
Demonstration ReadMe for Regenerative Braking using MATLAB®/SIMULINK®, MCLV-2 and dsPIC33CK256MP508 External Op-Amp PIM

1. INTRODUCTION

This document describes the setup requirements for running the Regenerative Braking algorithm, using MATLAB®/Simulink®, MCLV-2 Development Board and dsPIC33CK256MP508 External Op-Amp Motor Control Plug-In Module (PIM).

2. SUGGESTED DEMONSTRATION REQUIREMENTS

2.1. MATLAB Model Required for the Demonstration

- MATLAB model can be cloned or downloaded as zip file from the Github repository ([link](#)).

2.2. Software Tools Used for Testing the MATLAB/Simulink Model

- MPLAB X IDE and IPE (v6.0)
- XC16 compiler (v2.00)
- MATLAB R2022a
- Required MATLAB add-on packages are:
 - Simulink
 - Simulink Coder
 - Stateflow
 - MATLAB Coder
 - Embedded Coder (v7.8)
 - Motor Control Blockset (v1.4)
 - MPLAB Device blocks for Simulink (v3.50.27)

Note:

The software used for testing the model during release is listed above. It is recommended to use the version listed above, or later versions, for building the model.

2.3. Hardware Tools Required for the Demonstration

Hardware Tool	Part Number	Quantity
dsPICDEM™ MCLV-2 Development Board	DM330021-2	2
dsPIC33CK256MP508 External Op-Amp Motor Control Plug-In Module	MA330041-1	2
Benchtop power supply (compatible 24V, 5A)	-	1
24V 3-Phase Brushless DC Motor with Encoder	AC300022	2
USB to RS-232 cable	-	2

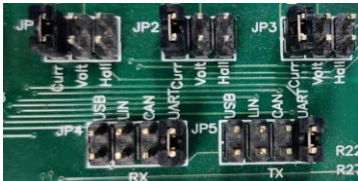
Note:

The two motors shafts are coupled together. The fixture of both motors coupled together is not sold by Microchip Technology. The fixture was created only for this demonstration purpose. Any standard motor shaft coupler can be used with 8mm diameter on both the sides.

3. HARDWARE SETUP

This section describes the hardware setup needed for the demonstration. In this demonstration two MCV-2 boards are used to control the motor and the generator. The MCLV-2 board connected to the motor is referred as 'the motor side MCLV-2 board' and the MCLV-2 board connected to the generator is referred as 'the generator side MCLV-2 board'

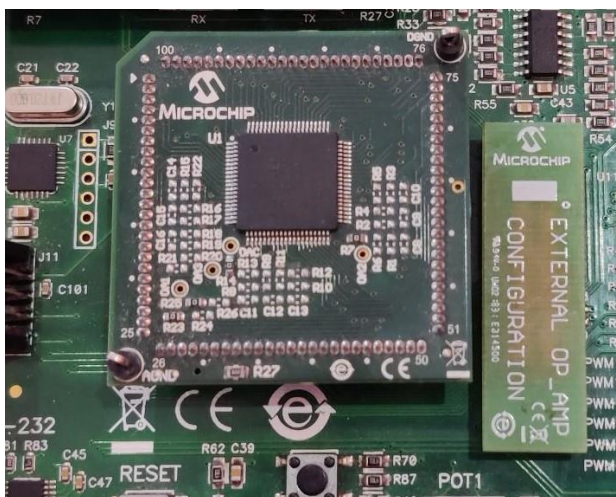
1. Disconnect power from both the MCLV-2 Boards and set up the following jumpers:

Jumper	Pins to Short	Board Reference
JP1	1-2(Curr)	
JP2	1-2(Curr)	
JP3	1-2(Curr)	
JP4	7-8(UART)	
JP5	7-8(UART)	

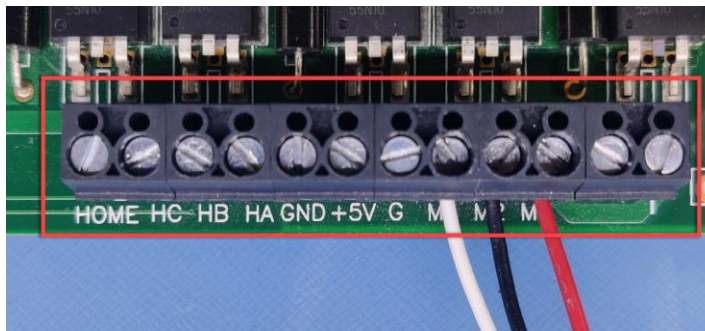
2. On both the boards, insert the 'External Op Amp Configuration Matrix board' into matrix board header J14. Ensure the matrix board is correctly oriented before proceeding.



