input mode (HAL ADC SINGLE);
 hal adc set conversion mode (HAL ADC SINGLE STEP);
 hal adc set resolution (HAL ADC RES 8BIT);
 hal adc set data just (HAL ADC JUST RIGHT);
 while(1)
  {
   hal adc start(); // Start the ADC
   while( hal adc busy() ) // Wait for the ADC to finish a
conversion
   adc measurement = hal adc read LSB(); // Read the ADC result
  }
}
```

Figure 30. Code example 2



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24 adc_measurement = hal_adc_read_LSB(); // Read the ADC real 25 > 26 > ▼ ▼					
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Rebuild all target files nRFProbe Ke					

Figure 31. Creating an application that measures an analog input by using the HAL

- 9. After pasting the code into main.c, as shown in <u>Figure 31.</u>, use the **Rebuild** function to rebuild the target and verify that it builds successfully.
- 10. You have now successfully included and used the first HAL module. The HAL provides an easy way to start using a specific functionality such as the ADC. Your next step will be to start debugging the project.



3.4 Step 4: Debug your project

An important feature of the Keil compiler is the possibility it gives to debug the application by using the nRFprobe debugger.

1. To start the debug session select the **Start Debug Session** button. See encircled area in <u>Figure</u> <u>32. on page 28.</u>

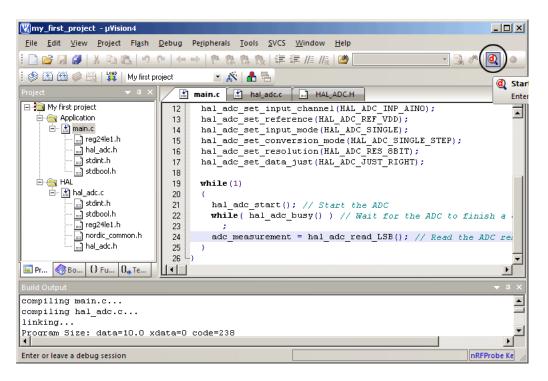


Figure 32. Start debug session (shortcut Ctrl + F5)

- 2. In debug mode you have access to the disassembly window, SFR registers and all variables in the project. You can run code in real time, set breakpoints, single step or run to cursor.
- 3. To simplify the project window, you can exit the dissassembly window for the purposes of this application note. (See the encircled area in Figure 33. on page 29 for how to exit the window. You can open it again later from the **View** menu at the top.) Also select the "Project" tab which is shown on Figure 33. on page 29 to see all project files.



Winy_first_project - µVision4 File Edit View Project Flash Image: State of the state of th	Disassembly C: 0x0000 020001 LJMF 6: void main() 7: (8: // Init a varia 9: uint8_t adc_mea 10: 12 hal_adc_set_input_c 13 hal_adc_set_referen 14 hal_adc_set_referen 14 hal_adc_set_resolut 15 hal_adc_set_resolut 16 hal_adc_set_resolut 17 hal_adc_set_data_ju 18 19 while(1)	C:00D1 C:00D1 ble for the ADC m surement = 0; HAL_ADC.H hannel(HAL_ADC_IN ce(HAL_ADC_REF_VD ode(HAL_ADC_SINGL ion_mode(HAL_ADC ion(HAL_ADC_RES_8	<pre>measurement P_AINO); D); E); SINGLE_STEP); BIT);</pre>	
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Figure 33. Default debug window



🕅 my_first_project - µVision4				
File Edit View Project Flash Debug Peripherals Tools SVCS Window Help				
Project V 4 X main.c hal_adc.c HAL_ADC.H				
