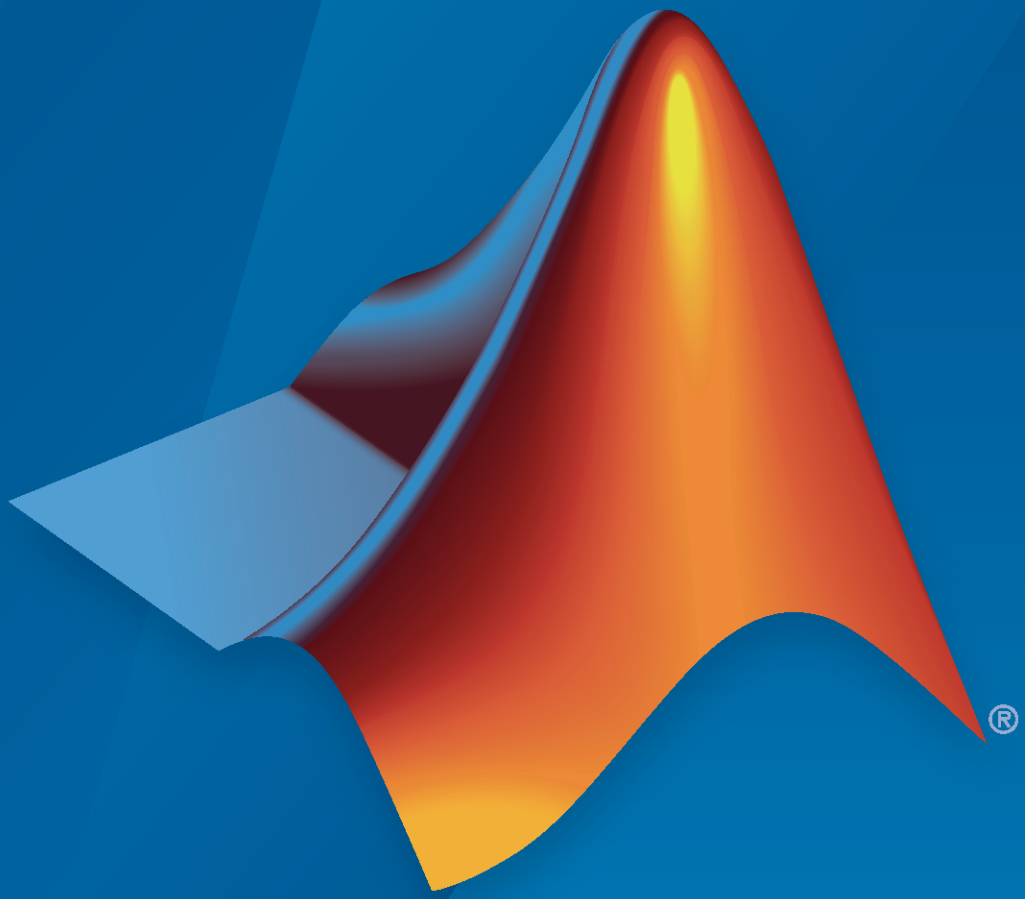
Motor Control Blockset™

Sensorless Field-Oriented Control (FOC) of PMSM Using Microchip's dsPICDEM™ MCLV-2 Development Board



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R2021b

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Motor Control Blockset™ (Nonrelease)

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Revision History

April 2022	First printing	"Release for R2021b"

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About This Example

Introduction

This example implements the field-oriented control (FOC) technique to control the speed of a three-phase permanent magnet synchronous motor (PMSM). This example uses the flux observer sensorless position estimation technique.

This motor control is realized using the Microchip dsPICDEM™ MCLV-2 Development Board. It provides a cost-effective method of evaluating and developing 3-phase sensored or sensorless Brushless DC (BLDC) and Permanent Magnet Synchronous Motor (PMSM) control applications. The board supports Microchip's 100-pin motor control Plug-In-Modules (PIMs) for the dsPIC33C, dsPIC33E and dsPIC33F Digital Signal Controllers (DSCs) and also for the PICM32MK and ATSAME70 families. The board supports the use of the internal on-chip op amps found on certain dsPIC® or PIC32MK devices, or the external op amps provided on the MCLV-2 board. For more details about the hardware, see dsPICDEM™ MCLV-2 Development Board (DM330021-2).