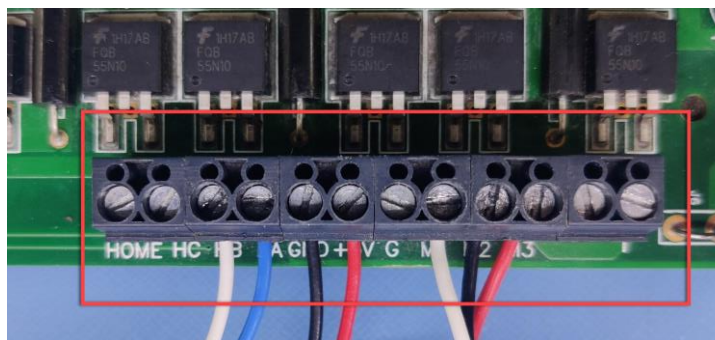
3. Insert the dsPIC33CK256MP508 External Op-Amp Motor Control PIM into the PIM Socket U9 provided on MCLV-2 Boards. Make sure the PIM is correctly placed and oriented before proceeding.



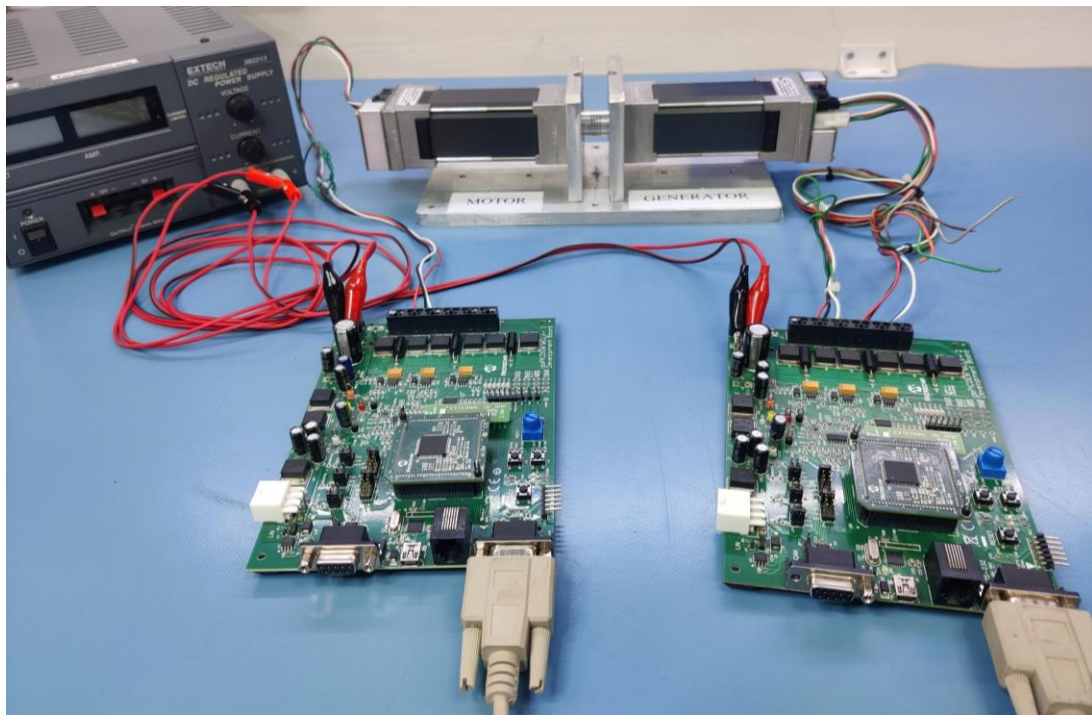
4. Connect the three phase wires from the motor to M1, M2, and M3 terminals of connector J7, on 'the motor side MCLV-2 Board' in the sequence as shown below.



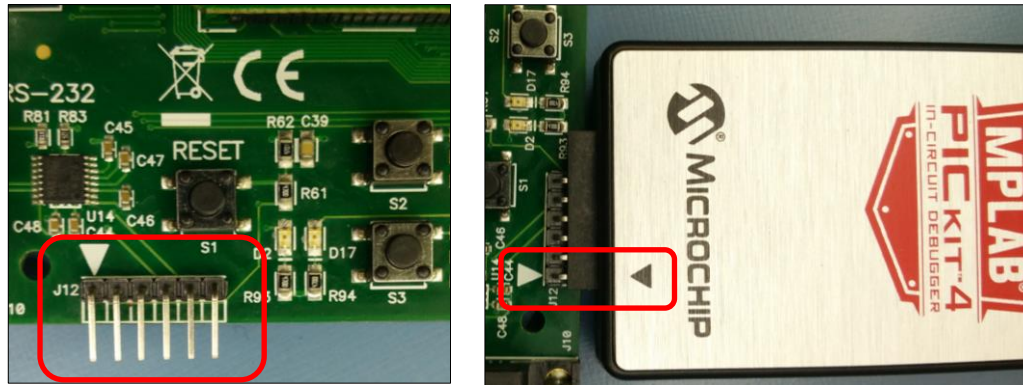
5. Connect the three phase wires from the generator to M1, M2, and M3 terminals of connector J7, on the 'generator side MCLV-2 Board'. Please note that for sequence of 3 phase wires and the encoder wires sequence must be as shown below.



