RZ/T2H
Startup Manual (RZ/T2H Motion Control Utility)

Introduction

This document is a quick start manual for controlling 9-axis motors with a sample program using Evaluation Board equipped with RZ/T2H of MPU by Renesas Electronics Corporation. This document explains how to set up and connect the hardware, the operating instructions for rotating the motor, and the tool to support development: RZ/T2H Motion Control Utility.

The targeted software for this application note is only to be used as reference purposes only and Renesas Electronics Corporation does not guarantee the operations. Please use this after carrying out a thorough evaluation in a suitable environment.

Operation Checking Device

Operations of the target software of this application note are checked by using the following device.

・RZ/T2H (R9A09G077M44GBG)

Target Software

The following shows the target software for this application note.

・RZT2H_INVBLV_SPM_ENCD_FOC_**E2S**_V100 (e^2 studio)

・RZT2H_INVBLV_SPM_ENCD_FOC_**EWARM**_V100 (IAR Embedded Workbench for Arm)

・RZ/T2H Motion Control Utility

Contents

1. Overview

This document explains how to control 9-axis motors by combining the following hardware and a sample program.

- RZ/T2H Evaluation Board
- Bus Board
- Inverter Board
- Motor/Absolute encoder (Built-in type) manufactured by TAMAGAWA SEIKI CO., LTD.

Hardware/Software configuration and operation instructions are explained in detail in subsequent chapters.

2. Hardware Configuration

Figure 2-1 shows the hardware connection configuration and Table 2-1 lists the equipment to be connected.

In addition, the settings for each board are explained in Sections 2.1 to 2.3, and how to connect to each piece of equipment is explained in Sections 2.4 to 2.8.

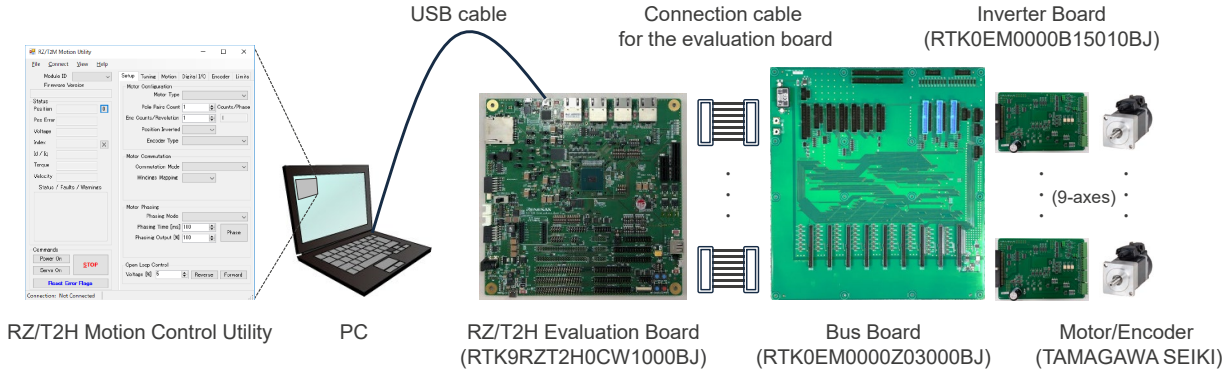


Figure 2-1 Hardware Configuration (Connection Configuration)

Table 2-1 Hardware Configuration (Connection Equipment)

Equipment		Model name
RZ/T2H Evaluation Board		RTK9RZT2H0CW1000BJ
	MPU	R9A09G077M44GBG 729-pin FCBGA, RAM 2[MB]
	On-board memory	OctaFlash: 64[MB]
	Operating frequency	Cortex-R52 CPU0: 1000[MHz] Cortex-R52 CPU1 and Cortex-A55 are unused.
	Operating voltage	DC 15[V]/3[A], 24[V]/3[A]
	Operating mode	xSPI0 boot mode (x1 boot serial flash)
Bus Board		RTK0EM0000Z03000BJ
Inverter Board		RTK0EM0000B15010BJ
	Operating voltage	DC 24[V]
Motor /Encoder (manufactured by TAMAGAWA SEIKI)		TSM3101N2001E020 /TS5669N124 (FA-CODER®)

2.1 RZ/T2H Evaluation Board Settings

Table 2-2 shows the RZ/T2H Evaluation Board switch settings, and Table 2-3 shows the jumper settings.

