

## Renesas ASSP EASY Motor Control Solution

Based on RISC-V

### **Graphical User Interface operation description**

This manual describes in detail the "Graphical User Interface" for evaluation and tuning of the motor control solution.

This manual is organized in the following sections:

- Installation guide
- Connection to the target board
- Speed Control
- Motor tuning
- Parameter description

Target Device: R9A02G0204

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## 1. PC Graphical User Interface (GUI) Software Installation

The PC GUI supports 32-bit and 64-bit Windows<sup>™</sup> operating systems (Windows 10, 8.1, 8, 7, Vista). Note: Windows<sup>™</sup> Vista, 7, 8 and 10 users must install the software with administration rights. User may experience a "User Account Control" dialog box pop-up. In such case, enter the administrator password and click **<OK>**. Else, to install right-click on the "**MotorControlSetup\_x.x.x.exe**" and select "**Run as administrator**" or double-click on **<MotorControlSetup\_x.x.x.exe>** and then follow the on-screen instructions until reaching the following installer screen and then click **<Finish>** to complete installation.

🕞 Setup - Motor Control	- 🗆 X
	Completing the Motor Control Setup Wizard Setup has finished installing Motor Control on your computer. The application may be launched by selecting the installed shortcuts. Click Finish to exit Setup.
	Einish



The Motor Control GUI program icon (see below) will be available on the desktop:



The GUI software will be installed by default within the folder "C:\Program Files\BFG Engineering\Motor Control". As a final step, it is mandatory to copy the ASSP\_V01.ini file



within the Motor Control GUI installation folder. The .ini file is delivered with the installation software and contains some configuration settings for the initial setup.

## 2. Installing USB Drivers

The ASSP EASY Motor Control Kit features an on-board USB to serial (UART) converter interface, to communicate with the PC. It is mandatory to download and install the respective USB divers for enabling the communication. Please download and install the latest drivers from https://ftdichip.com/drivers/.

(Information about the converter IC is available from the FDTI website).

### 3. Using the Graphical User Interface (GUI)

Note: Windows Vista and Windows 7, 8 users must run the GUI with administrative rights. To automatically set the administrator privilege level, press the right mouse button over the icon of the GUI, select "**Properties**", press the left mouse button on the "**Compatibility**" tab and select the checkbox "**Run this program as an administrator**" under the privilege Level; then click **<OK>**.

It is recommended to connect the USB cable to the PC and the board before opening the GUI as this makes the connection process easier. The GUI can be opened without the board being connected.

Double-click on the Motor Control GUI icon to start the program; once opened, use the following procedure to connect the GUI to the kit:

• Click on the "Settings" button. Usually, the following window will appear.



Fig. 1



Please select the Board Setup .ini file, then select "COM port" or "Auto detect" • options and finally configure the baud rate setting which must be set to 19200 or Auto-detect as shown in the screenshot:

Motor Control					- □ >
Motor Control	Motor Control Refere	nce Platform Us or easily with RISCV mice	ser Interface -	ASSP_RISCV_V01	RENESAS
Status Disconnected Settings					
		Settings		×	
		Board setup	ASSP_V01.ini	-	
		COM port	Auto detect	-	
		Baud rate	9600 Disconnected	-	
				Save settings	

Fig. 2

Save the settings for future sessions. •

If the settings are set correctly, after saving the status will change from 'Disconnected' (black font) to 'Connected' (green font) indicating the connection with the kit is established successfully.

Furthermore, some menu items will appear on the left side of the GUI



Fig. 3

Now the GUI is ready to be used



### 4. GUI overview

Below some screenshots to illustrate the various functions provided by the GUI interface.



Fig. 4



time all the variables and store them in a ".csv" file



Fig. 6



Motor Control	Motor Control Refe Drive your own AC Brushless			- ASSP_R	ISCV_V01	ENESAS
Status Connected	Speed control		Stop reco	rding 3 Ref	et recording Stop a	pdate X
	Speed 2101	e	Voltage 25 0.000 V	2	Current 417	0
	1050.5 0		12.5 0.000 V 0.000 V 0.000 V		208.5	_
	-1050.5		-12.5 -25 a. 7 a. 5		-417 dt -7 -6 -6 -4	
	Reference (rpm)		Direct [V] 📕 Quedr		Direct (mA)	
	0			Property	monitor	
Motor identification			Motor speed	0 rpm	Imposed Frequency	0 Hz
	-9000	9000		0 mA	Torque Current	0 mA
			Direct Voltage	ov	Guadrature Voltage	ov
	0		DC Bus Voltage	23.8 V	Alarm Code	0
	-18000	18000		0	Total Current	0 mA
		3	Total Voltage	ov	Dummy	259

