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:

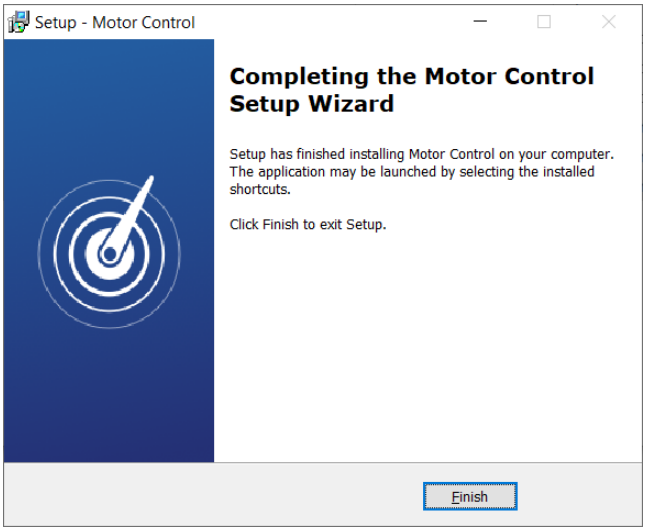
- Installation guide
- Connection to the target board
- Speed Control
- Motor tuning
- Parameter description

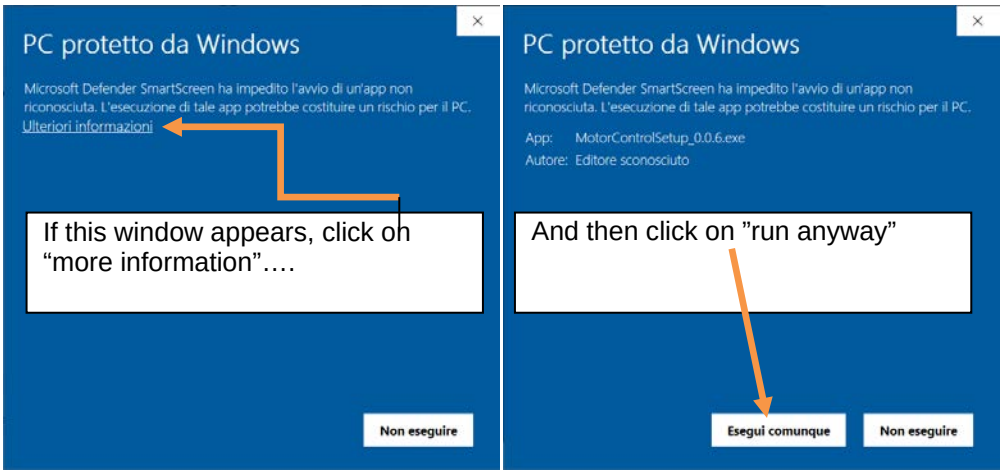
Target Device: R9A02G0204

Contents

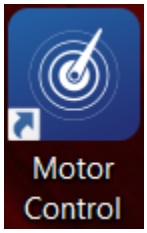
1. PC Graphical User Interface (GUI) Software Installation

The PC GUI supports 32-bit and 64-bit Windows™ operating systems (Windows 10, 8.1, 8, 7, Vista). Note: Windows™ 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.





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.

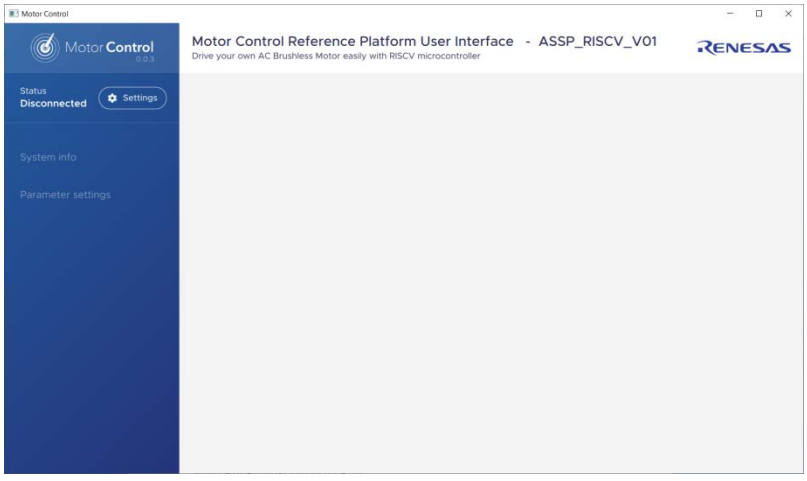


Fig. 1

- 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:

