Development Board
EPC9147D
Quick Start Guide

Motor Drive Controller Interface Board -
Renesas RA6T2/RA4T1 Controller Board

‖EPC

EFFICIENT POWER CONVERSION

DESCRIPTION

The EPC9147D is an interface board that permits connection of the Renesas controller Board RTK0EMA270C00000BJ, equipped with an RA6T2 microcontroller, to a compatible 3-phase eGaN® FET/ IC motor drive inverter board as shown in figure 1. The interface board allows users to utilize the existing Renesas Motor Workbench together with dedicated files to program the Renesas controller board to control a motor with an EPC eGaN® FET/IC 3-phase inverter.
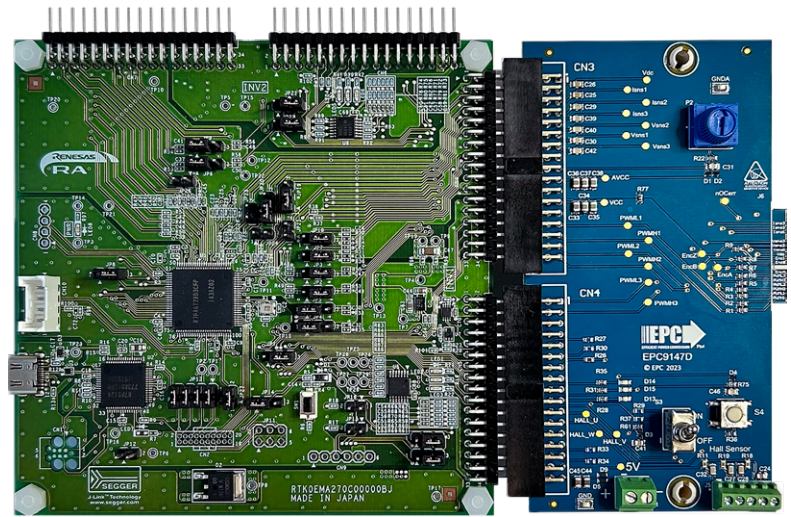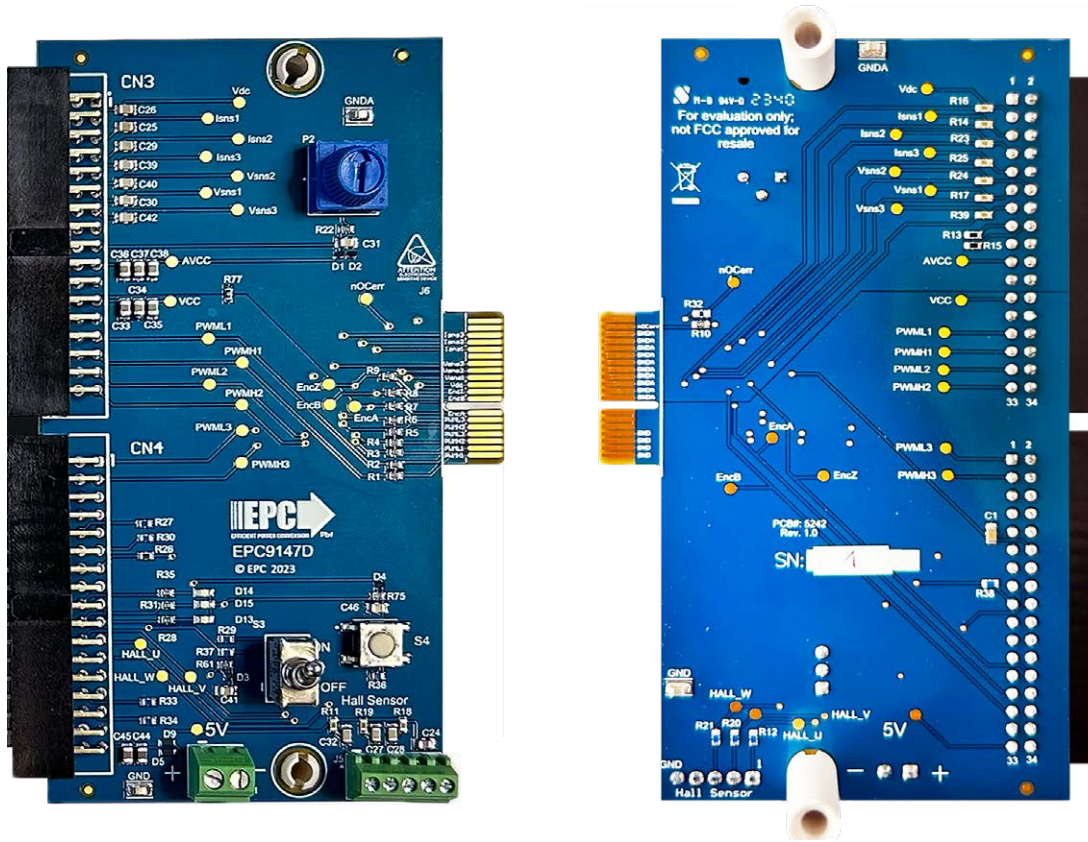

Figure 1: Assembly overview

Figure 2: EPC9147D top and bottom overview

Compatible Boards

Table 1: Compatible EPC motor inverter drives

Inverter board	Description	EPC GaN FET/IC
EPC9167/HC	30 A_{RMS} 3-Phase BLDC Motor Drive Reference Design Board	EPC2065
EPC9193/HC	40 A_{RMS} 3-Phase BLDC Motor Drive Reference Design Board	EPC2619
EPC9194	40 A_{RMS} 3-Phase BLDC Motor Drive Reference Design Board	EPC2302
EPC9176	20 A_{RMS} 3-Phase BLDC Motor Drive Reference Design Board	EPC23102
EPC9173	35 A_{RMS} 3-Phase BLDC Motor Drive Reference Design Board	EPC23101
EPC9186	150 A_{RMS} 3-Phase BLDC Motor Drive Reference Design Board	EPC2302

Table 2: Compatible Renesas controllers

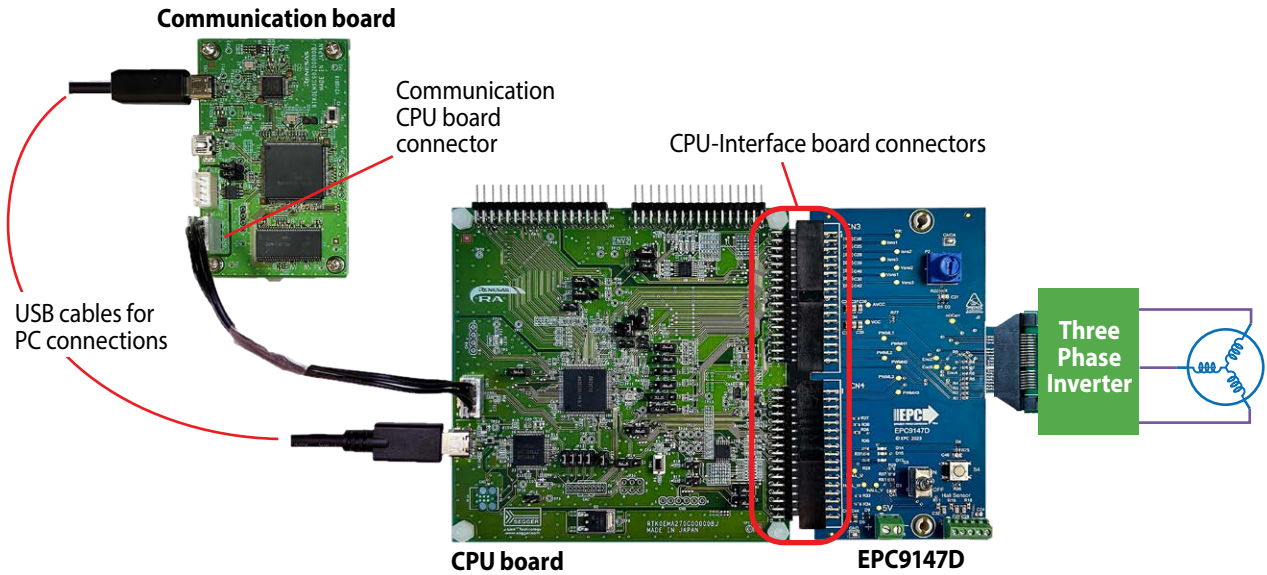| Controller board	Description	Renesas Controller
RTK0EMA270C00000BJ	CPU board for double motor control evaluation equipped with RA6T2	RA6T2
RTK0EMA430C00000BJ	CPU board for single motor control evaluation equipped with RA4T1	RA4T1