As soon as you click, you will be requested to create a file of type ".csv". Give it the desired name and press "Enter" on the keyboard to confirm and save. The recording starts and will be stopped by clicking on the "Stop recording" button

#### Fig. 7

#### 4.1 Parameter settings

Click on "Parameter setting" button to open the parameters list.

Motor Control	Motor Control Reference Drive your own AC Brushless Motor easi			ASSP_RISCV_V01	RENESAS
Status Connected Settings	Parameter settings				Always on top
	C Reload Write	T Load file	Save file	Co Create .h	Handle custom parameter
	Parameter	Unit	Min	Max	Value
Parameter settings	00. Operation Select	4.	0	0	0
Speed control	Q1. Minimum Speed	rpm	1	10000	310
	02. Maximum Speed	rpm	10	32767	3000
	03. Acceleration	rpm/s.	1	32767	3000
Cur. Pl tuning (AUTO)	04. Deceleration	rpm/s	1	32767	3000
	05. Polar Couples		1	24	2
	06. Startup Current	Apk/1000	0	15000	500
Oscilloscope	07. Maximum Current	Apk/1000	0	15000	1500
Constant of the	08. Stator Resistance	Ohm/100	0	30000	62
	09. Synchronous Q Inductance	Henry/10000	0	30000	[11
	10. Doors second Manager Day	Minduna Perintenan	<u>^</u>	30000	966

After changing the value of a parameter, click on the "Write" button to store it in the DataFlash.

#### Fig. 8: parameters list

Note: it is possible to change the value of any parameter; to store its value click on "Write" button.

Motor Control	Motor Control Reference Drive your own AC Brushless Motor easi			ASSP_RISCV_V01	RENESAS
Status Connected	Parameter settings				Always on top
	C Reload Write		Save file	Co Create .h	Handle custom parameter
	Parameter	Unit	Min	Mass	Value
	00. Operation Select	<i>x</i>	0	0	0
Speed control	Q1. Minimum Speed	rpm	1	10000	310
	02. Maximum Speed	rpm	10	32767	3000
	03. Acceleration	rpm/s	1	32767	3000
Cur. Pl tuning (AUTO)	04. Deceleration	rpm/s	1	32767	3000
	05. Polar Couples		1	24	2
	06. Startup Current	Apk/1000	0	15000	500
Oscilloscope	07. Maximum Current	Apk/1000	0	15000	1500
	08. Stator Resistance	Ohm/100	0	30000	62
	09. Synchronous Q Inductance	Henry/10000	0	30000	[11
	10. Doom second Manager Day	WARAN MONTO	0	20000	000

Furthermore, in order to read the parameters stored in the DataFlash, and display them in the parameters window, click on the "Reload" button.



## 5. Motor Tuning

The menu items "Cur. PI tuning", "Cu. PI tuning (AUTO)", "Motor Identification" and "Oscilloscope" on the lefthand side of the GUI are used for the self-calibration of the motor.

Motor Control	Drive your own AC Brushless Motor	ce Platform User Interface - easily with RISCV microcontroller		RENESA
itatus Connected <b>Settings</b>	Speed control		( & Save data to file )	Stop update X
System info	Speed 2101	Voltage	Current 417	~
arameter settings	050.5	12.5	208.5	
ipeed control	-1050.5	-12.5 -4 -3 -2 -1 -25 -8 -7 -6 -5	-4 -3 -2 -1 -417 -8 -7	6 -5 -4 -3 -2 -1
Cur. Pl tuning				0 -5 -4 -3 -2 -1 ] Torque (mA] Total (r
Cur. Pl tuning (AUTO)	o		Property monitor	
		Motor speed	1779 rpm Imposed Frequ	ency 59.3 Hz
Notor identification	-9000	9000 Direct Current	71 mA Torque Current	202 mA
oscilloscope		Direct Voltage	1.7 V Guadrature Vol	age 9.9 V
	210	DC Bus Voltage	23.7 V Alarm Code	0
	-18000	18000 Flags	256 Total Current	214 mA
	н ()-	) 5 Total Voltage	10 V Dummy	264

Fig. 10

As first step, it is advised to clean the DataFlash contents and start with the default parameters in the DataFlash.

