



COMPILING AND INSTALLING THE PAC2XXXX FIRMWARE USING THE  
PAC22140 AS AN EXAMPLE  
*Power Application Controller Battery Management*

# COMPILING AND INSTALLING THE PAC2XXXX FIRMWARE USING THE PAC22140 AS AN EXAMPLE

*Power Application Controller® Battery Management*



© 2023 Qorvo US, Inc.

No portion of this document may be reproduced or reused in any form without Qorvo's prior written consent



## Contents

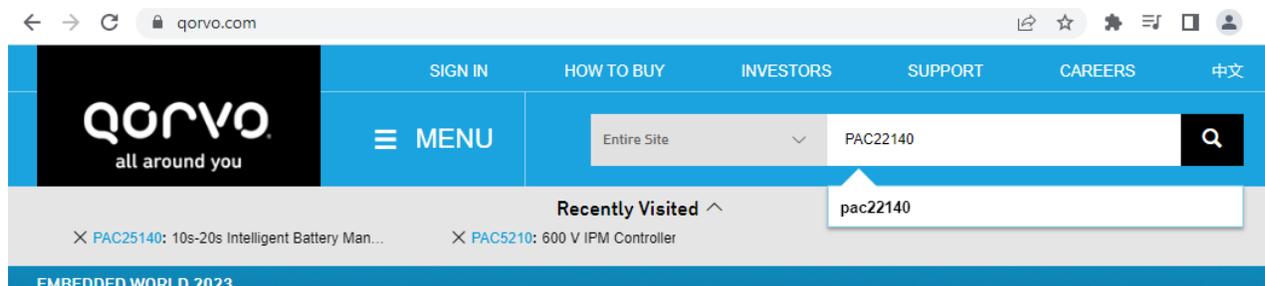
SETUP FOR COMPILING PAC2XXXX FIRMWARE.....	3
1.1 DOWNLOADING THE FIRMWARE.....	3
1.2 EXTRACTING THE FIRMWARE .....	7
1.3 SETTING UP THE ENVIRONMENT .....	8
1.4 MULTIPLE COMPILERS .....	11
1.5 BUILDING FIRMWARE .....	13
1.6 LOADING THE FIRMWARE ON TO THE TARGET USING THE DEBUGGER.....	14
1.7 LEGAL INFORMATION .....	16

## SETUP FOR COMPILING PAC2XXXX FIRMWARE

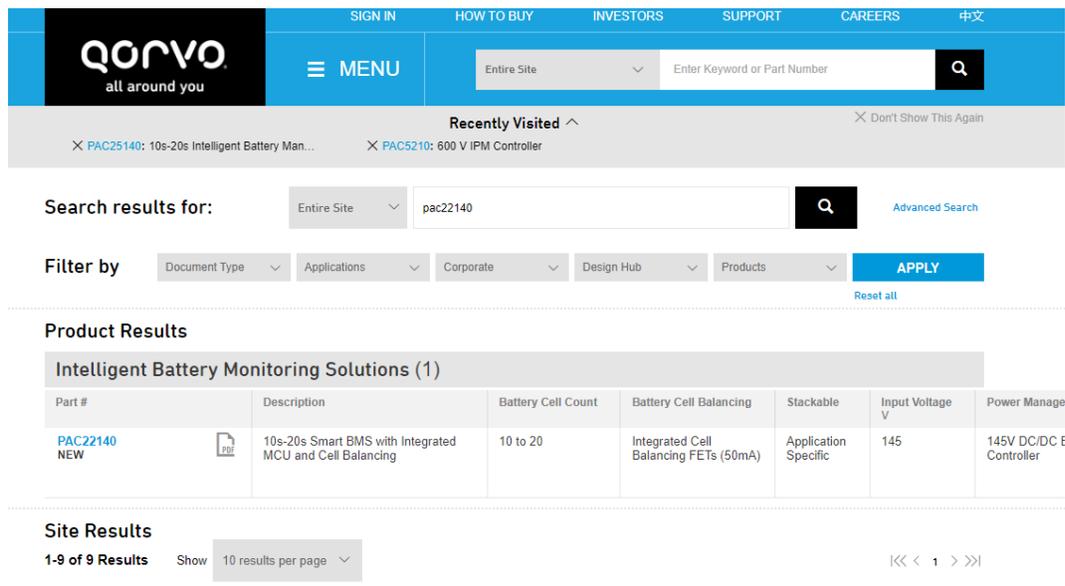
### 1.1 DOWNLOADING THE FIRMWARE

This example uses the PAC22140 firmware to demonstrate how to use Keil and create the firmware executable file that can be flashed to the PAC22140 battery monitoring IC.

Go to Qorvo.com and in the search bar type PAC22140 and press enter



In the product results table, click on the PAC22140 link



This loads the PAC22140 product page linked here,  
<https://www.qorvo.com/products/p/PAC22140#overview>

## PAC22140

10s-20s Smart BMS with Integrated MCU and Cell Balancing

[Production >](#)

[Product Data Sheet](#)  
 Rev 1.0 – 09/23/2022



### Key Features

- Fully Programmable 50Mhz Arm Cortex M0 with 32kB Flash
- 10s-20s Cell Monitoring & Balancing
- 19V-145V Input Buck DC/DC
- High Voltage Charge Pump for gate drive
- 5V/225mA Regulator
- CHG/DSG FET Driver
- 20s Cell Balancing FETs (50mA)
- 16-bit SD ADC for Current Sense with Differential PGA
- 16-bit SD ADC for voltage sense, cell balance
- 10-bit SAR ADC for voltage/temp sense
- Programmable 2-Level OCP
- Ta = -40 C to 105 C
- 9 x 9 mm, 60 pin QFN with power pad

