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Chapter 1 Introduction

1.1 Description

This AMS32M200xA DFP and BSP user guide provides the necessary information for setting up the AMS32M200xA development environment on Keil® MDK.

This document includes two major items: Device Family Pack (DFP) for AMS32M200xA and the Board Support Pack (BSP) for AMS32M200xA. The DFP has CMSIS drivers, a device header file, register layer driver, system startup, and initialize file. The BSP mainly contains evaluation board materials, including: a printed circuit board (PCB), demo board, and peripheral example code.

1.2 Terms and Abbreviation

Abbreviation	Description
BSP	Board Support Pack
CMSIS-Pack	Cortex Microcontroller Software Interface Standard-Pack
DFP	Device Family Pack
MDK/MDK-ARM	ARM Keil Microcontroller Development Kit
RL	Register Layer

Chapter 2 Device Family Pack (DFP) for AMS32M200xA

2.1 General Description

The Device Family Pack (DFP) provides the software pack containing the support files for the microcontroller. The AMS32M200xA DFP includes ARM® CMSIS for Cortex®-M0 drivers, getting started with AMS32M200xA BSP and DFP document, AMS32M200xA device header file, device system initial and startup, and register layer header file.

The default install path is located at:
"C:\Diodes\"

2.2 File Tree Diagram

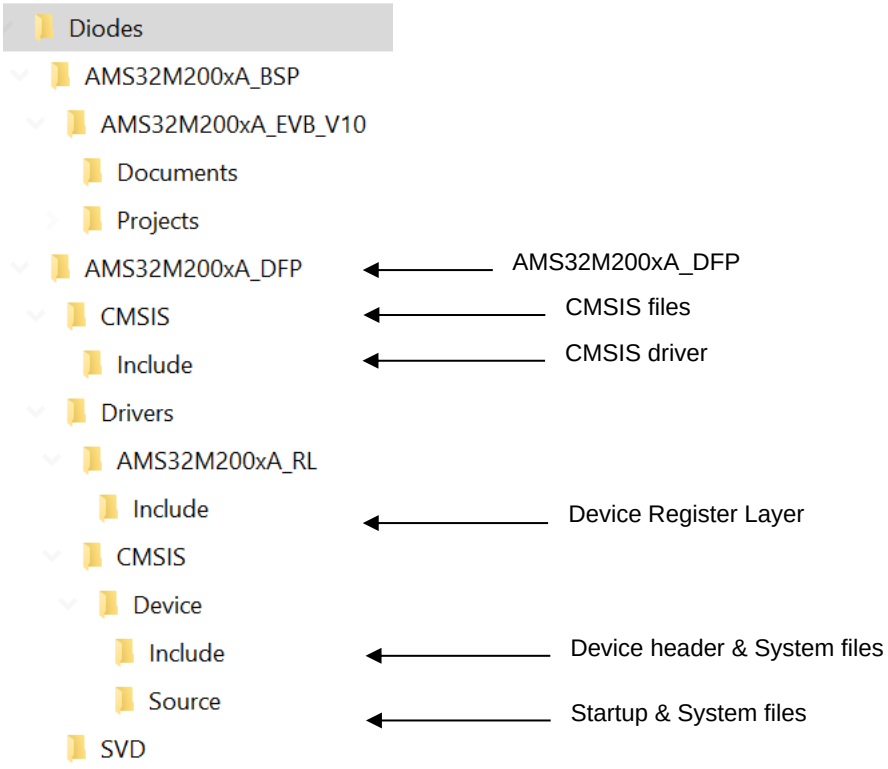


Figure 1. AMS32M200xA DFP file tree diagram

2.3 AMS32M200xA DFP File

2.3.1 Register Layer (RL)Included File

Table 1 - Register Layer (RL) included file list

Register Layer (RL) Drivers		
Functionalities	**IP Name**	**RL Include File**
Analog Comparator	ACMP	AMS32M200xA_acmp.h
Analog Control Unit	ACU	AMS32M200xA_acu.h
Analog Digital Converter	ADC	AMS32M200xA_adc.h
Capture Compare Unit 4	CCU4	AMS32M200xA_ccu4.h
Clock	CLK	AMS32M200xA_clk.h
Direct Memory Access	DMA	AMS32M200xA_dma.h
Enhance Capture Compare Unit 6	eCCU6	AMS32M200xA_eccu6.h
General-purpose I/O	GPIO	AMS32M200xA_gpio.h
Inter-Integrated Circuit	I2C	AMS32M200xA_i2c.h
Interrupt Unit	ITU	AMS32M200xA_itu.h
AMS32M200xA Device Macro	--	AMS32M200xA_macro.h
Math coprocessor	MATH	AMS32M200xA_math.h
Non-Volatile Memory	NVM	AMS32M200xA_nvm.h
Operational Amplifier	OPA	AMS32M200xA_opa.h
Position Interface	POSIF	AMS32M200xA_posif.h
Reset Control Unit	RCU	AMS32M200xA_rcu.h
System Management Unit	SMU	AMS32M200xA_smu.h
Serial Peripheral Interface	SPI	AMS32M200xA_spi.h
Timer Unit	TMU	AMS32M200xA_tmu.h
Universal Asynchronous Receiver Transmitter	UART	AMS32M200xA_uart.h
AMS32M200xA DFP version	--	AMS32M200xA_version.h
Watchdog	WDG	AMS32M200xA_wdg.h

Chapter 3 Board Support Pack (BSP) for AMS32M200xA

3.1 General Description

The Board Support Pack (BSP) provides the software pack containing the support files for microcontroller. The AMS32M200xA BSP includes AMS32M200xA Emulation (EMU) Board.

3.2 AMS32M200xA BSP File

AMS32M200xA Evaluation Board (AMS32M200xA_EMU_V10)

Table 2 – AMS32M200xA EVB BSP items

Items	Files
Document	**AMS32M2006X_EMU_V1.0.pdf**
PCB	**AMS32M2006A_EMU_V1.0.pcb**
Projects	**AMS32M200xA example code**

Reference Design (Reserved)

Table 3 – AMS32M2006A Reference Design items (Reserved)

Items	Files
Document	
PCB	
Projects	
Schematic	

Reference Design (Reserved)

Table 4 – AMS32M2006A Reference Design items (Reserved)

Items	Files
Document	
PCB	
Projects	
Schematic	

The default install path of AMS32M200xA BSP is located at
"C:\Diodes\"

Table 5 – list of AMS32M200xA's example codes

Category	Example	Description
ACMP	ACMP	ACMP Output
ACU	LVD	ACU Low Voltage Detect (LVD)
	LVR	ACU Low Voltage Reset (LVR)
ADC	Regular_DMA	ADC Regular Mode with DMA Function
	Injected	ADC Injected
CCU4	Timer_IRQ	CCU40 Timer Mode
	Capture_IRQ	CCU40 Capture Mode
	Compare_IRQ	CCU40 Compare Mode
	PWM_Edge_Duty	CCU40 PWM Edge-aligned using Duty Mode
	PWM_Edge_Offset	CCU40 PWM Edge-aligned using Offset Mode
	PWM_Center_Duty	CCU40 PWM Center-aligned using Duty Mode
	PWM_Center_Offset	CCU40 PWM Center-aligned using Offset Mode
eCCU6	Timer_IRQ	eCCU61 Timer Mode
	Capture_IRQ	eCCU61 Capture Mode
	Compare_IRQ	eCCU61 Compare Mode
	PWM_Edge_Duty	eCCU61 PWM Edge-aligned using Duty Mode
	PWM_Edge_Offset	eCCU61 PWM Edge-aligned using Offset Mode
	PWM_Center_Duty	eCCU61 PWM Center-aligned using Duty Mode
	PWM_Center_Offset	eCCU61 PWM Center-aligned using Offset Mode
DMA	M2M	DMA M2M (Memory to Memory)
	M2M_Circular_IRQ	DMA M2M using Circular Mode (Memory to Memory)
GPIO	TTL	GPIO Input Mode with TTL Configuration
	Schmitt	GPIO Input Mode with Schmitt Configuration
	Schmitt _OSPD	GPIO Input Mode with Schmitt and Output Speed Configuration
	OutputMask	GPIO Output Mode with Masked Configuration
	LED_Blinky	GPIO LED Blink