6. Set 24V on the benchtop power supply and connect it to the connectors BP1 and BP2 provided on both the MCLV-2 Boards (The single power supply is used for both the MCLV-2 boards). Couple the motors shafts using a coupler and connected to MCLV-2 boards. Make sure the setup is as shown below.



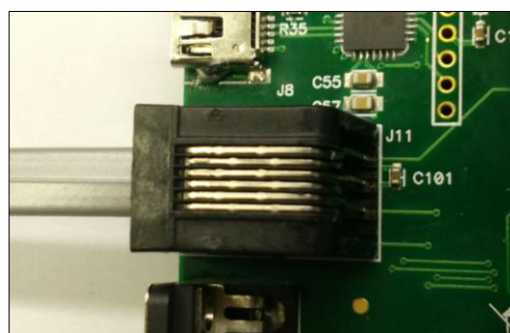
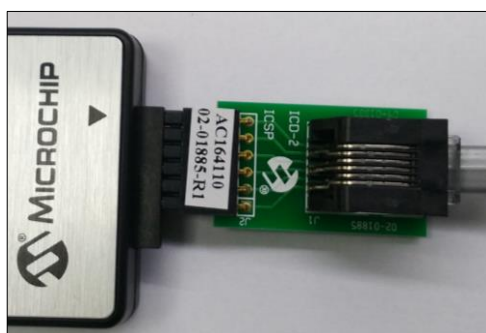
7. The Microchip MPLAB PICKit 4 In-Circuit Debugger needs to be connected to the Connector J12 of the MCLV-2 Board, as shown below. Also connect to the Host PC used for programming the device. Ensure the arrows indicated on the board and PICKit 4 orient as shown in the picture.



Note:

It is recommended to use a right-angled pin header to use J12 for programming. A straight header mounted with PICKit 4 may result in mechanical stresses on the programmer connector or the development board in use.

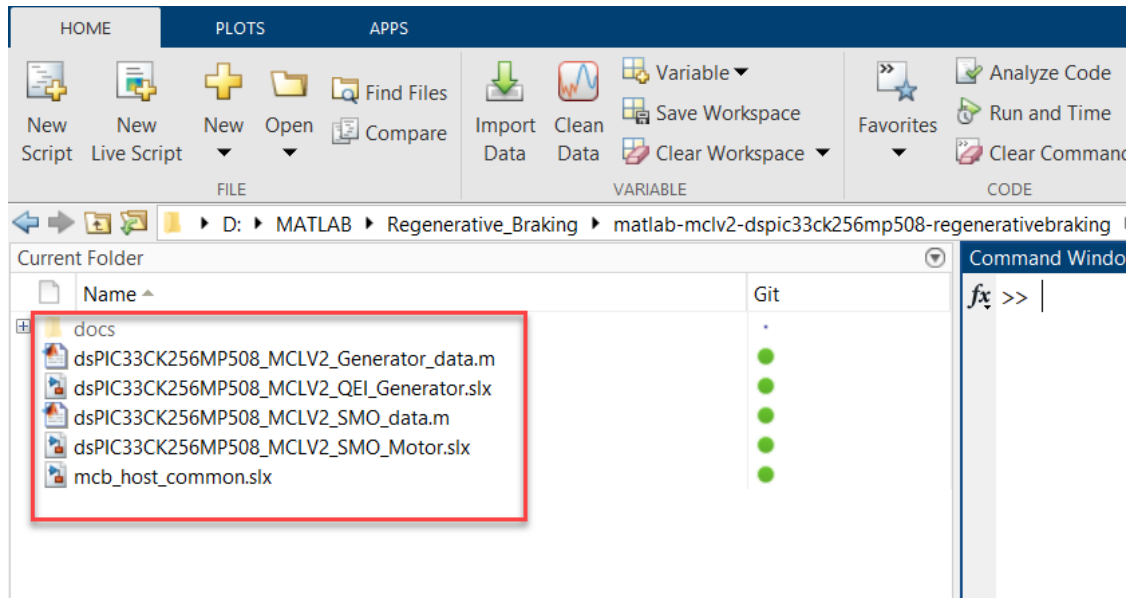
Alternatively, the programmer/debugger can be connected to J11 using a RJ-11 to ICSP adapter (AC164110).