***1** shows the setting that is changed from the default.

Table 2-2 RZ/T2H Evaluation Board Switch Settings

SW1

1	2	3	4	5	6	7	8
ON	OFF	ON	OFF	**OFF*1**	**OFF*1**	OFF	OFF

SW2

1	2	3	4	5	6	7	8
ON	**OFF*1**	**OFF*1**	OFF	OFF	ON	**OFF*1**	**OFF*1**

SW4

1	2	3	4	5	6	7	8
ON	OFF	ON	OFF	ON	OFF	ON	OFF

SW5

1	2	3	4	5	6	7	8	9	10
OFF	ON	OFF	ON	**ON*1**	**OFF*1**	**ON*1**	**OFF*1**	**ON*1**	**OFF*1**

SW6

1	2	3	4	5	6	7	8	9	10
OFF	OFF	ON	OFF	ON	OFF	**OFF*1**	**ON*1**	**OFF*1**	**ON*1**

SW7

1	2	3	4	5	6	7	8	9	10
ON*1	**OFF*1**	**ON*1**	**OFF*1**	**ON*1**	**OFF*1**	OFF	ON	OFF	ON

SW8

1	2	3	4	5	6	7	8	9	10
ON	OFF	ON	OFF	ON	OFF	ON	OFF	**OFF*1**	**ON*1**

SW12

1	2	3	4
OFF	OFF	OFF	OFF

SW14

1	2	3	4	5	6	7	8
ON	**ON*1**	ON	OFF	OFF	OFF	ON	OFF

SW15

1	2	3	4	5	6	7	8
ON	ON	OFF	OFF	OFF	OFF	OFF	OFF

SW17

1	2
ON	OFF

SW18

1	2	3	4	5	6
OFF	ON	OFF	ON	OFF	ON

Table 2-3 RZ/T2H Evaluation Board Jumper Settings

No.	Jumper number	Setting
1	CN9	1-2 Short
2	CN29	Short
3	CN30	Short
4	CN35	Short
5	CN36	Short
6	CN37	2-3 Short
7	CN38	2-3 Short
8	CN39	1-2 Short
9	CN40	**2-3 Short**[*1]
10	CN56	2-3 Short
11	CN57	2-3 Short
12	CN62	**Open**[*1]
13	CN73	Open
14	CN77	2-3 Short
15	CN78	**1-2 Short**[*1]
16	CN81	Short
17	CN82	Short
18	CN83	Short
19	CN84	Short
20	CN85	Short
21	CN86	Short
22	CN87	Short
23	CN89	Open

2.2 Bus Board Settings

Table 2-4 shows the Bus Board jumper settings.

***1** shows the setting that is changed from the default.

Table 2-4 Bus Board Jumper Settings

No.	Jumper number	Setting
1	JP1	2-3 Short
2	JP2	2-3 Short
3	JP3	2-3 Short
4	JP4	2-3 Short
5	JP5	2-3 Short
6	JP6	2-3 Short
7	JP7	2-3 Short
8	JP8	2-3 Short
9	JP9	2-3 Short
10	JP10	2-3 Short
11	JP11	2-3 Short
12	JP12	2-3 Short
13	JP13	2-3 Short
14	JP14	2-3 Short
15	JP15	2-3 Short
16	JP16	2-3 Short
17	JP17	2-3 Short
18	JP18	2-3 Short
19	JP19	2-3 Short
20	JP20	2-3 Short
21	JP21	2-3 Short
22	JP22	2-3 Short
23	CN41C	2-3 Short
24	CN21C	2-3 Short
25	CN21D	2-3 Short
26	CN_OC_DET	5-6 Short
27	P00_6_A	Short
28	P00_6_B	Open
29	P00_7_A	**Open**[*1]
30	P00_7_B	**Short**[*1]
31	P01_0_A	**Open**[*1]
32	P01_0_B	**Short**[*1]
33	P03_5_A	**Open**[*1]
34	P03_5_B	**Short**[*1]
35	P04_5_A	Short
36	P04_5_B	Open
37	P04_6_A	**Open**[*1]
38	P04_6_B	**Short**[*1]
39	P04_7_A	**Open**[*1]
40	P04_7_B	**Short**[*1]
41	P12_4_A	Short
42	P12_4_B	Open
43	P12_5_A	**Open**[*1]
44	P12_5_B	**Short**[*1]

No.	Jumper number	Setting
45	P12_7_A	**Open*1**
46	P12_7_B	**Short*1**
47	P13_0_A	Short
48	P13_0_B	Open
49	P13_1_A	Short
50	P13_1_B	Open
51	P13_5_A	Short
52	P13_5_B	Open
53	P13_6_A	Short
54	P13_6_B	Open
55	P13_7_A	Short
56	P13_7_B	Open
57	P18_4_A	Short
58	P18_4_B	Open
59	P18_5_A	Short
60	P18_5_B	Open
61	P18_7_A	Short
62	P18_7_B	Open

2.3 Inverter Board Settings

Please use the default settings for the Inverter Board.

For details on the default settings, see "4.1.5 Jumper Settings" in "RZ/T Series Inverter Board/Kit User's Manual (R12UZ0155)".

2.4 Connection of PC (RZ/T2H Motion Control Utility) and RZ/T2H Evaluation Board

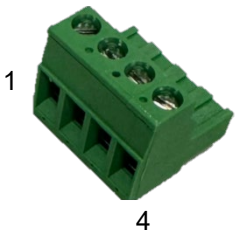
Connect the USB cable (mini USB Type-B) to the USB connector (CN34) on the RZ/T2H Evaluation Board.

2.5 Connection of Bus Board and Inverter Board

For details on the connections, see "4.5.1 Board Connection" in "Bus Board for RZ/T2H User's Manual (R12UZ0156)".

2.6 Connection with Motor/Encoder

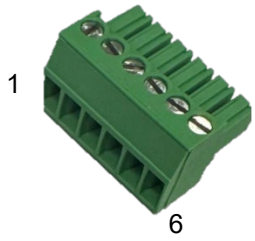
The connection of the motor and connector is shown below.



Pin		cable color	signal
1	⟷	Red	U
2	⟷	White	V
3	⟷	Black	W
4		N.C	N.C

4pin Connector by TE Connectivity

The connection of the absolute encoder and connector is shown below.



Pin		cable color	signal
1	⟷	Red	VDD1
2	⟷	Black	GND
3	⟷	Blue	D0+
4	⟷	Blue/Black	D0-
5		N.C	N.C
6		N.C	N.C

6pin Connector by TE Connectivity

2.7 Connection with ICE

When using the on-board debugging function J-Link OB, "Open" the jumper (CN62) and connect the USB cable (Micro USB Type-B) to the USB connector (CN14) on the RZ/T2H Evaluation Board.

