

Lab 01: Introducing Arm Programming using Keil Software

COSC2440: Computer Organization and Architecture

[**Take the Lab 1 Quiz when Done**](#)

Dr. Kevin Long

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ARMKEIL

Microcontroller Tools



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Cortex-M7
Software Packs for
Atmel and STM32



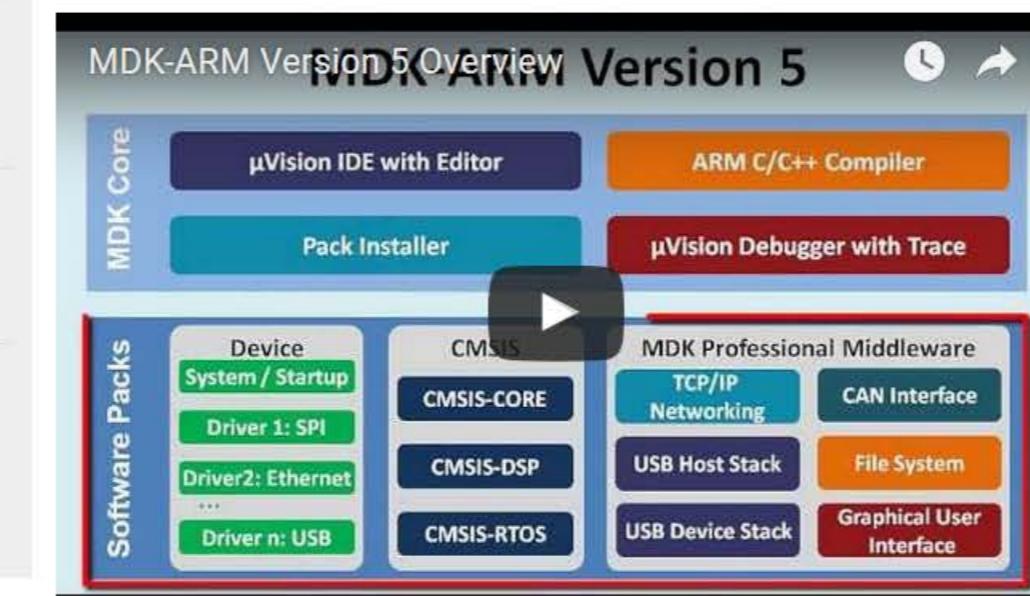
Learning
Platform for
Cortex-M



free Keil MDK for STM32F0/L0
■ ARM C/C++ Compiler
■ µVision IDE/Debugger
■ CMSIS-RTOS RTX

MDK Version 5 Microcontroller Development Kit

Keil MDK Version 5 is the latest release of our complete software development environment for a wide range of ARM Cortex-M based microcontroller devices. MDK includes the µVision IDE/Debugger, ARM C/C++ Compiler, and essential middleware components. It's easy to learn and use.



DS-MDK for Cortex-A/Cortex-M Software Development

DS-MDK is part of MDK-Professional and adds support for heterogeneous systems based on Cortex-A and Cortex-M. It uses Software Packs for device awareness, software frameworks, board support, and examples. Today NXP i.MX7 devices are supported (other devices follow soon).

News

- What's new in MDK
- MCB54110 Evaluation Board for NXP LCP54000
- MDK-Professional supports heterogeneous systems

Updates

- MDK-ARM V5.22
- Notify Me!
Receive e-mail when new updates are available.

Events

- 2/16/2017: Webinar: Transition to ARM C/C++ Compiler 6 (Webinar)
- 3/7/2017: Development Environment for Embedded Modules (Paris, France)
- 3/14/2017: embedded world Exhibition & Conference 2017 (Nürnberg, Germany)
- 3/20/2017: ARM Microcontroller Software Development Workshop (Richardson, TX, USA)

Overview

Keil downloads include software products and updates, example programs and various utilities you may use to learn about or extend the capabilities of your Keil development tools.



Product Downloads

Download current and previous versions of the Keil development tools.

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File Downloads

Download example projects and various utilities which enable you to extend the capabilities of your Keil development tools.

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Download Products

Select a product from the list below to download the latest version.



MDK-ARM

Version 5.22 (November 2016)

Development environment for Cortex and ARM devices.



C51

Version 9.56 (August 2016)

Development tools for all 8051 devices.



C251

Version 5.59 (October 2016)

Development tools for all 80251 devices.



C166

Version 7.56 (October 2016)

Development tools for C166, XC166, & XC2000 MCUs.

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PSN or LIC: Submit

Further information about installing your software is available in the [Read Me First](#) brochure.

Note

For **Flex Floating licenses**, please use the PSN mentioned in [Knowledgebase Article 3698](#). Refer to the [FlexLM Client Setup Guide](#) for setup instructions.

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ARM

Microcontroller Development Kit
Version 5.22

Complete the following form to download the Keil software development tools.

Enter Your Contact Information Below

5

First Name:

Last Name:

E-mail:

Company:

Address:

City:

State/Province:

Zip/Postal Code:

Country:

Phone:

Send me e-mail when there is a new update.

NOTICE:
If you select this check box, you **will** receive an e-mail message from Keil whenever a new update is available. If you don't wish to receive an e-mail notification, don't check this box.

Not shown anymore



Which ARM architectures are you using?

(Select all that apply)

- Cortex-M0
- Cortex-M1
- Cortex-M3

- Cortex-M4
- Other

Do you have any questions or comments?

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ARMKEIL Microcontroller Tools

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ARM

Microcontroller Development Kit
Version 5.22

The Keil ARM Evaluation Kit allows you to create programs for ARM7, ARM9, Cortex-M and MCU devices.

- Review the [hardware requirements](#) before installing this software.
- Note the [limitations of the evaluation tools](#).
- [MDK5 Overview and Introduction](#)
- [MDK5 Installation instructions](#)

(MD5:74d87b53d2fe03c65dfb80c2d0b3c5f8)

To install the ARM Software...

- Right-click on **MDK522.EXE** and save it to your computer.
- PDF files may be opened with Acrobat Reader.
- ZIP files may be opened with [WINRAR](#) or WINZIP.

7 **MDK522.EXE** 796.282K Friday, November 20, 2015

- If you are evaluating the tools, be sure to request a quote.

8

- Open Link in New Tab
- Open Link in New Window
- Open Link in New Private Window
- Bookmark This Link
- Save Link As...**
- Save Link to Pocket
- Copy Link Location
- Search Google for "MDK522.EXE"
- Inspect Element (Q)
- Download with IDM
- Download all links with IDM
- Adblock Plus: Block images

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Extra large icons

Large icons

Medium icons

Small icons

List

Details



Current
view ▾

Item check boxes

File name extensions

Hidden items



Hide selected
items



Options ▾

Navigation
pane ▾

Panes

Layout

Show/hide

← → ⌂ ⌃ ⌄ This PC > Downloads > Programs



Search Pro... 🔎

Quick access

Desktop

Downloads

Documents

Pictures

Fall 2016 Gar

Edited

Lab

New folder



3 items

Welcome to Keil MDK-ARM

Release 11/2016



This SETUP program installs:

MDK-ARM V5.22

This SETUP program may be used to update a previous product installation.
However, you should make a backup copy before proceeding.