4. BASIC DEMONSTRATION

Follow the below instructions step-by-step, to set up and run the motor control demo application:

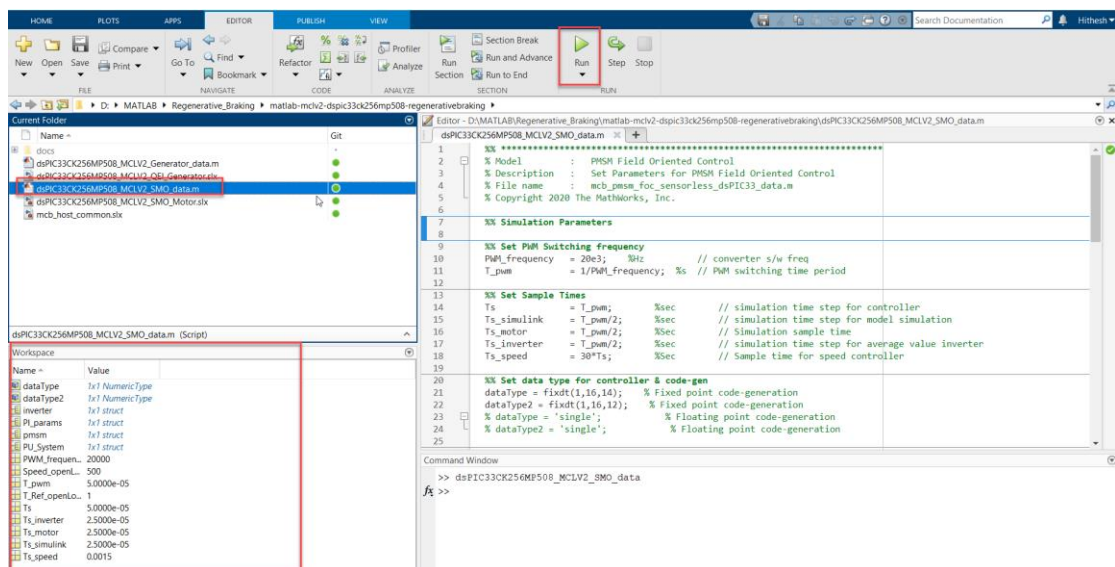
1. Launch the MATLAB (refer the section “[2.2 Software Tools Used for Testing the MATLAB/Simulink Model](#)”).
2. Open the folder downloaded from the repository, in which the MATLAB files are saved (refer “[2.1 MATLAB Model Required for the Demonstration](#)”).



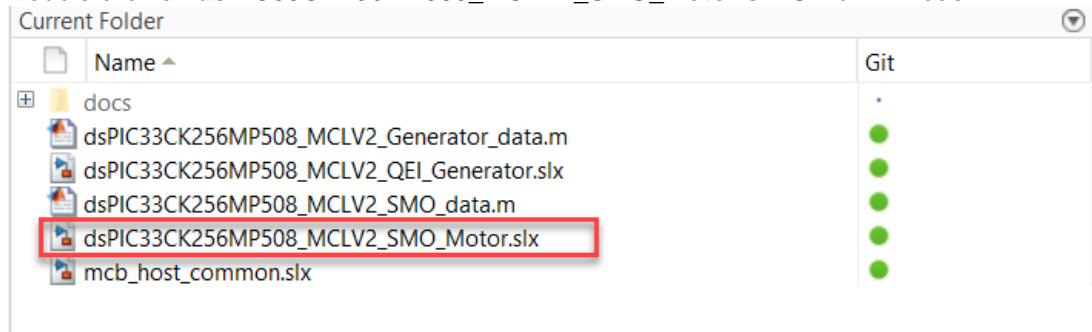
In this folder there will be five files used for the demonstration,

File Name	Description
dsPIC33CK256MP508_MCLV2_Generator_data.m	Data file for generator side Simulink model
dsPIC33CK256MP508_MCLV2_QEI_Generator.slx	Simulink model for ‘the generator side MCLV-2 board’ using optical encoder
dsPIC33CK256MP508_MCLV2_SMO_data.m	Data file for motor side Simulink model
dsPIC33CK256MP508_MCLV2_SMO_Motor.slx	Simulink model for ‘the motor side MCLV-2 board’ using Sliding motor observer
mcb_host_common.slx	Simulink model to monitor real time parameters from the hardware