[CONTACT A SALES REP >](#)

[SIGN UP FOR ALERTS >](#)

[REQUEST SAMPLE >](#)

[Overview](#)

[Parameters](#)

[Documents](#)

[Evaluation Tools](#)

[Related Products](#)

The Qorvo® PAC22140 is a Smart Battery Monitoring System (BMS) that can monitor 10-series to 20-series Li-Ion, Li-Polymer and LiFePO4 battery packs. The PAC22140 integrates a FLASH-programmable MCU, Power Management, Current/Voltage/Temperature Sense and drive circuits for charge/discharge FETs and protection fuses. It can communicate using UART/SPI or I2C/SMBus serial interfaces.

The PAC22140 contains an Arm® Cortex®-M0 with 32kB of FLASH and 8KB of SRAM and has access to several different analog and digital peripherals that is intended to be used for the fuel gauging algorithm and system telemetry reporting. There is a single supply 145V input Buck

### Typical Applications

- Garden Tools
- Power Tools
- E-Transportation
- Broad Industrial Battery Management

Next click on the Evaluation Tools tab and scroll down to the PAC22xxx Software section

[Overview](#)
[Parameters](#)
[Documents](#)
[Evaluation Tools](#)
[Related Products](#)

### PAC22140EVK1 Evaluation Kit

Qorvo's PAC22140EVK1 development platform is a complete hardware solution enabling users not only to evaluate the PAC22140 device, but also develop Smart Battery Management System (BMS) solutions by taking advantage of the fully integrated Arm® Cortex®-M0 based microcontroller with BMS specific Analog Front End. The module contains a PAC22140 Power Application Controller® (MCU) and all the necessary circuitry to properly energize the MCU and its internal peripherals once power is applied.

To aid in the application development the PAC22140EVK1 offers access to each and every one of the PAC22140 device's signals by means of a series of male header connectors.

[PAC22140EVK1 User's Guide](#)

[PAC22140EVK1 Schematics, Layout, BOM, Gerber Files and Altium Project](#)



### Supporting Evaluation Tools

The ET-UARTSWD adapter is the preferred adapter for evaluation of PAC devices/firmware and combines a USB to UART adapter with SWD debugger connector adaptation into a single board with isolation. The ET-UARTISO-1 adapter provides only the USB to UART adapter with isolation for Qorvo application GUI communications.

#### ET-UARTSWD

The ET-UARTSWD isolated communications and debugging interface unifies two modules into one. Previously, interfacing a PC Computer to any of Qorvo's PAC5xxx Evaluation Modules required one module to enable UART based serial communications and a second module to allow for in-system debugging and FLASH memory programming.

[Download ET-UARTSWD User Manual](#)



### PAC5xxx Flash Programmer Tools

Qorvo has partnered with Flash Programmer solution providers to support our Intelligent Motor Control PAC product families. These proven tools are suitable for emerging and high volume product manufacturing. Both package level (socketed) and board level Flash programming solutions are available.

Qorvo will support other vendors familiar with Arm® Serial Wire Debug (SWD) protocol to add PAC product compatibility on their existing Flash programmer platforms. For details, please contact [Qorvo Sales](#).

### PAC22xxx Software

[PAC22xxx BMS Application Firmware](#)  
 Version: v1.0.0

Installer for the PAC22xxx BMS application firmware, which a full featured Battery Management System solution (BMS), which offers charge and discharge control, cell state of charge reporting, fault generation and protection, as well as cell balancing control. The installer contains example application source code, Windows graphical user interface (GUI), and documentation to allow the user to configure the system to work with their target motor. Project files for IAR Systems Embedded Workbench for Arm (EWARM), Keil uVision, and Eclipse are included.

Click on the PAC22xxx BMS Application Firmware link highlighted with the yellow circle.

This should take you to a registration page. Enter the requested information and fill the CAPTCHA and submit. A link to download the application should be sent within a few minutes to the specified email ID.

## SOFTWARE DOWNLOAD

Thank you for your interest in this software download.

Please complete the form below so we can e-mail you a one-time link for the requested software download.

First Name*	Last Name*
<input type="text"/>	<input type="text"/>
E-mail Address*	Company*
<input type="text"/>	<input type="text"/>
Country*	ZIP / Postal Code
<input type="text" value="---"/>	<input type="text"/>
<input type="checkbox"/> Yes, I agree to receive periodic emails from Qorvo related to products and services and can unsubscribe at any time. I accept the <a href="#">Qorvo Privacy Policy</a> .*	
<input type="checkbox"/> Yes, please notify me when a new version of this software download is available.	
Refresh Enter the text you see above.	
<input type="text"/>	
<input type="submit" value="SUBMIT FORM"/>	

Download and save the zip file to any desired folder on your computer.

Name	Date modified	Type	Size
installer-pac22140_bms_fw_gui_v1.0.0_11152022.zip	1/24/2023 3:04 PM	Compressed (zipp...	1,892 KB

## 1.2 EXTRACTING THE FIRMWARE

Extract the exe file within the zip file. Then run the installer file “installer-pac22140\_bms\_fw\_gui\_v1.0.0\_11152022.exe”. Please note that you will need admin rights to run this file.