<pre> My first project 11 // Configure ADC hal_adc_set_input_channel(HAL_ADC_INP_AINO); hal_adc_set_reference(HAL_ADC_REF_VDD); hal_adc_set_input_mode(HAL_ADC_SINGLE); hal_adc_set_conversion_mode(HAL_ADC_SINGLE_STEP); hal_adc_set_resolution(HAL_ADC_ESE_6BIT); hal_adc_set_data_just(HAL_ADC_JUST_RIGHT); hal_adc_set_data_just(HAL_ADC_JUST_RIGHT); hal_adc_start(); // Start the ADC while(1) 20 { hal_adc_start(); // Start the ADC while(hal_adc_busy()) // Wait for the ADC to finish a conv ; adc_measurement = hal_adc_read_LSB(); // Read the ADC result</pre>				
E Project Registers				
Command V I X Locals V X				
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>				
ASM ASSIGN BreakDisable BreakEnable BreakKill 🚱 Call Stack 🐺 Locals 🐺 Watch 1 🔲 Memory 1				
nRFProbe Ke				

Figure 34. Simple debug window (disassembly closed)



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Image: HAL 14 hal_adc_set_input_mode(HAL_ADC_SINGLE); Image: HAL 15 hal_adc set_conversion mode(HAL_ADC_SINGLE);	Show Disassembly at C:0x000
16 hal_adc_set_resolution(HAL_ADC_RES_8BIT);	Set Program Counter
17 hal_adc_set_data_just(HAL_ADC_JUST_RIGHT);	Run to Cursor line
19 while (1)	Insert/Remove Breakpoi
20 (21 hal adc start(); // Start the ADC	Enable/Disable Breakpoint
22 while (hal_adc_busy()) // Wait for the A 23 ;	Go To Definition Of ';'
24 adc_measurement = hal_adc_read_LSB(); //	Go To Reference To ';'
	Add ';' to
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Insert or remove a breakpoint at the current line	Select All

Figure 35. Set breakpoints (shortcut F9)

4. You can set breakpoints in the application by double-clicking on a code line, as illustrated in <u>Figure 35.</u> or right-click and select **Insert/Remove breakpoint**.

: 💦 🗐 🔇	() } } } } } } } } } } } } } } } } } } }				
Figure 36. Debug toolbar					

•	•

- 5. The debug toolbar can be used to reset or run the code. You can also run to line, single step or step into code during debugging. For each step you can read out variables and register values. Move cursor over the buttons to acquaint yourself with the purpose of the debug buttons.
- 6. Select the **Run Application** function button to run the code. See <u>Figure 36. on page 31</u>. The application will then run until it encounters a breakpoint or stops.



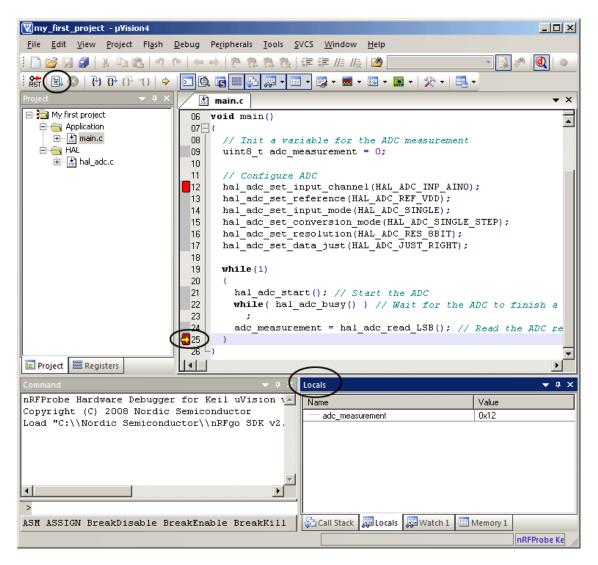


Figure 37. Running to breakpoint and reading out local variables

7. Each time the program stops, a yellow arrow (see encircled area around yellow arrow in <u>Figure</u> <u>37</u>.) where the program currently is running, and local variables are read out in the "Locals" window to the bottom right of the Keil window.



8. In this example you can step through the loop and see the ADC measurement changes as you change the input, for instance place a finger on the analog input 0 to change reading.