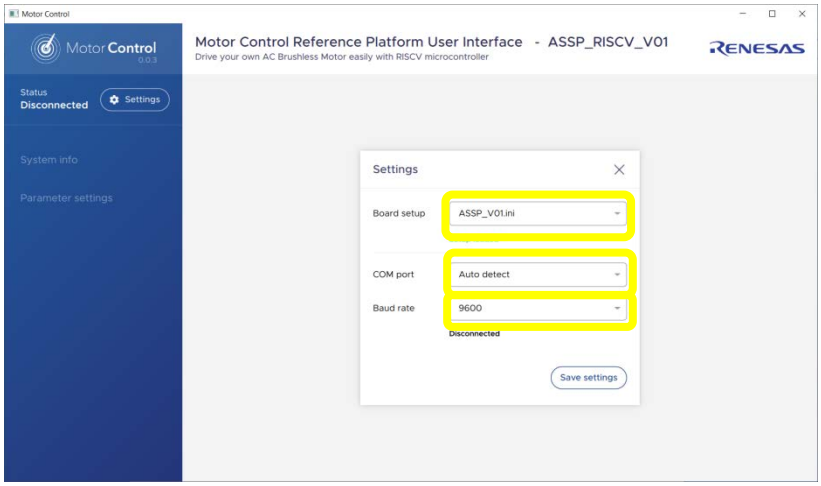


Fig. 2

- 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

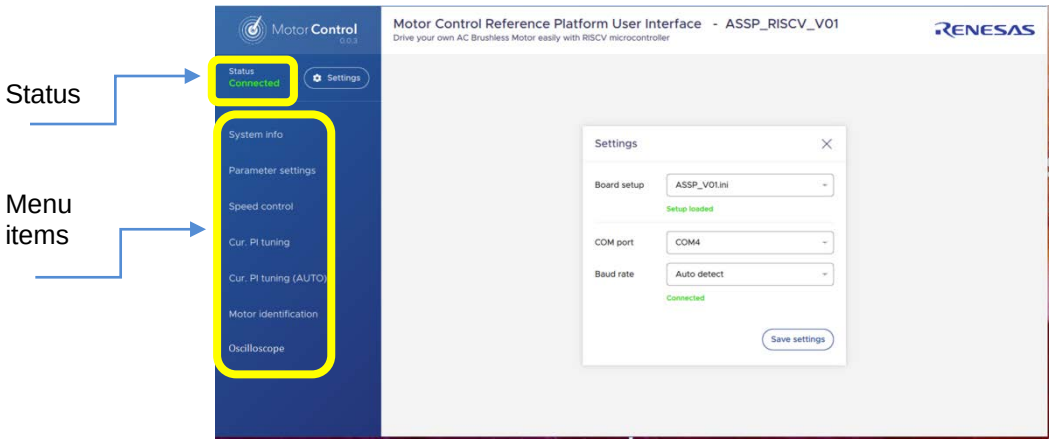


Fig. 3

Now the GUI is ready to be used

4. GUI overview

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

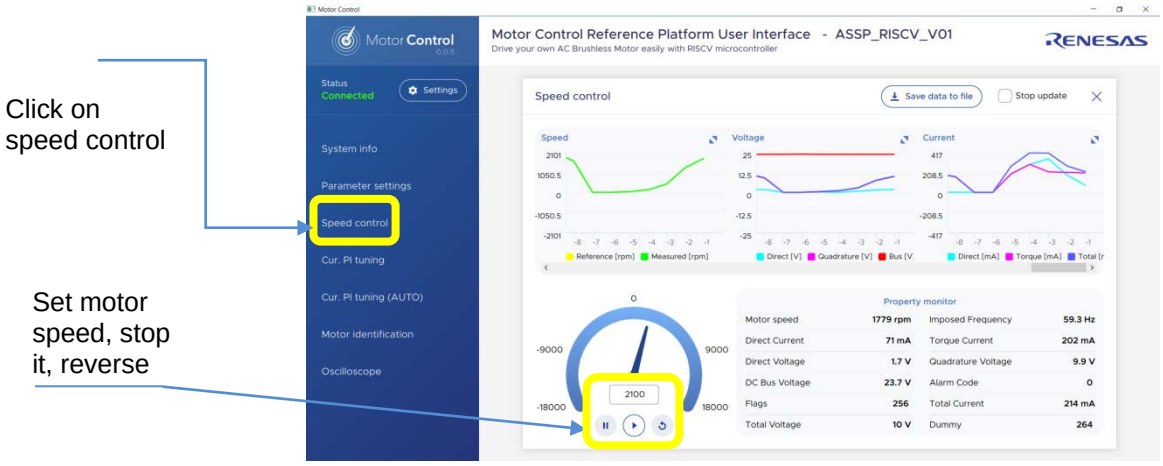


Fig. 4

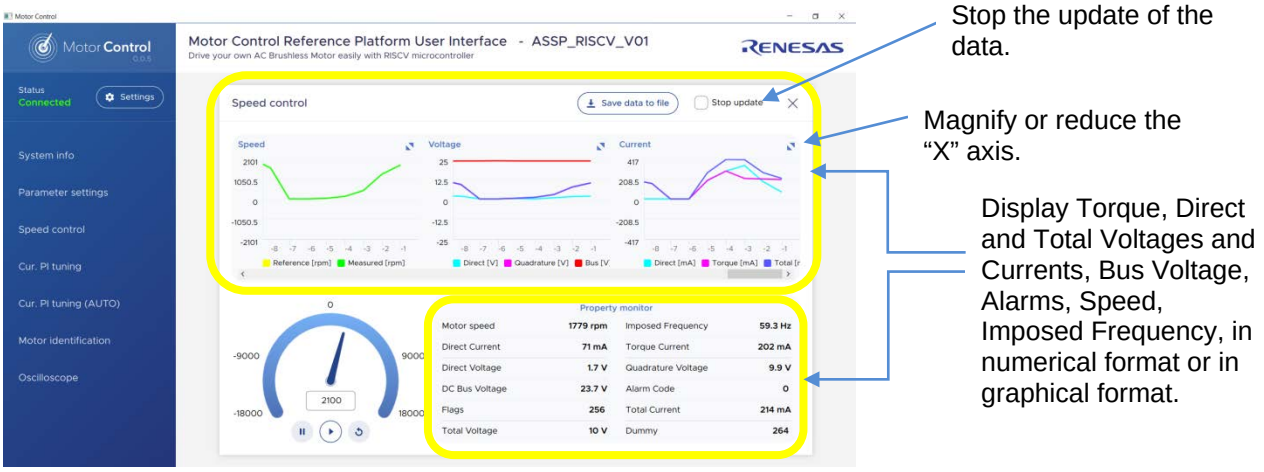


Fig. 5

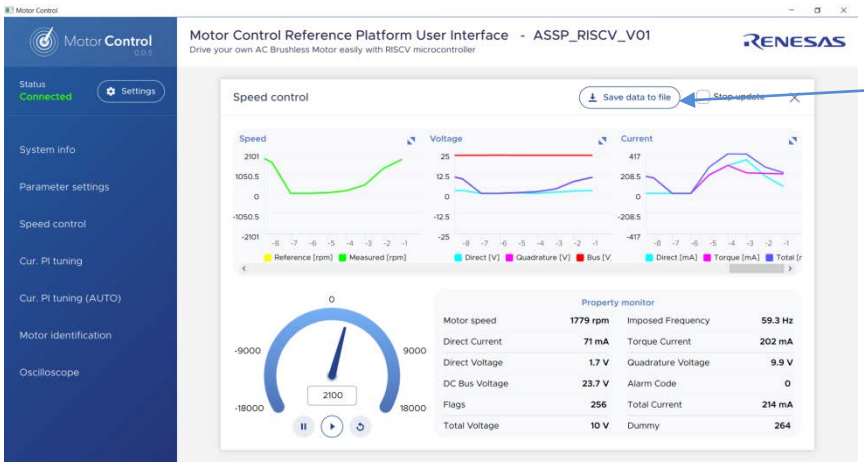
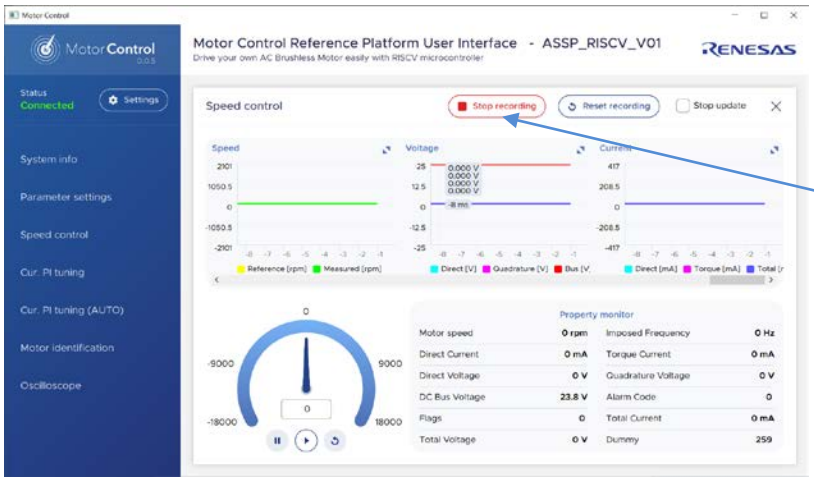


Fig. 6

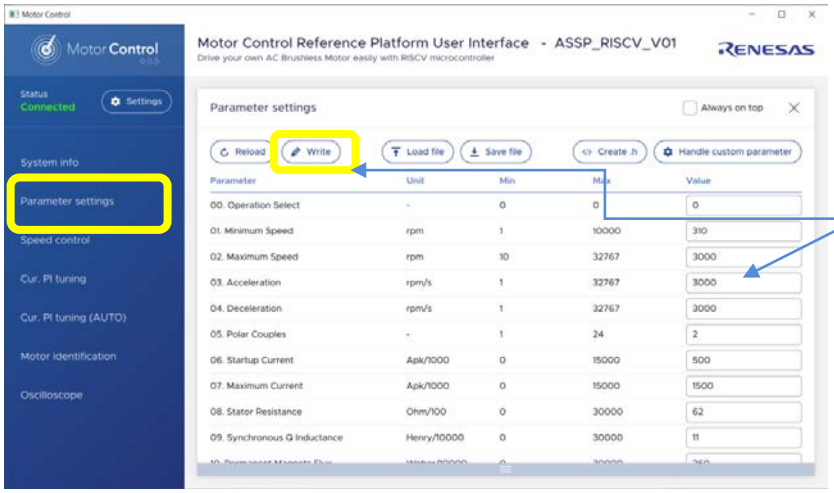


As soon as you click, you will be requested to create a file of type ".csv". Give it the