Name	Date modified	Type	Size
installer-pac22140_bms_fw_gui_v1.0.0_11152022.exe	11/28/2022 3:45 PM	Application	2,058 KB

This should extract all the files into a subdirectory under the installer folder

Name	Date modified	Type	Size
pac22140_bms_fw_gui_v1.0.0_11152022	1/25/2023 8:29 PM	File folder	
installer-pac22140_bms_fw_gui_v1.0.0_11152022.exe	11/28/2022 3:45 PM	Application	2,058 KB

Double click on the newly created folder, then navigate to the \pac22xxx\keil\_proj subfolder within it. In there you should see the bms\_keil.uvprojx file. This is the project file that contains the code required to build the firmware using Keil uvision IDE.

Name	Date modified	Type	Size
Listings	3/13/2023 2:15 PM	File folder	
Objects	3/13/2023 2:15 PM	File folder	
bms_keil.sct	11/2/2022 6:35 AM	Windows Script C...	1 KB
bms_keil.uvguix.dn101358	11/2/2022 6:35 AM	DN101358 File	93 KB
bms_keil.uvguix.vc105639	3/13/2023 2:15 PM	VC105639 File	90 KB
bms_keil.uvoptx	3/13/2023 2:14 PM	UVOPTX File	59 KB
bms_keil.uvprojx	3/13/2023 2:15 PM	µVision5 Project	43 KB
EventRecorderStub.scvd	11/7/2022 3:37 PM	SCVD File	1 KB
JLinkSettings.ini	11/2/2022 6:35 AM	Configuration sett...	1 KB
project_build_info_keil.h	11/2/2022 6:35 AM	C Header Source F...	1 KB

### 1.3 SETTING UP THE ENVIRONMENT

**NOTE:** When Keil is installed, it offers the option of installing it in the current user’s userspace in Windows, which is usually under C:\Users\**USERNAME**\AppData\Local\ folder. The other option is to install for all users. If the user chooses this option, then the files are placed under the Keil installation directory. This is typically under C:\Keil\_v5.

We encourage users to select the option of installing Keil under the current user’s userspace. This allows for multiple users to have the flexibility to create their own settings.

This document is written with Keil setup for the current user’s userspace.

Keil includes a package manager that contains files that support MCUs from multiple vendors. Qorvo’s PAC22140 uses an MCU that was designed by Active Semi which later merged with Qorvo. As of the time of creation of this document, ARM has removed the package files required to support the PAC22140 since Active Semi is no longer an independent vendor. We are working to resolve this exclusion.

Until then, we provide the required files with our firmware development kit. Included in the firmware package is a file, Active-Semi.zip. Extract the contents of this file into a separate folder called Active-Semi. The directory should look as shown below

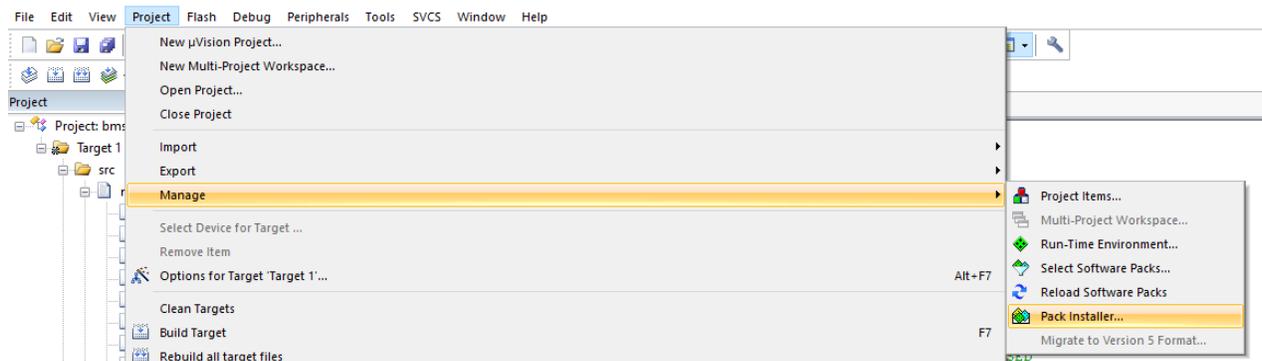
Name	Date modified	Type	Size
PAC52XX	2/22/2023 11:59 AM	File folder	
PAC55XX	2/22/2023 11:59 AM	File folder	

Copy the Active-Semi folder into the path where the ARM packs are located. Typically, if the default paths are used, the directory for the packs is C:\Users\**USERNAME**\AppData\Local\Arm\Packs\Active-Semi where **USERNAME** is the Windows username. If these are placed in the wrong path, the firmware project will be unable to build the binary to upload to the device.