When using an external emulator (IAR I-jet), change the jumper (CN62) to "**Short**" and connect the cable to CN61 or CN60 on the RZ/T2H Evaluation Board.

2.8 Connection with Power Supply

Table 2-5 shows the connection of the RZ/T2H Evaluation Board and the power supply.

Supply power from either one.

Table 2-5 Connecting the RZ/T2H Evaluation Board and Power Supply

Connector	Specifications and supply voltage
CN46	USB PD supporting type-C connector, 15[V]/3[A] DC input
CN47	2.0[mm] center-positive power jack, 15[V]/3[A] DC input
CN90	5.08[mm] pitch bipolar terminal block, 24[V]/3[A] DC input

3. Software Configuration

Table 3-1 shows the software development environment and Table 3-2 shows the tool to support development.

Table 3-1 Software Configuration (Development Environment)

Integrated Development Environment (IDE)	e² studio	IAR Embedded Workbench for Arm
IDE version	2024-10	9.60.2 + patch (EWARM patch for RZ/T2H Rev.1.0)
FSP version	2.2.0	FSP Smart Configurator 2024-10
Toolchain version	GNU Arm Embedded 12.2.1.arm-12-24	-
In Circuit Emulator (ICE)	J-Link OB	IAR I-jet

Table 3-2 Software Configuration (Tool to Support Development)

Tool name	Tool version
RZ/T2H Motion Control Utility	1.0.0.0

4. Operating Instructions: Start/Stop Motor Rotation

The operating instructions for rotating the motor are explained in detail in the following sections.

4.1 Start the Hardware

(1) Set up each board and connect each piece of equipment.
For details, see "2. Hardware Configuration".

(2) Supply power to the Bus Board.

(3) Supply power to the RZ/T2H Evaluation Board and turn ON the slide switch (SW16).

4.2 Build and Download the Program

(4) Build the sample program and write it to the serial flash memory.
For details on the operating instructions, see "RZ/T2H Program Writing Guide (R01AN7335)".

4.3 Operate RZ/T2H Motion Control Utility

RZ/T2H Motion Control Utility is a tool to support development for debugging, tuning and analyzing motor control programs using the RZ/T2H. By using this tool, users can rotate the motor with simple operations.

For the RZ/T2H Motion Control Utility functions, see "6.1 Tool to Support Development: RZ/T2H Motion Control Utility".

4.3.1 Unzip RZ/T2H Motion Control Utility

(5) Unzip the following compressed file (RZT2H_Motion_Control_Utility.zip) to any folder.

The path should be only half-width alphanumeric characters and underscores.

r01an7333XX0100-rzt2h-motor-control.zip

./workspace/RZT2H_Motion_Control_Utility.zip

./RZT2H_Motion_Control_Utility.exe

./default.mtr (Motor Parameter for TSM3101N2001E020/TS5669N124 (FA-CODER®))

./fastJSON.dll

For Motor Parameter, see "6.1.5 Motor Parameter".

4.3.2 Launch RZ/T2H Motion Control Utility

(6) Double-click the unzipped executable file (RZT2H_Motion_Control_Utility.exe) to launch the RZ/T2H Motion Control Utility.

(7) Specify the COM port number to connect using the "Serial Port" combo box in the "New Connection" dialog (Figure 4-1) and press the "OK" button to establish communication.

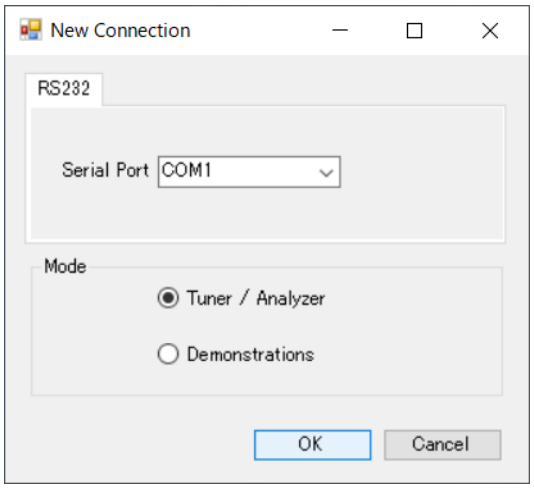


Figure 4-1 "New Connection" Dialog

4.3.3 Save Motor Parameter

Save Motor Parameter (Motor/encoder specific parameters, parameters for various controls, etc.) to serial flash memory.

For Motor Parameter, see "6.1.5 Motor Parameter".

EWARM version does not support the SAVE command, so skip this subsection.

If there are no changes to the connected motor/encoder, users can skip this subsection next time.

(8) Select the control target (axis number) from the "Module ID" drop-down list (Figure 4-2).

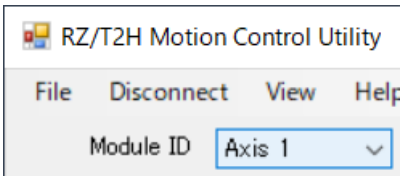


Figure 4-2 "Module ID" Drop-down List

(9) Select "Import" from the "File" menu (Figure 4-3) to import the unzipped Motor Parameter (./default.mtr).

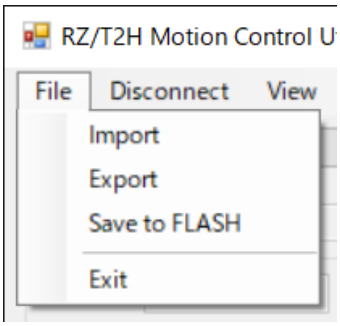


Figure 4-3 "File" Menu

(10) Select "Save to FLASH" from the "File" menu (Figure 4-3) to save the imported Motor Parameter to the serial flash memory.