desired name and press "Enter" on the keyboard to confirm and save. The recording starts and will be stopped by clicking on the "Stop recording" button

Fig. 7

4.1 Parameter settings

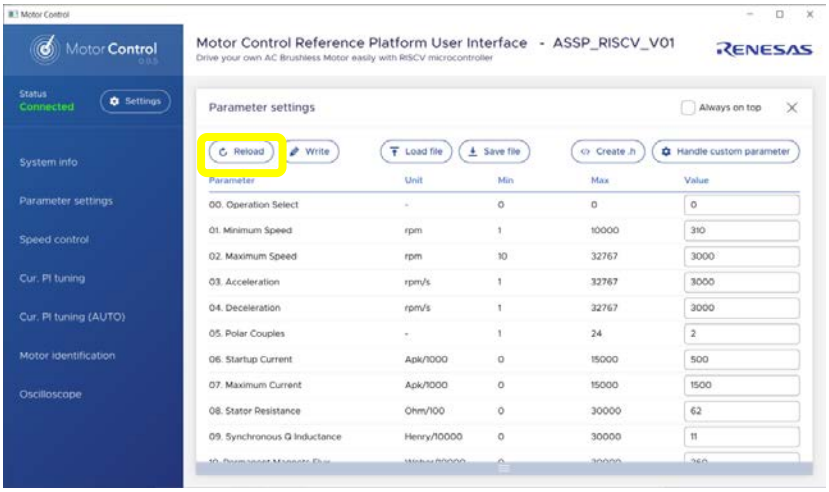
Click on "Parameter setting" button to open the parameters list.



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.



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

Fig.9

5. Motor Tuning

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

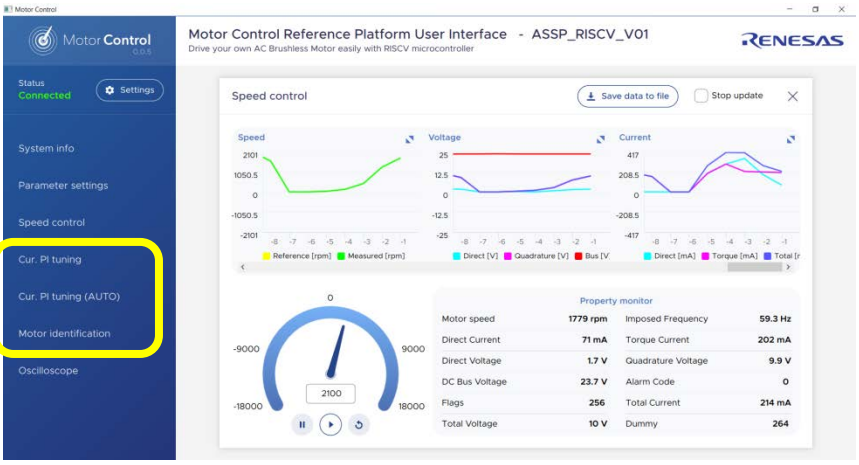


Fig. 10

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.