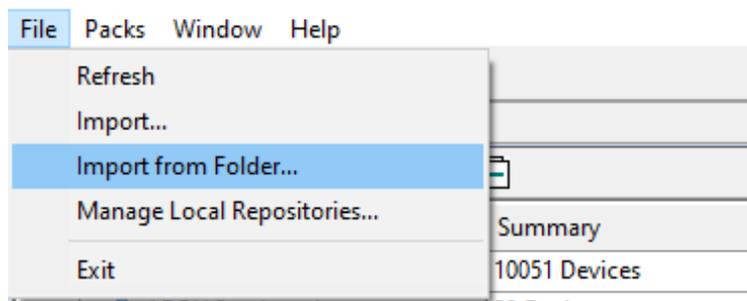
If Active-Semi is the only PACK set that is included in the path, the contents of the directory would look as shown below

Name	Date modified	Type	Size
.Download	2/10/2023 1:00 PM	File folder	
.Local	2/10/2023 1:00 PM	File folder	
.Web	4/5/2023 12:37 PM	File folder	
Active-Semi	2/22/2023 11:59 AM	File folder	
ARM	2/10/2023 12:59 PM	File folder	
Keil	2/10/2023 1:00 PM	File folder	

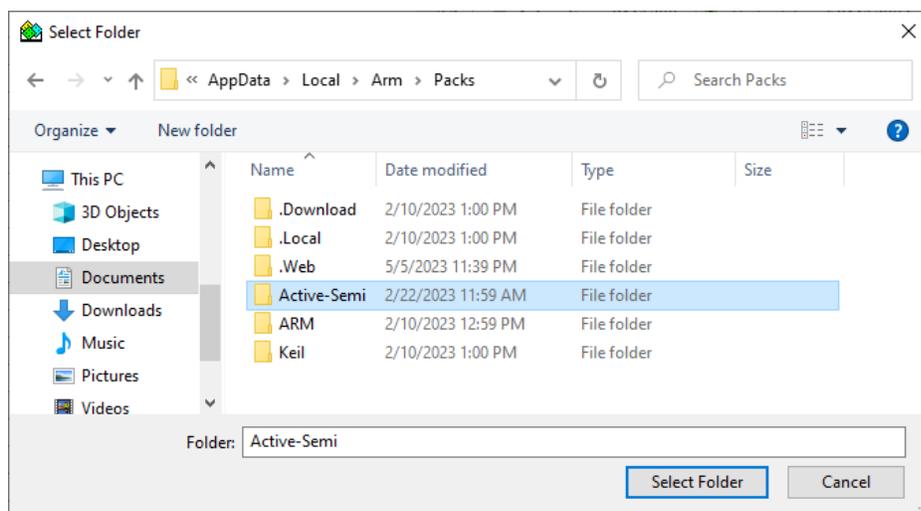
To ensure that the package files are loaded and listed in the package manager, click on **Project** in the Menu bar, then choose **Manage**, and click on **Pack Installer**.



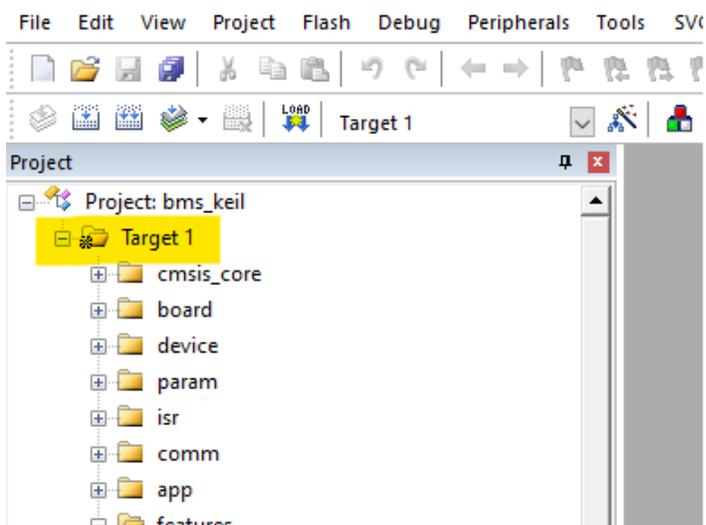
Then, on the **Pack Installer** menu bar, click on **File**, then click on **Import from Folder**



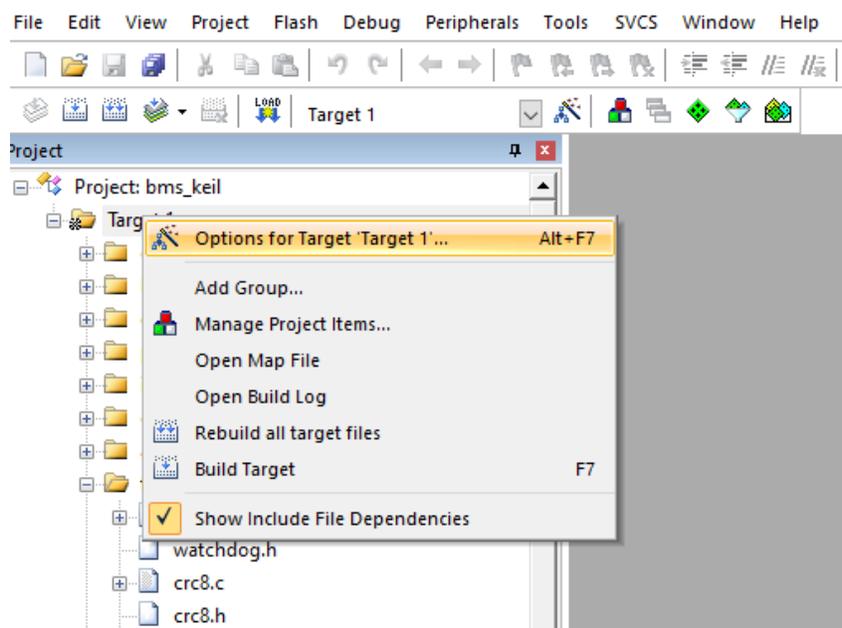
Now, navigate to the folder that contains the **Active-Semi** folder and click on **Select Folder**