Category	Example	Description
I2C	Master_TX	I2C Master Transmission Mode
	Master_TX_DMA	I2C Master Transmission with DMA Mode
	Slave_RX	I2C Slave Receive Mode
	Slave_RX_DMA	I2C Slave Receive with DMA Mode
ITU	Ext_FallingEdge_IRQ	ITU External Interrupt at I/O Falling Edge
	Ext_HighLevel_IRQ	ITU External Interrupt at I/O High Level
	Ext_LowLevel_IRQ	ITU External Interrupt at I/O Low Level
	Ext_RisingEdge_IRQ	ITU External Interrupt at I/O Rising Edge
	NMI_eCCU61_TMU0_IRQ	Non-Maskable Interrupt with eCCU61 and TMU0
MATH	Divider	MATH Divider
	Cordic	MATH CORDIC
NVM	FLASH	NVM FLASH Erase and Program
	UserOption	NVM User Option Erase and Program
OPA	OPA	OPA Operational Amplifier Enable
POSIF	Quadrature_IRQ	POSIF Quadrature Mode
	Hall_IRQ	POSIF Hall Mode
RCU	RCU	RCU Master and System Reset and Reset Status
SLEEP	Sleep_WFI	Sleep Mode using WFI
	Sleep_SleepOnExit_WFI	Sleep-on-exit Mode using WFI
	DeepSleep_WFE	DeepSleep Mode using WFE
	DeepSleep_SleepOnExit_WFE	DeepSleep Sleep-on-exit Mode using WFE
SPI	Master_TX	SPI Master Single Byte Transmission with Manual Mode
	Master_RX	SPI Master Single Byte Receive with Manual Mode
	Master_TX_DMA	SPI Master Transmission with DMA Mode
	Slave_TX	SPI Slave Single Byte Transmission with Manual Mode
	Slave_RX	SPI Slave Single Byte Receive with Manual Mode
	Slave_RX_DMA	SPI Slave Receive with DMA Mode

Category	Example	Description
SysTick	CMSIS_IRQ	SysTick using CMSIS Driver
	Ext_CLK_IRQ	SysTick using External Clock: HSIRC8M/2 as Clock Source
	HCLK_IRQ	SysTick using Internal Clock: HCLK as Clock Source
TMU	Timer_IRQ	TMU Timer Mode
	Capture_IRQ	TMU Capture Mode
	Compare_IRQ	TMU Compare Mode
UART	TX_RX	UART Transmission and Receive Mode
	TX_RX_Retarget	UART Transmission and Receive Retarget
	TX_RX_IRQ	UART Transmission and Receive Interrupt Mode
	TX_DMA_IRQ	UART Transmission with DMA Mode
	RX_DMA_IRQ	UART Receive with DMA Mode
WDG	Reset	WDG Reset Mode
	Reset_IRQ	WDG Reset Interrupt Mode
	Timer	WDG Timer Mode
	Timer_IRQ	WDG Timer Interrupt Mode

Chapter 4 Project in Keil® MDK version 6 Legacy Format

In the following chapters, the project will be saved in uv4 format (uvproj).

4.1 Create a New Project

1. Click **Project**; then, **New Project**

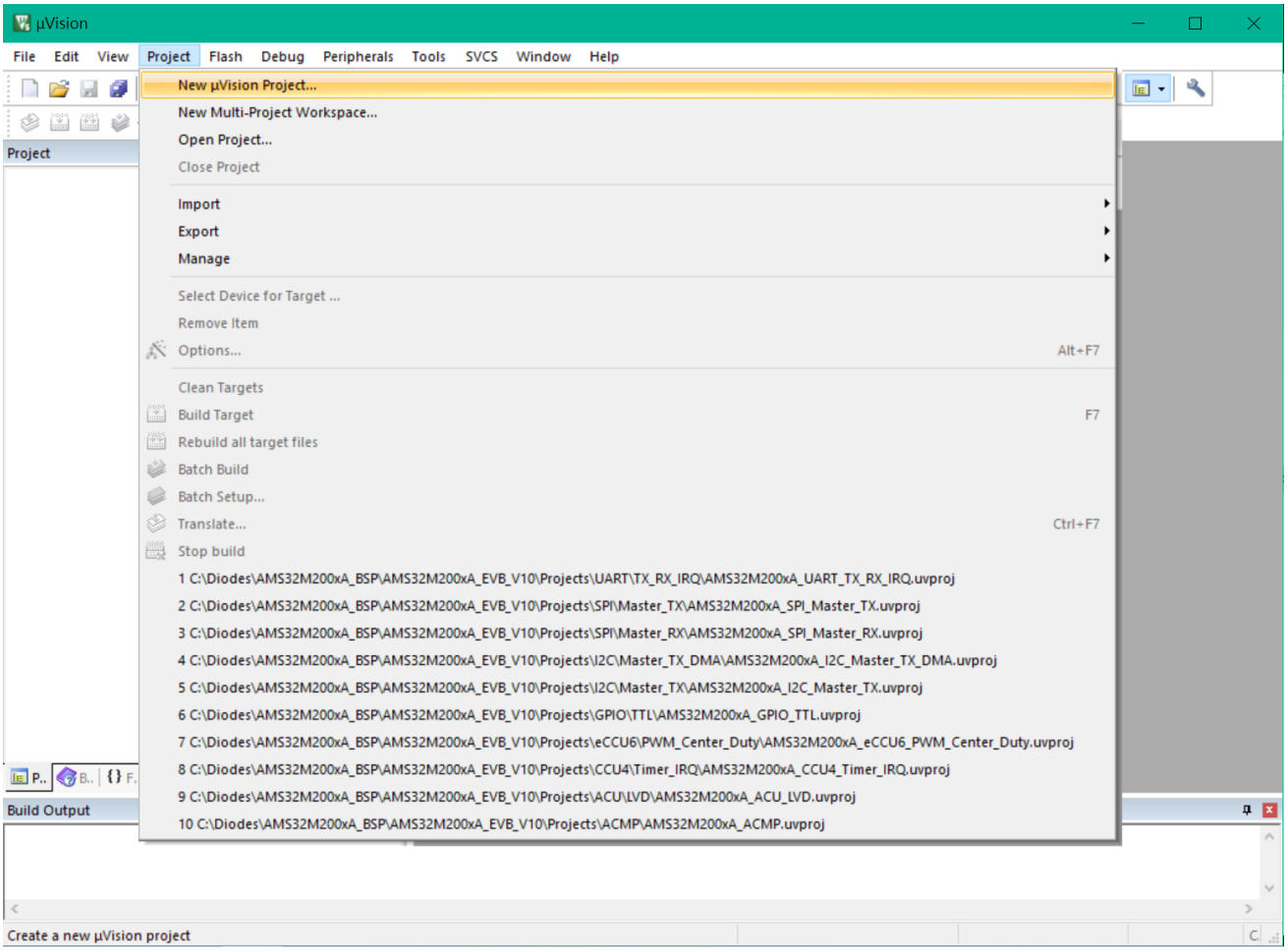


Figure 2. Create a new project

2. Select a destination path to save new project. Type a project name and **Save** it.

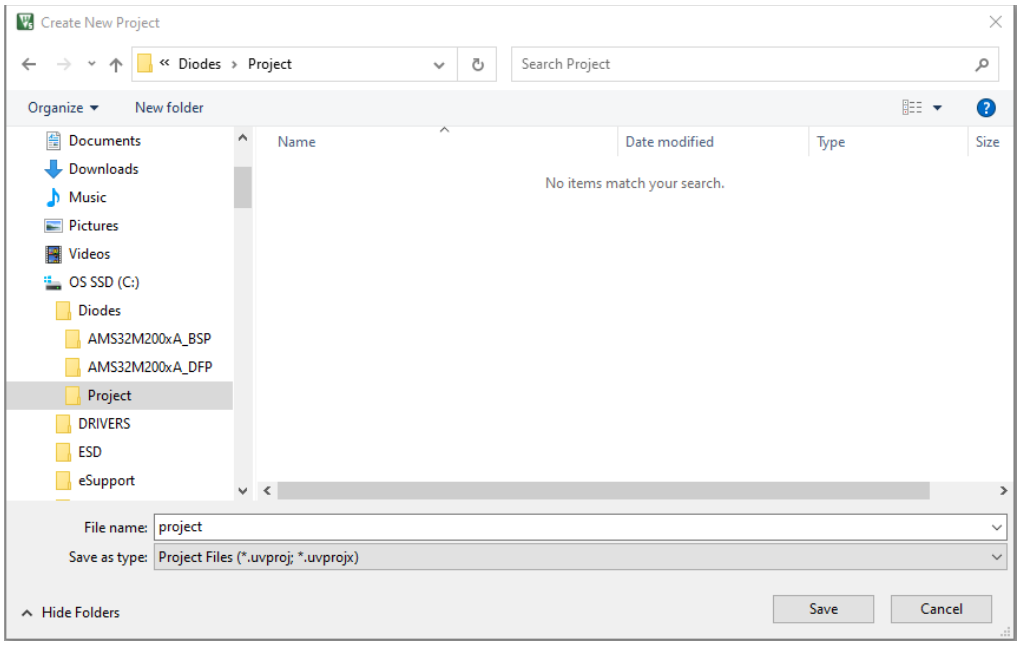


Figure 3. Save new project name

3. Select Diodes Incorporated's (Diodes) AMS32 Device Database in the Vender list.
Expand Diodes and **Select** the Device for this project. For example, AMS32M2006A.
Click **OK** to continue.