At that time, the "Warning" message (Figure 4-4) will appear. Please check it and press the "OK" button.

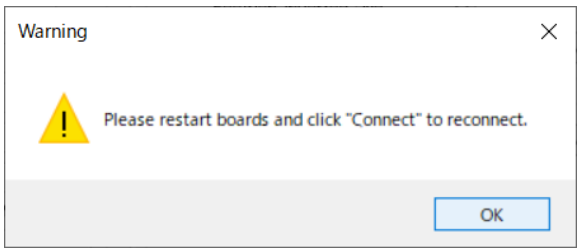


Figure 4-4 "Warning" Message

(11) Repeat steps (8) to (10) for all control targets.

(12) Toggle the slide switch (SW16) to restart the hardware.

(13) Relaunch the RZ/T2H Motion Control Utility.

4.3.4 Start/Stop Motor Rotation

(14) Select the control target (axis number) from the "Module ID" drop-down list (Figure 4-2).

(15) Press the "Power On" button (Figure 4-5) to enable the PWM output.

Figure 4-5 "Power On/Off" Toggle Button

(16) Press the "Phase" button (Figure 4-6) to adjust the motor phase.

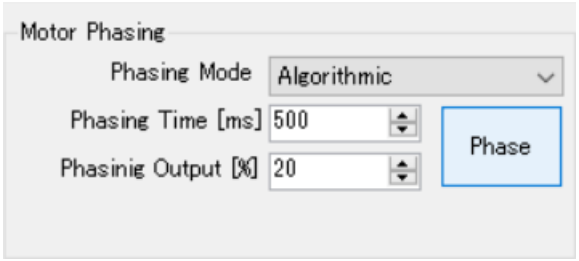


Figure 4-6 "Phase" Button

(17) Set 350 to the q-axis current reference in the "Current [mA]" edit box (Figure 4-7).

(18) Press the "Forward" button (Figure 4-7) and users can rotate the motor.

The motor continues to rotate while the button is pressed and stops when the button is released.

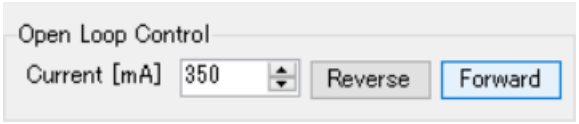


Figure 4-7 "Current [mA]" Edit Box and "Forward" Button

4.3.5 Close RZ/T2H Motion Control Utility

(19) If the caption of the "Power On/Off" toggle button is "Power Off", press the "Power Off" button (Figure 4-5) to disable the PWM output.

(20) Select "Exit" from the "File" menu (Figure 4-3) or press the "Close" button to close the RZ/T2H Motion Control Utility.

4.4 Shut Down the Hardware

(21) Turn off the power to the Bus Board.

(22) Turn OFF the slide switch (SW16) on the RZ/T2H Evaluation Board to turn off the power.

5. Reference Documents

- RZ/T2H Program Writing Guide (R01AN7335)
- RZ/T2H Vector Control for Permanent Magnetic Synchronous Motor with Encoder (9-axis)
  - Absolute Encoder (R01AN7333)

- RZ/T2H Evaluation Board User's Manual (R20UT5405)
- RZ/T Series Inverter Board/Kit User's Manual (R12UZ0155)
- Bus Board for RZ/T2H User's Manual (R12UZ0156)

- e^2 studio Integrated Development Environment User's Manual: Getting Started Guide RZ Family (R20UT4535)

6. Appendix

6.1 Tool to Support Development: RZ/T2H Motion Control Utility

RZ/T2H Motion Control Utility (Figure 6-1) is a tool to support development for debugging, tuning and analyzing motor control programs using the RZ/T2H. Widgets have ASCII communication protocol command (hereinafter referred to as command) linked to them, and users can dynamically set/get variables inside the MPU by manipulating them. Users can also check the operation status in real time on the waveform graph.

RZ/T2H Motion Control Utility functions are explained in detail in the following subsections.

For details on each command, see "RZ/T2H Vector Control for Permanent Magnetic Synchronous Motor with Encoder (9-axis) (R01AN7333)".