Hardware Specifications

Hardware tools required to run example:

- MCLV-2 Development Board (DM330021-2) .
- dsPIC33EP256MC506 Internal Op-Amp Motor Control PIM (MA330031).
- MPLAB PICkit4 In-Circuit Debugger (PG164140) (or any supported Debugger).
- 24V Power Supply (AC002013).
- 24V 3-Phase Brushless DC Permanent Magnet Motor - Hurst300 (AC300022).

Software Requirements

This section lists the software products from MathWorks® and Microchip that you need to simulate and run the example models on the dsPICDEM™ MCLV-2 Development Board.

Required MathWorks Products

To simulate an example model:

- Motor Control Blockset
- Stateflow®

To generate code and deploy an example model:

- Motor Control Blockset
- Embedded Coder®
- Fixed-Point Designer™
- MATLAB® Coder™
- Simulink® Coder

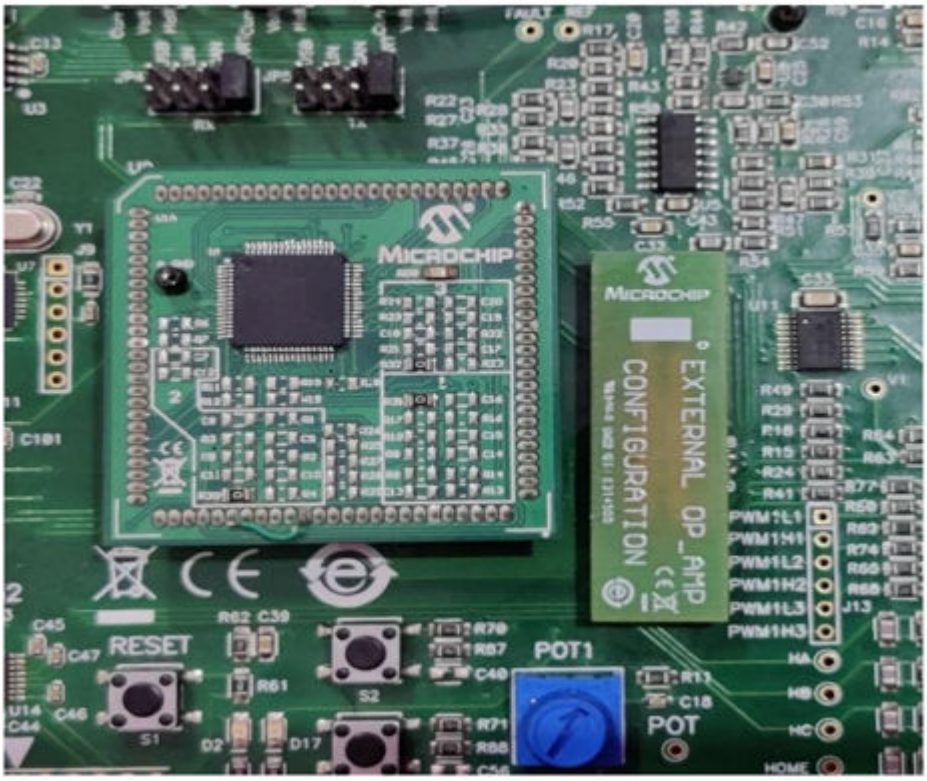
Required Microchip Products

- MPLAB X IDE and IPE (v5.45 or later).
- XC16 compiler (v1.6 or later).
- MPLAB Device Blocks for Simulink Toolbox.

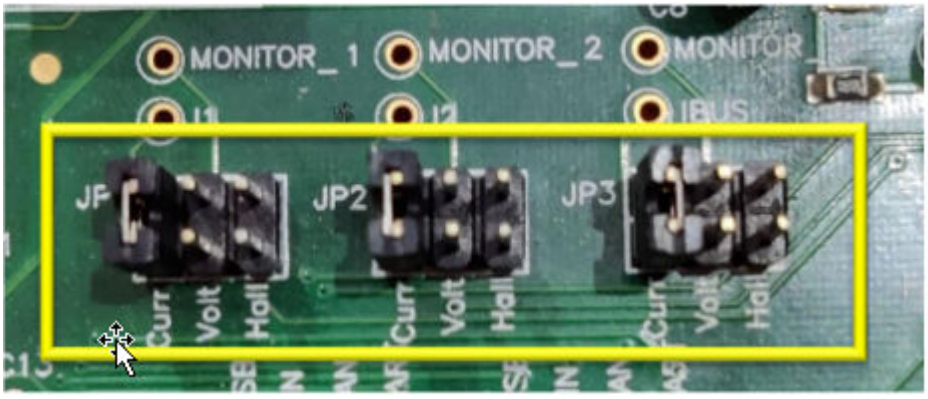
Hardware Setup

The hardware setup procedure is described below:

1. Connect the dsPIC33EP256MC506 external op-amp PIM and external op-amp matrix to the MCLV2 board. Also keep the 'POT' at the minimum position as shown in the picture below.

