## Start a New Project with Keil MDK-ARM Version 5 and ST Micro Nucleo-F446RE

This tutorial is intended for starting a new project to develop software with ST Micro Nucleo-F446RE board (with **STM32F446RE MCU**) using Keil Microcontroller Development Kit for ARM (MDK-ARM) version 5.24a.



## Create a New Project in Keil MDK v5.24a

- 1. Launch Keil uVision IDE by double clicking on the icon
- 2. From menu, select Project>New uVision Project...

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3. In the "Create New Project" dialog box, browse to a folder location where you would like to create your project folder, click "New folder".

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4. Type in a folder name, for example, we chose "blinky" for the folder name here, then click the "Open" button. This will create a folder named "blinky" to hold all the files for the new project. It will also take you inside that folder.

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5. While in the project folder, type "blinky" in the File name field and click "Save" button. This creates a project with the project named "blinky". Although we used the same name for the project folder and the project, they do not have to be identical.

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6. The Project Wizard will prompt you to select the device type for the project target device. If you already installed the device software pack for STM32F446, skip to step 10. If you have not installed the device software pack for STM32F446 yet, this will be the time to do so. Click on the Pack Installer button to launch the software pack installation.



7. Select "Devices" tab and drill down to find "STM32F446", click on that device name and "Keil::STM32F4xx\_DFP" will appear on the right panel "Packs" tab. In the "Action" column, click on the "Install" button. The software pack will be downloaded, built, and installed. This may take some time. If ARM::CMSIS and Keil::ARM\_Compiler have update available (the Action has a yellow diamond with Update), click them.

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🗉 🍕 STM32F3 Series	70 Devices	ARM::CMSIS-RTOS_Validation	📀 Install	CMSIS-RTOS Validation
STM32F4 Series	200 Devices	ARM::mbedClient	📀 Install	ARM mbed Client for Cortex-
🖶 🔧 STM32F401	20 Devices	ARM::mbedTLS	📀 Install	ARM mbed Cryptographic an
± 🥙 STM32F405	5 Devices	ARM::minar	🚸 Install	mbed OS Scheduler for Corte
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😠 🕫 STM32F410	10 Devices	Keil::ARM_Compiler	🚸 Update	Beil ARM Compiler extension
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F STM32F412	14 Devices	Keil::MDK-Middleware	🚸 Up to date	Middleware for Keil MDK-Pro
⊕ 🥸 STM32F413	14 Devices		🚸 Install	IwIP is a light-weight implem
😠 🕫 STM32F415	4 Devices	Micrium::RTOS	📀 Install	Micrium software componen
E STM32F417	8 Devices		🚸 Install	SharkSSL-Lite is a super small
F STM32F423	7 Devices	RealTimeLogic::SMQ	🚸 Install	Simple Message Queues (SMG
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8. When the installation of the software pack is complete, the "Install" button changes to "Up to date" and the icon turns from grey to green.

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vice /	Summary		Device Specific	2 Packs	STM32F446 selected	
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9. Dismiss the "Pack Installer" window. A confirmation dialog box will pop up. Click "Yes" to close it.



10. You may drill down the device family tree to find "STM32F446RETx". If a large number of devices software packs were installed in your computer, it may take a while to find the device in the family trees. In that case, type in a unique substring of the device name in the "Search" field and the matching devices will appear in the window below. Click select the device type then click "OK" button.

elect Devi	ice for Target Target T	
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	OK Cancel Hel	p

11. Next, the Project Wizard will help you manage the run-time environment. Expand the Software Component selections, check "CMSIS>CORE" and "Device>Startup" then click "OK" button.

	STM32F429I-Discovery	<ul> <li>1.0.0</li> <li>5.0.2</li> <li>1.5.2</li> <li>1.0.0</li> </ul>	STMicroelectronics STM32F429I-Discovery Kit Cortex Microcontroller Software Interface Components CMSIS-CORE for Cortex-M, SC000, SC300, ARMv8-M CMSIS-DSP Library for Cortex-M, SC000, and SC300
		5.0.2 1.5.2	Cortex Microcontroller Software Interface Components CMSIS-CORE for Cortex-M, SC000, SC300, ARMv8-M CMSIS-DSP Library for Cortex-M, SC000, and SC300
		5.0.2 1.5.2	CMSIS-CORE for Cortex-M, SC000, SC300, ARMv8-M CMSIS-DSP Library for Cortex-M, SC000, and SC300
		1.5.2	CMSIS-DSP Library for Cortex-M, SC000, and SC300
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RTOS2 (API)     CMSIS Driver			CMSIS-RTOS API for Cortex-M, SC000, and SC300
CMSIS Driver		2.1.2	CMSIS-RTOS API for Cortex-M, SC000, and SC300
			Unified Device Drivers compliant to CMSIS-Driver Specifications
🚸 Compiler	ARM Compiler	1.2.1	Compiler Extensions for ARM Compiler 5 and ARM Compiler 6
CycloneCommon	CycloneCommon	1.7.8	Common Files
CycloneCrypto	CycloneCrypto	1.7.8	Cryptographic Library
🚸 CycloneSSL	CycloneSSL	1.7.8	SSL/TLS Library
CycloneTCP	CycloneTCP	1.7.8	Dual IPv4/IPv6 Stack
Device			Startup, System Setup
		2.6.0	System Startup for STMicroelectronics STM32F4 Series
🐵 🗇 STM32Cube Framework (API)		1.0.0	STM32Cube Framework
E 💠 STM32Cube HAL			STM32F4xx Hardware Abstraction Layer (HAL) Drivers
lidation Output	Description		