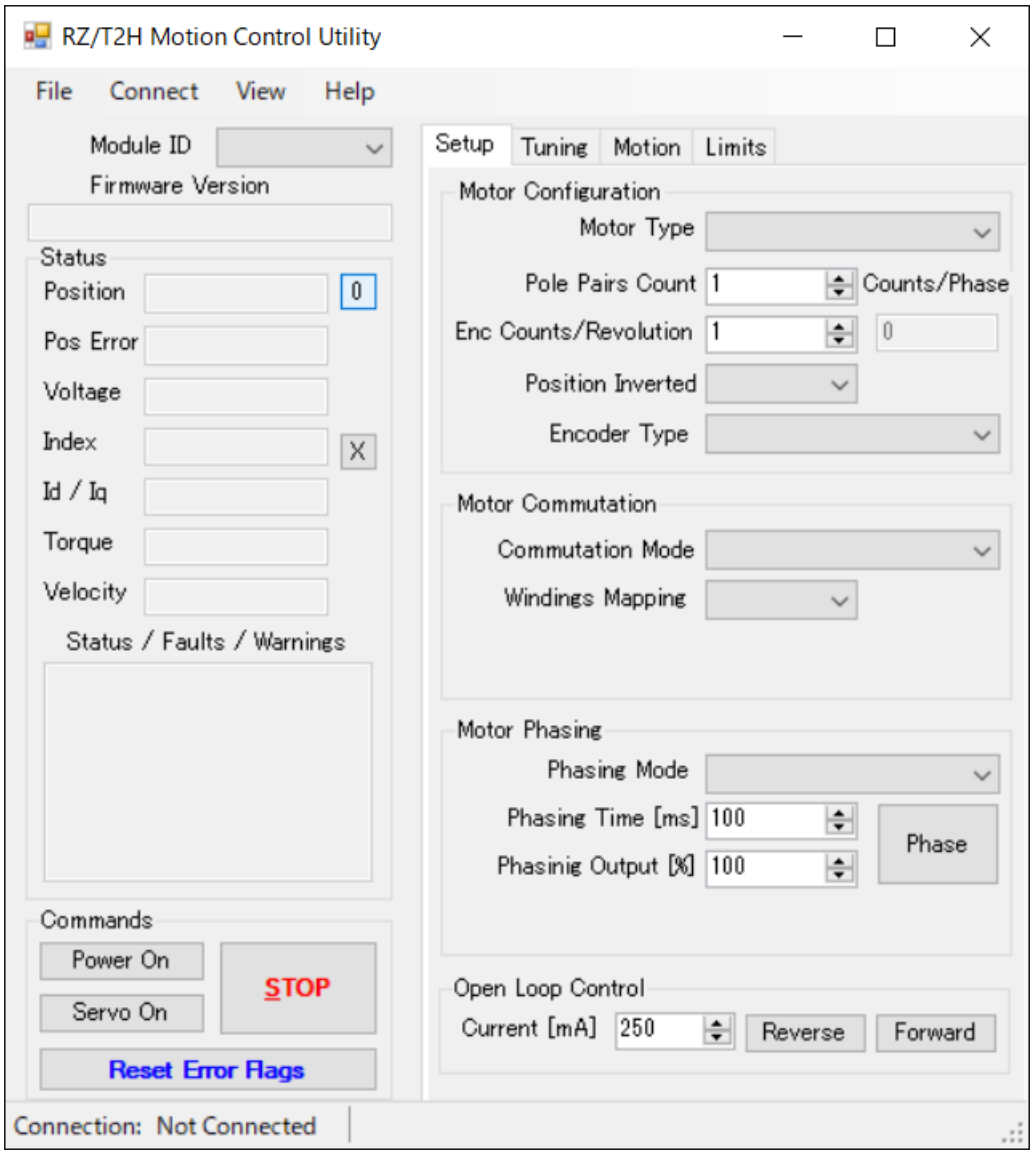


Figure 6-1 RZ/T2H Motion Control Utility

6.1.1 New Connection

"New Connection" dialog (Figure 6-2) appears when users double-click the executable file (RZT2H_Motion_Control_Utility.exe) to launch the RZ/T2H Motion Control Utility. In this dialog, specify the COM port number to be used for serial communication and select the mode to launch.

Table 6-1 shows the function of each widget.

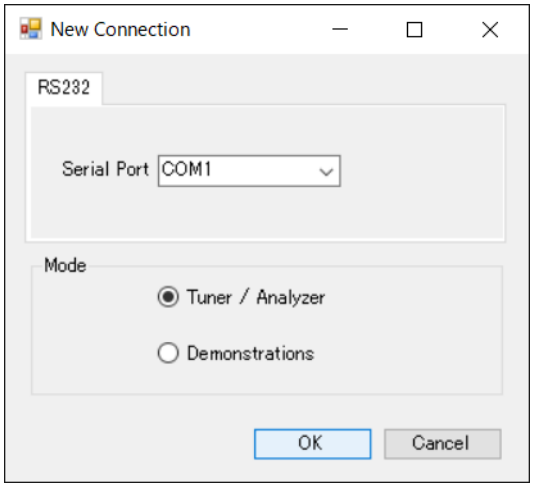


Figure 6-2 "New Connection" Dialog (1)

Table 6-1 "New Connection" Dialog (1)

Item	Description
Serial Port	Specify the COM port number to connect to the RZ/T2H Evaluation Board. Set the COM port number by directly entering it in the combo box. COM1 to COM6 can also be selected from the list. The baud rate is fixed at 115200[bps].
Mode	Select the mode (Tuner / Analyzer, Demonstrations) to launch. For each mode, see "6.1.2 Tuner / Analyzer Mode" or "6.1.4 Demonstrations Mode".
OK	1. Display the window for the selected mode. 2. Establish communication with the specified COM port number. If the connection fails, the "Error" message (Figure 6-3) will appear. Please check the settings and connections of each board and relaunch the RZ/T2H Motion Control Utility.
Cancel	Close the RZ/T2H Motion Control Utility.

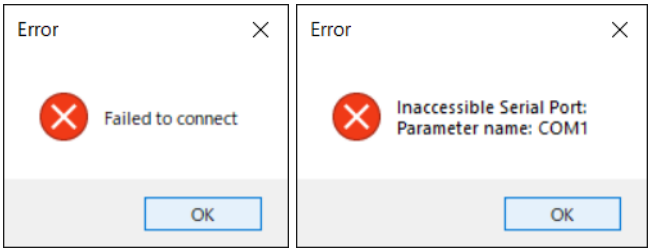


Figure 6-3 "Error" Message

6.1.2 Tuner / Analyzer Mode

"Tuner / Analyzer Mode" window (Figure 6-4) appears when users select Tuner / Analyzer Mode in the "New Connection" dialog. In this window, users can tune and analyze various parameters, with the motor of the selected axis number as the control target.