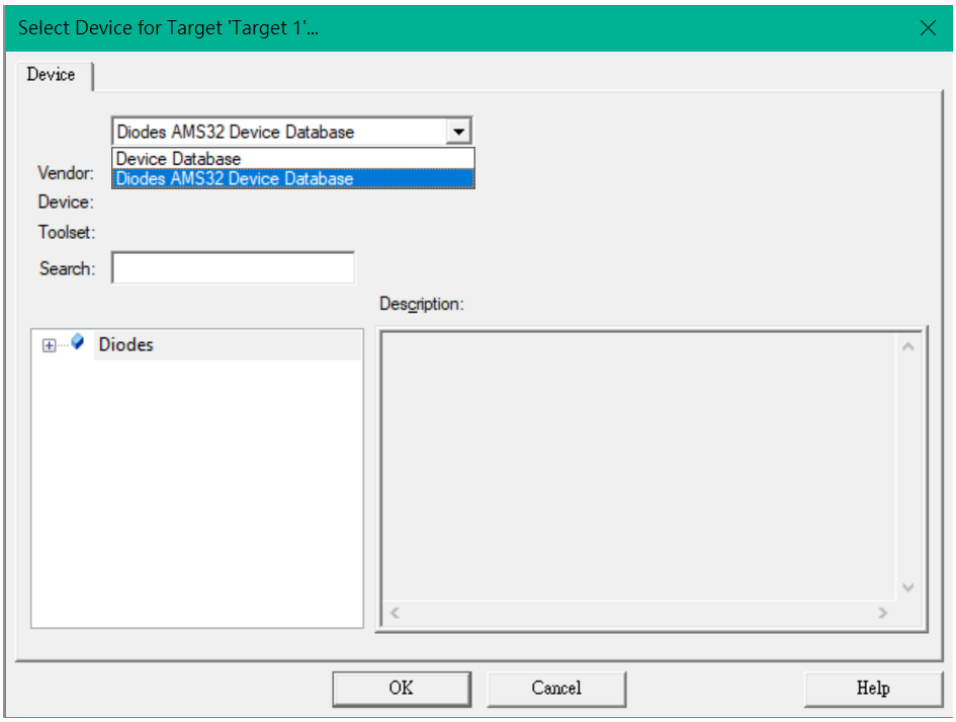


Figure 4. Select vender: Diodes Incorporated AMS32 Device Database

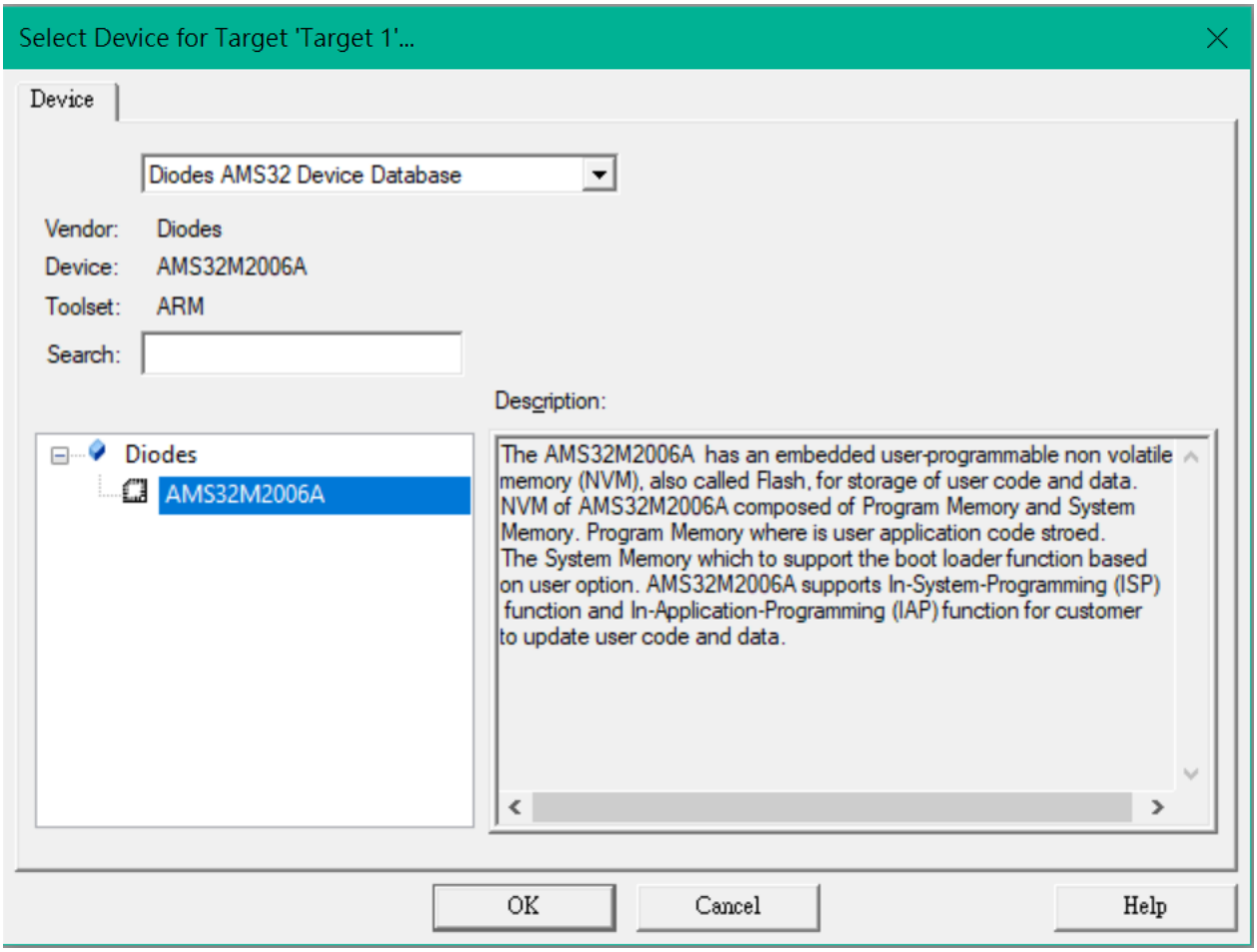


Figure 5. Select a device of AMS32M200xA series for a new project

4. Keil® will pop a dialog asking whether copy 'startup_AMS32M200xA.s' to project folder and add file to project. Select **Yes** to continue.