12. You should see a project with a target created in the Project pane. If you click the + signs to open the target, you would see the CMSIS and startup codes for the specific device were created in the project.



13. Click "New" button for a new text file in the editing window.



14. Copy the code below into the new text file window. This is a simple program to blink the LD2 (green LED) on the Nucleo-F446RE board.

```
/* use delay loop, 1 sec on 1 sec off
 * default 16 MHz clock
 * LD2 connects to PA5
 */
#include "stm32f4xx.h"
void delayMs(int n);
int main(void) {
   RCC \rightarrow AHB1ENR |= 1;
                            /* enable GPIOA clock */
    GPIOA->MODER &= ~0x00000C00;
                                   /* clear pin mode */
    GPIOA->MODER |= 0x00000400;
                                    /* set pin to output mode */
   while(1) {
                                   /* turn on LED */
        GPIOA -> BSRR = 0 \times 00000020;
        delayMs(500);
        GPIOA->BSRR = 0x00200000;
                                   /* turn off LED */
        delayMs(500);
    }
}
/* 16 MHz SYSCLK */
void delayMs(int n) {
    int i;
   for (; n > 0; n--)
        for (i = 0; i < 3195; i++);
}
```

15. Click "Save" button to save the file with the code. By default the file will be saved in the project folder.



16. Give the file name "blinky.c" and click "Save" button. The editor is context sensitive. Once you make it a C source file, the file content will change the color.

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17. Once the source file is saved, it needs to be associated with the project. Right click on "Source Group 1" and select "Add Existing Files to Group 'Source Group 1'...".

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CMSIS	Options for Group 'Source Group 1' Alt+F7	ff4xx.h"		
startup.	Add New Tem to Group Source Group 1 Add Existing Files to Group 'Source Group 1' Remove Group 'Source Group 1' and its Files	it n);		
	Rebuild all target files Build Target F7	IR  = 1;	/* enable GPIOA clock */	
	Aanage Project Items	R = 0x00000000;	/* clear pin mode */ /* set pin to output mode */	
.1	Show Include File Dependencies			
Project Books {}	Functions 0. Templates	->BSRR = 0x00000020;	/* turn on LED */	>
Build Output	and the second second second second second second second second second second second second second second second			

18. Locate the file blinky.c, click select it then click the "Add" button. Click "Close" button to proceed.

🔣 Add Files t	o Group 'Source Group 1'		$\times$
Look <u>i</u> n:	blinky	▼ = * *	
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19. Once the file is added to the project, it will appear under "Source Group 1".



20. Click "Build" button to build the project.

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<ul> <li>Project: blinky</li> <li>Target 1</li> <li>Source Group 1</li> <li>Dlinky.c</li> <li>CMSIS</li> <li>Device</li> <li>startup.stm32f446xx.s (Startup)</li> <li>system_stm32f4xc.c (Startup)</li> </ul>	<pre>1 /* use delay loop, 1 sec on 1 sec off 2 * default 16 MHz clock 3 * LD2 connects to PA5 4 */ 5 6 finclude "stm32f4xx.h" 7 8 void delayMs(int n); 9 10 int main(void) { 11 RCC-&gt;AHBIENR  = 1; /* enable GPI0A clock */ 12 13 GPI0A-&gt;MODER &amp;= ~0x00000C00; /* clear pin mode */ 14 GPI0A-&gt;MODER = 0x00000400; /* set pin to output mode */ 15 16 whele(b) { </pre>	-
<u>دا کا</u>	17 GPIOA->BSRR = 0x00000020; /* turn on LED */	~
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21. You should get a clean build with this project with 0 Error and 0 Warning.



- 22. Once the project is built, we need to configure the debug interface so that the program may be downloaded to the target. Make sure the Nucleo-F446RE board is connected to the computer with the USB cable. It may take a moment for the device driver to load.
- 23. Click "Options for Target..." button.



