Development Board EPC9147D Quick Start Guide

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

Revised January 31, 2024

Revision 1.1



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: Compat	able 1: Compatible EPC motor inverter drives			enesas controllers	
Inverter board	Description	Description EPC GaN FET/IC		Description	Renesas
EPC9167/HC	30 A_{RMS} 3-Phase BLDC Motor Drive Reference Design Board	EPC2065			Controller
EPC9193/HC	40 A _{RMS} 3-Phase BLDC Motor Drive Reference Design Board	EPC2619	RTKOFMA270C00000BJ	CPU board for double motor control evaluation equipped with RA6T2	RA6T2
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		CPII hoard for single motor	
EPC9173	35 A_{RMS} 3-Phase BLDC Motor Drive Reference Design Board	EPC23101	RTKOEMA430C00000BJ	control evaluation equipped	RA4T1
EPC9186	150 $\mathrm{A}_{\mathrm{RMS}}$ 3-Phase BLDC Motor Drive Reference Design Board	EPC2302		with RA4T1	



Several LEDs

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.



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 k Ω) 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 N	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
	Inde	x	
18	EncB	GNDA	17
20	Encl	GNDA	19
22	Vdc	GNDA	21
24	Vsns1	GNDA	23
26	Vsns2	GNDA	25
28	Vsns3	GNDA	27
30	NC	GNDA	29
32	lsns1	GNDA	31
34	lsns2	GNDA	33
36	lsns3	GNDA	35
38	NC	OCPn	37
40	NC	NC	39

Table 4: CN3 interface connector to Renesas CPU board					
Pin #	Pin Na	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 M	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 e² studio

- 1. Download the *e² 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 e² studio 2023-07 Installer for Windows (setup_e2_studio_2023-07.exe)

• (ENESAS	Q Search	🗏 🖶 🌐 🕲	
Products Applications D	esign Resources Sales & Support About		
Design Resources > Development	'ools → e² studio		
e² studio IDE and Coding Tool			
Overview Downloads Docur	nentation Design & Development Explore Support Vide	os & Training	
Additional Details	nload secure documents. Please login now, or register for a new acco	ount.	
Additional Details	nload secure documents. Please login now, or register for a new acco	sunt.	
Additional Details	nload secure documents. Please login now, or register for a new acco Downloads Title I	punt.	Date 🔹
Additional Details	nload secure documents. Please login now, or register for a new acc	Type © Upgrade - IDE	Date 🛛
Additional Details	nload secure documents. Please login now, or register for a new acco	Type III Upgrade - IDE Upgrade - IDE	Date © Jul 20, 2023 Jul 20, 2023
Additional Details	nload secure documents. Please login now, or register for a new acc ・ Downloads Title ・ e ¹ studio 2023-07 Linux Host ・ RUN 1,225.58 MB 日本語 e ² studio 2023-07 Installer for Windows ・ ZIP 1,504.61 MB 日本語 e ² studio V7.8.0 installer (Offline installer) ・ 1,396.24 MB 日本語	Type 🌢 Upgrade - IDE Upgrade - IDE Upgrade - IDE	Date 0 Jul 20, 2023 Jul 20, 2023 Apr 20, 2020

Figure 6: e² studio software Renesas web page

4. Follow the steps in figure 7.



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



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:



III. Configure Motor Main (QE)

Evaluating Renesas Motor Solutions	1. Preparation (?) Prepare software for motor control and make tool setting.	2. Tuning Run the tuning program to obtain the motor control parameters.	3. Analyze ⑦ Analyze and monitor the motor system operation.
Obtain More Information Renesas has a diverse portfolio of motor solutions to support a wide range of motor application. Find out more by clicking the button below. Explore Introduce Sample Program Download and import sample programs for motors. Start	Select Target Project Select a target project from the e ² studio workspace Series : Device : Configure Motor Software Start Configuration Start Configuration Download and install Renesas Motor Workbench Start Configure Tool Open QE Setting	Prepare Tuning Program Select Tuning Program Generate Tuning Program Download Tuning Program Tuning Program: Download Start Tuner Select a configuration file for Tuner Use Default Configuration file for Tuner Launch Renesas Motor Workbench Tuner	Build Application Program Build Project Download Application Program Application Program. Download Start Analyzer Select a configuration file for Analyzer Use Default Configuration file for Analyzer Use Default Configuration

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.