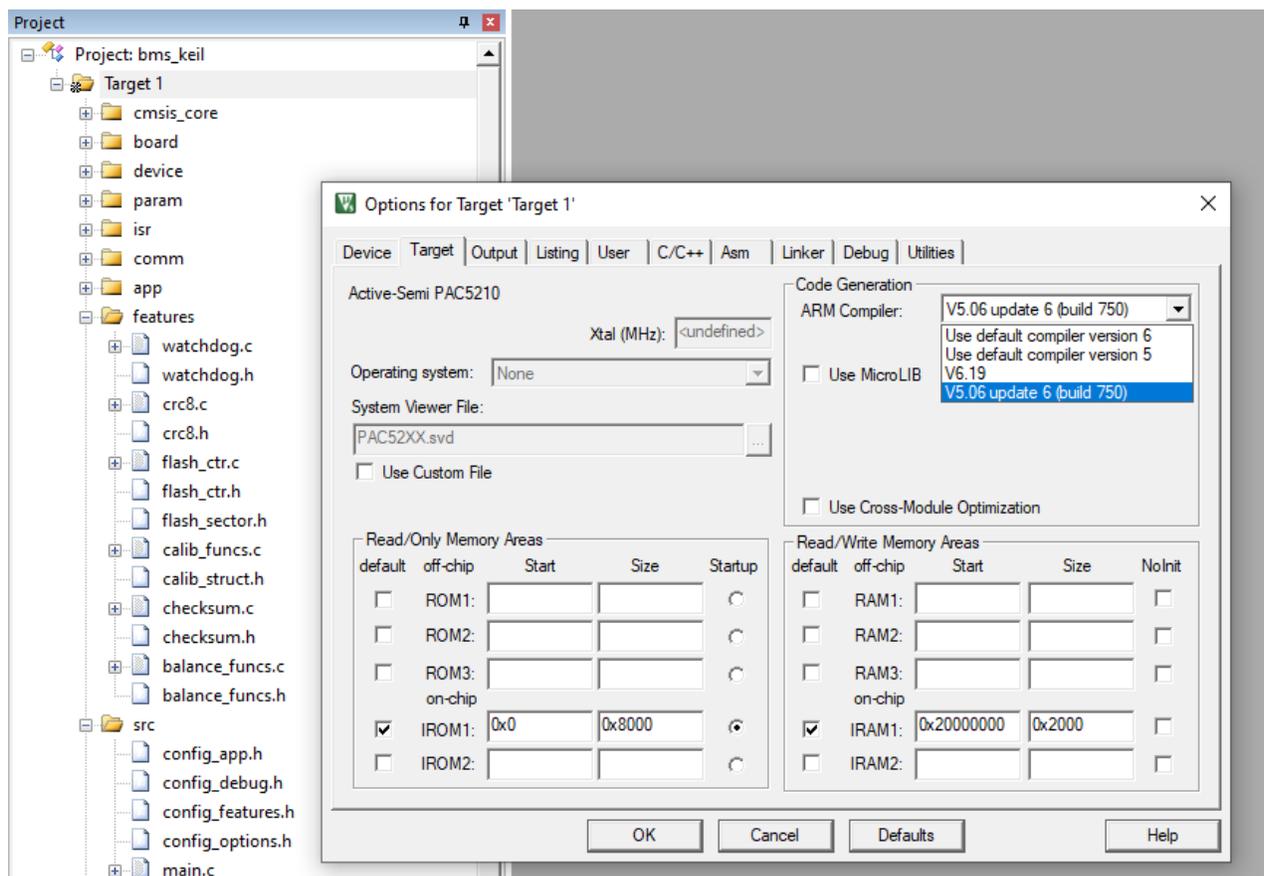
Now, go back to the folder where the firmware package was extracted. Double click on bms\_keil.uvprojx and open it.



Right click on the Target 1 text highlighted in yellow and click on Options for Target “Target 1” ... highlighted here



Navigate to the Target tab and under the Code Generation section, next to the ARM Compiler drop down option, select v5.06 Update 6 (Build 750). Next click OK and close the window



This completes the setup requirements for creating the PAC22140 firmware using Keil.

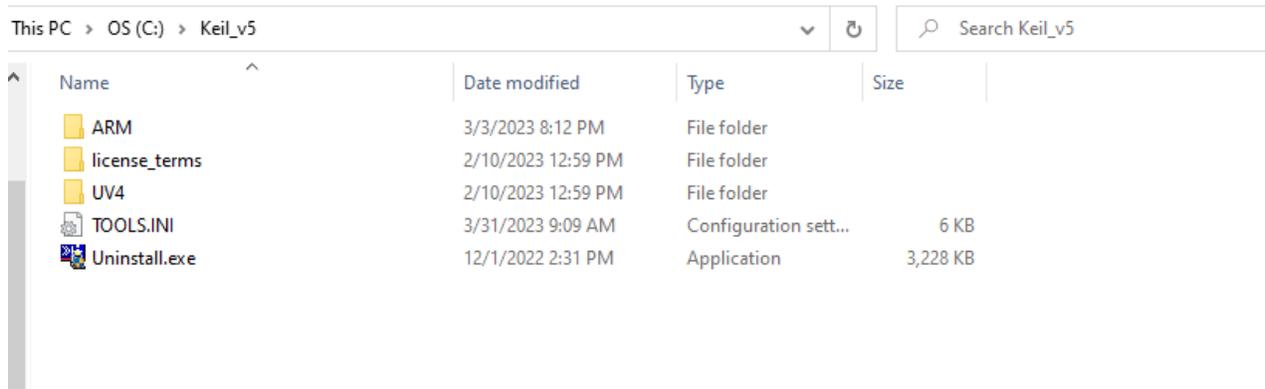
## 1.4 MULTIPLE COMPILERS

It is possible to have multiple compilers for ARM installed separately. This is because ARM offers the option of downloading various compilers from their website. The compilers are available in the website linked here, <https://developer.arm.com/documentation/ka005184/latest>

If the paths of the compilers are not the default paths used by Keil, it is possible to encounter errors when building firmware as the licenses and artifacts used with each compiler may be missing. Therefore, while

using the option of downloading a separate compiler, please ensure that the path under which the compiler is installed is as indicated here.