The first thing to do is to ensure that the inverter board is configured in the default state, and the default parameters are written inside. The procedure below details how to ensure it:

• Click on the "Parameters Setting" button and enter the magic value "33" in the "00. Operation Select" field, then push the RESET button on the board.



Fig. 11

Set the maximum current (parameter n°07) as it will influence all the next steps:

• Click on "Parameters settings", Then enter the value: **1500** (the unit is in mA) and click on "Write" to save the parameter into the DataFlash and close the parameter setting window. The maximum current parameter is fundamental for the auto-calibration. The maximum value allowed by the motor must be used to guarantee the highest resolution.

Motor Control	Motor Control Reference			SSP_RISCV_	- • ×
Status Connected	Parameter settings	any with Rise v microcontre	aner .		Always on top
	C Reload Write	<u> </u>	Save file	( Create .h ) (	Handle custom parameter
	Parameter	Unit	Min	Max	Value
	00. Operation Select	8	0	0	0
	01. Minimum Speed	rpm	1	10000	310
	02. Maximum Speed	rpm	10	32767	3000
	03. Acceleration	rpm/s	1	32767	3000
Cur. Pl tuning (AUTO)	04. Deceleration	rpm/s	1	32767	3000
	05. Polar Couples	-	1	24	2
Motor identification	06. Startup Current	Apk/1000	0	15000	500
Oscilloscope	07. Maximum Current	Apk/1000	0	15000	1500
	U8. Stator Resistance	Onm/100	0	30000	02
	09. Synchronous Q Inductance	Henry/10000	0	30000	11
	10. Dormanent Magnete Elver	Wabar/10000	0	20000	260

Fig. 12

## 6. Current PI tuning (AUTO)

• Click now on "Cur. PI tuning (AUTO)" button and press "Start" to perform an automatic Current PI tuning. The two coefficients of the PI current block will be extracted thanks to the embedded software able to generate a step voltage and measuring the motor response.

Motor Control	0				- 🗆 ×
Motor Control	Motor Control Reference Drive your own AC Brushless Motor			P_RISCV_V01	RENESAS
Status Connected Settings					
		Cur. PI tuning (AL	JTO)	×	
		Automatic current PI c Warning: a current equ injected in the motor.	ontrol gains determinatio al to 80% of IMAX (par.	on. 7) will be	
		Кр	150		
		Ki	600		
		(	Start		
Fig. 13					

Fig. 13

Note: depending on the motor, the values of the parameters found by the automatic procedure can be too low or too high and the PI current regulator will be not stable. Click on YES button to store the parameters in the Data Flash.



#### Fig. 14



#### 7. Current PI tuning (manual)

 Now click on the button "Cur. PI tuning" to open the manual current PI tuning window and check the step answer by clicking on "Apply current step" button.



#### Fig. 15

Note: depending on the motor, the parameters found by the automatic procedure can be too fast or too slow.







Here below a couple of examples of excessive high overshoot or ringing:

Motor Control	rive your own AC Brushless Motor easily with RISCV microcontroller		RENESAS
Connected Settings	Cur. PI tuning		×
	Too high		
System info	<sup>Output current</sup> Overshoot		
Parameter settings	1085 868 651		
Speed control	434 217	0.0043 0.0054	
Cur. PI tuning	0.0000 0.0021 Current [A]	0.0043 0.0064	,
Cur. PI tuning (AUTO)	Кр 206	•	
Motor identification	Кі 4098 —	•	
Oscilloscope	Cra (%) 50		
	Apply c	current step	



Motor Control		- 🗆 ×
Motor Control	Motor Control Reference Platform User Interface - ASSP_RISCV_V01 Drive your own AC Brushless Motor easily with RISCV microcontroller	RENESAS
Status Connected Settings	Cur. Pl tuning	×
	Output current	- •
	1360	
	816 524 200	
	© 0.0000 0.0021 0.0043 0.0064 ■ Current [A] < ■	,
	Кр 406	
	кі 6098	•—
	Cra (%) 50	
	Apply current step	



You can adjust manually the parameters to obtain a better step response and increase the step current level by increasing the percentage of "Cur. [%] to 90%. The default value is 50%. Once it's done, the window can be closed as the proportional and integral coefficients of the PI current are tuned.