This window has the menu bar, the "Main" panel, and the "Control" panel that can be switched using tabs. The menu bar is explained in 6.1.2.1, and each panel is explained in 6.1.2.2 to 6.1.2.6.

In addition, Table 6-2 shows the process when this window opens/closes.

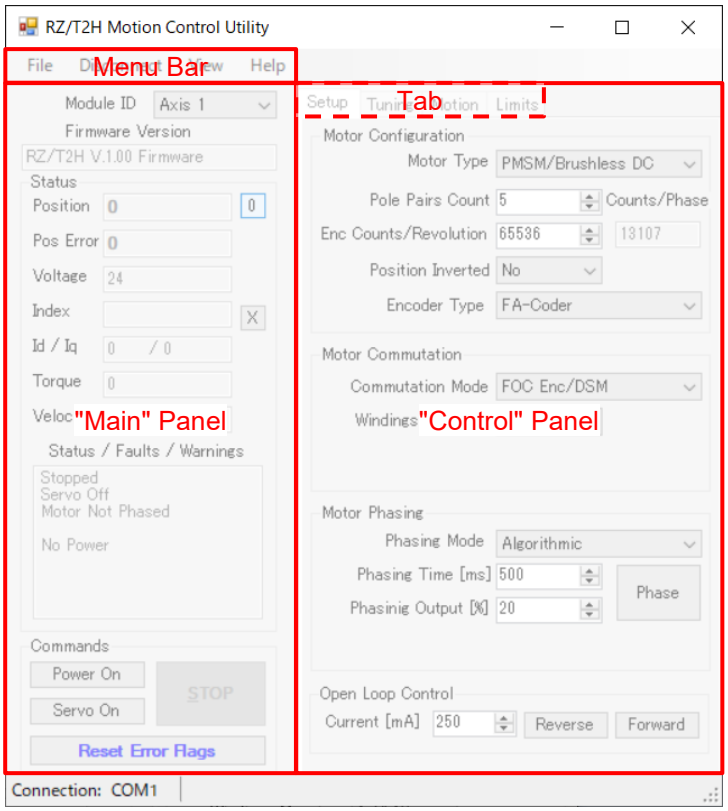


Figure 6-4 "Tuner / Analyzer Mode" Window

Table 6-2 "Tuner / Analyzer Mode" Window

Item	Description
When the window opens	Set the control target (axis number) to "Axis 1". Set 0 by the CTRLMODE command.
When the window closes	If the caption of the "Power On/Off" toggle button is "Power Off", execute the OFF command.

6.1.2.1 Menu Bar

Table 6-3 shows each function of the menu bar (Figure 6-5).

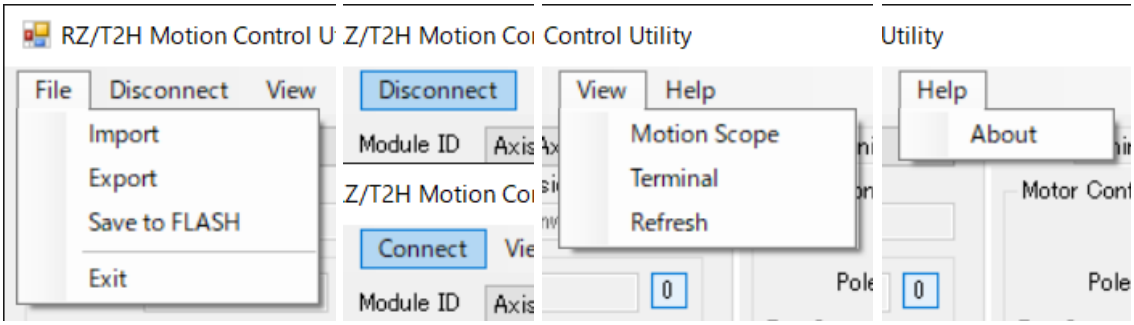


Figure 6-5 Menu Bar

Table 6-3 Menu Bar

Item	Description
File:	
Import	Import the specified Motor Parameter (*.mtr). Change the setting values of the imported Motor Parameter.
Export	Export (*.mtr) the Motor Parameter.
Save to FLASH	Execute the SAVE command.
Exit	Close the RZ/T2H Motion Control Utility.
Disconnect/Connect:	
	Disconnect: Disconnect communication. Connect: Display the " New Connection " dialog (Figure 6-6) for reconnection.
View:	
Motion Scope	Display the "Motion Scope" window (Figure 6-14). For "Motion Scope" window, see "6.1.3 Motion Scope".
Terminal	Show/hide the combo box that allows users to directly execute commands, execution log, and check box that stops polling (get the value of the command at 200[ms] intervals) of the "Main" panel, etc.
Refresh	Import the Motor Parameter (./default.mtr). Change the setting values of the imported Motor Parameter.
Help:	
About	Display the "About RZ/T2H Motion Control Utility" dialog (Figure 6-7). In this dialog, users can confirm the version of the RZ/T2H Motion Control Utility.