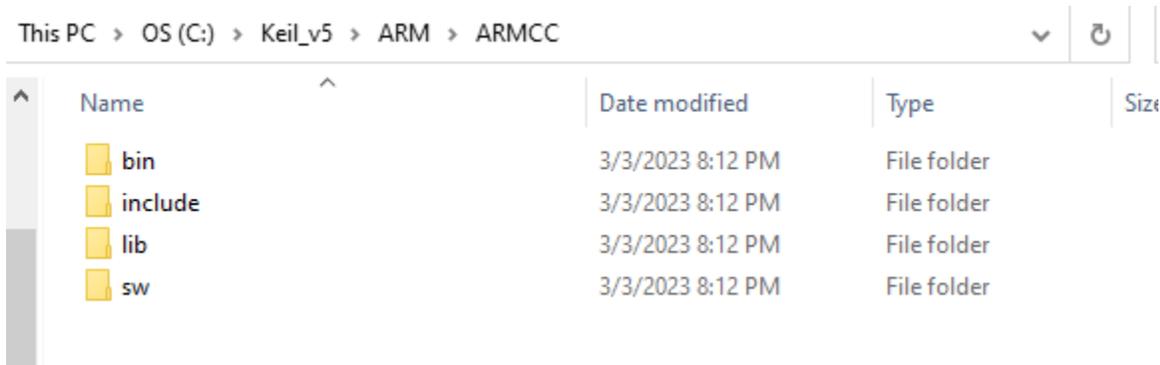
If Keil has been installed in the path C:\Keil\_v5 as shown in the image below