1. Preparation (2) Prepare software for motor control and make tool setting.	Select Target Project Select a target project from the e ² studio workspace	Motor Main (QE) IPA672_MCILV1_SPM_LESS_FOC_E2S_V101] F59 Configuration × Stacks Conliguration Generate Project Contem
Select Target Project Select a target project from the e ² studio workspace	RA6T2_MCILV1_SPM_LESS_FOC_E ♥ Series : RA6T2 Device : R7FA6T2BD3CFP ♥ Configure Motor Software	Thread New Thread Thread Remove HAL/Common Stack HAL/Com
RA6T2_MCILV1_SPM_LESS_FOC_E2S_V101 Device :	2 Start Configuration	Objects New Objects •

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:
 - 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**

	Renesas Motor V	Vorkhench	Confirm Installation	
	Le nenesas motor i			
	Select Instal	ation Folder	The installer is ready to install Renesas Motor Workbench on you	ir computer.
Renesas Motor Workbench			Click "Next" to start the installation.	
Welcome to the Renesas Motor Workbench	S The installer will insta	II Renesas Motor Workbench to the following folder.		
Wizard	To install in this folde	r, click "Next". To install to a different folder, enter it b	elow or clicy Br	
The installer will guide you through the steps required to install Renesas	M Eolder:			
computer.	C:\Program Files	(x86)\RenesasElectronics\Renesas Motor Workben	Brow	
			Disk (
(Install Renesas M	otor Workbench for yourself, or for anyone who uses	this computer:	2
	Everyone		(Back	Navt) Cancal
WARNING: This computer program is protected by copyright law and int	O Just me	2		Curcer
Unauthorized duplication or distribution of this program, or any portion of or criminal penalties, and will be prosecuted to the maximum extent poss	t	< Back Next	> Cancel	
< Back Nex	Cancel		Renesas Motor Workbench	
				(
			Renesas Motor Workbench has been successfully installed.	
			Please use Windows Update to check for any critical updates to the	he .NET Framework.
			(Berly)	
			< Back	Close Cancel
	Figure 1.	5: Renesas Motor Workbe	Nch setup windows	Close Cencel
	Figure 1	5: Renesas Motor Workbe	rch setup windows	Close Cancel
	Figure 1.	5: Renesas Motor Workbe	C Back C Back C C C C C C C C C C C C C C C C C C C	Case Cancel
	Figure 1.	5: Renesas Motor Workbe	C Back C Back C C C C C C C C C C C C C C C C C C C	Cose Concel Cose − 0 ⇔ * ⇔ •
	Figure 1.	5: Renesas Motor Workbe	C Back C	Close Cancel Close Cancel Cover Cov
Introduce Palated Teal	Figure 1.	5: Renesas Motor Workbe	C Back C	Cores Cancel Cores Cancel
Introduce Related Tool	Figure 1.	5: Renesas Motor Workbe	C Back C	Cose Cancel Cose Cancel ⇔ + ⇔ tor Workbench.exe Brows
Introduce Related Tool Download and install Renes	Figure 1	5: Renesas Motor Workbe	C Back C	Close Cencel
Introduce Related Tool Download and install Renes Motor Workbench	Figure 1.	5: Renesas Motor Workbe bypefiler text bype filter text Module Download My Renesas Reality Al Authenticat C Gen Renesas Go GE for Motor Renesas Toolchain Me Smart Browser Smart Configurator Smart Browser Smart Configurator Smart Browser Smart Configurator Smart Configurator Smart Browser Symery Configuration Symery Configuration H	C Back C	Close Cencel Close Cencel ⇔ ♥ ⇔ ↔ tor Workbench.exe Brows
Introduce Related Tool Download and install Renes Motor Workbench	Figure 1	5: Renesas Motor Workber	C Back C	tor Workbench.exe Browse tor Workbench.exe
Introduce Related Tool Download and install Renes Motor Workbench Start	Figure 1. as	5: Renesas Motor Workbe bypefiler text Module Download My Renesas QE QE for Motor Renesas Oc QE for Motor Renesas Colchain Mu Smart Demos Smart Configurator Smart Demos Smart Demos Symery Configurator Smart Demos Symery Configurator Traceal/Zear Tracea	C Back C	tor Workbench.exe Brows Downloads Brows
Introduce Related Tool Download and install Renes Motor Workbench Start Configure Tool	Figure 1	5: Renesas Motor Workbe	C Back C Control Conterol Contecont Control Control Control Control Control Control C	Close Cencel Close Cencel Cover Cover Cencel Cence
Introduce Related Tool Download and install Renes Motor Workbench Start Configure Tool	Figure 1	5: Renesas Motor Workbe bype filer text Module Download My Renesas Q Reality Al Authenticat Reality Al Authenticat Renesas Toolchain Mi Smart Demoser Smart Oornower Smart Demoser Smart Demose	C Back C	Close Cencel Close Cencel Cover Cover Cencel Cover Cover Cencel Cover Cover Cencel Cover Cencel Cover Cover Cencel Cencel Cover Cencel Cenc
Introduce Related Tool Download and install Renes Motor Workbench Start Configure Tool 1 Open QE Setting	Figure 1	5: Renesas Motor Workbe	C Back C	Close Cencel Close Cencel Close Cencel Covering

Figure 16: Motor Workbench configuration window

? ڬ 🗹 🔘

Apply and Close

Cance

- 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.