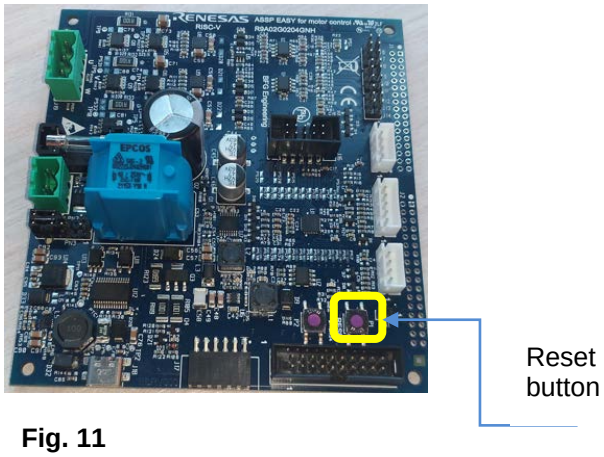


Fig. 11

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.

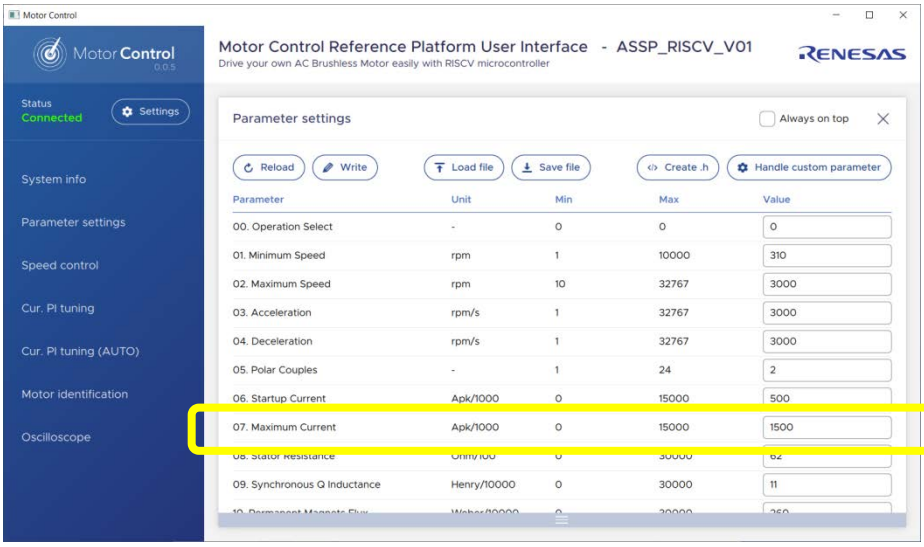


Fig. 12

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.

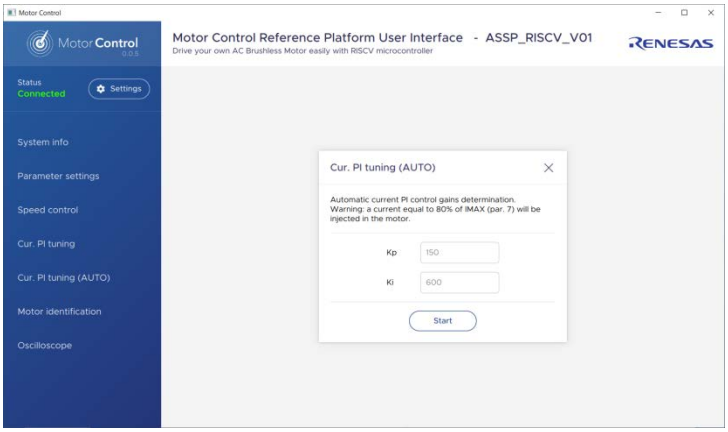


Fig. 13

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.

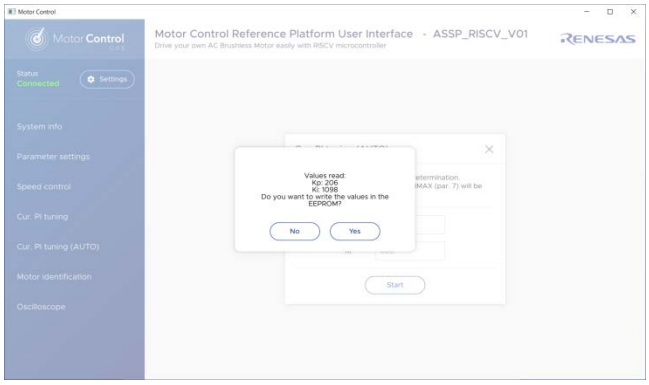


Fig. 14

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.