It is recommended that you exit all Windows programs before continuing with SETUP.

Follow the instructions to complete the product installation.

— Keil MDK-ARM Setup



<< Back

Next >>

Cancel

License Agreement

Please read the following license agreement carefully.



To continue with SETUP, you must accept the terms of the License Agreement. To accept the agreement, click the check box below.

END USER LICENCE AGREEMENT FOR MDK-ARM

THIS END USER LICENCE AGREEMENT ("LICENCE") IS A LEGAL AGREEMENT BETWEEN YOU (EITHER A SINGLE INDIVIDUAL, OR SINGLE LEGAL ENTITY) AND ARM LIMITED ("ARM") FOR THE USE OF THE SOFTWARE ACCOMPANYING THIS LICENCE. ARM IS ONLY WILLING TO LICENSE THE SOFTWARE TO YOU ON CONDITION THAT YOU ACCEPT ALL OF THE TERMS IN THIS LICENCE. BY CLICKING "I AGREE" OR BY INSTALLING OR OTHERWISE USING OR COPYING THE SOFTWARE YOU INDICATE THAT YOU AGREE TO BE BOUND BY ALL OF THE TERMS OF THIS LICENCE. IF YOU DO NOT AGREE TO THE

I agree to all the terms of the preceding License Agreement

Keil Software Group



<< Back

Next >>

Cancel

Folder Selection

Select the folder where SETUP will install files.



Press 'Next' to install MDK-ARM to these folders. Press 'Browse' to select different folders for installation.

Destination Folders

Core: C:\Keil_v5

Browse ...

Pack: C:\Keil_v5\ARM\PACK

Browse ...



Customer Information

Please enter your information.



Please enter your name, the name of the company for whom you work, and your E-mail address.

14

First Name:	Mohammed
Last Name:	Alshair
Company Name:	University of Houston
E-mail:	MSAlshair@UH.EDU

KEIL MDK-ARM Setup

15

Next >>

Cancel

Setup Status

MDK-ARM Setup is performing the requested operations.

Install Files ...



Installation Status



Keil Pack Unzip performs the requested operations.

Extract files ...

search.js



Keil Pack Unzip

<< Back

Next >>

Cancel

Installing ULINK Drivers



Keil MDK-ARM Setup completed

MDK-ARM V5.22



MDK-ARM Core Setup has performed all requested operations successfully.



Show Release Notes.

— Keil MDK-ARM Setup

<< Back

Finish

Cancel



File Packs Window Help

Device:

Devices Boards

Search: X

Device

All Devices 23 Devices
ARM 23 Devices

Packs Examples

Pack	Action	Description
Device Specific	0 Packs	No device selected
Generic	3 Packs	
ARM::CMSIS	Up to date	CMSIS (Cortex Microcontroller Software Interface Standard)
Keil::ARM_Comp...	Up to date	Keil ARM Compiler extensions

Pack Installer



Welcome to the Keil Pack Installer

Pack Installer is a utility for managing Software Packs on the local computer and provides the following windows:

Devices : List supported devices. Select a device to show related Packs and examples.

Boards : List supported boards. Select a board to show related Packs and examples.

Packs : List and manage Software Packs. Install a Pack for access within µVision.

Examples : List example projects. Copy projects and launch µVision for testing examples.

Pack Installer connects to www.keil.com/pack to obtain the published Software

To install a local Software Pack **File - Import...** from the

Show this dialog at startup

OK

Help

23

24

Output

Refresh Pack descriptions

Check for updates

Action (1 left): Update Pack descriptions, download http://www.keil.com/pack/Keil.FM3Basic_DFP.pdsc

25

12% ONLINE

26

Pack Installer - C:\Keil_v5\ARM\PACK

File Window Help

Device:

Check For Updates

Check for updates on web

Device Summary

- All Devices 3764 Devices
 - ABOV Semiconductor 10 Devices
 - Ambiq Micro 10 Devices
 - Analog Devices 20 Devices
 - ARM 35 Devices
 - Atmel 263 Devices
 - Cypress 425 Devices
 - Holtek 22 Devices
 - Infineon 166 Devices
 - Maxim 4 Devices
 - MediaTek 2 Devices
 - Microsemi 6 Devices
 - MindMotion 2 Devices
 - Nordic Semiconductor 10 Devices
 - Nuvoton 436 Devices
 - NXP 571 Devices
 - Renesas 3 Devices
 - Silicon Labs 397 Devices
 - SONiX 35 Devices
 - STMicroelectronics 910 Devices
 - Texas Instruments 342 Devices
 - Toshiba 90 Devices
 - Zilog 5 Devices

Packs Examples

Pack	Action	Description
Device Specific	0 Packs	No device selected
Generic	16 Packs	
+ ARM::CMSIS	Up to date	CMSIS (Cortex Microcontroller Software Interface Standard)
+ ARM::CMSIS-Dri...	Install	CMSIS-Driver Validation
+ ARM::CMSIS-RTOS...	Install	CMSIS-RTOS Validation
+ ARM::mbedClient	Install	ARM mbed Client for Cortex-M devices
+ ARM::mbedTLS	Install	ARM mbed Cryptographic and SSL/TLS library for Cortex-M dev
+ ARM::minar	Install	mbed OS Scheduler for Cortex-M devices
+ Keil::ARM_Comp...	Up to date	Keil ARM Compiler extensions
+ Keil::Jansson	Install	Jansson is a C library for encoding, decoding and manipulating .
+ Keil::MDK-Midd...	Up to date	Keil MDK-ARM Professional Middleware for ARM Cortex-M bas
+ IwIP:IwIP	Install	IwIP is a light-weight implementation of the TCP/IP protocol sui
+ Micrium:RTOS	Install	Micrium software components
+ Oryx-EMBEDDED...	Install	Middleware Package (CycloneTCP, CycloneSSL and CycloneCryp
+ RealTimeLogic:S...	Install	SharkSSL-Lite is a super small and super fast pre-compiled Shar
+ RealTimeLogic:S...	Install	Simple Message Queues (SMQ) is an easy to use IoT publish sub
+ YOGITECH:fRSTL...	Deprecat.	!!! DEPRECATED Product !!! YOGITECH fRSTL Functional Safety E
+ YOGITECH:fRSTL...	Deprecat.	!!! DEPRECATED Product !!! YOGITECH fRSTL Functional Safety E

Double check to have these packets, install or update any that aren't up to date.
Do this after step 27