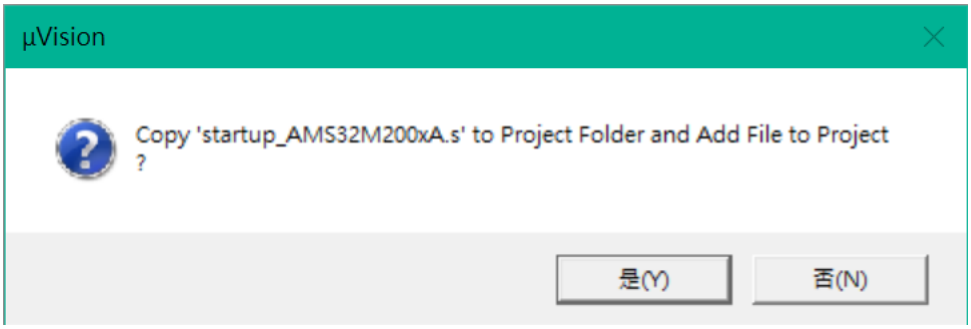


Figure 6. Adding a startup file into a project

5. Project and folder tree are demonstrated as following figures.

Project Tree

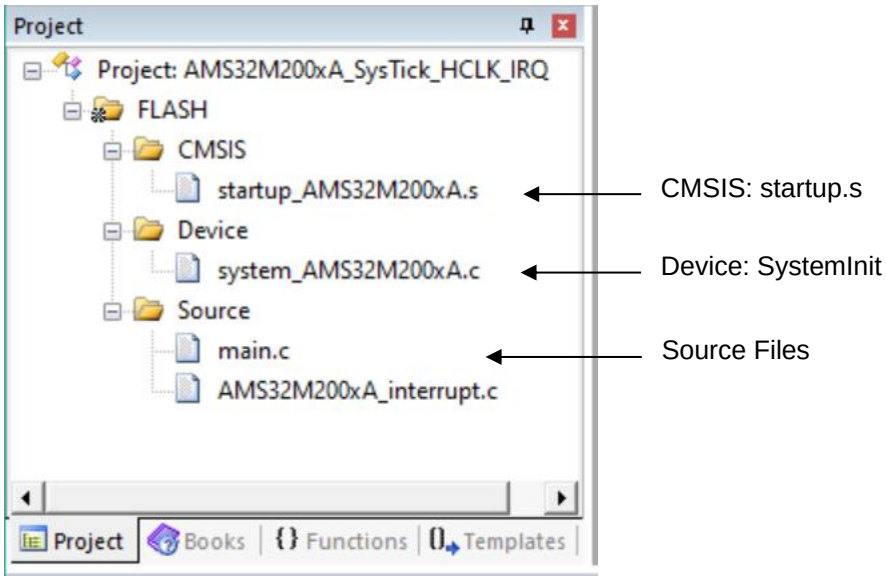


Figure 7. Project tree diagram

4.2 Keil® MDK toolbar and debug menu

The Keil® MDK IDE user interface is shown in the following figure.

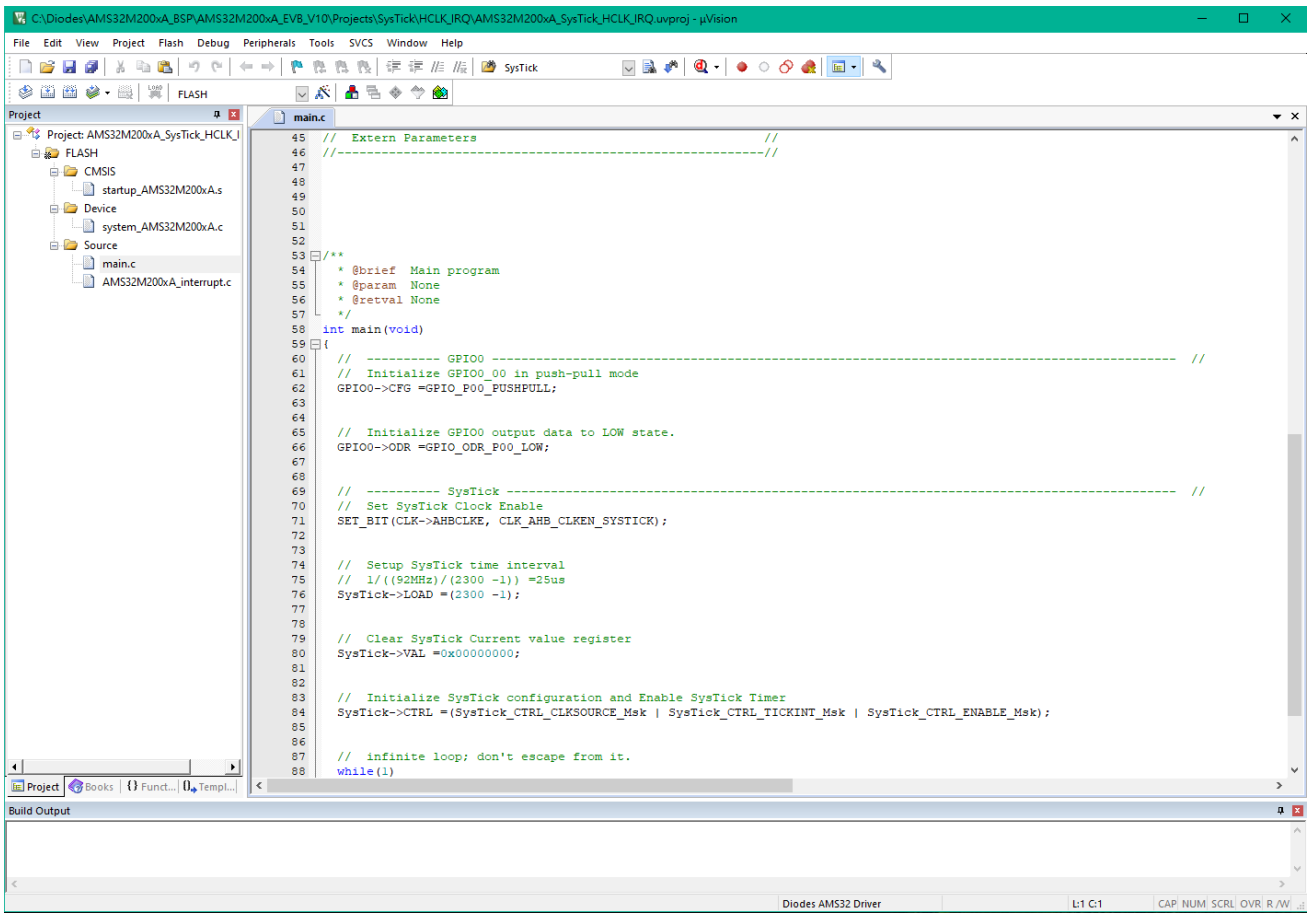
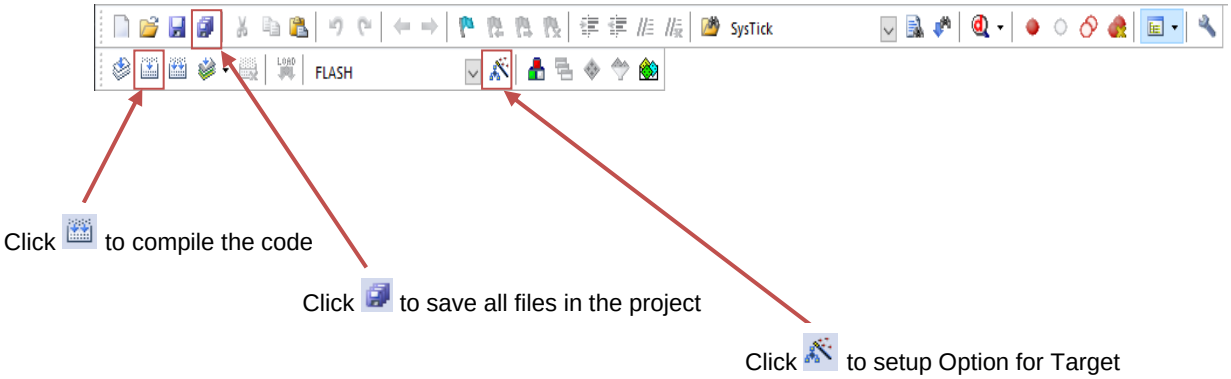


Figure 8. Keil® MDK IDE user interface

In the menu and toolbar:



Checksum value display.
After building the target, file checksum value will display in the “Build Output” window.