24. Select Debug tab. Click the radio button before "Use:". Click the pull-down menu on the right and select "ST-Link Debugger".

evice   Target   C	output Listing User C/C++	Asm Linke	Debug Utilities		
<ul> <li>Use Simulator</li> <li>Limit Speed to</li> </ul>	with restrictions Real-Time	Settings		2/ME Cortex Debugger 2/ME Cortex Debugger	Settings
✓     Load Application at Startup     Iv     Run to main()       Initialization File:			Load A CMSIS	main()	
Restore Debug Session Settings P Breakpoints Watch Windows & Performance Analyzer Memory Display System Viewer			Restore Stellaris ICDI VULink Debugger Stellaris ICDI Frag SiLabs UDA Debugger Altera Blaster Cortex Debugger V Watch Windows V Memory Display V System Viewer		
CPU DLL:	Parameter:		Driver DLL:	Parameter:	
SARMCM3.DLL	-REMAP -MPU		SARMCM3.DLL	-MPU	
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DCM.DLL	-pCM4		TCM.DLL	-pCM4	
		- C	iowar Deparimtion Fil	-	

25. Click on **Settings** next to the newly selected ST-Link Debugger. *You must visit the Settings dialog box for the debugger to make the proper connection for each new project created.* 

Options for Target 'Target 1'	×
Device   Target   Output   Listing   User   C/C++   Asm	Linker Debug Utilities
C     Use Simulator     with restrictions     Settings       □     Limit Speed to Real-Time	Use: ST-Link Debugger     Settings
✓ Load Application at Startup ✓ Run to main() Initialization File:	✓ Load Application at Startup ✓ Run to main() Initialization File:
Restore Debug Session Settings	Restore Debug Session Settings

26. In the next dialog box, make sure ST-LINK is showing in the Unit of Debug Adapter and there is a Serial Number showing. Pull down the Port: and select "SW" if "SW" is not already selected. If the board is properly connected to the computer, the SW Device information should be filled with an IDCODE. Click "OK" button to close it then click "OK" button to close the Options dialog box.

	SW Device			
Unit: STELINK/V25]	SWDIO	IDCODE	Device Name	Mov
Carial Mumbury		UK2DAU1477	Antin ColeSignt SW-DF	Dov
066DFF485457725187131440	€ Aut	omatic Detection	ID CODE:	
Version: FW: V2J28M18 HW: V2-1	C Mar	nual Configuration	Device Name:	
	Add	Delete U	odate IR len:	AP: 0
arget Com				
Clock	-			
Clock Clock 4 MHz Selected: 4 MHz	<u>.</u>			
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arget Com Port: SW Clock 4 MHz Selected: 4 MHz Abug Connect & Reset Options Connect & Reset Options		Cache Optio	Download Options	

27. The selected debug interface should appear at the lower right corner. Click on the "Start/Stop Debug Session" button to launch the debugger.



28. It should start to program the target device. The programmer progress bar appears at the bottom of the window. When done, the message should appear in the Build Output pane. If you are using the evaluation version of the Keil uVision, a warning message of the code size limitation will pop up after the target device is programmed. Click "OK" to close the size warning message dialog box.



29. The uVision IDE should change to the debug perspective. Click "Run" button and the program will start running and the LD2 blinks.

File Edit View Project Flash Debug Peripherals Tools SVCS Window Help	
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II: RCC->AHBIENR  = 1; /* enabl	le GPIOA clock */
B) 0x20000060 12:	
R1 0x20000260	0x080003C4
R2 0x2000260	
R3 0x20000260	
R4 0x00000000 blinky.c j startup_stm32f446xx.s	₹ ×
R3 0x2000000 9	^
B7 Cr0000000 10 int main(void) {	Second Second Second
B8 0x0000000 11 RCC->AHBIENR  = 1; /* enable	GPIOA clock */
R9 0x0000000 12 CD103 >MODER (= -0x0000000000 (* -1	nin made #/
R10 0x080003E8	pin mode */
R11 0x0000000 115	n co oucput mode /
R12 0x20000040 16 while (1) (	
R13 (SP) 0x2000660 17 GPIOA->BSRR = 0x00000020; /* turn or	n LED */
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Command 📮 🖬 Call Stack + Locals	д 🔀
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• main 0-00000000 int f0	6
*** Restricted Version with 32768 Byte Code Size Limit	
*** Currently used: 1000 Bytes (3%)	
ASSIGN BreakDisable BreakEnable BreakKill BreakList	
Start code execution	ST-Link Debugger

30. To stop the debug session and return to the build project perspective, click on the "Start/Stop Debug Session" button.



31. Congratulations! You have successfully finished the first programming project for Nucleo-F446RE board using Keil MDK v5 uVision IDE!