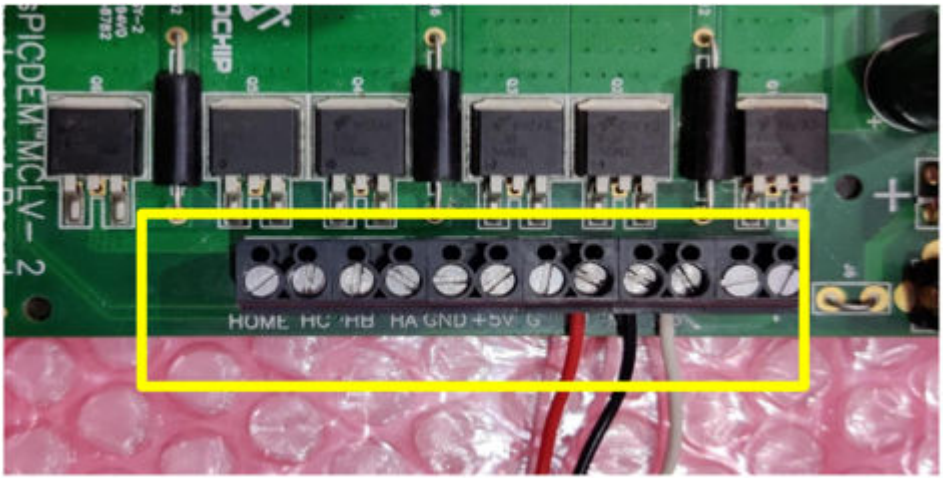


2. Keep the Jumper connections of JP1, JP2 and JP3 at Curr position.



3. The Hurst 300 motor phase current connections are shown as follows.

Note The sequence of 3 phase wires is immaterial for sensorless algorithm.



4 Connect the programmer to MCLV2 board to program the device and while aligning the triangle on the connector pin with MCLR pin of PICKIT-4 connector as shown.

Contents of Downloaded ZIP Folder

The ZIP folder that you downloaded from the GitHub® repository, includes:

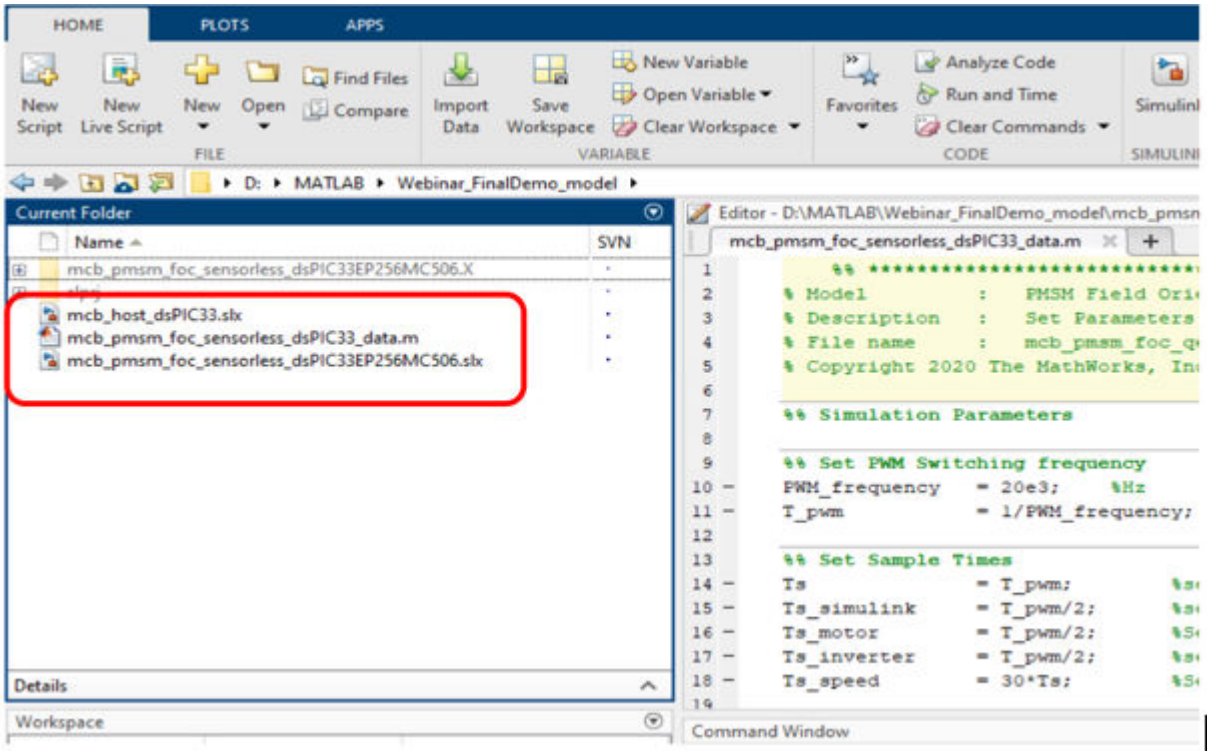
File Name	Description
`mcb_pmsm_foc_sensorless_dsPIC33EP256MC506.slx`	Target model
`mcb_pmsm_foc_sensorless_dsPIC33_data.m`	Target model initialization script
`mcb_host_dsPIC33.slx`	Host model
`Sensorless_FOC_Hardware_Test_Procedure_dsPIC33EP.pdf`	Documentation