Then the ARM compilers for the legacy releases should be under

C:\Keil\_v5\ARM\ARMCC

The contents of the folder should be

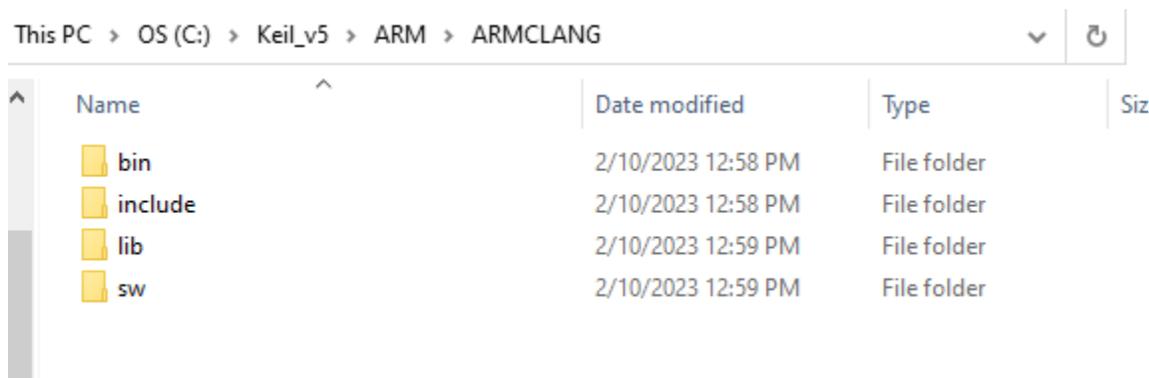


without other nested folder paths such as C:\Keil\_v5\ARM\ARMCC\ARMCC

The new compilers should be under

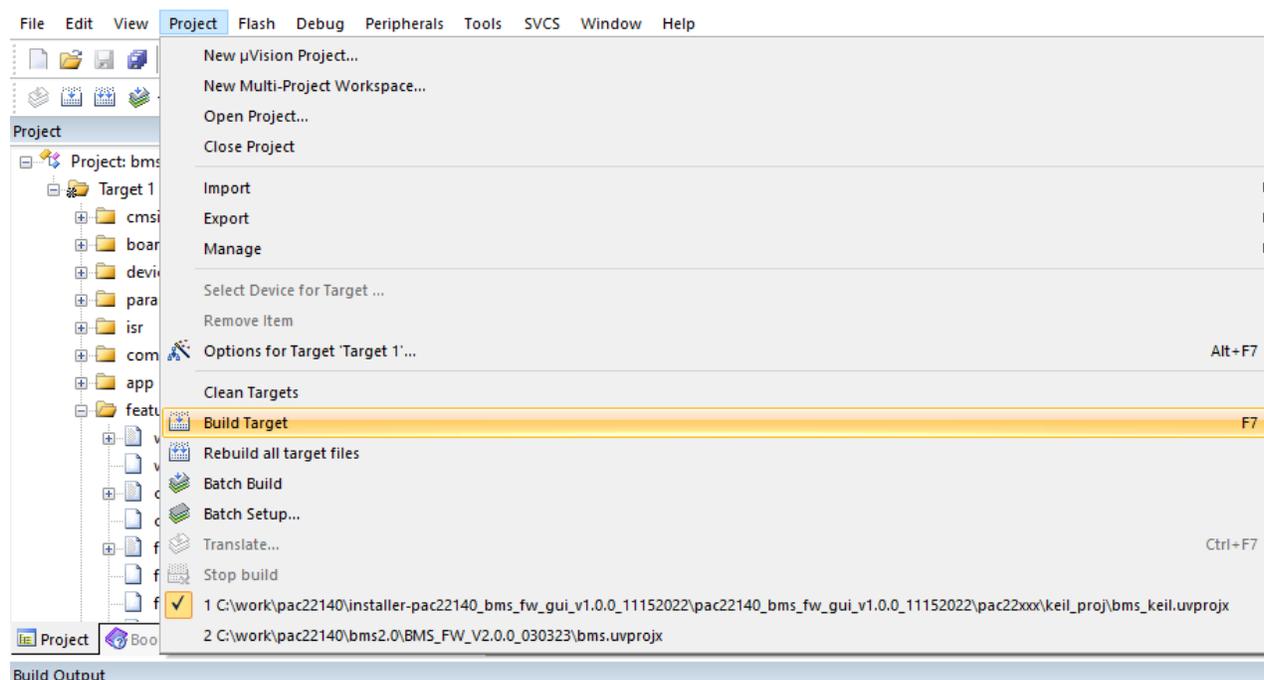
C:\Keil\_v5\ARM\ARMCLANG

and the contents of the folder should be



## 1.5 BUILDING FIRMWARE

With the Keil environment ready, the next step is to create the firmware executable that can be programmed into the PAC22140 BMS EVK. To do this, go to the Project menu and click on Build Target or press F7

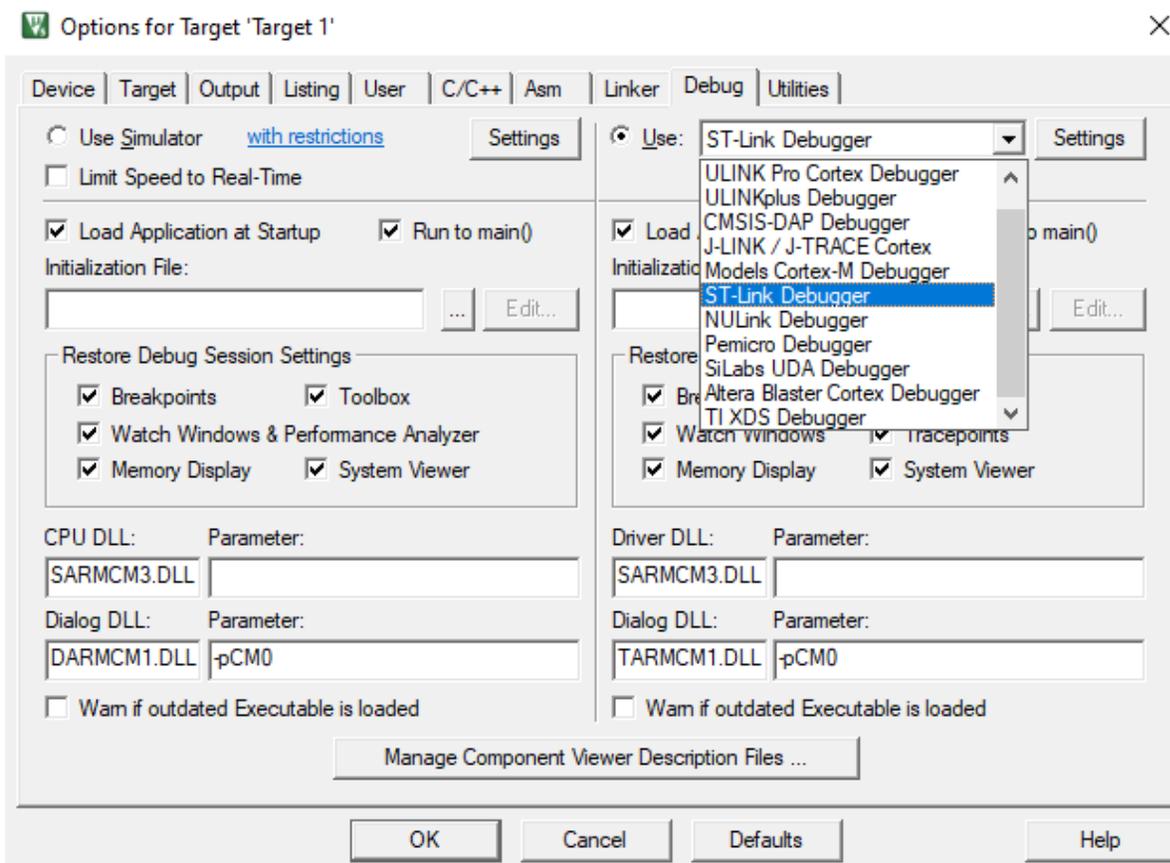


The compiler should now output the binary firmware package that can be flashed on to the PAC22140.