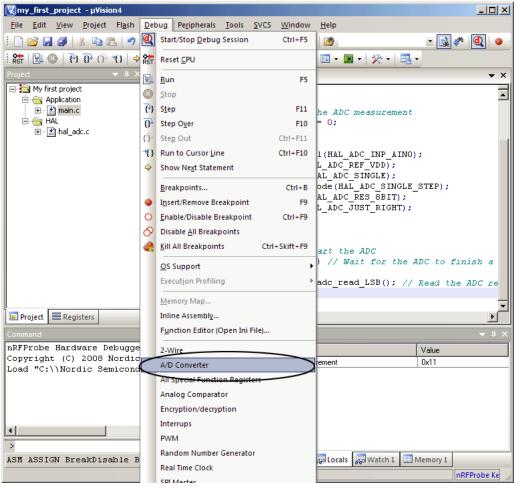


Figure 38. Debugging the A/D converter hardware module directly

- 9. You can also view the hardware module embedded in the nRF24LE1. See encircled area in Figure 38. for the relevant menu selection.
- 10. If you want to change configurations directly during run time without re-compiling, this can save time during prototype development to test different configurations.

Analog/Digital Converter		×			
ADCCON1	ADCCON2	ADCCON3			
Power Up	Continuous conv.	Right justified			
Conversion in Progress	Select mode:				
Input Channel Select:	Single Ended 🗾	ABC resolution			
AIN00	Rate: 0 us 💌	8 bits			
Reference Select:	Acquisition window:				
VDD 💌	0.75 us 💌	Overflow Underflow Underflow or overflow			
ADCDATH: 0x00 ADCATL: 0x11					

Figure 39. Screenshot showing how to modify the A/D converter configuration during debugging

You can now debug your own project and you have completed the tutorial. For more example projects make sure to view the projects included in the nRFgo SDK.



4 Conclusions

The nRFgo SDK with the Keil compiler provides an easy-to-use environment for programming and developing nRF devices. The nRFgo SDK contains the HAL, libraries and an RF protocol that can be used as-is or as a reference when writing your own applications.

Some of the advantages of using the nRFgo SDK are:

- · Ready made software modules that can be re-used for several projects
- Proven and tested code
- Simple functions that are easy to use
- Shorter development time
- Flexible development environment



Appendix A - References

Useful reference projects and documentation during development include:

- Documentation for nRFgo SDK •
- nRFgo SDK example projects •
- Documentation for nRFgo Starter KitDocumentation for nRFprobe



Appendix B - Troubleshooting

The debugging is not working. What has happened?

• If nRFgo Studio is running at the time you are debugging, then debugging will not work.

I am not able to flash the nRF24LE1. What has happened?

• If the jumper on P7 on the Motherboard is missing you will not be able to flash the nRF24LE1.

The UART functionality is not working. What has happened?

• The GPIOs used during debugging cannot be used for other purposes during debugging, so any functionality such as UART will not work if the same pins are used for debugging.

The debugger is not working. What has happened?

• The debugger must be set up correctly to work, so make sure that the nRFprobe driver is selected for both Debug and Utilities in the 'Options for Target' menu in Keil. Also make sure to program the nRF24LE1 before debugging.

How can I run the code without a debugger?

• Make sure to disable the debug bit if you want to run the code without debugger, and vice versa.

Note: The debug bit is set if the project file is moved.

Nothing seems to work. What has happened?

- Check the supply voltage (in nRFgo Studio) for the board if nothing seems to work.
- Make sure that you have the latest development software from http://www.nordicsemi.com/update/ index.php
- Run nRFgo Studio and make sure that the Motherboard is using the latest firmware. You will be prompted to update the firmware if it is outdated.

I am having difficulty debugging in power-down mode. What has happened?

• It is not possible to debug in power down.

I am having difficulty using my GPIO as ADC. What has happened?

• A GPIO cannot be used as ADC if it's already used as UART, SPI, I2C, or something similar.

The error message "Error: Flash Download failed - C:\path\to\keil\BIN\nrfkeil515d.dll" appeared while I was trying to download the program to the Motherboard. What has happened?

If you encounter "Error: Flash Download failed - C:\path\to\keil\BIN\nrfkeil515d.dll" while trying to download your program to the Motherboard, please check your compiler settings. From the menu, select **Project**, **Options for project**, then verify that the "nRFProbe Keil Driver" is selected from the "Utilities" and "Debug" tab.



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Revision History

Date	Version	Description
June 2011	1.1	Updated application note to reflect upgrade to SDK v. 2.2 and to reflect new convention for application note codes.
August 2010	1.0	