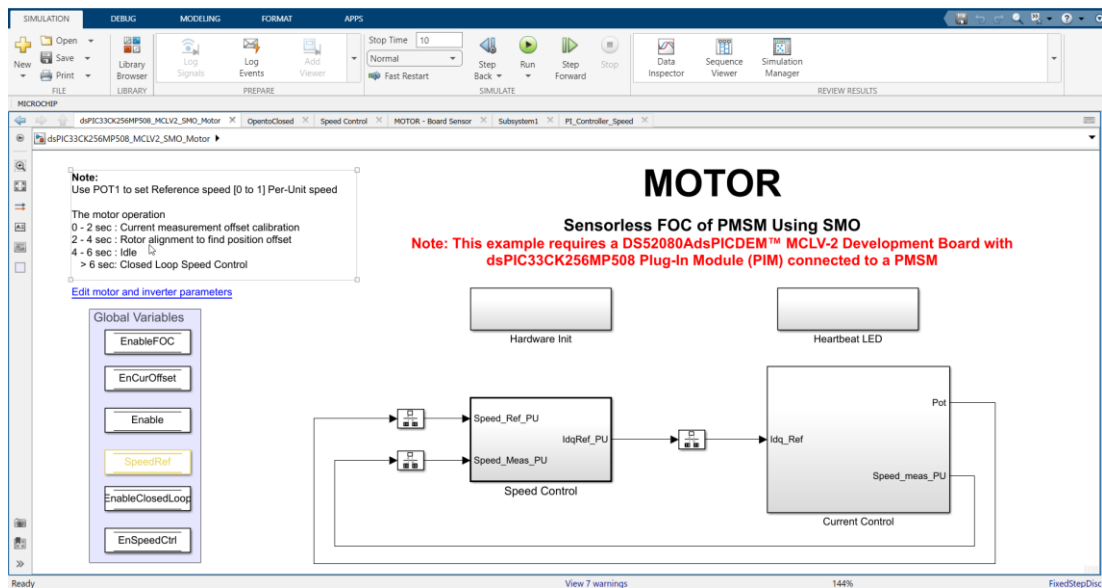
3. Connect the PICkit 4 In-Circuit Debugger to the Connector J12 of ‘motor side MCLV-2 Board’, as mentioned in the [step 7 of the HARDWARE SETUP section](#) and turn on the power supply.
4. Double click and open the **dsPIC33CK256MP508_MCLV2_SMO_data.m** file. This file contains the configuration parameter for the motor and board. By default, the file is configured to run Hurst 300 motor and MCLV-2 board. Run the file by clicking the “**Run**” icon and wait till all variables get loaded on the ‘**Workspace**’ tab.



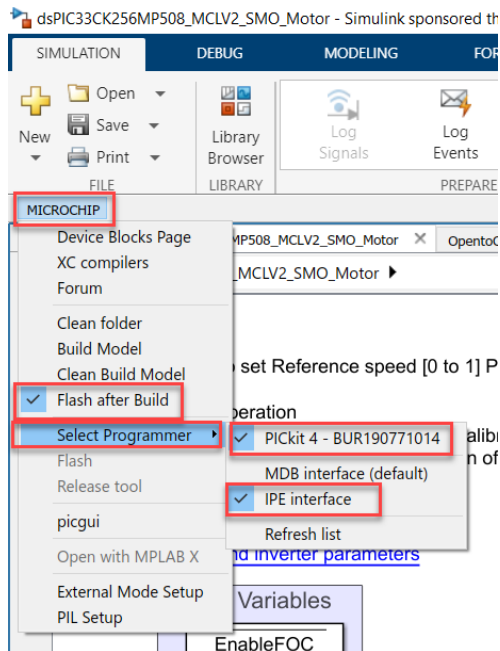
- Double click on **dsPIC33CK256MP508_MCLV2_SMO_Motor.slx** Simulink model.



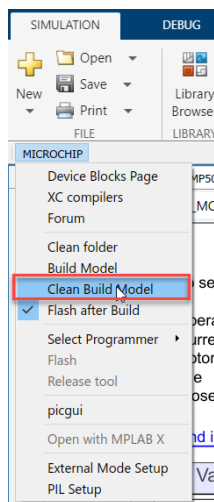
6. This opens the Simulink model, as shown below.



- From this Simulink model, an MPLAB X project is generated, and it can be used to run the motor using MCLV-2 board. To generate the code from the Simulink model, go to the **“MICROCHIP”** tab, and enable the tabs shown in the figure below.



- To generate the code and program the dsPIC33CK256MP508, click on **‘Build Model’** or **‘Clean Build Model’** option under the **“Microchip”** tab. This will generate the MPLAB X project from the Simulink model.



- After completing the process, the **‘Operation Succeeded’** message will be displayed on the **‘Diagnostics Viewer.’** This completes the programming of the motor side MCLV-2 board.



- If the device is successfully programmed, **LED’s – D2 and D17** will be blinking.