Output

Refresh Pack descriptions

Check for updates

Refresh Pack descriptions

Check for updates on web

27

ONLINE

Best match



Keil uVision5
Desktop app

30

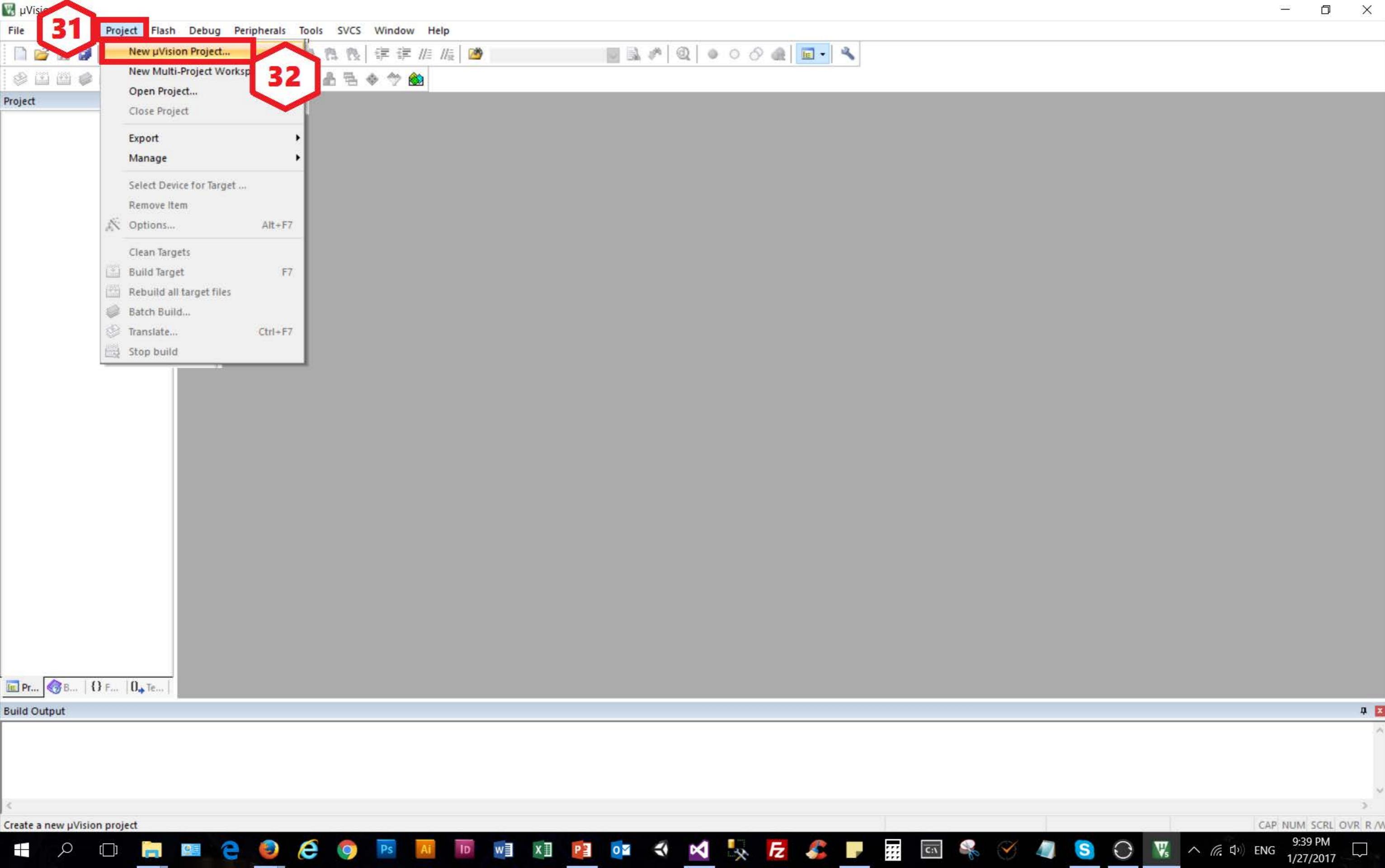
29

keil



28





31

32

← → ↑ This P... Documents ↓ ⌂ Search Documents ?

Organize ▾ New folder

This PC

Desktop

Documents

Downloads

Music

Pictures

Videos

Windows 10 Edu

Windows 10 Edu

Network

33

Name	Date modified	Type
Objects	1/27/2017 9:43 PM	File folder
Outlook Files	12/3/2016 7:20 PM	File folder
RTE	1/27/2017 9:43 PM	File folder
SQL Server Management Studio	1/21/2017 2:57 PM	File folder
Test Client Projects	2/1/2016 5:00 PM	File folder
Visual Studio 2010	2/6/2016 1:38 AM	File folder
Visual Studio 2012	12/20/2016 4:05 PM	File folder
Visual Studio 2013	5/21/2016 11:02 PM	File folder
Visual Studio 2015	1/27/2017 11:34 AM	File folder
COSC2440_Lab_01_Mohammed_Alsair	1/27/2017 9:55 PM	File folder

File name:

Save as type: Project Files (*.uvproj; *.uvprojx)

34

35

Open Cancel

Hide Folders

Create New Project

← → ⌂ ↑ << Documents > COSC2440_Lab_01_Mohammed_Alsair ⌂ ⌂ Search COSC2440_Lab_01_Mo... ⌂ ?

Organize ▾ New folder

	Name	Date modified	Type	Size
This PC				
Desktop				
Documents				
Downloads				
Music				
Pictures				
Videos				
Windows 10 Edu				
Windows 10 Edu				
Network				

No items match your search.

File name: **Lab_01** 36

Save as type: Project Files (*.uvproj; *.uvprojx) 37

Save Cancel

Device

Software Packs

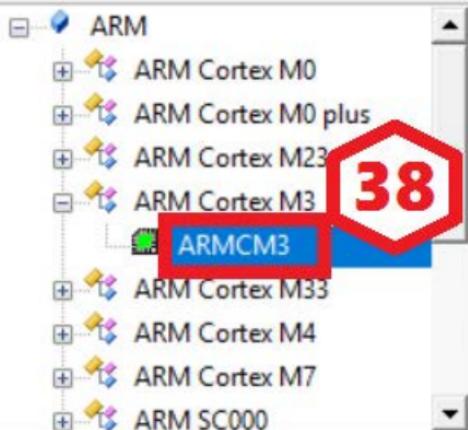
Vendor: ARM

Device: ARMCM3

Toolset: ARM

Search:

Description:



The Cortex-M3 processor is an entry-level 32-bit ARM Cortex processor designed for a broad range of embedded applications. It offers significant benefits to developers, including:

- simple, easy-to-use programmers model
- highly efficient ultra-low power operation
- excellent code density
- deterministic, high-performance interrupt handling
- upward compatibility with the rest of the Cortex-M processor family.