Sensorless Field Oriented Control of PMSM using Microchip Hardware

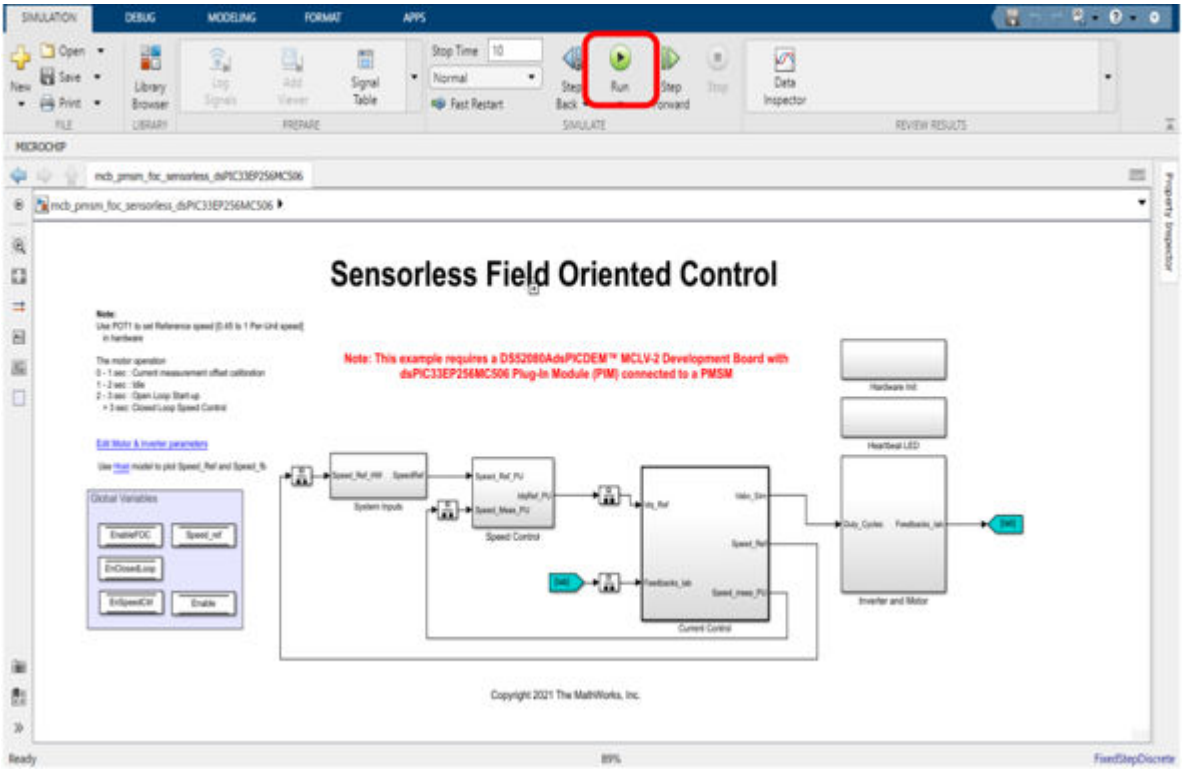
Simulate Target Model

This example supports simulation. Follow these steps to simulate the model.