GENERAL CONNECTION OVERVIEW

Figure 3: General connection overview

DETAILED DESCRIPTION OF THE EPC9147D BOARD

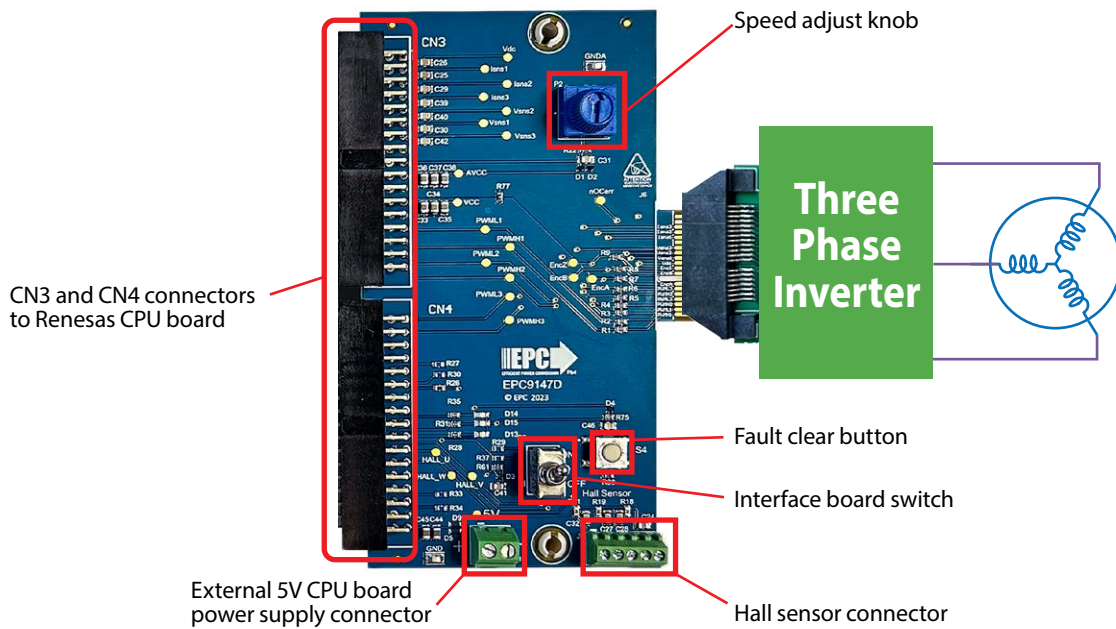Figure 4 shows an overview of the EPC9147D board with connectors and user interfaces

Figure 4: EPC9147D connectors and user interfaces description

On EPC9147D board

- Speed adjustment knob
- External 5 V supply connector
- Hall sensor connector
- Interface board switch
- Fault clear button
- Several LEDs

On Renesas CPU board

- Reset button
- Communication board connector
- Internal 3.3 V supply
- Various jumpers

Test Points

In the EPC9147D, several test points measure analog, digital, error, and PWM signals. Two test points for each signal are provided on the top and bottom of the board to allow easier measurement of signals. The test point locations are shown in figure 5.
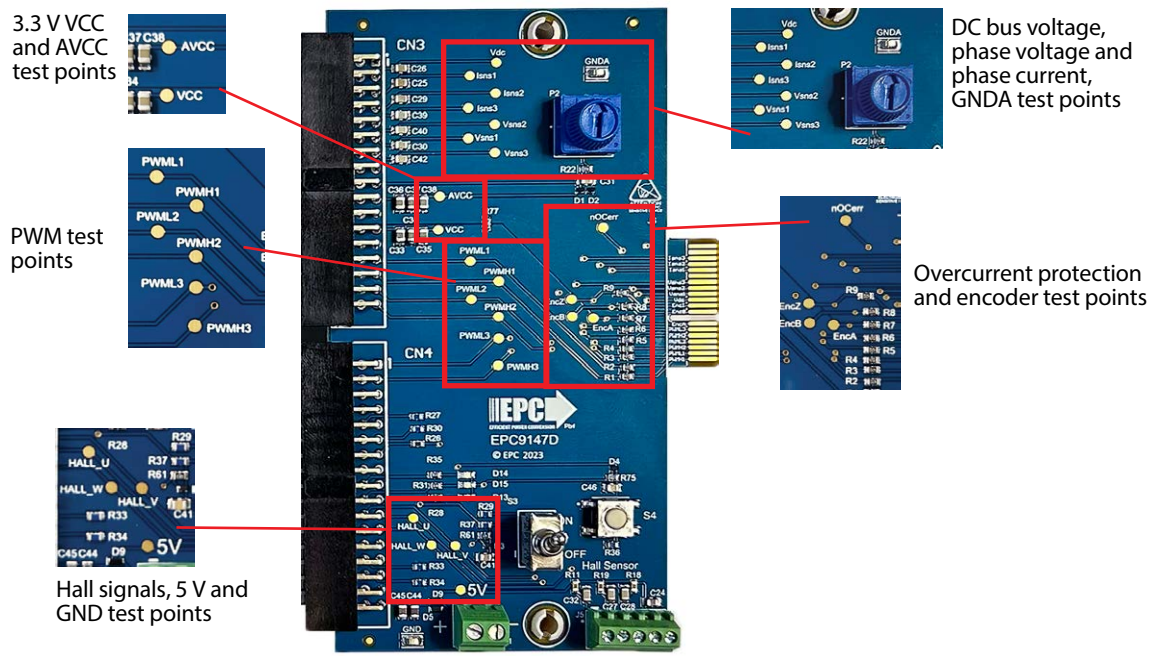
(a)
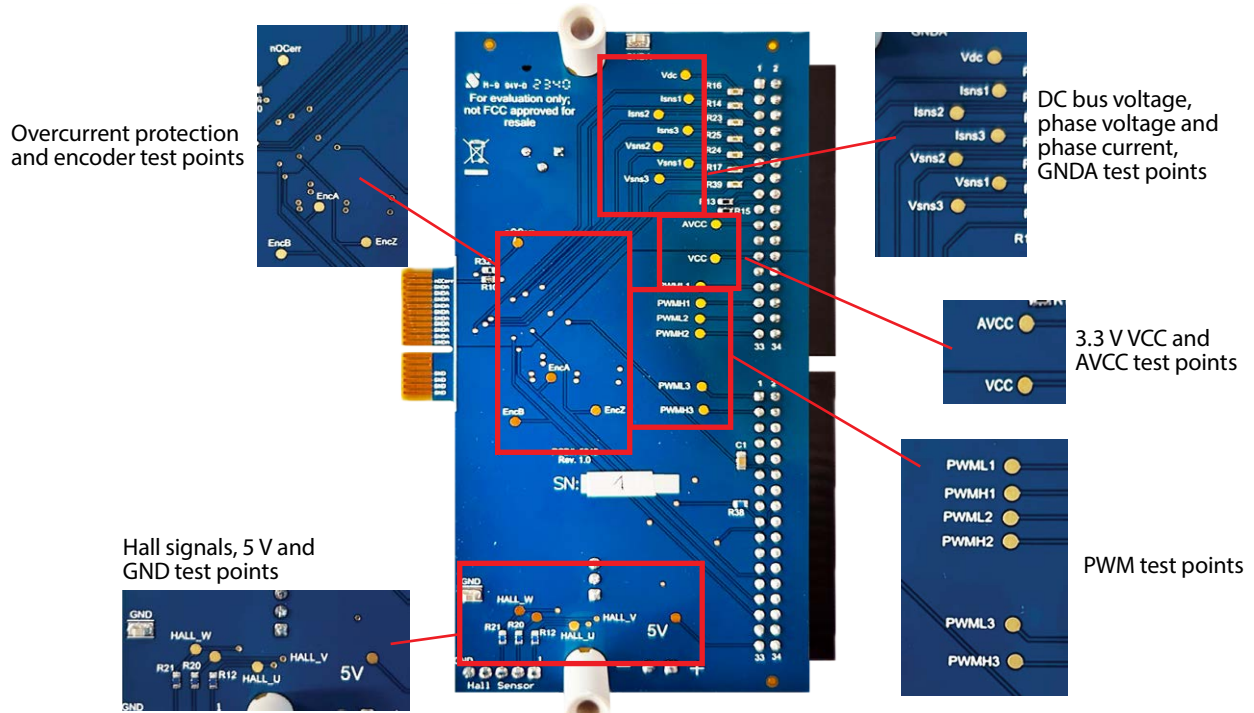
(b)

Figure 5: a) Top side test points; b) Bottom side test points.