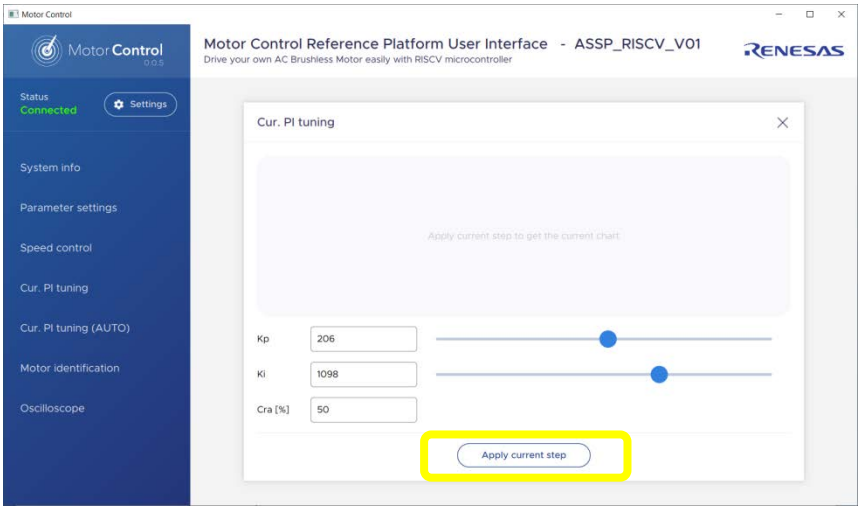


Fig. 15

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

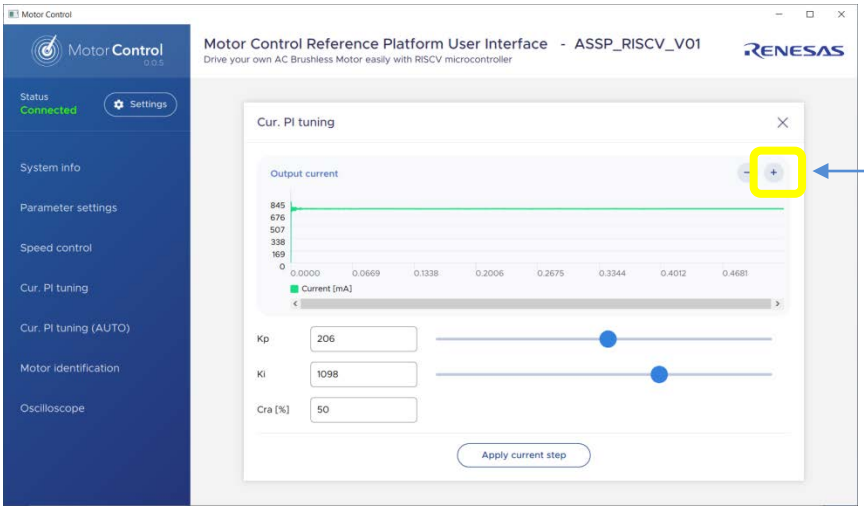


Fig. 16

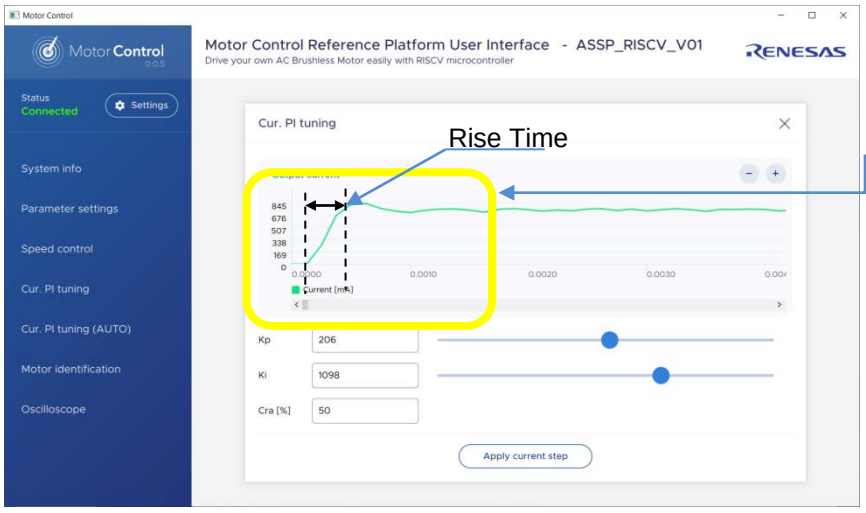


Fig. 17

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

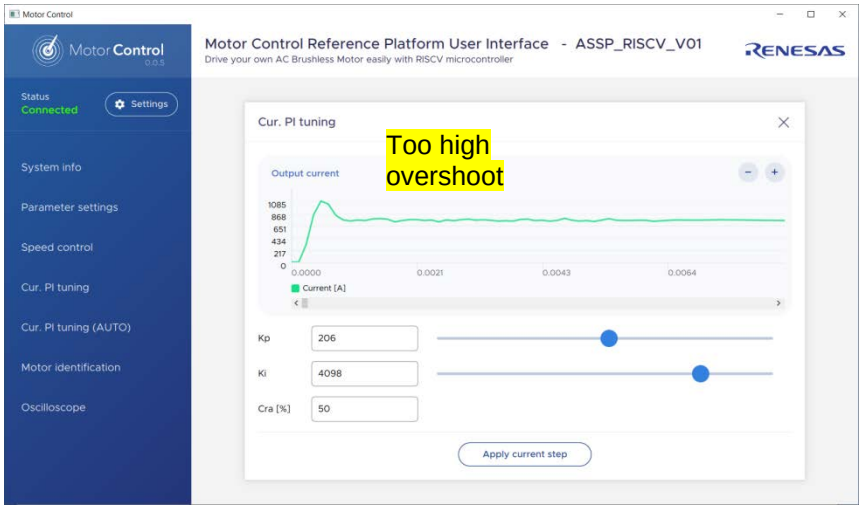


Fig. 18

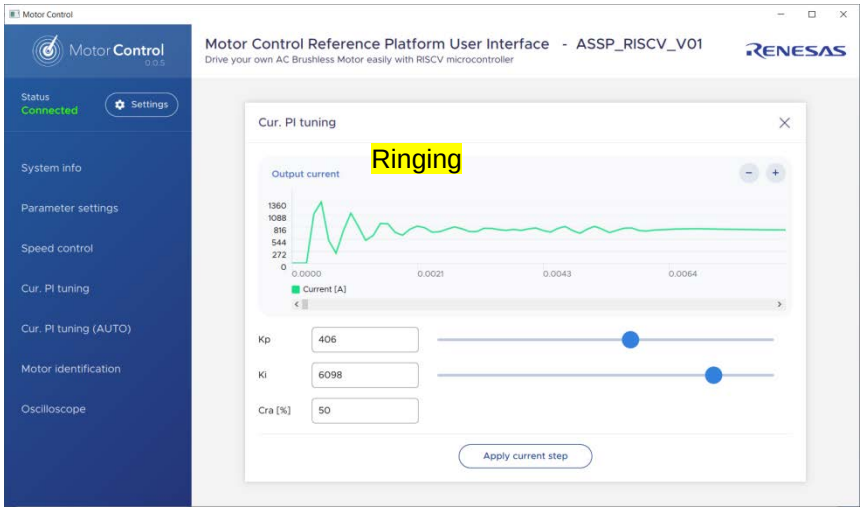


Fig. 19

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.