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OK

Cancel

Help

Software Component

- + CMSIS
- + CMSIS Driver
- + Compiler
- + Device
 - + Startup
 - + File System
 - + Graphics
 - + Network
 - + USB

Sel.	Variant	Version	Description
			Cortex Microcontroller Software Interface Components
			Unified Device Drivers compliant to CMSIS-Driver Specifications
	ARM Compiler	1.1.0	Compiler Extensions for ARM Compiler ARMCC and ARMClang
			Startup, System Setup
<input checked="" type="checkbox"/>		1.0.1	System and Startup for Generic ARM Cortex-M3 device
	MDK-Pro	6.9.0	File Access on various storage devices
	MDK-Pro	5.36.6	User Interface on graphical LCD displays
	MDK-Pro	7.3.0	IPv4/IPv6 Networking using Ethernet or Serial protocols
	MDK-Pro	6.9.0	USB Communication with various device classes

40

41

42

Validation Output

- ! ARM::Device:Startup
 - require CMSIS:CORE
 - + ARM::CMSIS:CORE

Description

Additional software components required

Select component from list

CMSIS-CORE for Cortex-M, SC000, SC300, ARMv8-M

Resolve

Select Packs

Details

OK

Cancel

Help

Software Component
+ CMSIS
+ CMSIS Driver
+ Compiler
+ Device
Device
Startup
+ File System
+ Graphics
+ Network
+ USB

Sel.	Variant	Version	Description
			Cortex Microcontroller Software Interface Components
			Unified Device Drivers compliant to CMSIS-Driver Specifications
	ARM Compiler	1.1.0	Compiler Extensions for ARM Compiler ARMCC and ARMClang
			Startup, System Setup
	MDK-Pro	6.9.0	File Access on various storage devices
	MDK-Pro	5.36.6	User Interface on graphical LCD displays
	MDK-Pro	7.3.0	IPv4/IPv6 Networking using Ethernet or Serial protocols
	MDK-Pro	6.9.0	USB Communication with various device classes

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44

45

Validation Output

Validation Output

Description

OK

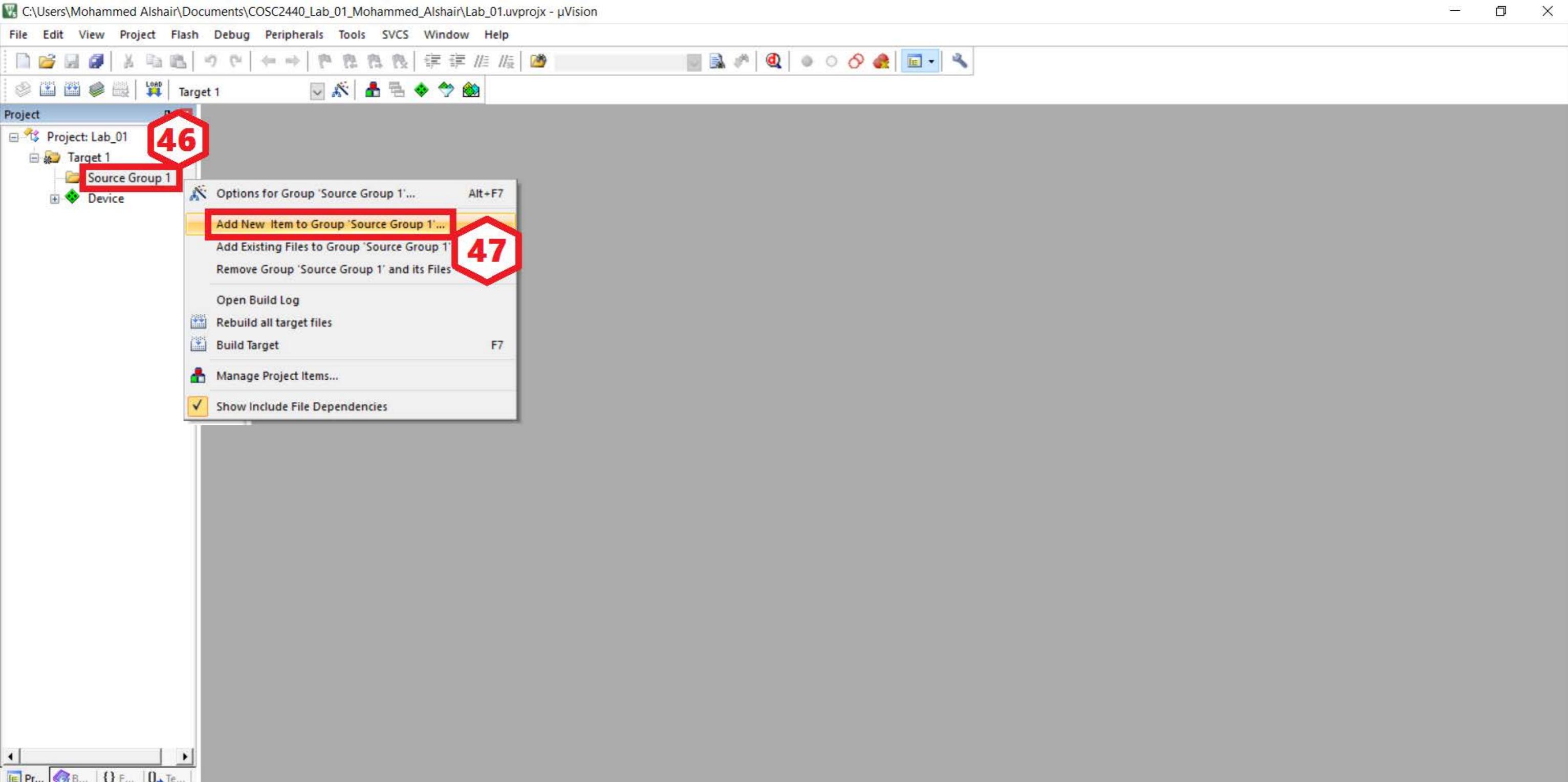
Cancel

Help

Resolve

Select Packs

Details



```
Build Output
compiling system_ARMCM3.c...
C:\Keil_v5\ARM\PACK\ARM\CMSIS\5.0.0\Device\ARM\ARMCM3\Include\ARMCM3.h(110): error: #5: cannot open source input file "core_cm3.h": No such file or directory
#include "core_cm3.h"          /* Processor and core peripherals */
RTE\Device\ARMCM3\system_ARMCM3.c: 0 warnings, 1 error
compiling Source.cpp...
```

48

Create a new C source file and add it to the project.