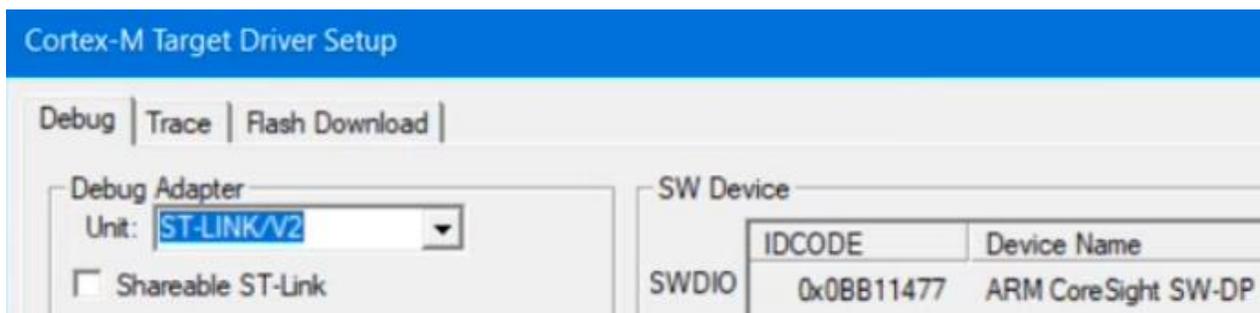
```
Build Output
Build started: Project: bms_keil
*** Using Compiler 'V5.06 update 6 (build 750)', folder: 'C:\Keil_v5\ARM\ARMCC\Bin'
Build target 'Target 1'
Before Build - User command #1: ..\..\pre_build.bat .\ keil
executing pre_build.bat...
.\..\..\..\build_date_time.bat doesn't exist
After Build - User command #1: "C:\Keil_v5\ARM\ARMCC\bin\fromelf.exe" --bincombined ".
.\Objects\bms_keil.axf" - 0 Error(s), 0 Warning(s).
Build Time Elapsed: 00:00:01
```

## 1.6 LOADING THE FIRMWARE ON TO THE TARGET USING THE DEBUGGER

Connect the debugger to the powered-up target. Then open the Keil IDE. To make sure that the target is connected and recognized by the Keil environment, press “ALT+F7” to open the Options for Target menu. In it navigate to the Debug tab. Here, in the Use section select the debugger used.



Then, click on the Settings button next to the selected debugger. If the target is active and powered up, it will be listed under the SW Device section as shown in the example screenshot



If the SW Device section does not list a connected device with an ID, it means that the environment has not detected a powered device. In such a situation, please check and reconnect your device until it is detected. Without it, the firmware cannot be uploaded to the BMS device.

Once the device is detected, click on the OK button to close the window. Now press F8 to load the firmware onto the target.

Keil will proceed to program the target. Once programming is completed, it will be indicated in the Build Output tab as shown below.

```
Build Output
Program Size: Code=23548 RO-data=2224
After Build - User command #1: "C:\Ke
After Build - User command #2: "..\..
crc_insert v1.0.1; build-20160127.132
crc_insert-Opening BIN File for CRC16
crc_insert-Writing CRC16 checksum=0x7
crc_insert-Opening ELF File for CRC16
crc_insert-CRC Insertion Completed
".\Objects\PAC_FOC.axf" - 0 Error(s),
Build Time Elapsed: 00:00:06
Load "C:\\Users\\fa080022\\Git\\pac5
Erase Done.
Programming Done.
Verify OK.
Application running ...
Flash Load finished at 15:18:58
```

Now, the device can be used, and the firmware can be evaluated on the controller.



COMPILING AND INSTALLING THE PAC2XXXX FIRMWARE USING THE  
PAC22140 AS AN EXAMPLE  
*Power Application Controller Battery Management*

## 1.7 LEGAL INFORMATION

For the latest specifications, additional product information, worldwide sales and distribution locations:

**Web:** [www.qorvo.com](http://www.qorvo.com)

**Tel:** 1-844-890-8163

**Email:** [customer.support@qorvo.com](mailto:customer.support@qorvo.com)

The information contained in this Application Note and any associated documents (“Application Note information”) is believed to be reliable; however, Qorvo makes no warranties regarding the Application Note Information and assumes no responsibility or liability whatsoever for the use of said information. All Application Note Information is subject to change without notice. Customers should obtain and verify the latest relevant Application Note Information before placing orders for Qorvo® products. Application Note Information or the use thereof does not grant, explicitly, implicitly or otherwise any rights or licenses to any third party with respect to patents or any other intellectual property whether with regard to such Application Note Information itself or anything described by such information.

APPLICATION NOTE INFORMATION DOES NOT CONSTITUTE A WARRANTY WITH RESPECT TO THE PRODUCTS DESCRIBED HEREIN, AND QORVO HEREBY DISCLAIMS ANY AND ALL WARRANTIES WITH RESPECT TO SUCH PRODUCTS WHETHER EXPRESS OR IMPLIED BY LAW, COURSE OF DEALING, COURSE OF PERFORMANCE, USAGE OF TRADE OR OTHERWISE, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Without limiting the generality of the foregoing, Qorvo® products are not warranted or authorized for use as critical components in medical, lifesaving, or life-sustaining applications, or other applications where a failure would reasonably be expected to cause severe personal injury or death.

Applications described in the Application Note Information are for illustrative purposes only. Customers are responsible for validating that a particular product described in the Application Note Information is suitable for use in a particular application.

© 2023 Qorvo US, Inc. All rights reserved. This document is subject to copyright laws in various jurisdictions worldwide and may not be reproduced or distributed, in whole or in part, without the express written consent of Qorvo US, Inc. QORVO® is a registered trademark of Qorvo US, Inc.

© 2023 Qorvo US, Inc.

No portion of this document may be reproduced or reused in any form without Qorvo’s prior written consent