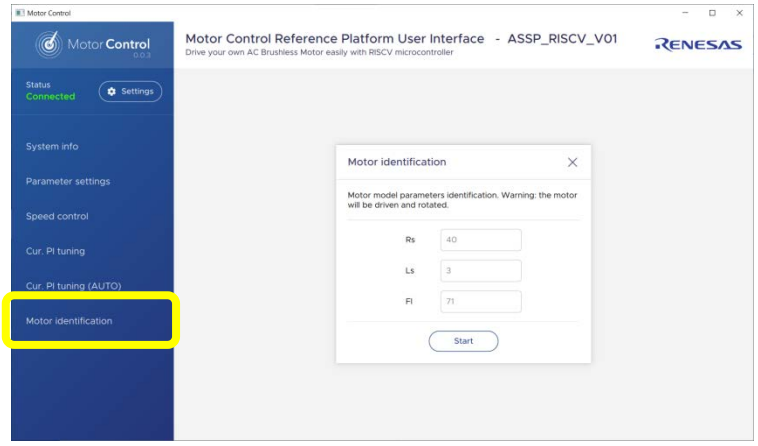


Fig. 20

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

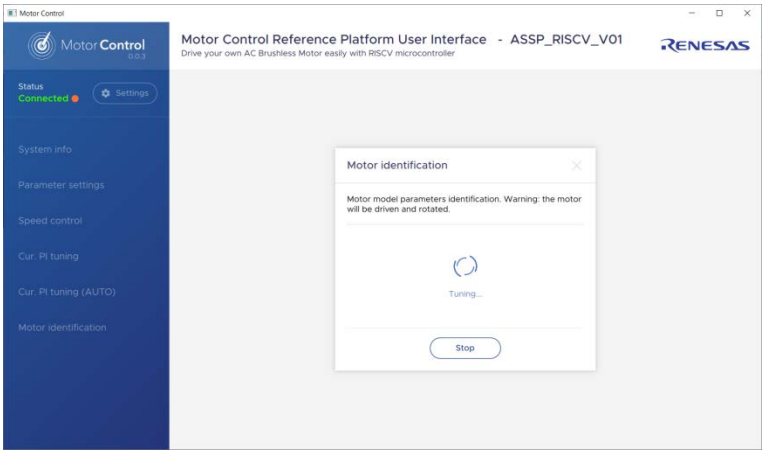


Fig. 21

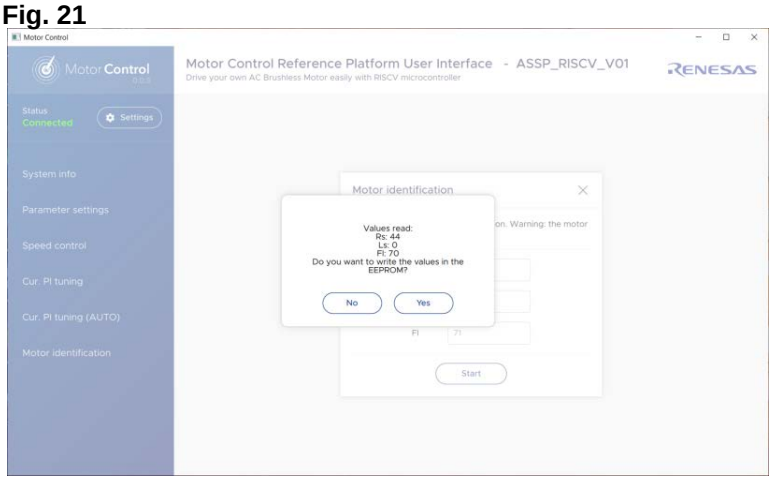


Fig. 22

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

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**

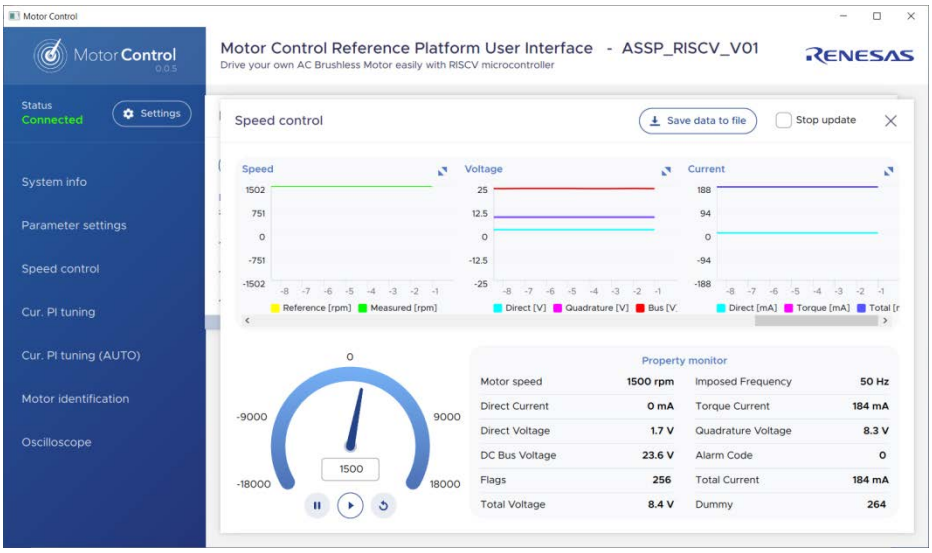


Fig. 24

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.

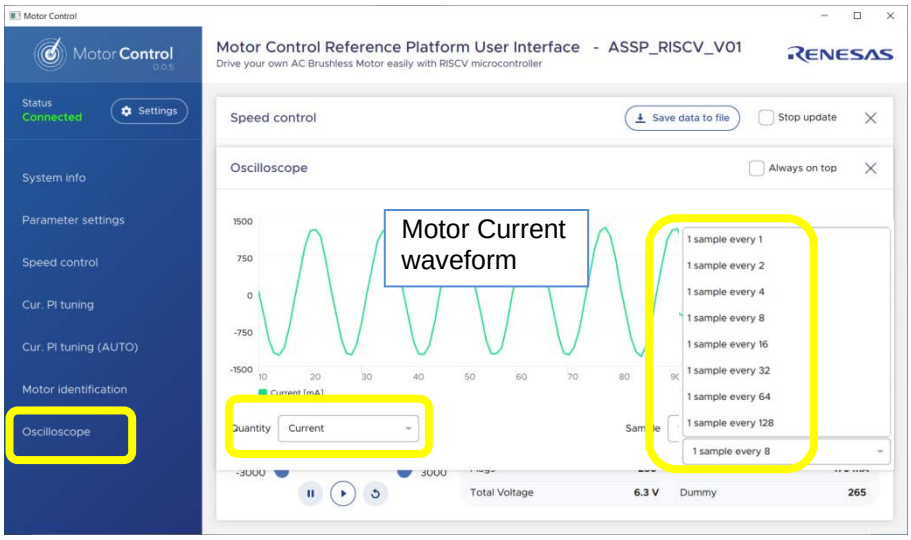


Fig. 24

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.