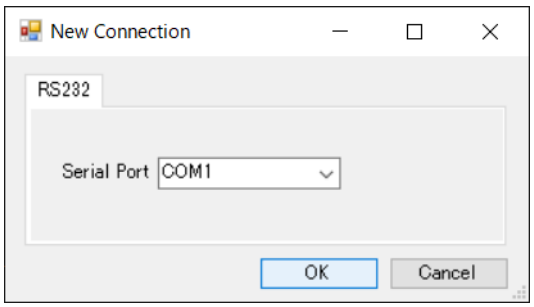


Figure 6-6 "New Connection" Dialog (2)

Table 6-4 "New Connection" Dialog (2)

Item	Description
Serial Port	Specify the COM port number to connect to the RZ/T2H Evaluation Board. Set the COM port number by entering it directly in the combo box. COM1 to COM6 can also be selected from the list. The baud rate is fixed at 115200[bps].
OK	Establish communication with the specified COM port number. If the connection fails, the "Error" message (Figure 6-3) will appear. Please check the settings and connections of each board and relaunch the RZ/T2H Motion Control Utility.
Cancel	Cancel the reconnection.

Figure 6-7 "About" Dialog

6.1.2.2 Main

"Main" panel (Figure 6-8) allows users to select the control target (axis number), check the current status, enable/disable PWM output and servo control, etc.

Table 6-5 shows the function of each widget.

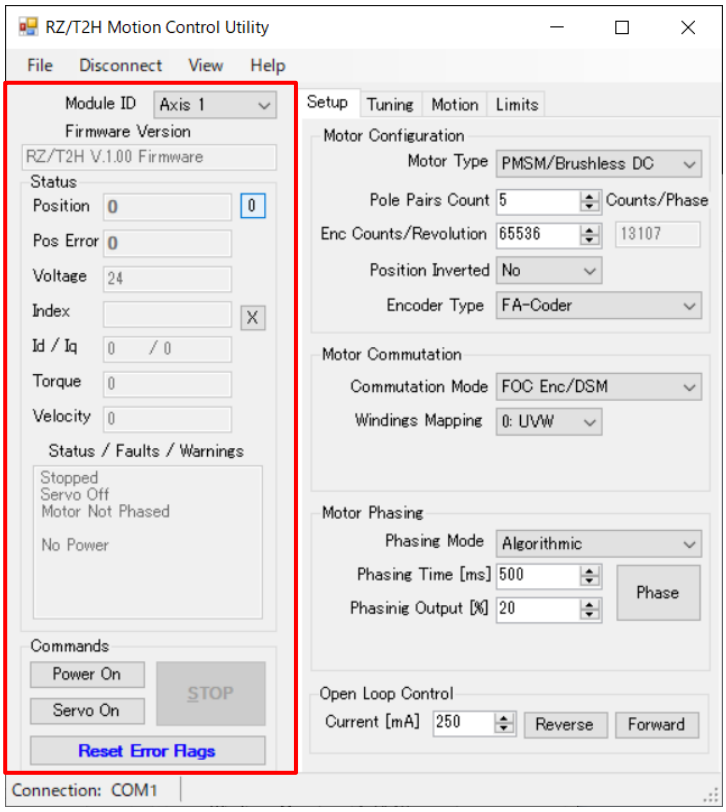


Figure 6-8 "Main" Panel

Table 6-5 "Main" Panel

Item	Description
Module ID	Select the control target (axis number) from the drop-down list.
Firmware Version	Displays the value of the VER command gotten.
Status:	
Position	Get the value of the POS command at 200[ms] intervals and display it.
0	Change the setting value of the POS command to 0.
Pos Error	Get the value of the ERR command at 200[ms] intervals and display it.
Voltage	Get the value of the EVOLT command at 200[ms] intervals and display it.
Index	Displays the value of the IND command gotten.
X	Get the value of the updated IND command.
Id / Iq	Get the value of the RVAL command (setting value: 11 and 12) at 200[ms] intervals and display it.
Torque	Get the value of the RAVL command (setting value: 30) at 200[ms] intervals and display it.
Velocity	Get the value of the CV command at 200[ms] intervals and display it.
Status / Faults / Warnings	Get the value of the STA command at 200[ms] intervals and display it.
Commands:	
Power On/Off	Toggle button to enable/disable PWM output. When the "Power On" button is pressed, execute the ENABLE command. When the "Power Off" button is pressed, execute the DISABLE command.
Servo On/Off	Toggle button to enable/disable servo control. When the "Servo On" button is pressed, execute the ON command. When the "Servo Off" button is pressed, execute the OFF command.
STOP	Execute the STOP command.
Reset Error Flags	Execute the ERESET command and OFF command in sequence.

6.1.2.3 Setup

"Setup" tab (Figure 6-9) allows users to change the motor/encoder specific parameters, and also execute motor phasing (phase adjustment) and open loop control.

Table 6-6 shows the function of each widget.