	3. Analyze 🕐	Renesas Motor Workbench <rmt file="">: C\Francesco\Renesas motor drive firmware\v01an6206xo0101-motor\v01an6206xo0101-motor\v0rkspace\RA612,</rmt>	MCILV1_SPM_LESS − □ ×
	Analyze and monitor the motor system operation.	File Help 4 Easy Analyzer Main Window	
1	Build Application Program Build Project	Menu Board UI RMW UI Details Resize	Pontrol Window
	Download Application Program Application Program: Debug/RA6T2 MCILV1 SPM LESS FOC E2S V101.elf	Execution No. 0 Execution No. 0	Variable Name Varial
2	Download	Exec No Seq No Command Value Descr	com_u1_sw_userif com_f4_ref_speed_rpm
	Start Analyzer Select a configuration file for Analyzer RA6T2_MCILV1_SPM_LESS_FOC_E2S_V101.rmt	Set speed Stop	g_u1_enable_write com_u1_enable_write
	Launch Renesas Motor Workbench Analyzer	Refiseed Execution No. 0	g_f4_id_ref_monitor g_f4_id_ad_monitor
3	Launch <analyzer></analyzer>		g_f4_iq_ref_monitor q f4_iq ad monitor
	1	Ch #6: g_14_ig_ad_monitor 200.00m 0 Ch #7: g_14_ig_ad_monitor 200.00m 0 Ch #7: g_14_iu_ad_monitor 200.00m 0	Select Data Control Up Dov
		Ready CPU : RA6T2 Serial : SCI9 PORT :COM3	

Figure 17: Build, Download and run project section



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



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)
- 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).

File	Help		Easy Analyzer		Main Window	
	Ready	Slider	Sequence	Speed Position	3 Reset RMW UI	Э Ш ध
	2 Start	Ref speed		Speed 0	- Ref speed [rpm]	speed [rpm]
meter	Value		0		3000 ·	3000
kc [V] 0		• rpm	ANTINA COMPANY	2000 -	2000	
	2400			1000	1000	
		-2400 Slider1	0.00		-1000	-1000
			0.00		-2000	-2000
			50	-2400 24	-3000	-3000
		Slider2	0.00		4000	-4000
		0	50	0 ror	100 300 500	700 900
		Slider3	0.00		Time[m	s]
			50	la 0	Ref Iq [A]	Iq [A]
		Slider4	0.00		0.3	0.4
		0		ATTITUTION AND A STATE	0.2	0.2
		0 Slider5	50		0.1	• 0.1
			0.00		0 .	• 0
		0	50		-0.1	-0.1
		Slider6	0.00		-02 -03 -	-0.3
		0	50	-0.5 0.5	-0.4	-0.4
		Slider7	0.00		0 200 400 6	00 800 1000

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:

Please contact **info@epc-co.com** or your local sales representative

Visit our website: www.epc-co.com

Sign-up to receive EPC updates at **bit.ly/EPCupdates**





EPC Products are distributed through Digi-Key. www.digikey.com

Demonstration Board Notification

The EPC9147D board is intended for product evaluation purposes only. It is not intended for commercial use nor is it FCC approved for resale. Replace components on the Evaluation Board only with those parts shown on the parts list (or Bill of Materials) in the Quick Start Guide. Contact an authorized EPC representative with any questions. This board is intended to be used by certified professionals, in a lab environment, following proper safety procedures. Use at your own risk.

As an evaluation tool, this board is not designed for compliance with the European Union directive on electromagnetic compatibility or any other such directives or regulations. As board builds are at times subject to product availability, it is possible that boards may contain components or assembly materials that are not RoHS compliant. Efficient Power Conversion Corporation (EPC) makes no guarantee that the purchased board is 100% RoHS compliant.

The Evaluation board (or kit) is for demonstration purposes only and neither the Board nor this Quick Start Guide constitute a sales contract or create any kind of warranty, whether express or implied, as to the applications or products involved.

Disclaimer: EPC reserves the right at any time, without notice, to make changes to any products described herein to improve reliability, function, or design. EPC does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights, or other intellectual property whatsoever, nor the rights of others.