Over-Current Detection

Both EPC inverter boards and Renesas CPU board are equipped with over current detection circuits. The interface board includes the option to mount the resistor R32 (10 kΩ) in case there is a need to pull up the over-current signal. **R32 is not mounted by default.**

CONNECTION DETAILS

The pin maps of each connector are shown in this section. Table 1 shows the map of the interface connector to the EPC inverter board. Table 2 and 3 show the interface connectors to Renesas CPU.

Table 3: Interface board connector to EPC inverter board

Pin #	Pin Name		Pin #
2	PWMH1	GND	1
4	PWML1	GND	3
6	PWMH2	GND	5
8	PWML2	GND	7
10	PWMH3	3V3	9
12	PWML3	3V3	11
14	EncA	3V3	13
Index			
18	EncB	GNDA	17
20	EncI	GNDA	19
22	Vdc	GNDA	21
24	Vsns1	GNDA	23
26	Vsns2	GNDA	25
28	Vsns3	GNDA	27
30	NC	GNDA	29
32	Isns1	GNDA	31
34	Isns2	GNDA	33
36	Isns3	GNDA	35
38	NC	OCPn	37
40	NC	NC	39

Table 4: CN3 interface connector to Renesas CPU board

Pin #	Pin Name		Pin #
1	NC	GNDA	2
3	VDC_AD	GNDA	4
5	IU_AD	GNDA	6
7	IW_AD	GNDA	8
9	IW_AD	GNDA	10
11	VU_AD	VV_AD	12
13	VW_AD	GNDA	14
15	GNDA	GNDA	16
17	Speed knob	GNDA	18
19	AVCC	AVCC	20
21	GNDA	GNDA	22
23	VCC	VCC	24
25	GND	GND	26
27	UL_IN	GND	28
29	UH_IN	GND	30
31	VL_IN	GND	32
33	VH_IN	GND	34

Table 5: CN4 interface connector to Renesas CPU board

Pin #	Pin Name		Pin #
1	WL_IN	GND	2
3	WK_IN	GND	4
5	NC	NC	6
7	NC	NC	8
9	NC	GND	10
11	GND	OC_INV_OUT	12
13	VCC	NC	14
15	NC	Toggle switch	16
17	FC Button	Blu LED	18
19	Green LED	Red LED	20
21	HALL_U	HALL_V	22
23	HALL_W	NC	24
25	NC	ENC_Z	26
27	ENC_A	GND	28
29	ENC_B	GND	30
31	GND	GND	32
33	+5V	+5V	34

CONTROLLING A TEKNIC M-3411P-LN-08D MOTOR USING RENESAS MOTOR CONTROLLER

I. Install e^2 studio

1. Download the **e^2 studio** software from the following link: **https://www.renesas.com/us/en/software-tool/e-studio**

2. The user must register and log in on renesas.com website to download the installation files

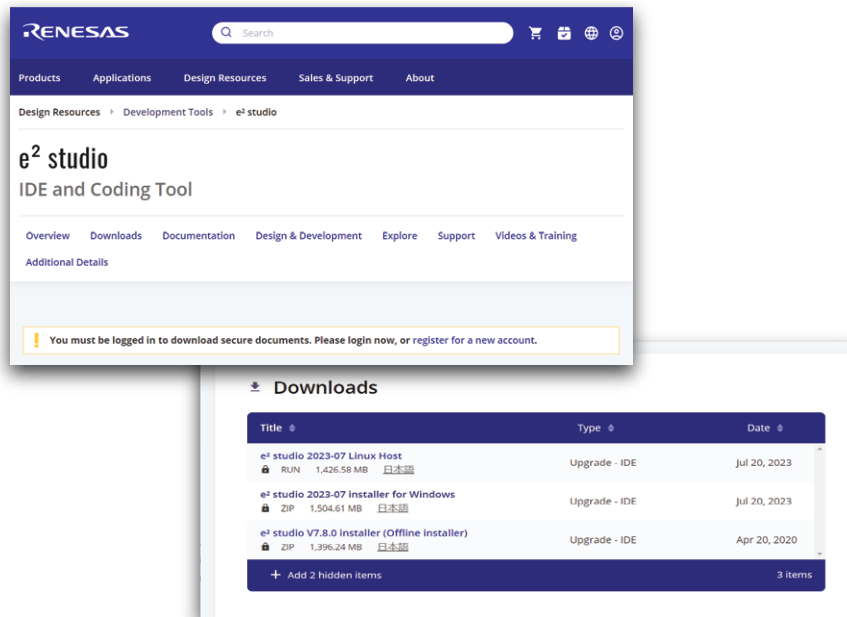3. Unzip the downloaded folder and execute the program **e^2 studio 2023-07 Installer for Windows (setup_e2_studio_2023-07.exe)**