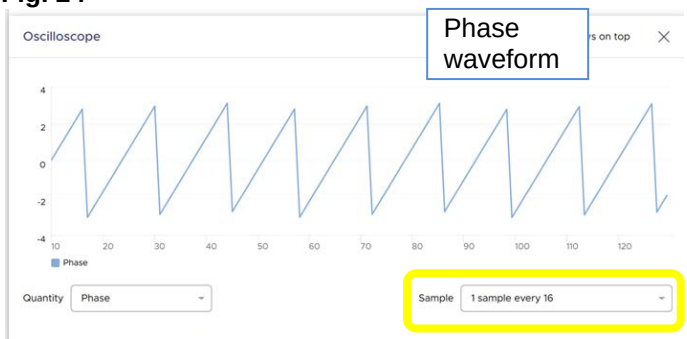


Fig. 25

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”.

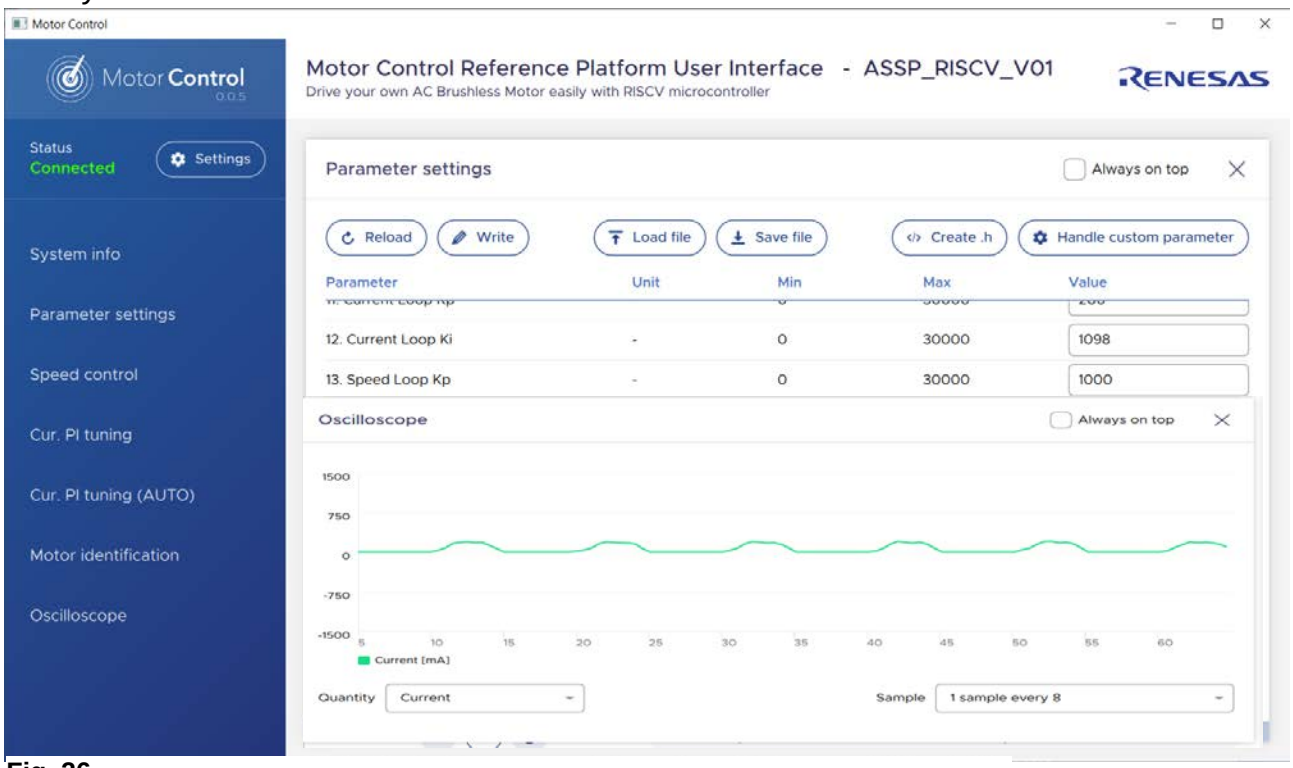


Fig. 26

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”.

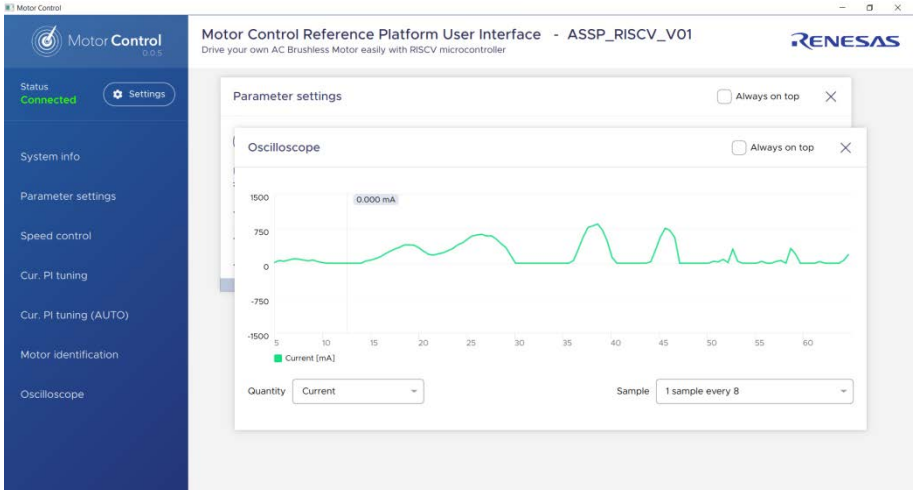


Fig. 27

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).