11. Now connect the PICKit 4 In-Circuit Debugger to the Connector J12 of 'generator side MCLV-2 Board', as mentioned in the [step 7 of the HARDWARE SETUP section](#).
12. To program the generator side dsPIC33CK256MP508 device repeat the step 4 to 10, using the **dsPIC33CK256MP508_MCLV2_Generator_data.m** and **dsPIC33CK256MP508_MCLV2_QEI_Generator.slx** files.
13. To run the setup, press the push button **S2** of the 'motor side MCLV-2 board' first and then the generator side MCLV-2 board.

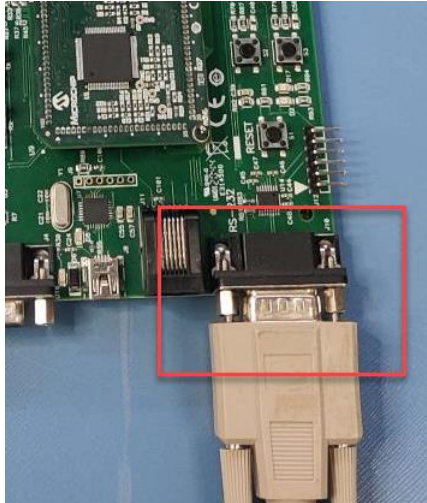


14. The motor speed can be varied using the potentiometer (labeled "**POT1**") of the motor side MCLV-2 board. The regenerative torque can be varied using the potentiometer (labeled "**POT1**") of the generator side MCLV-2 board.
15. Press the push button **S2** of the 'motor side and generator side MCLV-2' to stop the operation.

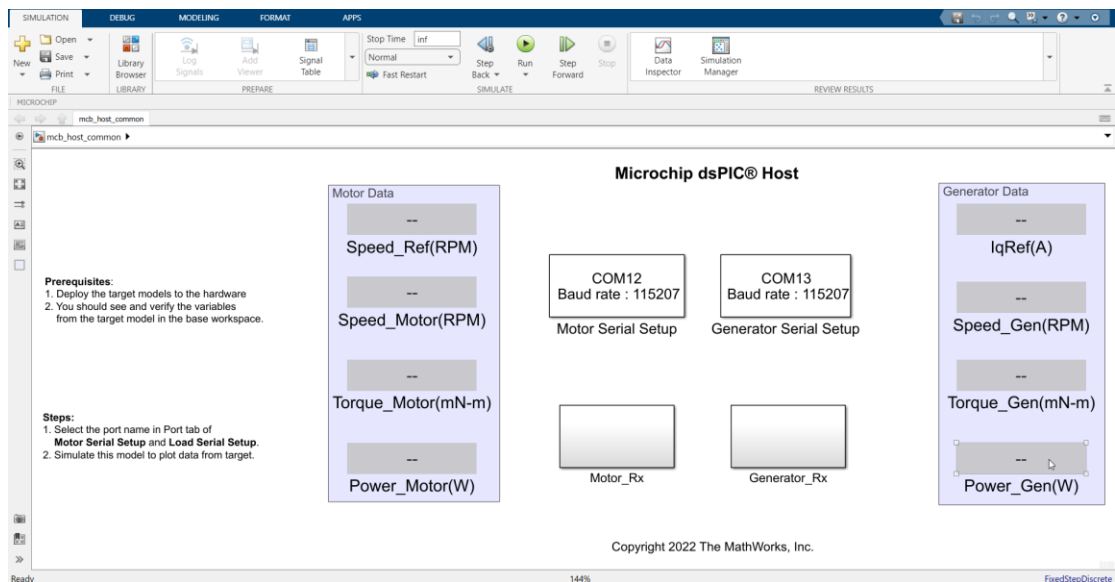
5. DATA MONITORING USING MOTOR CONTROL BLOCKSET (MCB) HOST MODEL

The regenerative braking simulink models comes with the initialization required for data monitoring using Motor Control Blockset Host Model (MCB Host Model). The MCB Host Model is a Simulink model which facilitates data monitoring through the UART Serial Interface.

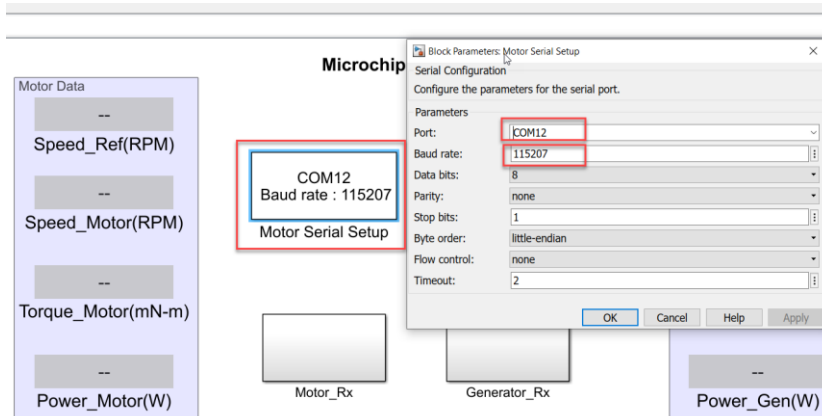
1. To establish serial communication with the host PC, connect a USB to RS-232 cable between the host PC and the MCLV-2 Board (J10 connector) of both motor and generator side.