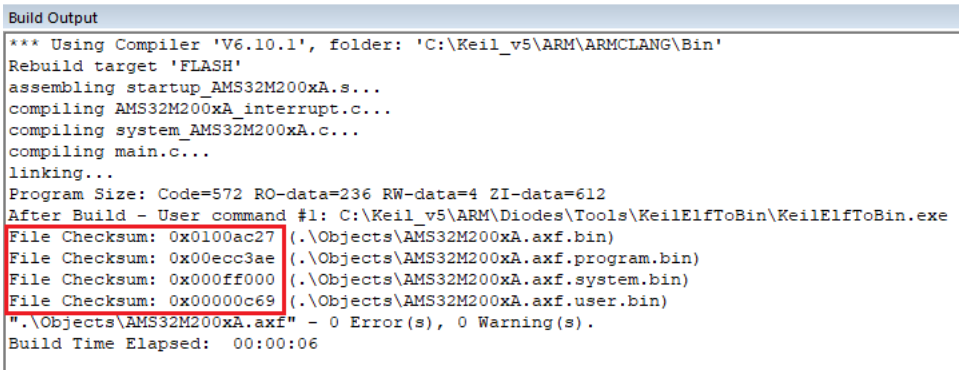


Figure 9. Keil® MDK output window

4.2.1 Project Options for Target

4.2.1.1 Target

User applies the ROM and RAM arrangement based on the below requirements:

- Code Generation: the default ARM compiler version 5 is selected.
- IROM1: A typical IROM setting starts from 0x01000000 and size is 0x8000 (32KB).
- IROM2: System Memory allocates from 0x02000000 and size is 0x1000 (4KB).
- IRAM1: AMS32M200xA series provides 8KB RAM and it starts from 0x20000000 and size is 0x2000.
- The default startup is IROM1 and SRAM is IRAM1.

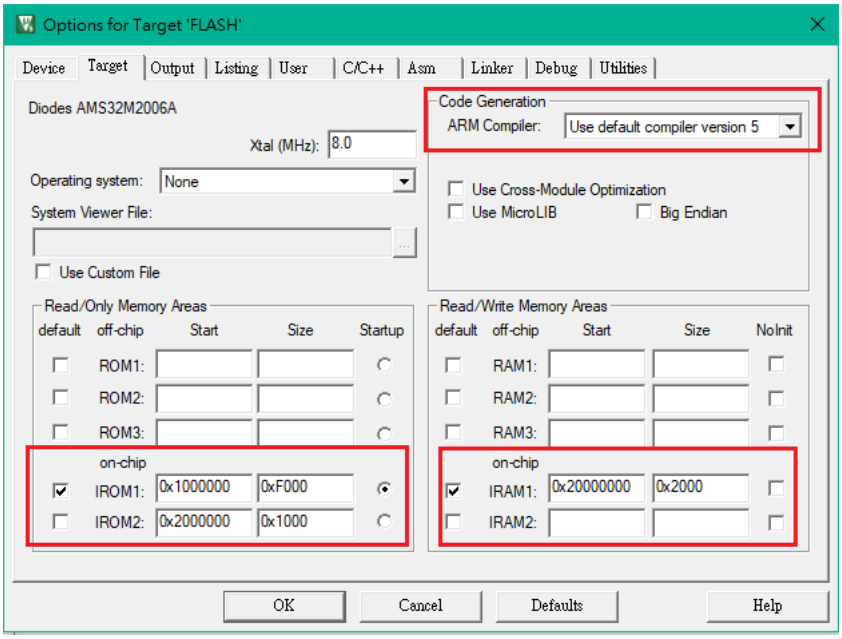


Figure 10. Options for Target: Target

4.2.1.2 Output

Make sure the Objects folder name is the same as what is shown in the Figure .
The Objects folder must be **Objects.**

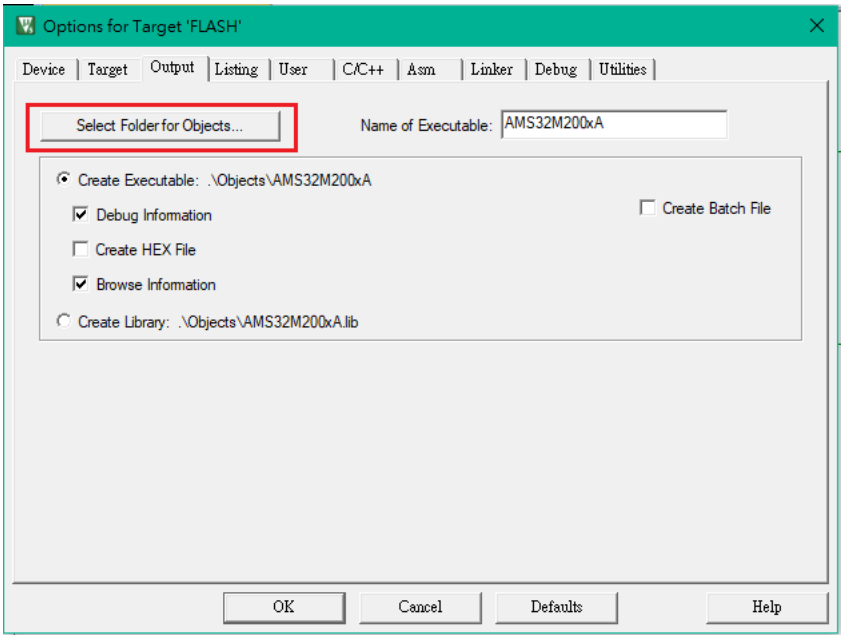


Figure 11. Options for Target: Output

4.2.1.3 Listing

Make sure the Objects folder name is the same as what is shown in Figure 12.
The Listing folder must be named "**Listings**".

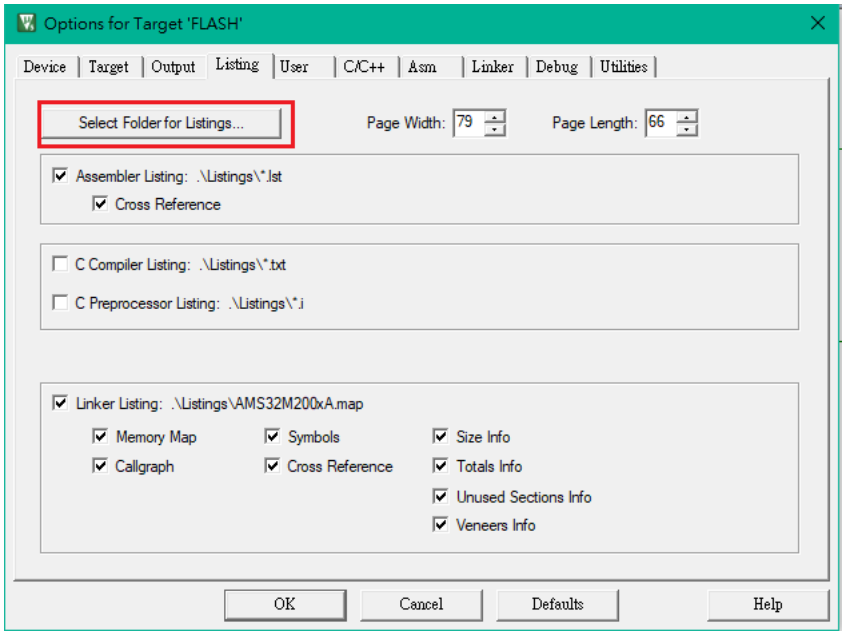


Figure 12. Options for Target: Listing

4.2.1.4 User

The after Build/Rebuild command is used for generating a binary file. The ElfToBin converter is built into Diodes' Keil® MDK ICE Driver.