1 Open the target model included in this workflow.



2 Click **Run** on the **Simulation** tab to simulate the model.



3 Click **Data Inspector** on the **Simulation** tab to view and analyze the simulation results.

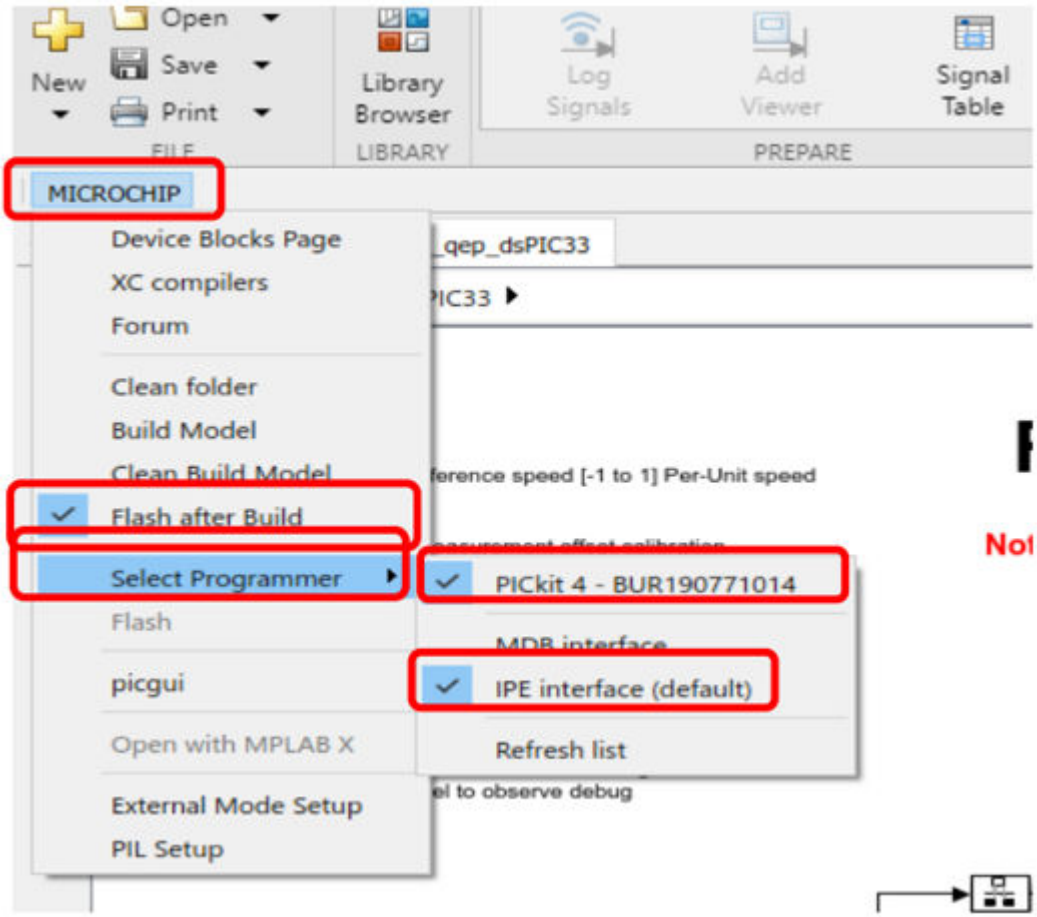
Generate Code and Deploy Model to Target Hardware

This section explains how to generate code and run the FOC algorithm on the target hardware.