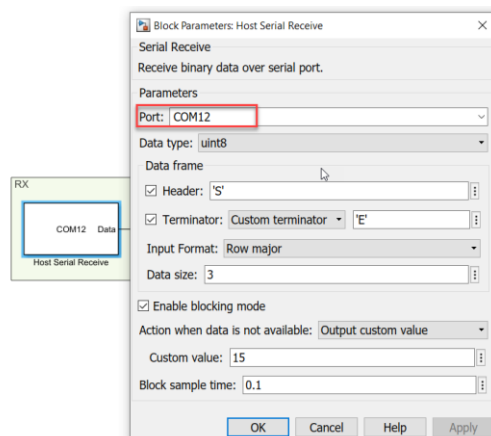
2. Ensure the regenerative braking simulink models are programmed and running as described under section 4. [Basic Demonstration](#) by following steps 1 through 14.
3. Open the MCB Host model (mcb_host_common.slx)



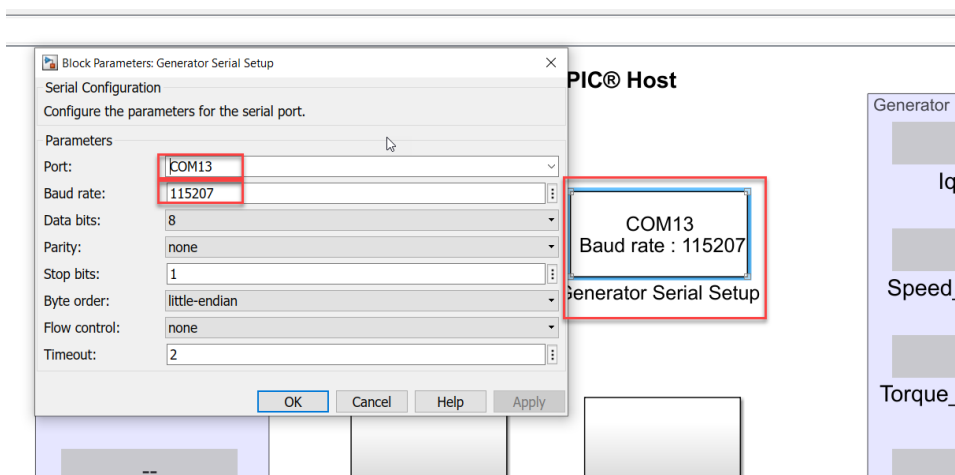
- Double click on the **“Motor Serial Setup”** block. Then select the appropriate COM port which is connected to the motor side MCLV-2 board from the drop-down menu and set the baud rate as 115207. Please note that the same baud rate has been set in the motor side Simulink **model** (the baud rate can be viewed on the **“UART Configuration block”** in the **“Hardware Init”** subsystem).



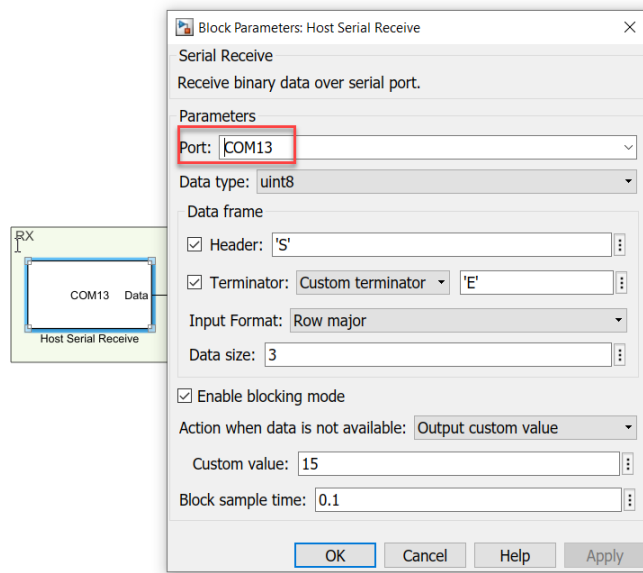
- Open the **“Motor_Rx”** subsystem to configure the COM port. This can be done by configuring the **“Host Serial Receive”** block of the **“Motor_Rx”** subsystem. Ensure to select the same COM port configured in step 4.