Figure 6: e^2 studio software Renesas web page

4. Follow the steps in figure 7.
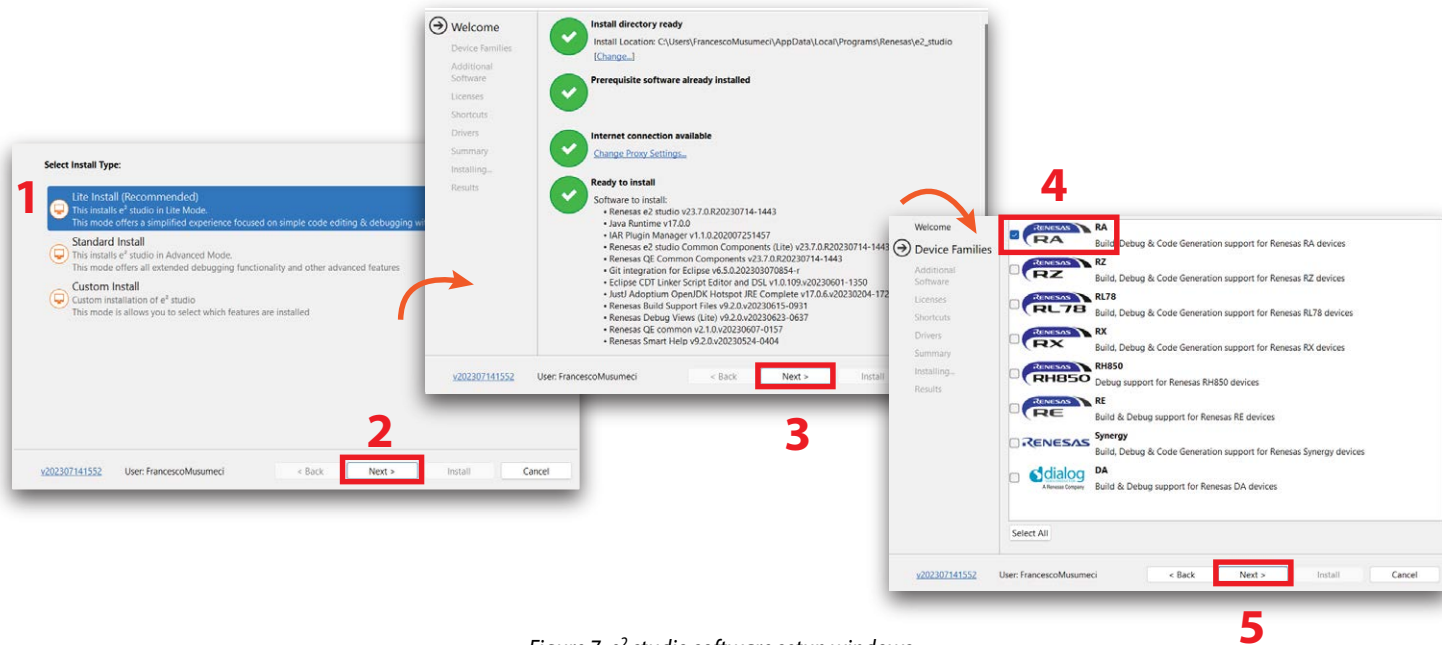
Figure 7: e^2 studio software setup windows

5. Select **QE for Motor** and **Renesas FSP v4.2.0** on the Additional Software window (figure 8)
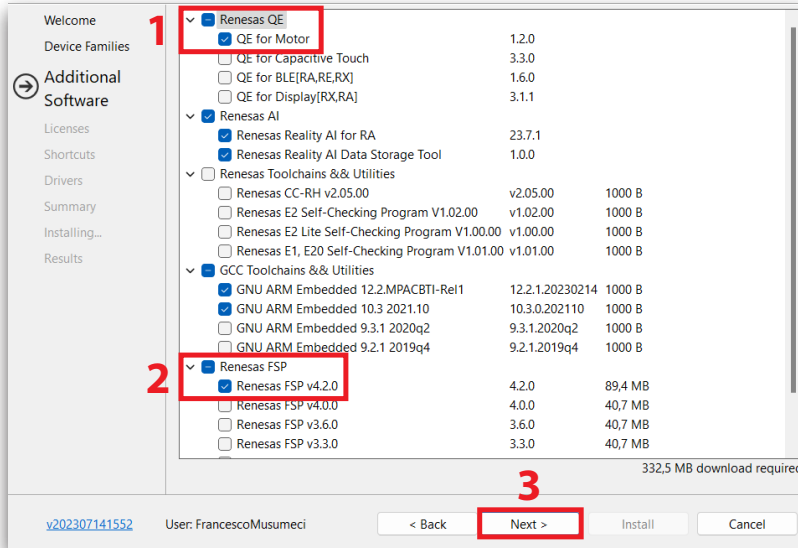
Figure 8: Additional Software setup section

6. Follow the steps in figure 9 and finally click on install
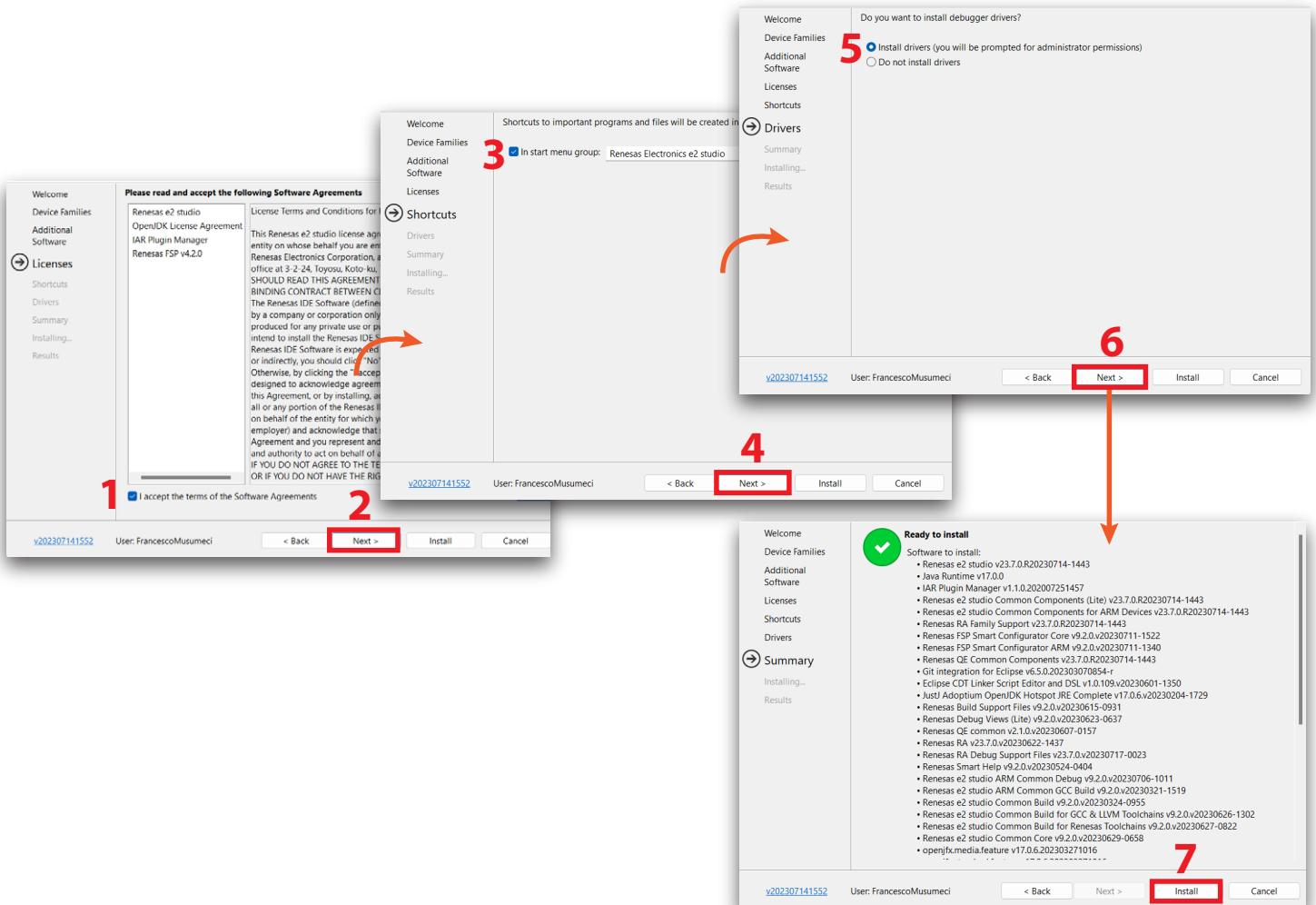
Figure 9: e² studio software setup windows

II. Preparing for the first launch

1. Download the firmware file by clicking on **GitHub EPC Reference Design Firmware** link on the EPC9147D web page. The firmware comes as a zipped directory. Unzip the directory and save it in your hard disk

2. Open *e² studio*

3. Open **QE Motor** and **FSP visualization** as shown in figure 10. At this point the FSP window may be empty and the QE Motor window may not display. In that case proceed to next step.
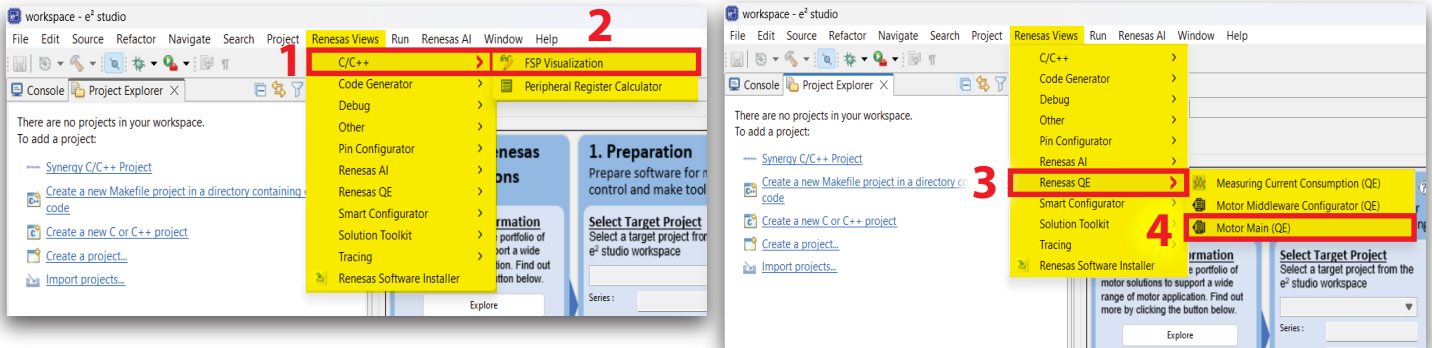
Figure 10: e² studio QE Motor and FSP enable