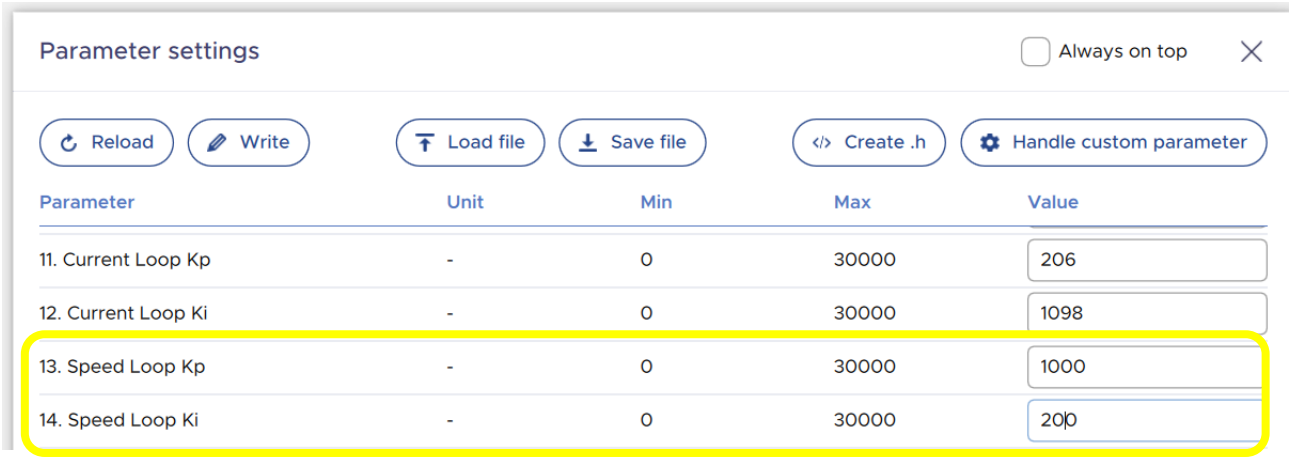


Fig. 28

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.

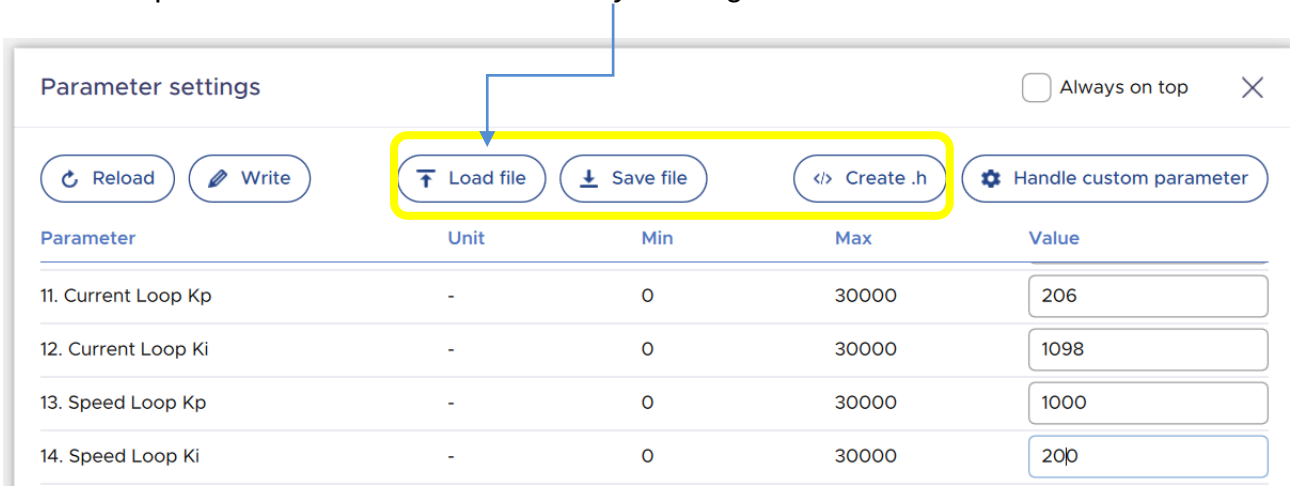


Fig. 29

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	I_START	Set the start-up current (peak) [Ampere/AMP_RES]. Used to specify the peak phase current value to be used during the start-up
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	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	KP_VEL	Set the Speed loop Proportional coefficient: KP
14	KI_VEL	Set the Speed loop Integral coefficient: KI
15	FB_GAIN	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	PHA_OFF	Set the phase offset [deg]. It is used to add a phase offset to the phase estimation, to reach better alignment
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.

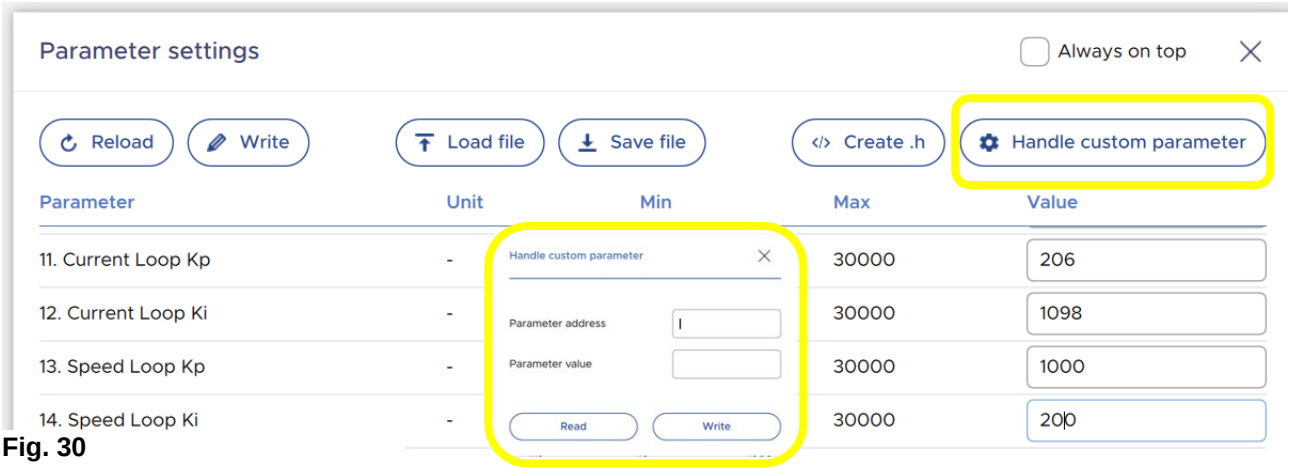


Fig. 30

Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
6. Renesas Electronics products are classified according to the following two quality grades: “Standard” and “High Quality”. The intended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below.
   "Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.
   "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.
   Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user’s manual or other Renesas Electronics document.
7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION (“Vulnerability Issues”). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. When using Renesas Electronics products, refer to the latest product information (data sheets, user’s manuals, application notes, “General Notes for Handling and Using Semiconductor Devices” in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

Corporate Headquarters
TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Contact information
For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.