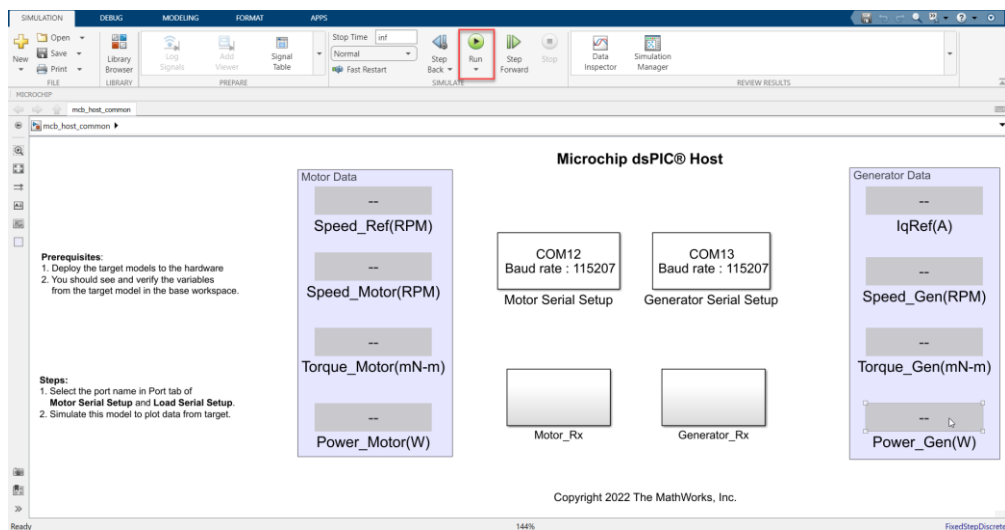
- Similarly, double click on the **“Generator Serial Setup”** block. Then select the appropriate COM port which is connected to the generator side MCLV-2 board from the drop-down menu and set the baud rate as 115207. Please note that the same baud rate has been set in the generator side Simulink **model** (the baud rate can be viewed on the **“UART Configuration block”** in the **“Hardware Init”** subsystem).



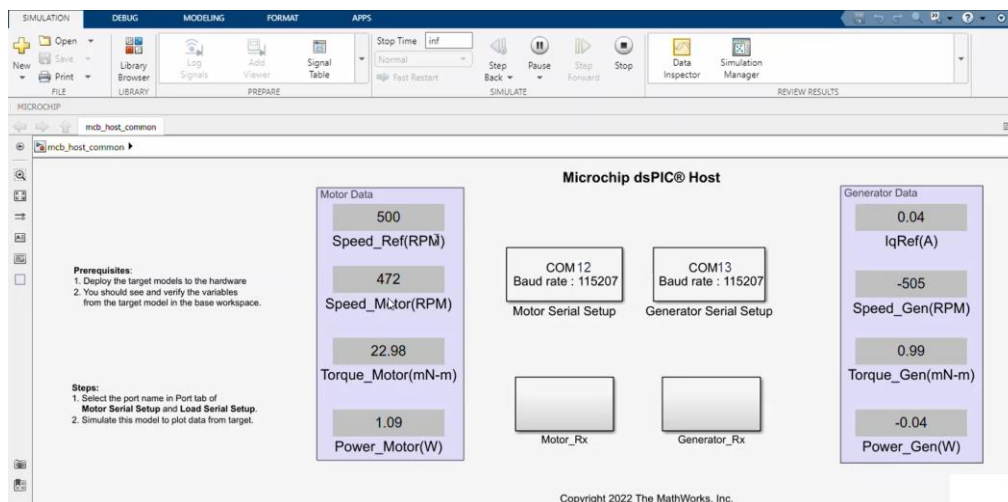
- Open the “**Generator_Rx**” subsystem to configure the COM port. This can be done by configuring the “**Host Serial Receive**” block of the “**Generator_Rx**” subsystem. Ensure to select the same COM port configured in step 6.



- Click the run icon of the **MCB Host** model to open the scope window and monitor the signals.



- Figure below shows an example of monitored signals using the MCB Host Model.



6. REFERENCES:

For more information, refer to the following documents or links.

1. AN1078 Application Note “[Sensorless Field Oriented Control of a PMSM](#)”
2. dsPICDEM[™] MCLV-2 Development Board User's Guide ([DS52080A](#))
3. dsPIC33CK256MP508 Motor Control Plug-In Module (PIM) Information Sheet for External Op Amp Configuration ([DS50002757A](#))
4. [MPLAB[®] X IDE installation](#)
5. [MPLAB[®] XC16 Compiler installation](#)
6. [Motor Control Blockset](#)
7. [MPLAB Device Blocks for Simulink :dsPIC, PIC32 and SAM mcu](#)