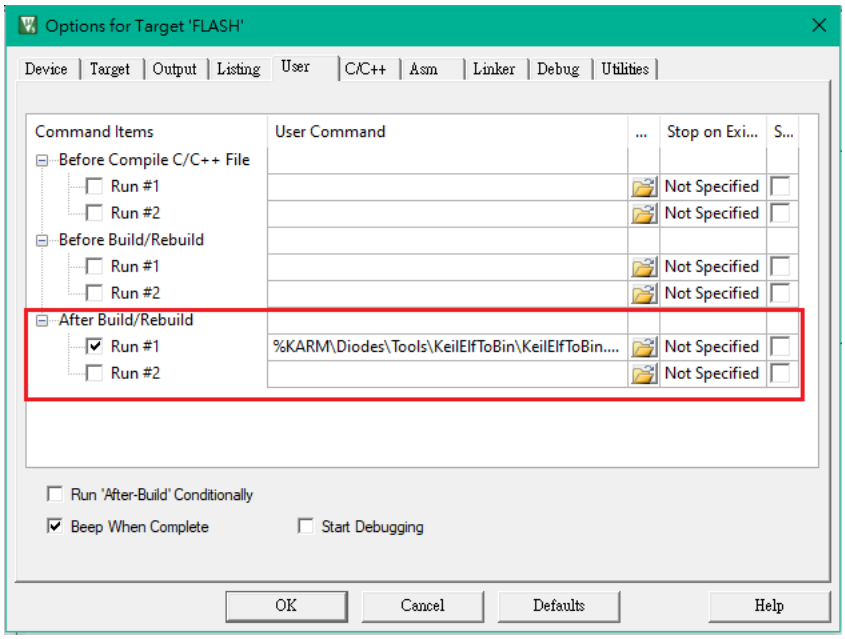


Figure 13. Options for Target: User

After being successfully complied, the BIN file will be automatically generated and the size of the BIN file will be 65KB. The ElfToBin converter command and location of the BIN file are shown by the following description:

```
%KARM\Diodes\Tools\KeilElfToBin\KeilElfToBin.exe ".\Objects\%L"  ".\Objects\%L.bin" "%KARM\Diodes\Tools\KeilElfToBin\Body\$D.json"
```

Note: The command path should be filled in one line. For your convenience, copying the above content and pasting to the project is recommended.

Note: The default path of objects is located at \Objects\, which is the sub-folder of the project.

4.2.1.5 C/C++

Setup the included path described as follows. This step is mandatory for including all required files.

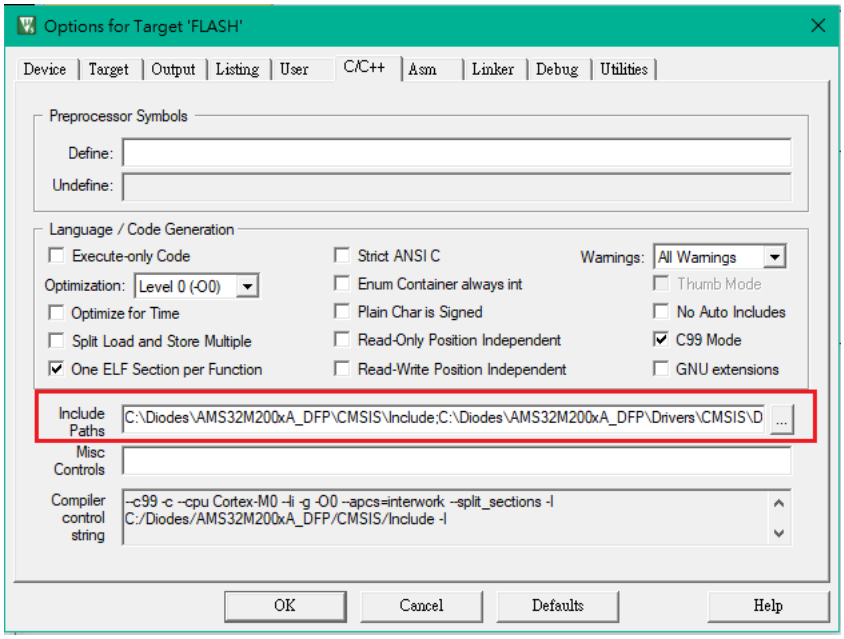


Figure 14. Options for Target: C/C++

Included paths are listed as below.

Table 6 – AMS32M200xA BSP and DFP path list

DFP path
C:\Diodes\AMS32M200xA_DFP\CMSIS\Include
C:\Diodes\AMS32M200xA_DFP\Drivers\CMSIS\Device\Include
C:\Diodes\AMS32M200xA_DFP\Drivers\AMS32M200xA_RL\Include

Project Local path
.\Inc

4.2.1.6 Linker

This section contains ARM Liner setup. User should select **Use the Memory Layout from Target Dialog** as the default by checking the check box shown in Figure 15. It is recommended to generate the Scatter file by Keil for the first time.

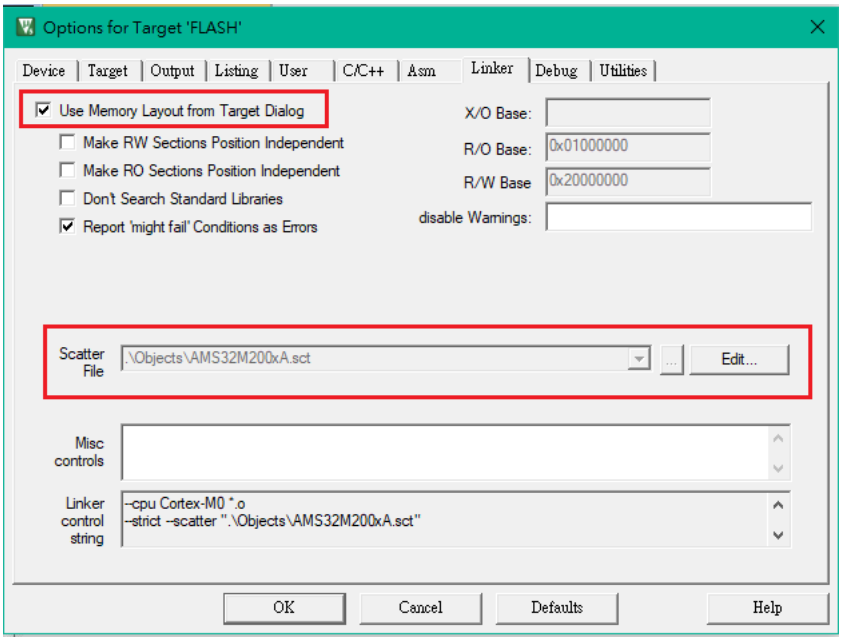


Figure 1. Options for Target: Linker

In addition, the user may arrange the Memory Layout by modifying the Scatter File. This is done by unchecking the box in front of the **Use the Memory Layout from Target Dialog** and clicking **Edit** to open the scatter file to modify.

Both Figure 16 and Figure 17 show the components and organization of a typical scatter file.

AMS32M200xA.sct

```
1  ; *************************************************************
2  ; *** Scatter-Loading Description File generated by uVision ***
3  ; *************************************************************
4
5  LR_IROM1 0x01000000 0x0000F000  {    ; load region size_region
6    ER_IROM1 0x01000000 0x0000F000  {  ; load address = execution address
7     *.o (RESET, +First)
8     *(InRoot$$Sections)
9     .ANY (+RO)
10    .ANY (+XO)
11   }
12   RW_IRAM1 0x20000000 0x00002000  {  ; RW data
13    .ANY (+RW +ZI)
14   }
15 }
16
17
```

Figure 16. Options for Target: Linker: Scatter file

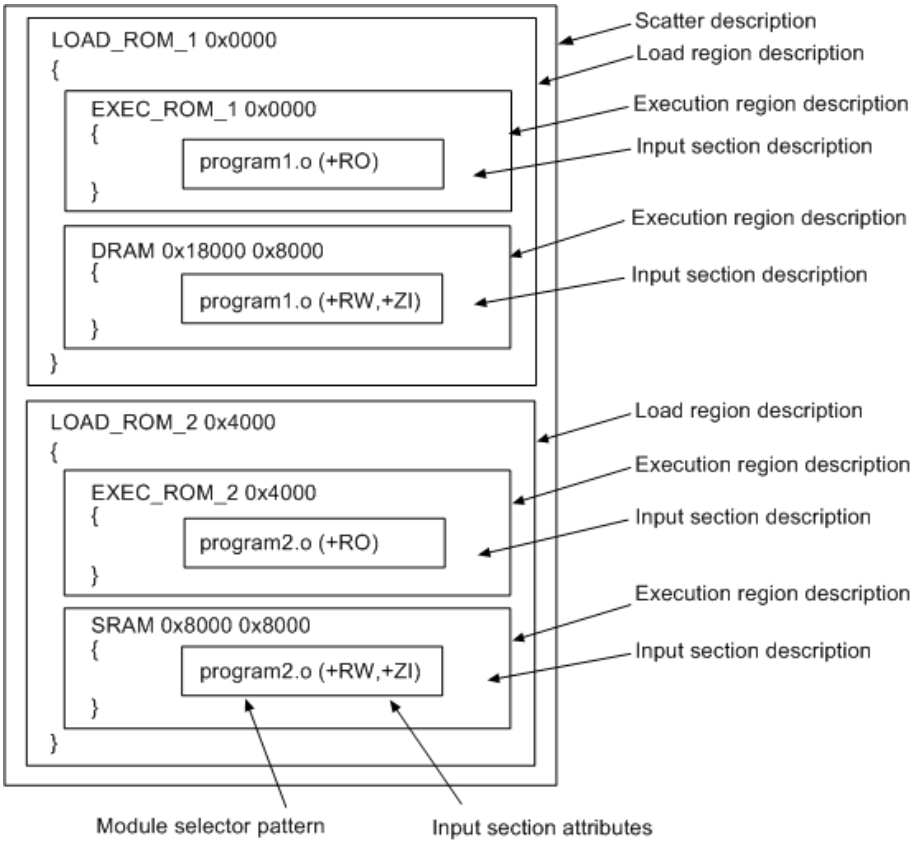


Figure 17. Options for Target: Linker: Scatter Syntax

For more information, please go to ARM Keil website.