## 8. Auto Identification

Perform an auto-identification of the motor parameters by clicking on "Motor Identification" and click "start. The GUI shows the actual parameters stored.



Fig. 20

Click "start" to initiate the identification process (ATTENTION: the motor will be driven and rotated, please leave the rotor free and do not load). At the end of the procedure, three parameters will be calculated: Stator resistance, Synchronous inductance, Permanent magnet flux



At the end of the process, you will be requested to store the calculated parameters. Click "YES" and the parameters will be stored.



Fig. 22



### 9. Speed PI Tuning

Now, it is possible to run the motor. Please click on the button: "Speed Control": To start the motor, let's enter a speed in the range of the rated motor speed, in this case **1500 rpm** 

Motor Control				- 🗆 ×
Motor Control		ence Platform User Interfa tor easily with RISCV microcontroller	ce - ASSP_RISCV_V01	RENESAS
Status Connected Settings	Speed control		🛓 Save data to file	Stop update
	Speed 1502	Voltage	Current	0
	- 751 0	0	94	
	-751 -1502 -8 -7 -6 -5 -4	-12.5 -3 -2 -1 -25 -8 -7 -6 -5	-94 5 -4 -3 -2 -1 -188 -8 -7 -6	-5 -4 -3 -2 -1
	Reference [rpm] 📕 M	easured [rpm] 🗧 Direct [V] 🧧 Qi	uadrature [V] 📕 Bus [V. 🗧 Direct [mA] 🚦	Torque [mA] 🗧 Total [r
	0	Motor speed	Property monitor 1500 rpm Imposed Frequency	50 Hz
	-9000	9000 Direct Current	0 mA Torque Current	184 mA
Oscilloscope		Direct Voltage	1.7 V Quadrature Voltage	8.3 V
	1500	DC Bus Voltage	23.6 V Alarm Code	0
	-18000	18000 Flags	256 Total Current	184 mA
		5 Total Voltage	8.4 V Dummy	264

#### Fig. 24

Please click on the "Oscilloscope" button to see the motor waveforms with the Phase or the current in Y-axis and the time in X-axis.



Fig. 23 Please adopt an appropriate time scale: "1 sample every 1" should be used for extremely fast variations when running at very high speed. The setting "1 sample every 128" should be used for extremely slow variations when running at very low speed.

#### Fig. 24



Start with an intermediate value and adjust it to see some periods of the current or the phase.





While the motor is running, you can adjust the two speed PI parameters: the proportional and integral terms: #13 and #14.

Please open the Oscilloscope window and the Parameters Setting windows as shown below to check the oscilloscope and to have the possibility to change some parameters "on fly".

Motor Control					- o ×
Motor Control	Motor Control Referenc Drive your own AC Brushless Motor e			ASSP_RISCV_V	VOI RENESAS
Status Connected Settings	Parameter settings				Always on top
System info	C Reload Write	T Load file	( Save file	Create .h	Handle custom parameter
Parameter settings	Parameter m. convent Loop np 12. Current Loop Ki	Unit	Min 0	30000	Value
Speed control	13. Speed Loop Kp	2 2	0	30000	1000
Cur. PI tuning	Oscilloscope				Always on top
Cur. PI tuning (AUTO)	1500				
Motor identification	0			$\sim$	$\sim$
Oscilloscope	-750 -1500 8 10 15	20 25	30 35	40 45 5	0 55 60
	Current [mA] Quantity Current	•		Sample 1 sample e	very 8 ~
Fig. 00	· · · · · · · · ·				

Fig. 26

To tune the coefficients, start by increasing the Parameter n°13 (Kp) until the instability that can be display in the current or phase waveform window.

Add a step of "1000" and click "write" to see the effect and keep on increasing it. In our case, at **200** it started to be very unstable, but the motor is still running. Set the speed to "0".