4. Import the firmware project into the *e² studio* workspace, as shown in figure 11:
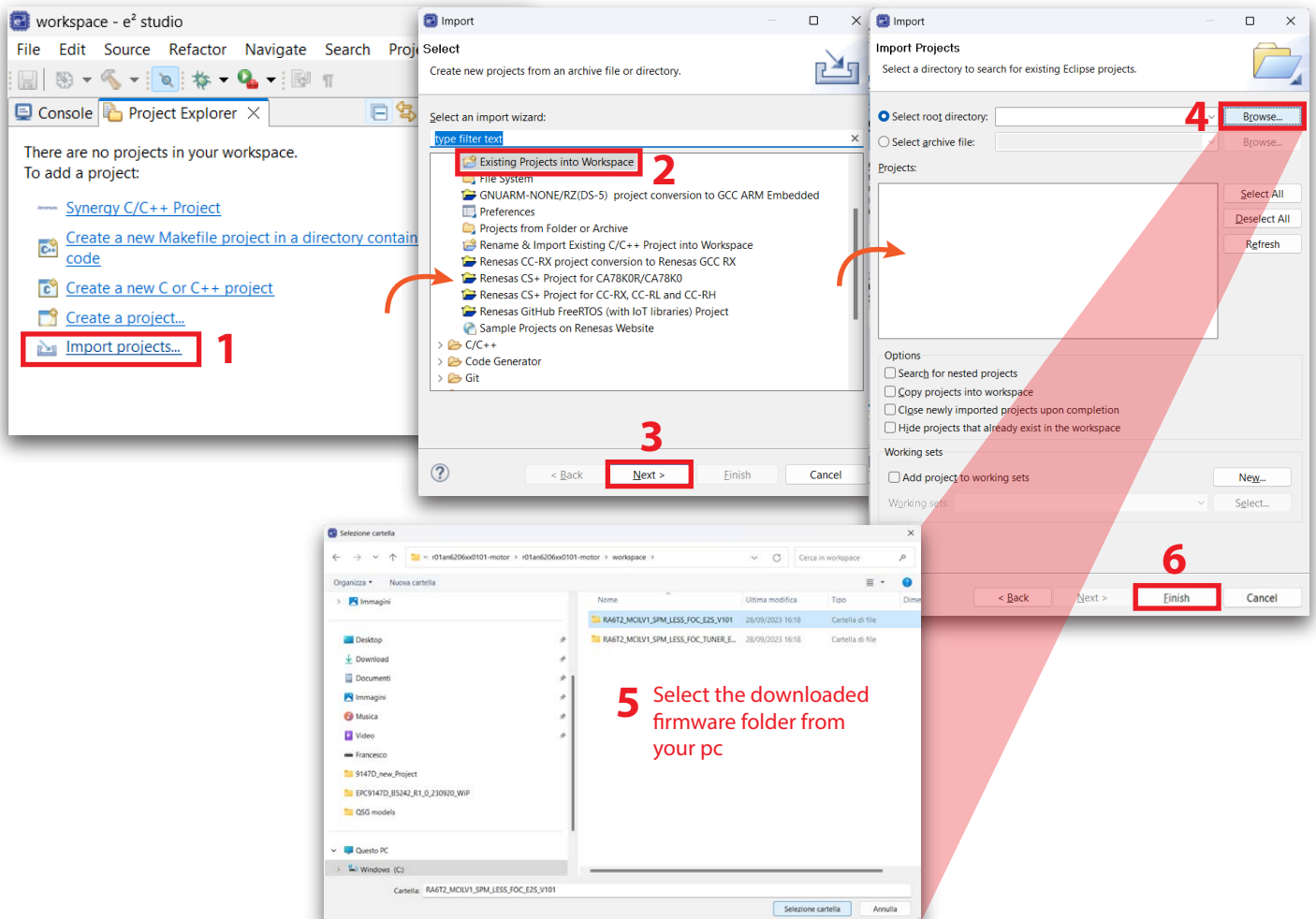
Figure 11: Project import window

III. Configure Motor Main (QE)
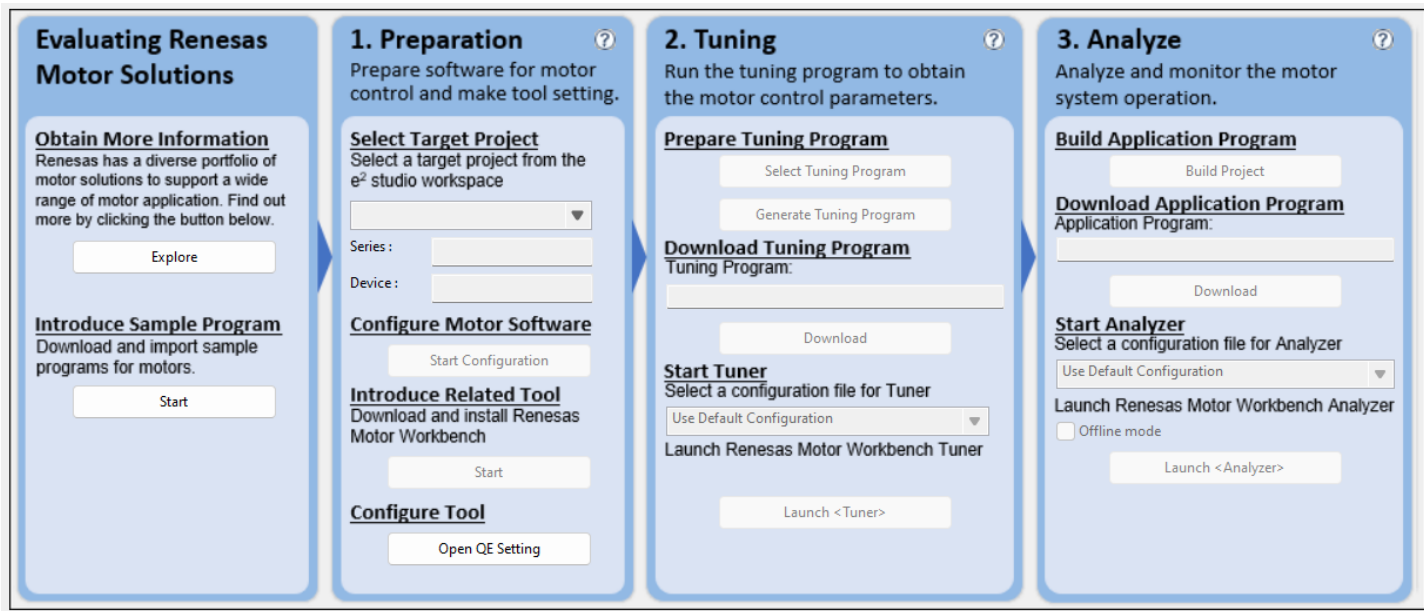
Figure 12: General QE Motor interface overview

1. In the **Motor Main interface**, under **Preparation Tab**, use the combo box to select the imported project

2. Click on **Start Configuration** to modify the project parameters

3. Click on the **Start Configuration** button shown in figure 13

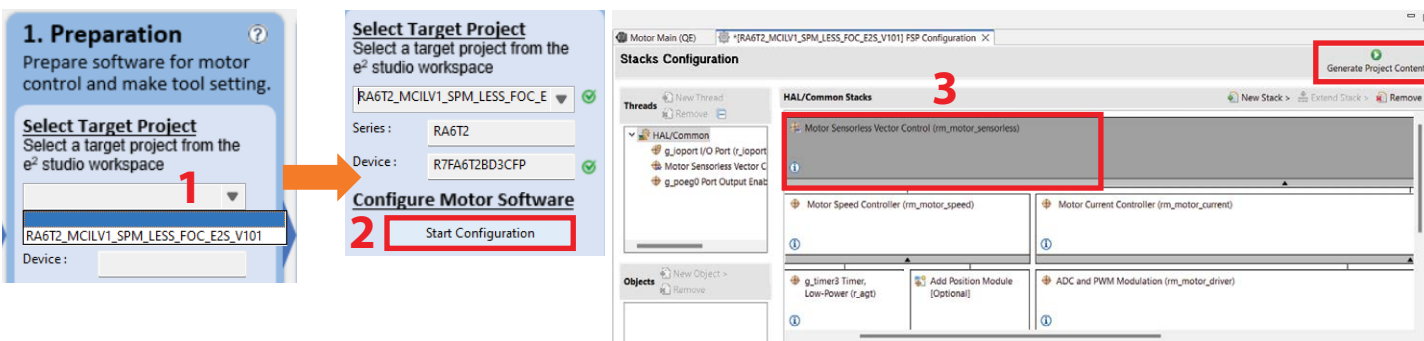4. Double click the **Motor Sensorless Vector Control** Box to open the FSP Visualization window; if the FSP window is not open repeat step 3.

Figure 13: QE Motor initial settings

5. Regarding the FSP visualization figure 14:

    1) Change the general parameters based on the characteristics of the EPC inverter board connected to the EPC9147D . In figure 14, the hardware parameters shown belong to the power board EPC9194.

    2) Set the open-loop parameters following these steps:

        a. Click on **Openloop State** button

        b. Set **1A** on the **Current Reference** section as in figure 14

    3) Set the voltage and current scale measurements

    4) Add the **TEKNIC M-3411P-LN-08D** motor main parameters shown in figure 14.