 C File (.c)

C++ File (.cpp)

Asm File (.s)

Header File (.h)

Text File (.txt)

Image File (*.*)

User Code Template

49

C File (.c)

Source

50

C:\Users\Mohammed Alshair\Documents\COS 1_Mohammed_Alshair

Add

Close

Help

C:\Users\Moh... Alshair\Documents\COSC2440_Lab_01_Mohammed_Alshair\Lab_01.uvprojx - µVision

File Edit View Flash Debug Peripherals Tools SVCS Window Help

Save (Ctrl+S) Save the active document

Project: Lab_01 Target 1 Source Group 1 Source.c Device

Source.c*

```
1 #include<stdio.h>
2 #include<math.h>
3
4 int main()
5 {
6     int number_1 = 10;
7     int number_2 = 20;
8     int number_3;
9
10    number_1 = number_1 + number_2;
11    number_3 = number_1 - number_2;
12
13    return 0;
14 }
```

Pr... B... F... O... Te...

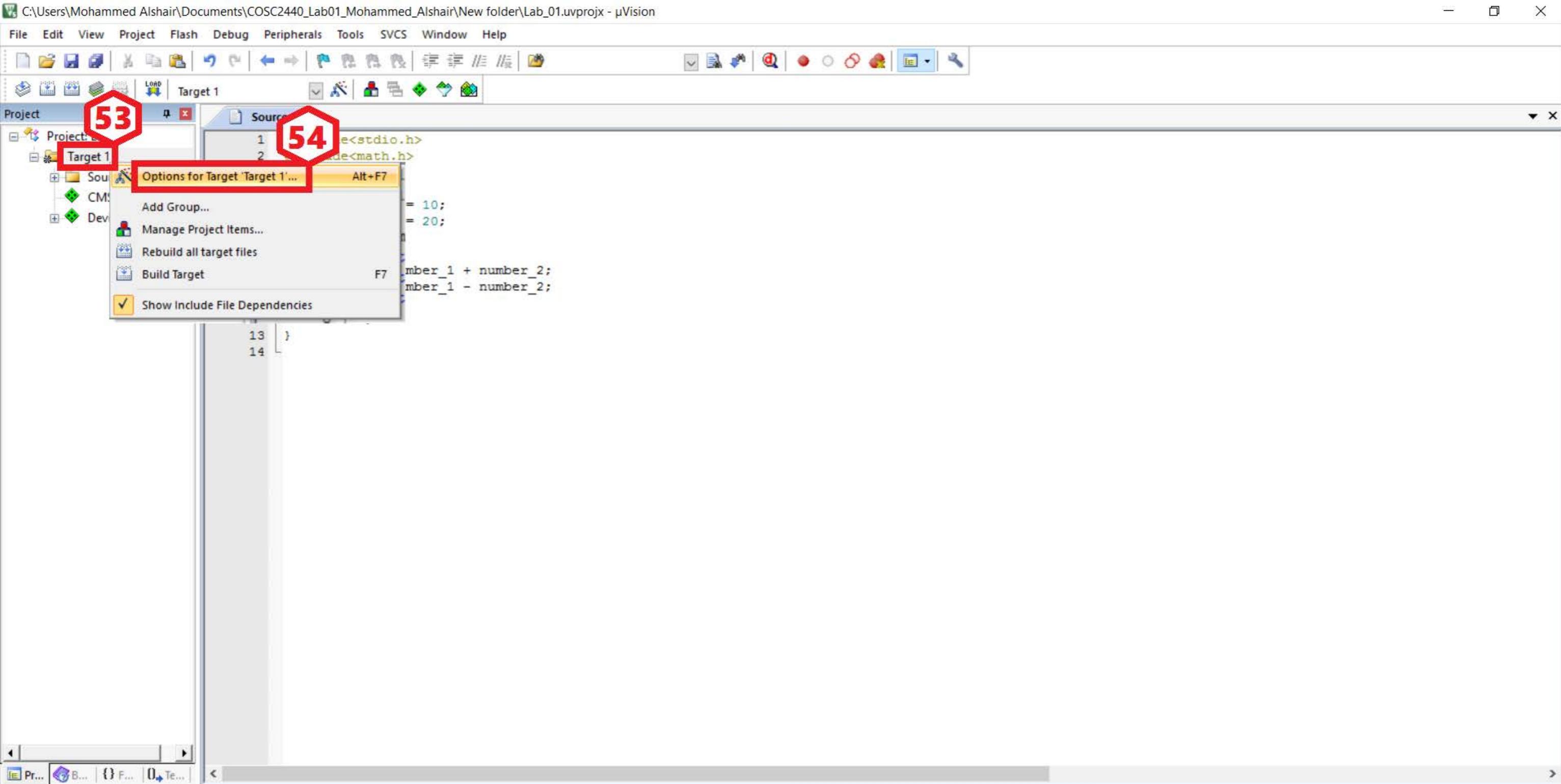
Build Output

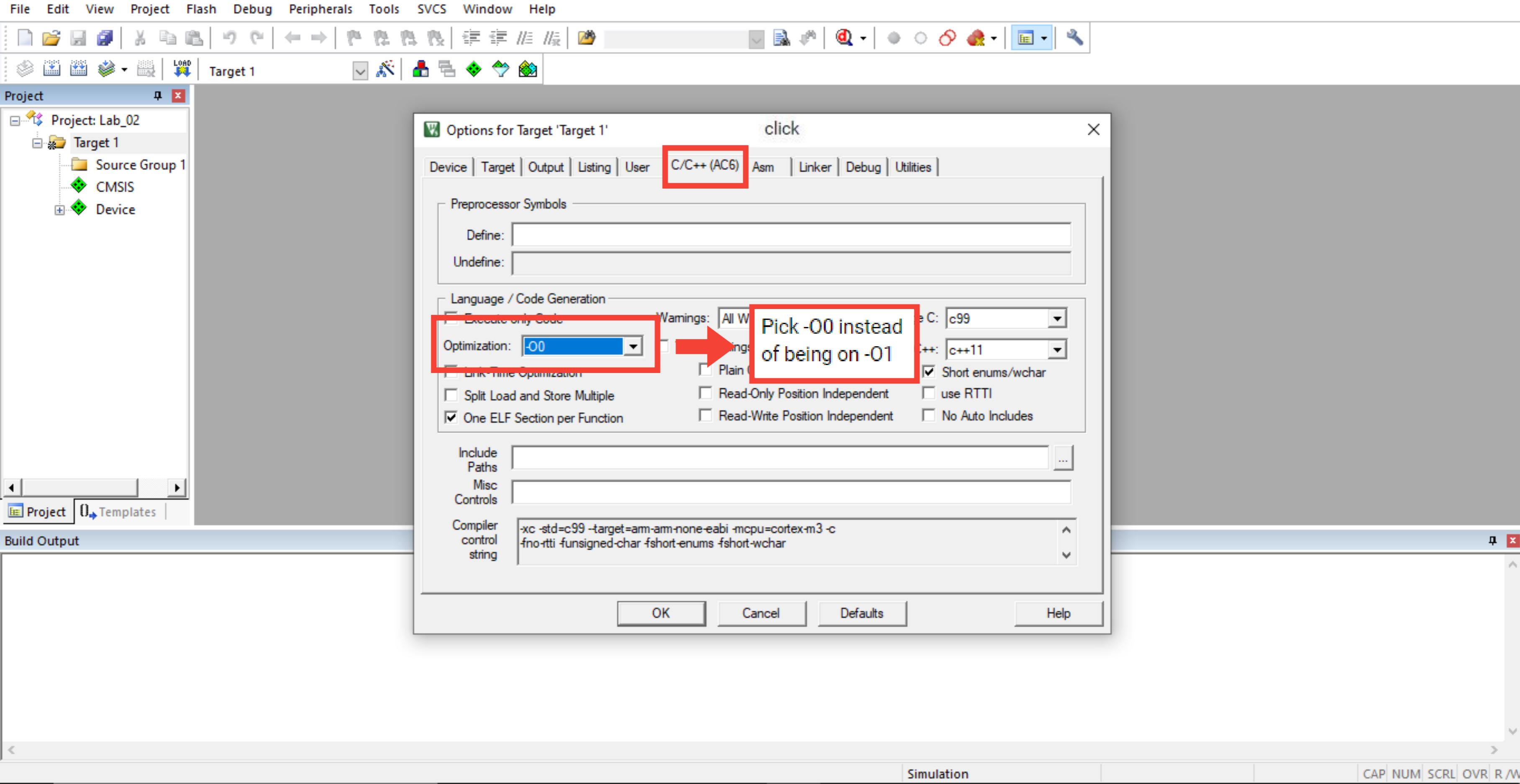
```
compiling system_ARMCM3.c...
C:\Keil_v5\ARM\PACK\ARM\CMSIS\5.0.0\Device\ARM\ARMCM3\Include\ARMCM3.h(110): error: #5: cannot open source input file "core_cm3.h": No such file or directory
#include "core_cm3.h"          /* Processor and core peripherals */
RTE\Device\ARMCM3\system_ARMCM3.c: 0 warnings, 1 error
compiling Source.cpp...
```