Status Connected Settings	Parameter se	ttings								ays on top	×	
System info	Oscilloscop	0e								Always on I	top	×
Parameter settings	1500	0.000 m	A									
Speed control	750		$\sim$			1		$\wedge$				
Cur. Pl tuning	• • •											
Cur. PI tuning (AUTO)	-750											
Motor identification	-1500 5 Curren	10 15 it [mA]	20	25	30	35	40	45	50	55	60	
Dscilloscope	Quantity Cu	urrent	~				Sample	1 sampl	e every 8			-

Fig. 27

Then use less than half of the found value or double it: **70 or 400** in our case; click on "write" and set the speed to 1500 RPM.

Do the same for the **parameter n°14** (integral coefficient) which is the speed loop Ki parameter. In our case the critical value is reached at **600** for Ki, so the value to be used is: **200** (half of the value found).

Parameter settings				Always on top
C Reload Write	T Load file (	➡ Save file	<pre> Create .h (</pre>	Handle custom parameter
Parameter	Unit	Min	Max	Value
11. Current Loop Kp	-	0	30000	206
12. Current Loop Ki	-	0	30000	1098
13. Speed Loop Kp	-	0	30000	1000
14. Speed Loop Ki	-	0	30000	200

#### Fig. 28

Test the parameters found in all the speed ranges and different rotations. Finally, the parameters list can be saved in a file in .CSV ("Save" button) or .h file ("Create.h" button) format for further usage and can also be uploaded later.

It is also possible to load a new .csv file by clicking "load file" button.

Parameter settings				Always on top
C Reload Write	T Load file	▲ Save file		Alandle custom parameter
Parameter	Unit	Min	Max	Value
11. Current Loop Kp	-	0	30000	206
12. Current Loop Ki	-	0	30000	1098
13. Speed Loop Kp	-	0	30000	1000
14. Speed Loop Ki	-	0	30000	200



## **10. Table of Parameters**

Here below the explanation of the parameters:

Parameter number	Short name	Description
0	SEL_OP	Default parameters setting, Used to perform special operations, like default parameter set re-loading, or current PI tuning working mode setting
1	RPM_MIN	Set the Minimum Speed in RPM
2	RPM_MAX	Set the Maximum Speed in RPM
3	R_ACC	Set the acceleration [RPM/s]
4	R_DEC	Set the deceleration [RPM/s]
5	C_POLI	Set the number of polar couples
6	Set the start-up current (neal) [Ampere/AMP_RES]	
7	I_MAX	Set the maximum phase current (peak) [Ampere/AMP_RES]
8	R_STA	Set the stator resistance [Ohm/OHM_RES]
9	L_SYN	Set the synchronous inductance [Henry/HEN_RES]
10	10       PM_FLX       Set the permanent magnets flux [Weber/WEB_RES]. This value is only used when the exact integration flux estimation algorithm is selected. By default, it's not needed as the approximated integration is selected.	
11	KP_CUR	Set the Current loop Proportional coefficient: KP
12	KI_CUR	Set the Current loop Integral coefficient: KI
13	13 KP_VEL Set the Speed loop Proportional coefficient: KP	
14	KI_VEL	Set the Speed loop Integral coefficient: KI
15 FB_GAIN the exact integration flux estimation algorithm is selected. By de		Set the flux amplitude feedback gain. This value is only used when the exact integration flux estimation algorithm is selected. By default, it's not needed as the approximated integration is selected
16	Set the phase offset [deg]. It is used to add a phase offset to the phase estimation	
17	ST_TIM	Set the Start-up acceleration time [sec/SEC_RES]
18	Not used	
19	SAM_FRE_DEF	Set the sampling frequency [Hz] of the control loop
20	F_RATIO_DEF	Set the ratio between the PWM frequency and sampling frequency, e.g. if 8000 is set in the parameter #19 and 2 in the parameter #20, the PWM frequency is 16KHz.

It is also possible to change a selected parameter: by clicking on "Handle custom parameter" a pop-up window will appear, allowing to read or to write a parameter stored in a selected address.

Parameter settings				igsquirin Always on top $igsquiring$
C Reload Write	T Load file ↓	Save file	</th <th>Handle custom parameter</th>	Handle custom parameter
Parameter	Unit	Min	Max	Value
11. Current Loop Kp	_ Handle custom p	parameter	× 30000	206
12. Current Loop Ki	- Parameter addre	255	30000	1098
13. Speed Loop Kp	_ Parameter value		30000	1000
14. Speed Loop Ki <b>g. 30</b>	- Read	Write	30000	200

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(Rev.5.0-1 October 2020)



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