6. Click on **Generate Project Content** (figure 13)
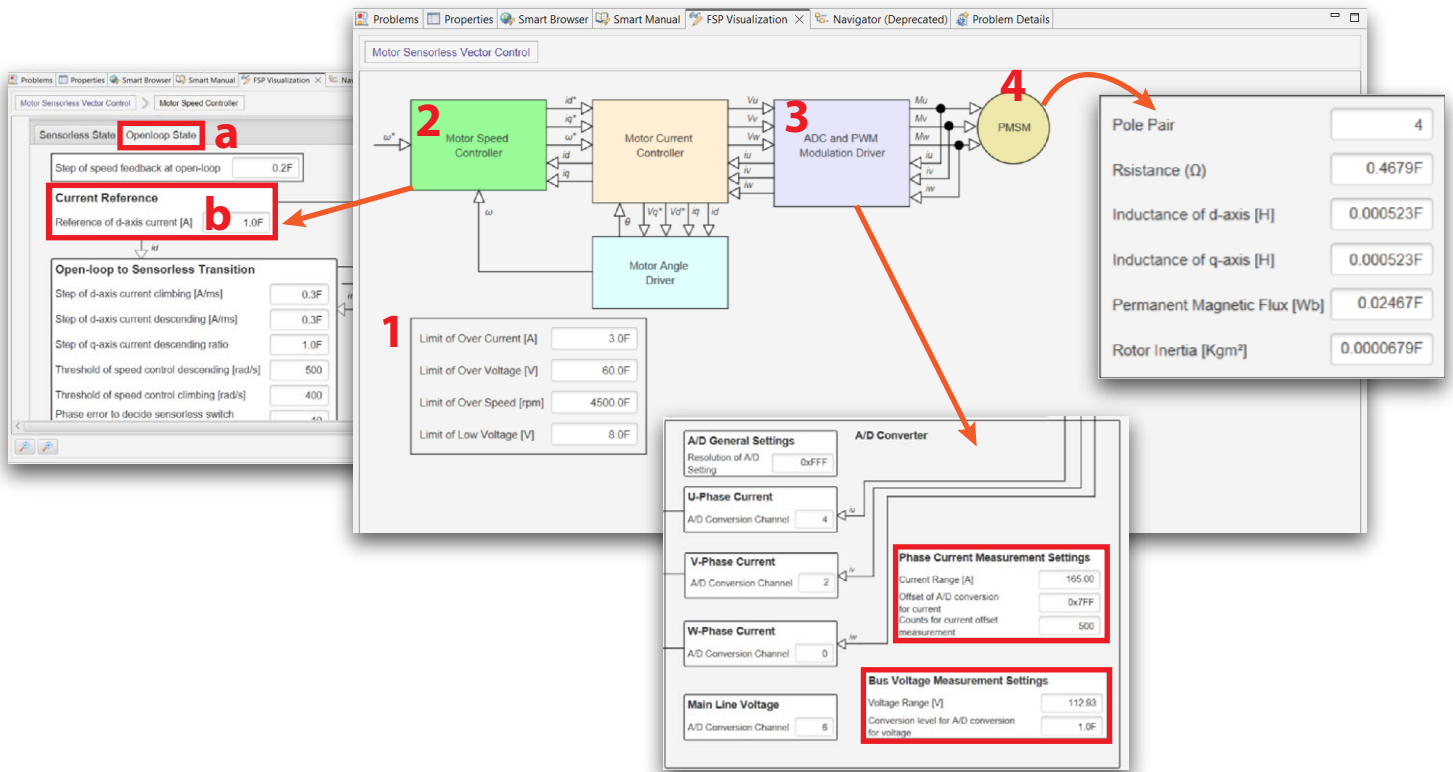
Figure 14: Motor control settings on FSP interface

7. Download and install **Renesas Motor Workbench**:

　1) Download the **Renesas Motor Workbench software** from the following link:
　　https://www.renesas.com/us/en/software-tool/renesasmotor-workbench

　2) Unzip the downloaded folder and execute the program on the internal **Installer** folder (called **renesas_motor_workbench_v311.msi**)

　3) Follow the installation steps in figure 15

　4) Click on **Open QE Setting**, in the **Configure Tool** section, and apply the default configuration (figure 16).

　5) Click on **Apply** and **Close**
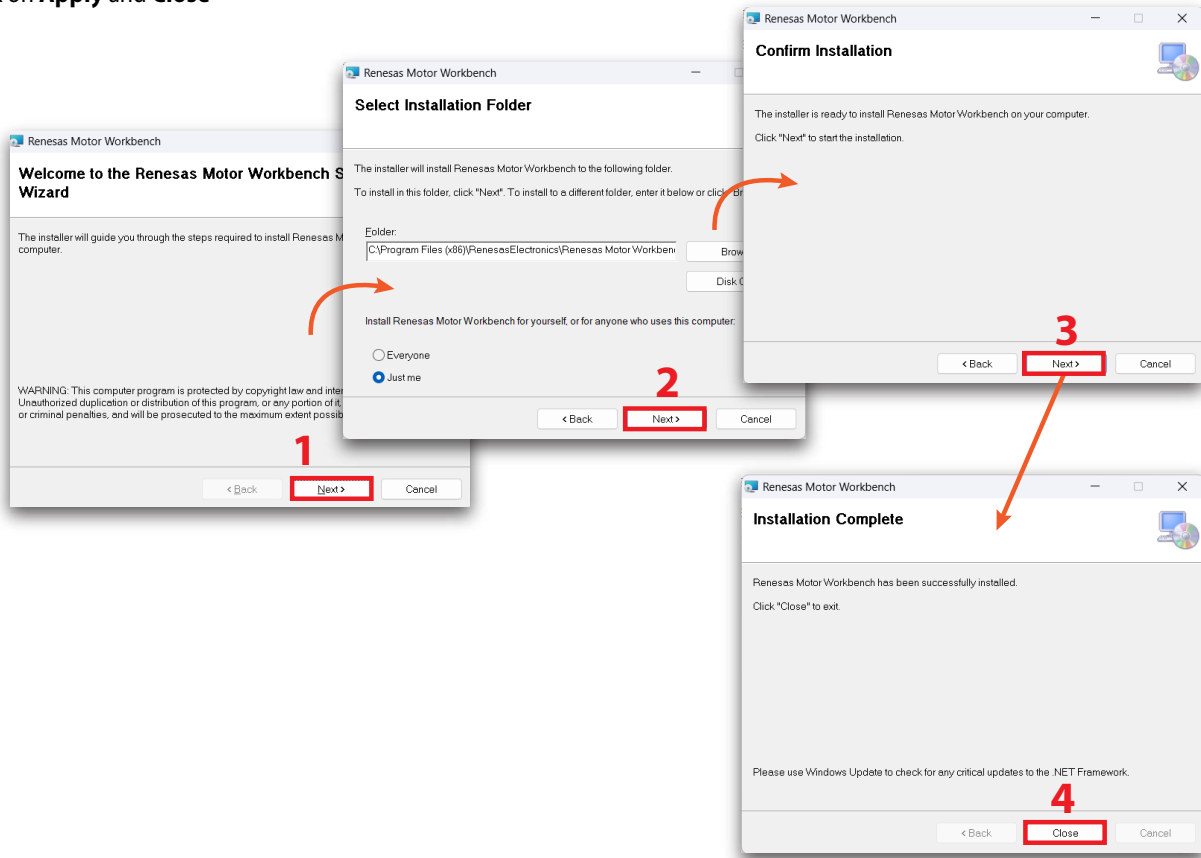
Figure 15: Renesas Motor Workbench setup windows
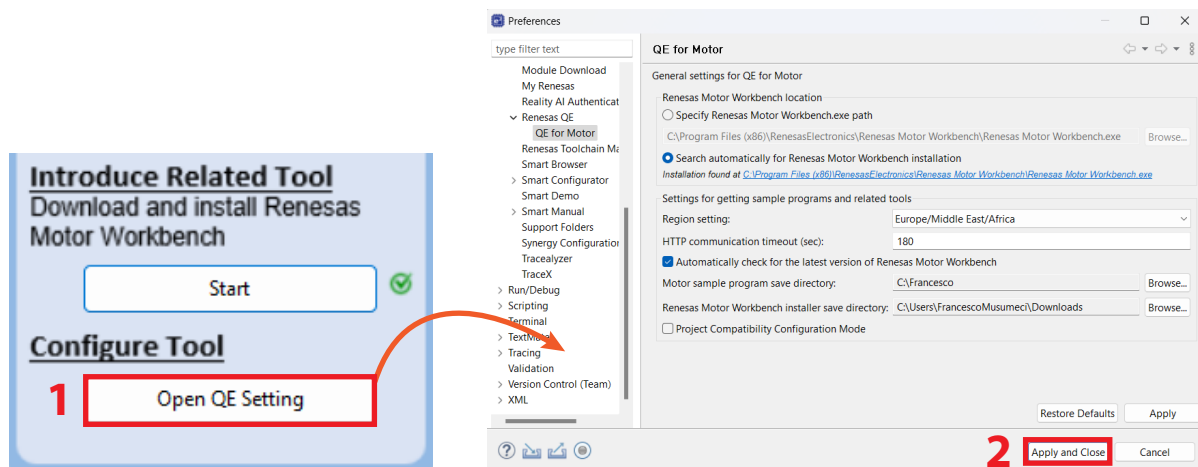
Figure 16: Motor Workbench configuration window