Save the active document

Simulation

L:14 C:2 CAP NUM SCRL OVR R/W





Pick -O0 instead
of being on -O1

Options for Target 'Target 1'



Device | Target | Output | Listing | User | C/C++ | Asm

Linker | **Debug**

UHL

Use Simulator

[with restrictions](#)

Settings

Use: **ULIN**

55

Debugger

Settings

Speed to Real-Time

56

Application at Startup

Run to main()

Initialization File:



Edit...

Restore Debug Session Settings

- Breakpoints Toolbox
- Watch Windows & Performance Analyzer
- Memory Display System Viewer

CPU DLL: Parameter:

SARMCM3.DLL

-MPU

Dialog DLL: Parameter:

DCM.DLL

-pCM3

Driver DLL: Parameter:

SARMCM3.DLL

-MPU

Dialog DLL: Parameter:

TCM.DLL

-pCM3

Manage Component Viewer Description Files ...

57

OK

Cancel

Defaults

Help

C:\Users\Mohammed Alshair\Documents\COSC2440_Lab01_Mohammed_Alshair\New folder\Lab_01.uvproj - μVision

File Edit View Project Flash Debug Peripherals Tools SVCS Window Help

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Project Build (F7) Build target files Target 1 Source.c

```
1 #include<stdio.h>
2 #include<math.h>
3
4 int main(){
5     int number_1 = 10;
6     int number_2 = 20;
7     int number_3;
8
9     number_1 = number_1 + number_2;
10    number_3 = number_1 - number_2;
11
12    return 0;
13 }
14
```

Note: If you make any changes to the code you must rebuild and save your code before starting to debug

Build Output

Build target files

Simulation

L:12 C:12

CAP NUM SCRL OVR R/W

C:\Users\Mohammed Alshair\Documents\COSC2440_Lab01_Mohammed_Alshair\New folder\Lab_01.uvprojx - μVision

File Edit View Project Flash Debug Peripherals Tools SVCS Window Help

Project Target 1 Source.c

```
1 #include<stdio.h>
2 #include<math.h>
3
4 int main(){
5     int number_1 = 10;
6     int number_2 = 20;
7     int number_3;
8
9     number_1 = number_1 + number_2;
10    number_3 = number_1 - number_2;
11
12    return 0;
13 }
14
```

Build Output

```
*** Using Compiler 'V5.06 update 4 (build 422)', folder: 'C:\Keil_v5\ARM\ARMCC\Bin'
Build target 'Target 1'
compiling Source.c...
Source.c(7): warning: #550-D: variable "number_3" was set but never used
    int number_3;
Source.c: 1 warning, 0 errors
assembling startup_ARMCM3.s...
compiling system_ARMCM3.c...
linking...
Program Size: Code=388 RO-data=224 RW-data=4 ZI-data=4196
".\Objects\Lab_01.axf" - 0 Error(s) 1 Warning(s).
Build Time Elapsed: 00:00:00
```

59

60

C:\Users\Mohammed Alshair\Documents\COSC2440_Lab01_Mohammed_Alshair\New folder\Lab_01.uvprojx - μVision

File Edit View Project Flash Debug Peripherals Tools SVCS Window Help

Project Target 1 Source.c startup_ARMCM3.s

Start/Stop Debug Session (Ctrl+F5)
Enter or leave a debug session

61

```
1 #include<stdio.h>
2 #include<math.h>
3
4 int main(){
5     int number_1 = 10;
6     int number_2 = 20;
7     int number_3;
8
9     number_1 = number_1 + number_2;
10    number_3 = number_1 - number_2;
11
12    return 0;
13 }
14
```

Build Output

```
*** Using Compiler 'V5.06 update 4 (build 422)', folder: 'C:\Keil_v5\ARM\ARMCC\Bin'
Build target 'Target 1'
compiling Source.c...
Source.c(7): warning: #550-D: variable "number_3" was set but never used
    int number_3;
Source.c: 1 warning, 0 errors
assembling startup_ARMCM3.s...
compiling system_ARMCM3.c...
linking...
Program Size: Code=388 RO-data=224 RW-data=4 ZI-data=4196
".\Objects\Lab_01.axf" - 0 Error(s), 1 Warning(s).
Build Time Elapsed: 00:00:00
```

Enter or leave a debug session

Simulation

L5 C1 CAP NUM SCRL OVR R/W

C:\Users\Mohammed Alshair\Documents\COSC2440_Lab01_Mohammed_Alshair\New folder\Lab_01.uvprojx - µVision

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Project Target 1 Source.c startup_ARMCM3.s

```
1 #include<stdio.h>
2 #include<math.h>
3
4 int main(){
5     int number_1 = 10;
6     int number_2 = 20;
7     int number_3;
8
9     number_1 = number_1 + number_2;
10    number_3 = number_1 - number_2;
11
12    return 0;
13 }
14
```