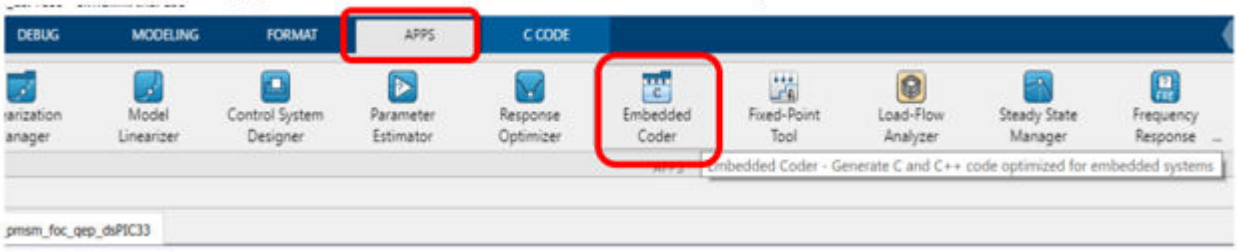
Follow these steps to deploy and run the target model on the dsPICDEM™ MCLV-2 Development Board kit.

1. Simulate the target model and observe the simulation results.
2. Connect the dsPICDEM™ MCLV-2 Development Board kit to the host computer.
3. Click the Edit motor & inverter parameters hyperlink available in the target model to open the target model initialization script. You can also use this command to open the initialization script `edit mcb_pmsm_foc_sensorless_dsPIC33_data.m`.
4. Verify and edit the motor and inverter parameters that are pre-configured in the model initialization script `edit mcb_pmsm_foc_sensorless_dsPIC33_data.m`.

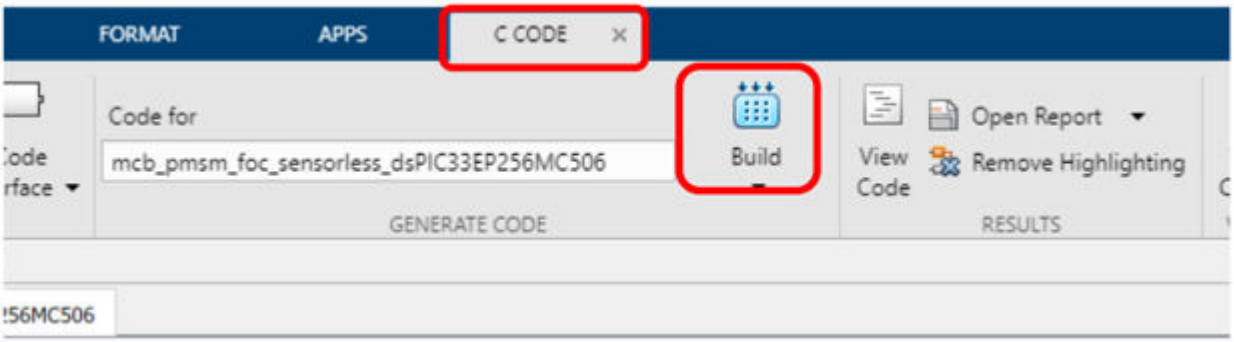
   For instructions to configure the script, see Estimate Control Gains from Motor Parameters.
5. In order to run the real permanent magnet synchronous motor, go to Microchip tab and enable the tabs shown in the figure below. This will select the Programmer and code will flashed to microcontroller after building.