8. Start the motor control figure 17:

   1) In the Motor Main **Analyze** window click on **Build Project** under **Build Application Program** section

   2) Connect the CPU board to the PC as shown in figure 18 and program the application firmware in the Renesas controller by clicking on download button in the **Download Application Program** section

   3) Launch **Renesas Motor Workbench** software:

      a) Disconnect the CPU board from the PC

      b) Connect the 3-phase inverter board and motor combo to the Communication board and CPU board combo (figure 19)

      c) Provide 5 V power supply to the interface board

      d) Provide a proper power supply to the 3 phase inverter board

      e) Turn on the power and click on **Launch Analyzer** button. **If a connection error is displayed, the virtual COM port (VCP) driver needs to be downloaded and installed from the following link** (**https://www.ftdichip.com/Drivers/VCP.htm**). You do not need to do anything if you do not see any error. More details are shown in the Renesas Application Development Guide from the following link: **https://www.renesas.com/us/en/software-tool/qe-motor-development-assistance-tool-motor-applications**

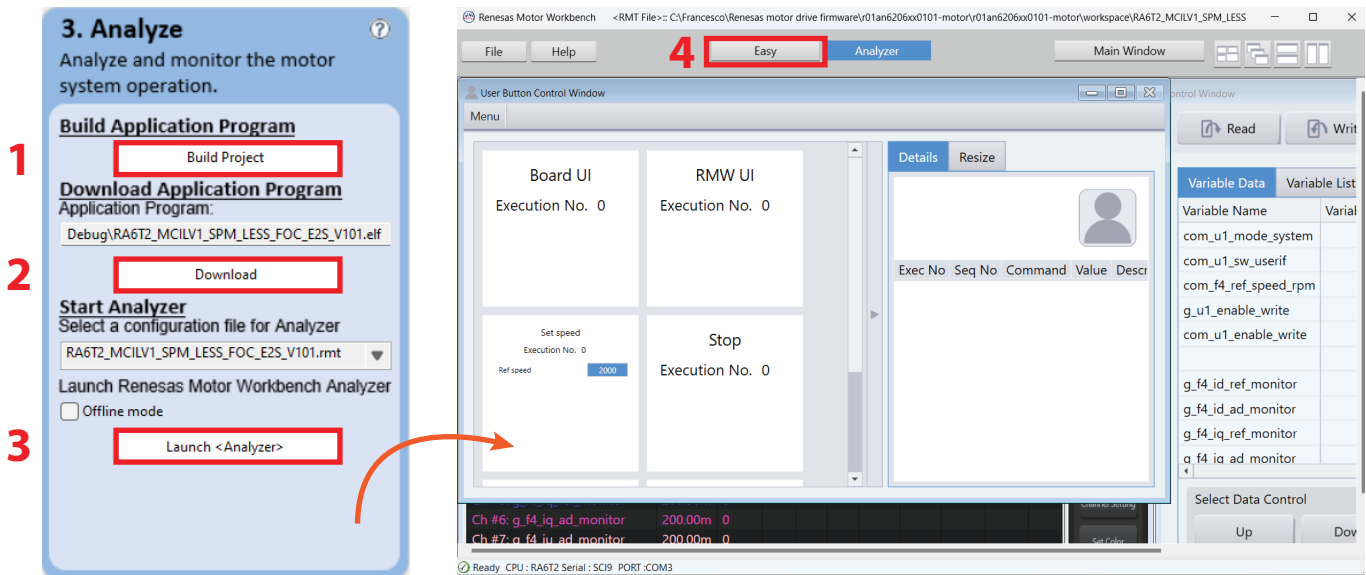   4) Click on the **Easy** button to open the easy motor drive GUI.
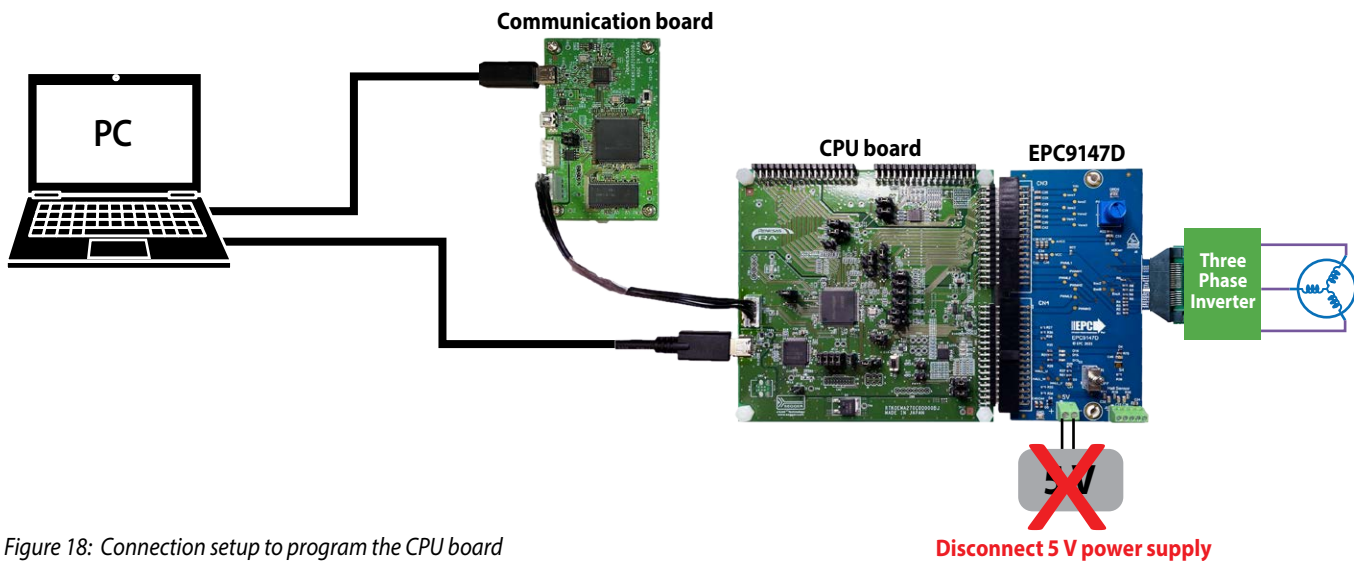