4.2.1.7 Debuger Setting

1. **Choose** Diodes AMS32 Driver to debug the program

   Select Run to main()

   Make sure to select Diodes AMS32 Driver in debugger.

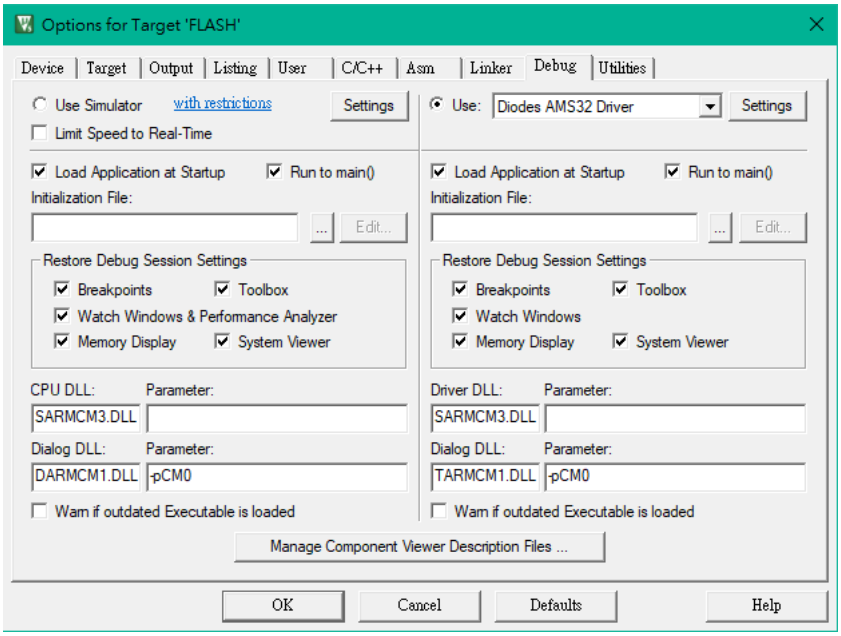


Figure 18. Options for Target: Debug

2. Setting:

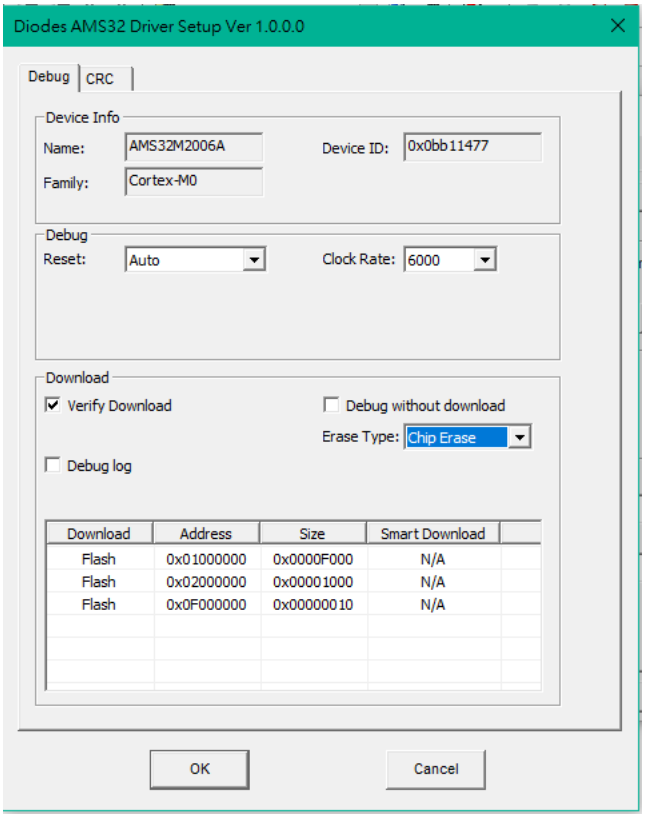


Figure 19. Debug setting setup

3. OpenOCD Setting

For the first time connecting Diodes Debug to PC, click **Allow access** to add OpenOCD into the whitelist in Windows Firewall.

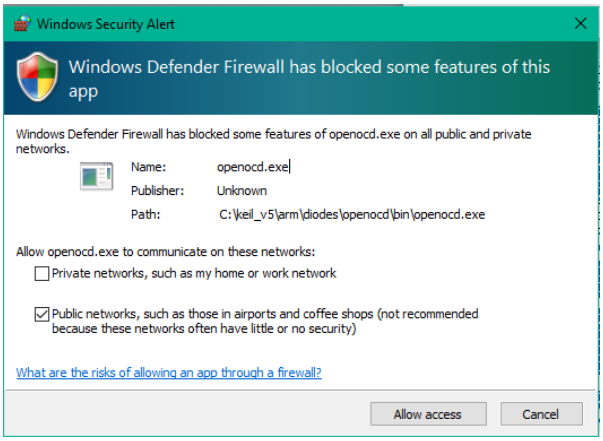


Figure 20. Windows firmware security alert

4. Start / Stop Debug Session

In Keil-MDK, in the **Debug** menu, select Debug and choose **Start/Stop Debug Session function**.