6. Click on the **Apps** tab on the menu bar and open **Embedded Coder**.

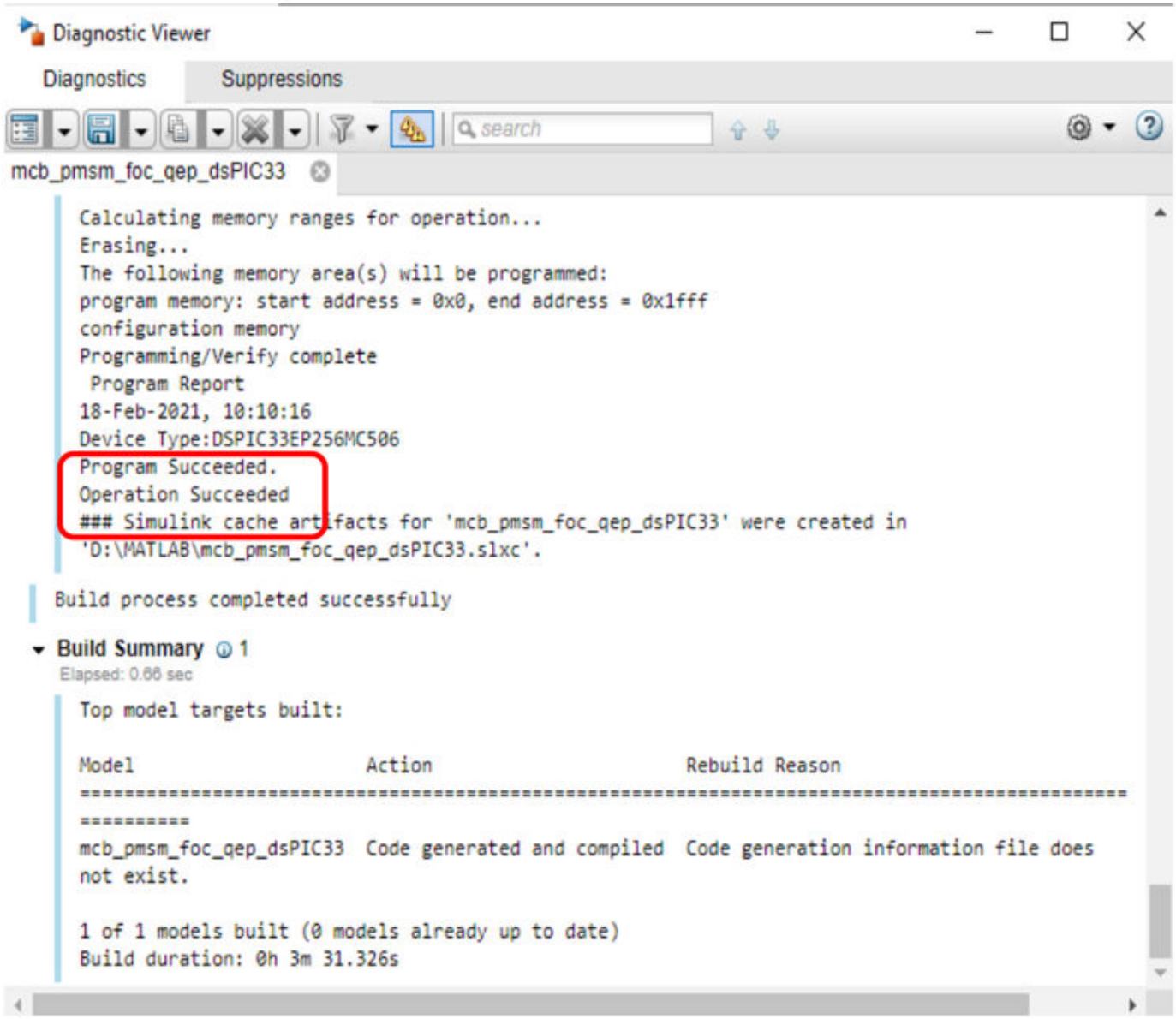


7 The **C Code** tab will appear on the menu bar, then click on **Build** to build, generate, and flash the code.



8 The code starts generating and **Diagnostics Viewer** window will open. After few seconds one notification window will pop-up.

9 After code generation the code will be flashed to dsPIC through the programmer and **Operation Succeeded** message will be seen on the **Diagnostics Viewer**.


Diagnostic Viewer
Diagnostics
Suppressions
search
mcb_pmsm_foc_qep_dsPIC33
Calculating memory ranges for operation...
Erasing...
The following memory area(s) will be programmed:
program memory: start address = 0x0, end address = 0x1fff
configuration memory
Programming/Verify complete
Program Report
18-Feb-2021, 10:10:16
Device Type:DSPIC33EP256MC506
Program Succeeded.
Operation Succeeded
Simulink cache artifacts for 'mcb_pmsm_foc_qep_dsPIC33' were created in
'D:\MATLAB\mcb_pmsm_foc_qep_dsPIC33.slxc'.
Build process completed successfully
Build Summary 1
Elapsed: 0.66 sec
Top model targets built:
Model Action Rebuild Reason
mcb_pmsm_foc_qep_dsPIC33 Code generated and compiled Code generation information file does not exist.
1 of 1 models built (0 models already up to date)
Build duration: 0h 3m 31.326s

Verification Test

- Verify the debug LED **D2** is blinking, this confirms that the dsPIC device successfully programmed.
- Press the push button S2 to start and stop the motor.
- The **POT** on the MCLV2 board is configured the vary motor speed from 0.45 to 1 per unit of rated speed. Vary the POT to spin the motor from minimum speed to maximum speed and verify that the generated code working fine.