Figure 17: Build, Download and run project section

Figure 18: Connection setup to program the CPU board
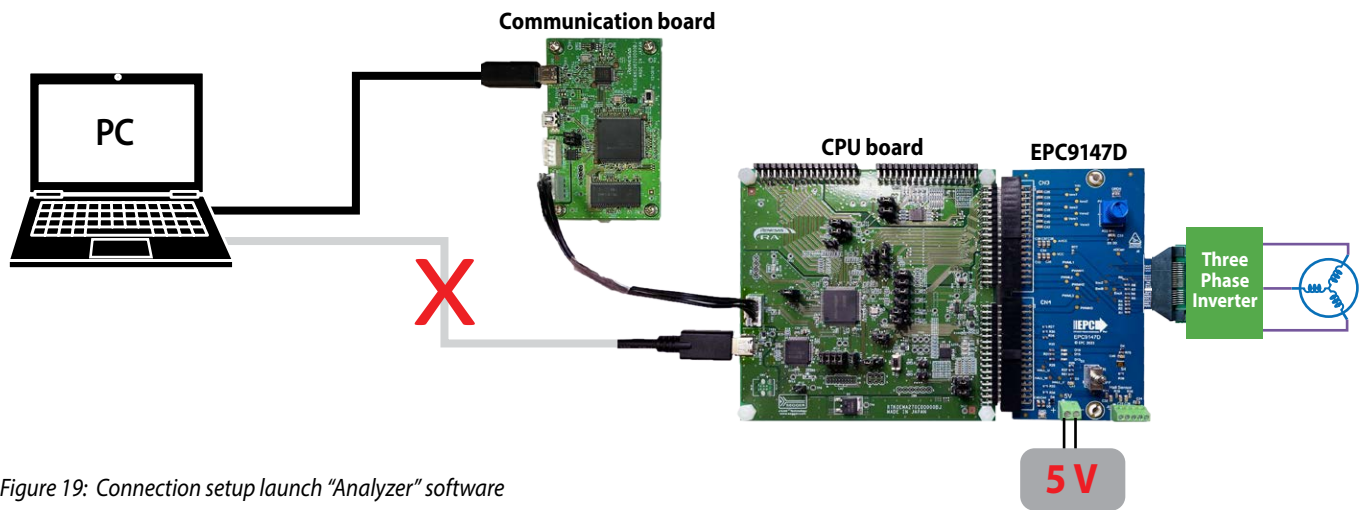
Figure 19: Connection setup launch "Analyzer" software

Renesas easy motor drive interface

There are two possible ways to control the motor:

1. Through the EPC9147D interface board;

2. Through the Renesas GUI.

EPC9147D interface board motor control

1) Make sure the interface board knob is starting in the upright position. (Tis is zero RPM)

2) Switch on the toggle switch on the interface board

3) Click on the interface fault clear button or double click on the GUI **Reset** switch

4) Switch off the **RMW UI** switch on the Motor Workbench software. Motor can now be controlled by the interface board knob

5) Click on the **Play** button, then the **Start** button to see the parameter values on the Motor Workbench software

6) Turn the board knob to change the motor speed and direction

7) To reset in case of error, click on the interface fault clear button or on the GUI reset button (it is advisable to set the motor control to zero RPM before resetting)

8) Click on the interface fault clear button or on the GUI reset button, to reset in case of an error (it is advisable to stop the motor control before resetting).
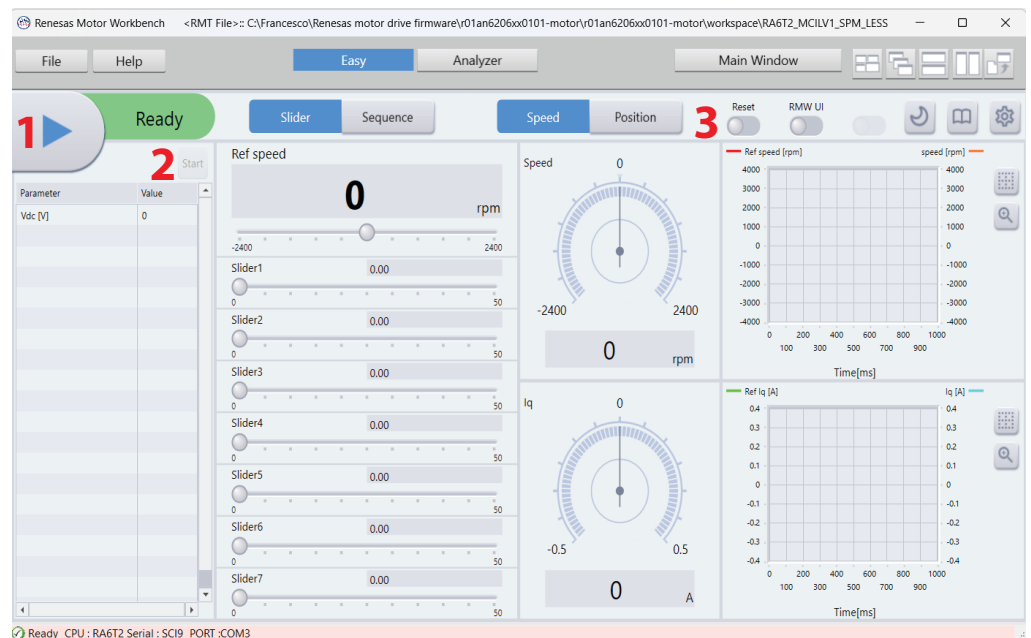

Figure 20: EPC9147D interface motor control settings

Renesas PC GUI motor control

1) Switch on the **RMW UI** switch on the Motor Workbench software

2) Double click on the **Reset** switch on the Motor Workbench software

3) Click on the **Play** button, then the **Start** button to see the parameter values on the Motor Workbench software

4) Enter the desired reference speed value in the **Ref speed** box

   • Can also use the slider to choose a value

   • Entering a negative value will change the direction of the motor

5) To reset in case of error, click on the interface fault clear button or on the GUI reset button (it is advisable to set the motor control to zero RPM before resetting).

6) Click on the **Settings** button and then click on the **blue button** in figure 21 to set the desired maximum reference speed value
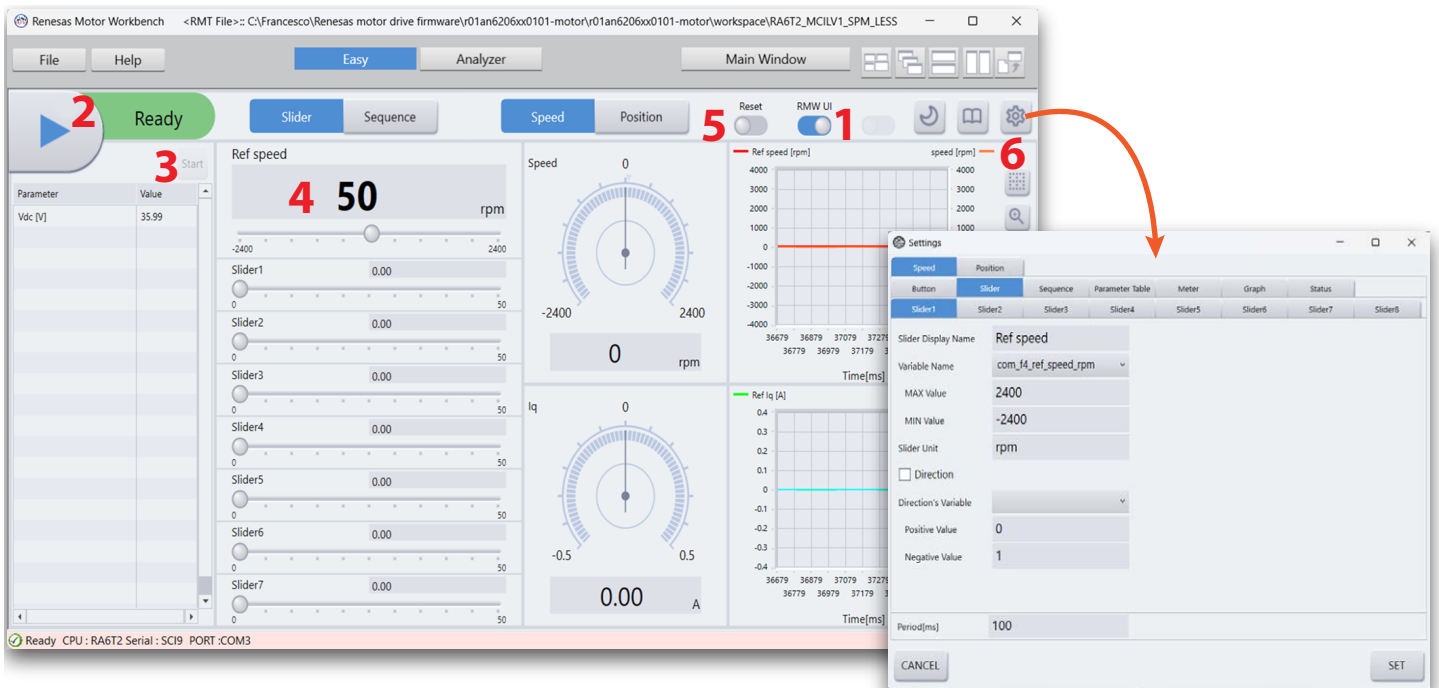
Figure 21: Renesas PC GUI motor control settings

For More Information:

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