Might not appear on your screen and it's fine

µVision

EVALUATION MODE
Running with Code Size Limit: 32K

OK

62

Build Output

```
*** Using Compiler 'V5.06 update 4 (build 422)', folder: 'C:\Keil_v5\ARM\ARMCC\Bin'
Build target 'Target 1'
compiling Source.c...
Source.c(7): warning: #550-D: variable "number_3" was set but never used
    int number_3;
Source.c: 1 warning, 0 errors
assembling startup_ARMCM3.s...
compiling system_ARMCM3.c...
linking...
Program Size: Code=388 RO-data=224 RW-data=4 ZI-data=4196
".\Objects\Lab_01.axf" - 0 Error(s), 1 Warning(s).
Build Time Elapsed: 00:00:00
```

Simulation

L5 C1 CAP NUM SCRL OVR R/W

C:\Users\Mohammed Alshair\Documents\COSC2440_Lab01_Mohammed_Alshair\New folder\Lab_01.uvproj - μVision

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RST Step (F11) Step one line

Registers

Core

- R0 0x20000068
- R1 0x20000C68
- R2 0x20000C68
- R3 0x20000C68
- R4 0x00000000
- R5 0x20000004
- R6 0x00000000
- R7 0x00000000
- R8 0x00000000
- R9 0x00000000
- R10 0x00000264
- R11 0x00000000
- R12 0x20000044
- R13 (SP) 0x20001068
- R14 (LR) 0x0000014B
- R15 (PC) 0x00000238

+ xPSR 0x21000000

Banked

- MSP 0x20001068
- PSP 0x00000000

System

- BASEPRI 0x00
- PRIMASK 0
- FAULTMASK 0
- CONTROL 0x00

Internal

- Mode Thread
- Privilege Privileged
- Stack MSP
- States 2820
- Sec 0.00023500

Project Registers

Disassembly

```
5:     int number_1 = 10;
6: 0x000000238 210A MOVS r1,#0x0A
7:     int number_2 = 20;
8:     int number_3;
9: 0x00000023A 2214 MOVS r2,#0x14
10:    number_1 = number_1 + number_2;
11: 0x00000023C 4411 ADD r1,r1,r2
12:    number_3 = number_1 - number_2;
13: 0x00000023E 1A8B SUBS r3,r1,r2
14: 0x000000240 2000 MOVS r0,#0x00
15: 0x000000242 4770 BX lr
16: 0x000000244 0264 DCW 0x0264
17: 0x000000246 0000 DCW 0x0000
18: 0x000000248 0000 DCW 0x0000
```

Source.c startup_ARMCM3.s system_ARMCM3.c

```
1: #include<stdio.h>
2: #include<math.h>
3:
4: int main()
5: {
6:     int number_1 = 10; 68
7:     int number_2 = 20;
8:     int number_3;
9:
10:    number_1 = number_1 + number_2;
11:    number_3 = number_1 - number_2;
12:
13: }
```

Call Stack + Locals

Name	Locatio...	Type
m..	0x00000...	int f()
	0x20000C...	auto - int
	0x20000C...	auto - int
	0x20000C...	auto - int

Command

```
Running with Code Size Limit: 32K
Load "C:\\\\Users\\\\Mohammed Alshair\\\\Documents\\\\COSC2440_Lab01_Mohammed_Alshair\\\\New folder\\\\Ob
*** Restricted Version with 32768 Byte Code Size Limit
*** Currently used: 616 Bytes (1%)
```

ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE DEFINE DIR

Step one line

Simulation t1: 0.00023500 sec L:5 C:1 CAP NUM SCRL OVR R/W

69

63

67

64

68

65

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RST Step (F11) Step one line Registers Disassembly

Core Register Core R0 0x20000068 R1 0x0000000A R2 0x20000C68 R3 0x20000C68 R4 0x00000000 R5 0x20000004 R6 0x00000000 R7 0x00000000 R8 0x00000000 R9 0x00000000 R10 0x00000264 R11 0x00000000 R12 0x20000044 R13 (SP) 0x20001068 R14 (LR) 0x0000014B R15 (PC) 0x0000023A xPSR 0x21000000

Banked MSP 0x20001068 PSP 0x00000000

System BASEPRI 0x00 PRIMASK 0 FAULTMASK 0 CONTROL 0x00

Internal Mode Thread Privilege Privileged Stack MSP States 2821 Sec 0.00023508

Source.c startup_ARMCM3.s system_ARMCM3.c

2 #include<math.h>
3
4 int main(){
5 int number_1 = 10;
6 int number_2 = 20;
7 int number_3;
8
9 number_1 = number_1 + number_2;
10 number_3 = number_1 - number_2;
11
12 return 0;
13 }
14

Call Stack + Locals

Name	Locatio...	Type
m..	0x000002...	int f()
	0x000000...	auto - int
	0x20000C...	auto - int
	0x20000C...	auto - int

ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE DEFINE DIR

Step one line Simulation t1: 0.00023508 sec L:6 C:1 CAP NUM SCRL OVR R/W

74

72

70

73

71

Also know that you will have some different items/values in your registers and assembly than what is shown.

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Registers

Register Core

- R0 0x20000068
- R1 0x0000000A
- R2 0x00000014** 77
- R3 0x20000C68
- R4 0x00000000
- R5 0x20000004
- R6 0x00000000
- R7 0x00000000
- R8 0x00000000
- R9 0x00000000
- R10 0x00000264
- R11 0x00000000
- R12 0x20000044
- R13 (SP) 0x20001068
- R14 (LR) 0x0000014B
- R15 (PC) 0x0000023C** 78

+ XPSR 0x21000000

Banked

- MSP 0x20001068
- PSP 0x00000000

System

- BASEPRI 0x00
- PRIMASK 0
- FAULTMASK 0
- CONTROL 0x00

Internal

- Mode Thread
- Privilege Privileged
- Stack MSP
- States 2822
- Sec 0.00023517

Project Registers

Disassembly

```
5:     int number_1 = 10;
0x000000238 210A    MOVS    r1,#0x0A
6:     int number_2 = 20;
7:     int number_3;
8:
0x00000023A 2214    MOVS    r2,#0x14
9:     number_1 = number_1 + number_2;
0x00000023C 4411    ADD     r1,r1,r2 75
10:    number_3 = number_1 - number_2;
11:
0x00000023E 1A8B    SUBS    r3,r1,r2
12:    return 0;
0x000000240 2000    MOVS    r0,#0x00
13: }
0x000000242 4770    BX      lr
0x000000244 0264    DCW    0x0264
0x000000246 0000    DCW    0x0000
0x000000248 0000    DCW    0x0000
```