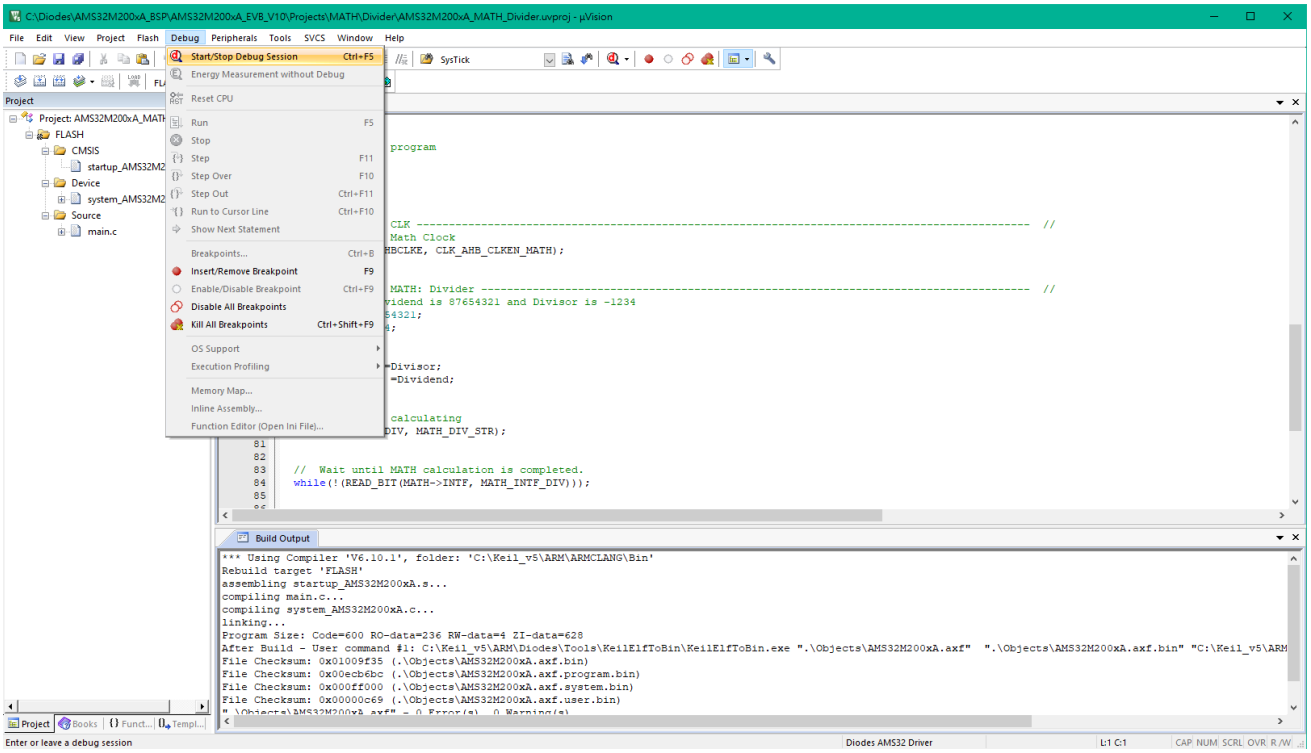


Figure 21. Debugging function

5. Use the Keil “Periodic Window Update” to monitor variables.

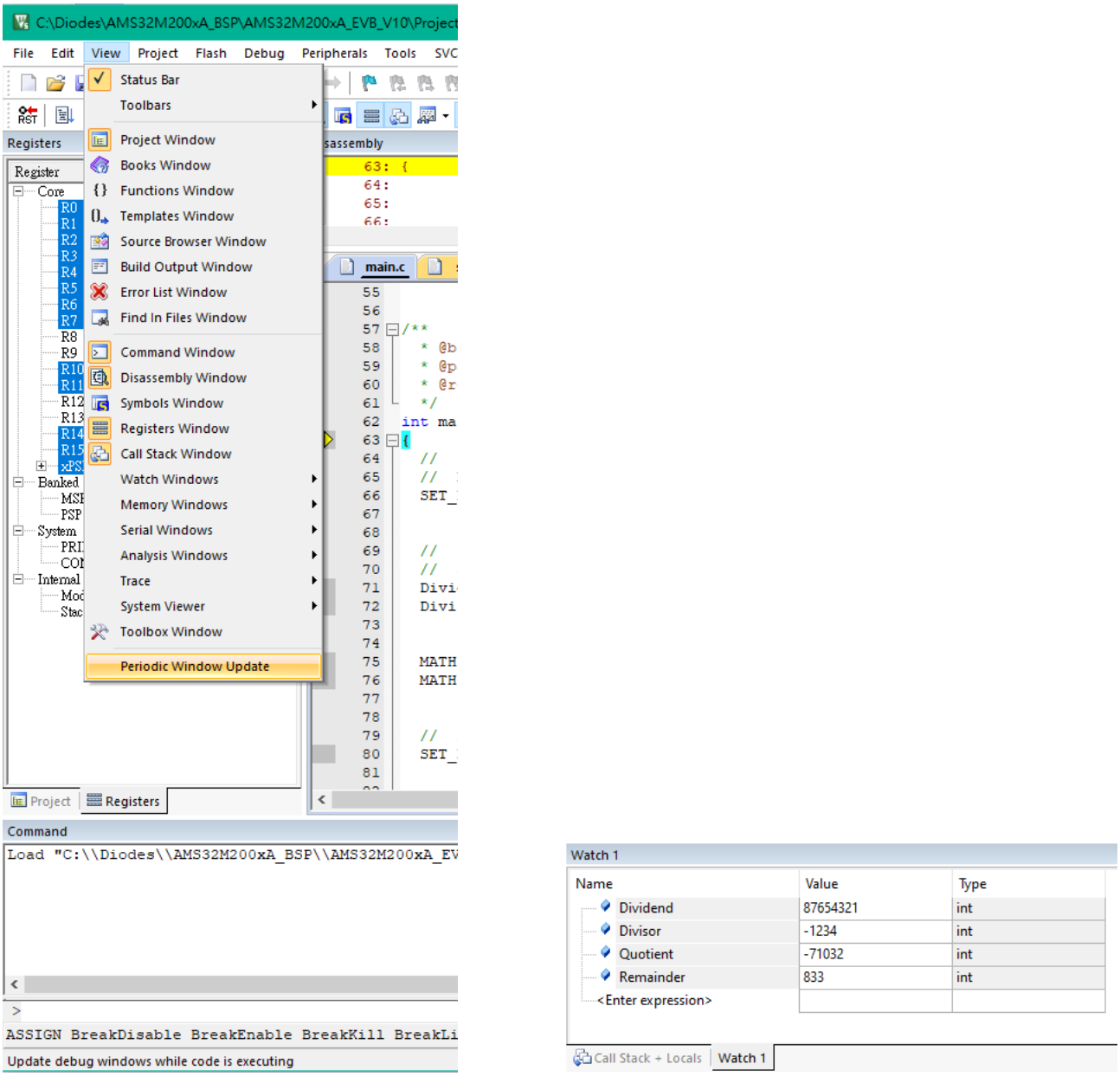


Figure 22. Enabling Period Window Update and monitor variable in Watch Window

4.3 Debug Interface

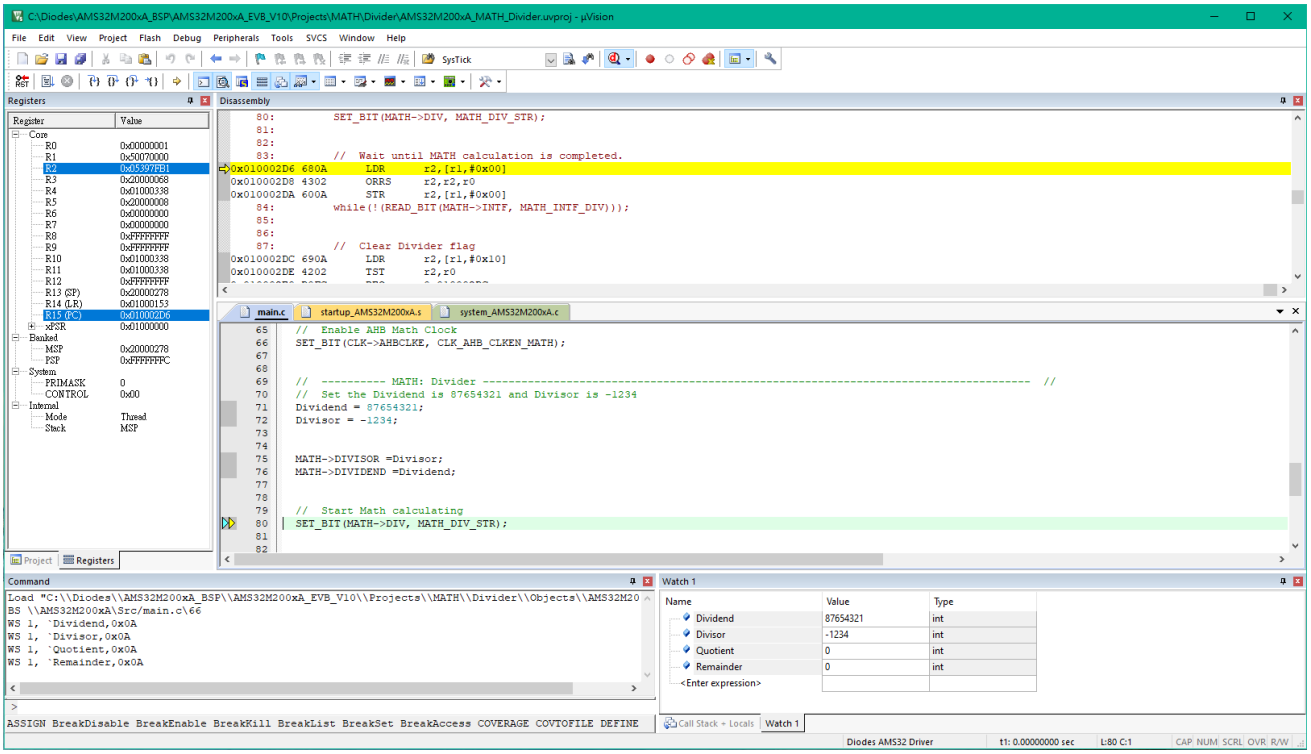


Figure 23. Debug interface

For more information on how to use the Debug Toolbar, please visit www.keil.com

Figure 24. Debug toolbar

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