Source.c startup_ARMCM3.s system_ARMCM3.c

```
2 #include<math.h>
3
4 int main(){
5     int number_1 = 10;
6     int number_2 = 20;
7     int number_3;
8
9     number_1 = number_1 + number_2; 76
10    number_3 = number_1 - number_2;
11
12    return 0;
13 }
```

Command

```
Running with Code Size Limit: 32K
Load "C:\\\\Users\\\\Mohammed Alshair\\\\Documents\\\\COSC2440_Lab01_Mohammed_Alshair\\\\New folder\\\\Ob
*** Restricted Version with 32768 Byte Code Size Limit
*** Currently used: 616 Bytes (1%)
```

Call Stack + Locals

Name	Locatio...	Type
m..	0x00000...	int f()
	0x00000...	auto - int
	0x00000...	auto - int
	0x20000C...	auto - int

ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE DEFINE DIR

Step one line

Simulation t1: 0.00023517 sec L:9 C:1

CAP NUM SCRL OVR R/W

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RST Step (F11) Step one line

Registers

Register Core

- R0 0x20000068
- R1 0x0000001E** 82
- R2 0x00000014
- R3 0x20000C68
- R4 0x00000000
- R5 0x20000004
- R6 0x00000000
- R7 0x00000000
- R8 0x00000000
- R9 0x00000000
- R10 0x00000264
- R11 0x00000000
- R12 0x20000044
- R13 (SP) 0x20001068
- R14 (LR) 0x0000014B
- R15 (PC) 0x0000023E** 83

+ XPSR 0x21000000

- Banked

- MSP 0x20001068
- PSP 0x00000000

- System

- BASEPRI 0x00
- PRIMASK 0
- FAULTMASK 0
- CONTROL 0x00

- Internal

- Mode Thread
- Privilege Privileged
- Stack MSP
- States 2823
- Sec 0.00023525

Project Registers

Disassembly

```
5: int number_1 = 10;
0x000000238 210A MOVS r1,#0x0A
6: int number_2 = 20;
7: int number_3;
8:
0x00000023A 2214 MOVS r2,#0x14
9: number_1 = number_1 + number_2;
0x00000023C 4411 ADD r1,r1,r2
10: number_3 = number_1 - number_2;
11:
0x00000023E 1A8B SUBS r3,r1,r2 80
12: return 0;
0x000000240 2000 MOVS r0,#0x00
13: }
0x000000242 4770 BX lr
0x000000244 0264 DCW 0x0264
0x000000246 0000 DCW 0x0000
0x000000248 0000 DCW 0x0000
```

Source.c startup_ARMCM3.s system_ARMCM3.c

```
2 #include<math.h>
3
4 int main(){
5     int number_1 = 10;
6     int number_2 = 20;
7     int number_3;
8
9     number_1 = number_1 + number_2;
10    number_3 = number_1 - number_2; 81
11
12    return 0;
13 }
```

Call Stack + Locals

Name	Locatio...	Type
m..	0x00000...	int f()
	0x00000...	auto - int
	0x00000...	auto - int
	0x20000C...	auto - int

ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE DEFINE DIR

Step one line

Simulation t1: 0.00023525 sec L:10 C:1 CAP NUM SCRL OVR R/W

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RST Step (F11) Step one line Disassembly Registers

Registers Register Core R0 0x20000068 R1 0x0000001E R2 0x00000014 R3 0x0000000A R4 0x00000000 R5 0x20000004 R6 0x00000000 R7 0x00000000 R8 0x00000000 R9 0x00000000 R10 0x00000264 R11 0x00000000 R12 0x20000044 R13 (SP) 0x20001068 R14 (LR) 0x0000014B R15 (PC) 0x00000240 xPSR 0x21000000 Banked MSP 0x20001068 PSP 0x00000000 System BASEPRI 0x00 PRIMASK 0 FAULTMASK 0 CONTROL 0x00 Internal Mode Thread Privilege Privileged Stack MSP States 2824 Sec 0.00023533

Disassembly

```
5: int number_1 = 10;
0x000000238 210A MOVS r1,#0x0A
6: int number_2 = 20;
7: int number_3;
8:
0x00000023A 2214 MOVS r2,#0x14
9: number_1 = number_1 + number_2;
0x00000023C 4411 ADD r1,r1,r2
10: number_3 = number_1 - number_2;
11:
0x00000023E 1A8B SUBS r3,r1,r2
12: return 0;
0x000000240 2000 MOVS r0,#0x00
13: }
0x000000242 4770 BX lr
0x000000244 0264 DCW 0x0264
0x000000246 0000 DCW 0x0000
0x000000248 0000 DCW 0x0000
```

Source.c startup_ARMCM3.s system_ARMCM3.c

```
2 #include<math.h>
3
4 int main(){
5     int number_1 = 10;
6     int number_2 = 20;
7     int number_3;
8
9     number_1 = number_1 + number_2;
10    number_3 = number_1 - number_2;
11
12    return 0;
13 }
```

Call Stack + Locals

Name	Locatio...	Type
m..	0x00000...	int f()
	0x00000...	auto - int
	0x00000...	auto - int
	0x00000...	auto - int

ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE DEFINE DIR

Step one line Simulation t1: 0.00023533 sec L:12 C:1 CAP NUM SCRL OVR R/W

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RST Start/Stop Debug Session (Ctrl+F5) Enter or leave a debug session

Registers Step (F11) Step one line

Core R0 0x00000000 91

R1 0x0000001E

R2 0x00000014

R3 0x0000000A

R4 0x00000000

R5 0x20000004

R6 0x00000000

R7 0x00000000

R8 0x00000000

R9 0x00000000

R10 0x00000264

R11 0x00000000

R12 0x20000044

R13 (SP) 0x20001068

R14 (LR) 0x0000014B

R15 (PC) 0x00000242 92

xPSR 0x61000000

Banked MSP 0x20001068

PSP 0x00000000

System BASEPRI 0x00

PRIMASK 0

FAULTMASK 0

CONTROL 0x00

Internal Mode Thread

Privilege Privileged

Stack MSP

States 2825

Sec 0.00023542

Source.c startup_ARMCM3.s system_ARMCM3.c 90

2 #include<math.h>

3

4 int main(){

5 int number_1 = 10;

6 int number_2 = 20;

7 int number_3;

8

9 number_1 = number_1 + number_2;

10 number_3 = number_1 - number_2;

11

12 return 0;

13 }

Call Stack + Locals

Name	Locatio...	Type
m..	0x00000...	int f()
	0x00000...	auto - int
	0x00000...	auto - int
	0x00000...	auto - int

ASSIGN BreakDisable BreakEnable BreakKill BreakList BreakSet BreakAccess COVERAGE DEFINE DIR

Step one line Simulation t1: 0.00023542 sec L:13 C:1 CAP NUM SCRL OVR R/W

91

92

90