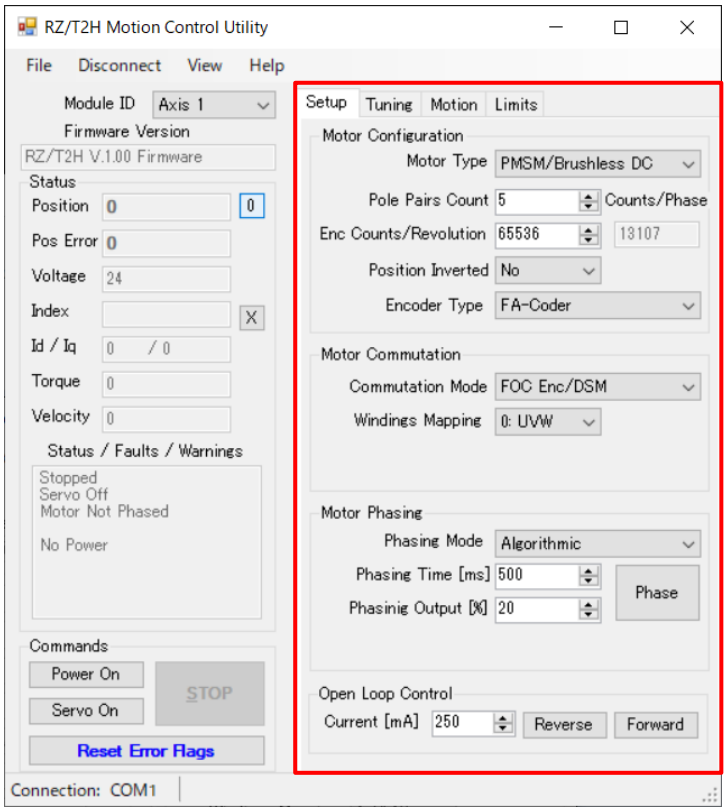


Figure 6-9 "Setup" Tab

Table 6-6 "Setup" Tab

Item	Description
Motor Configuration:	
Motor Type	Change the setting value of the PHASES command in the drop-down list. Cannot be changed (setting value is fixed at 3).
Pole Pairs Count	Change the setting values of the PPAIRS command and PCOUNTS command ("Enc Counts/Revolution" / input value) in the edit box.
Enc Counts/Revolution	Change the setting values of the ECPR command and PCOUNTS command (input value / "Pole Pairs Count") in the edit box.
Counts/Phase	Display the value of "Enc Counts/Revolution" / "Pole Pairs Count".
Position Inverted	Change the setting value of the PINVERT command in the drop-down list.
Encoder Type	Change the setting value of the ETYPE command in the drop-down list.
Motor Commutation:	
Commutation Mode	Change the setting value of the PCMODE command in the drop-down list. Cannot be changed (setting value is fixed at 4).
Windings Mapping	Change the setting value of the PMAP command in the drop-down list.
Motor Phasing:	
Phasing Mode	Change the setting value of the PIMODE command in the drop-down list.
Phasing Time [ms]	Change the setting value (input value x 10) of the PITIME command in the edit box.
Phasing Output [%]	Change the setting value (Input value x 327.67) of the PIOUT command in the edit box.
Phase	Button to execute motor phasing (phase adjustment). When pressed, execute the OFF command and ALIGN command in sequence.
Open Loop Control:	
Current [mA]	Change the value to be set by the PWM command in the edit box. The setting is confirmed when the "Reverse" button or the "Forward" button is pressed.
Reverse	Buttons to execute open loop control. When the "Reverse" button is pressed (mouse down), execute the OFF command and change the setting value (input value x -1) of the PWM command.
Forward	When the "Forward" button is pressed (mouse down), execute the OFF command and change the setting value of the PWM command. Also, when the button is released (mouse up), change the setting value of the PWM command to 0.

6.1.2.4 Tuning

Tuning" tab (Figure 6-10) allows users to change the position/speed control parameters and tune the current PI control gains.

Table 6-7 shows the function of each widget.

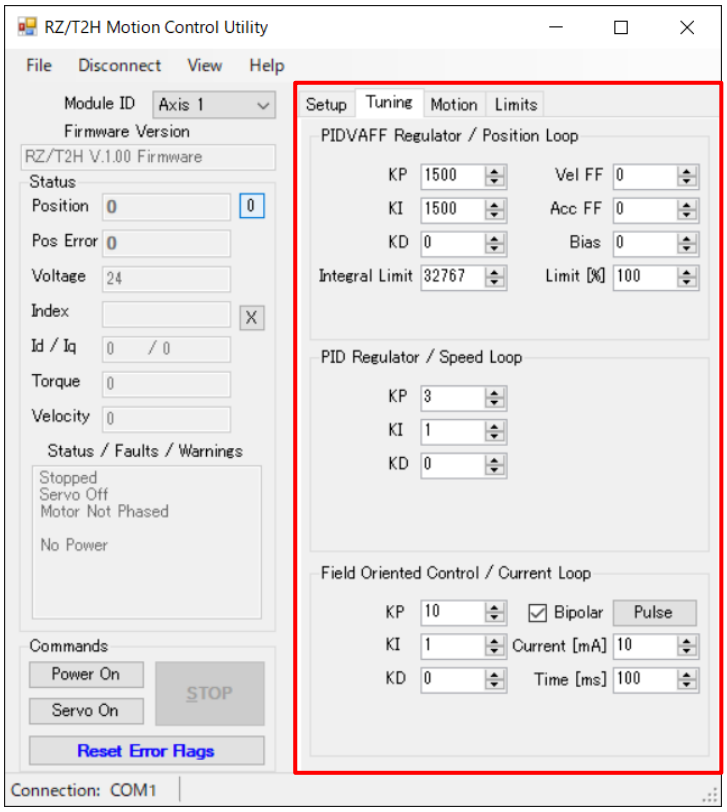


Figure 6-10 "Tuning" Tab

Table 6-7 "Tuning" Tab

Item	Description	
PIDVAFF Regulator / Position Loop:		
KP	Change the setting value of the KP command in the edit box.	
KI	Change the setting value of the KI command in the edit box.	
KD	Change the setting value of the KD command in the edit box.	
Integral Limit	Change the setting value of the IL command in the edit box.	
Vel FF	Change the setting value of the VFF command in the edit box.	
Acc FF	Change the setting value of the AFF command in the edit box.	
Bias	Change the setting value of the BIAS command in the edit box.	
Limit [%]	Change the setting value of the MLIMIT command (input value x 327.67) in the edit box.	
PID Regulator / Speed Loop:		
KP	Change the setting value of the VKP command in the edit box.	
KI	Change the setting value of the VKI command in the edit box.	
KD	Change the setting value of the VKD command in the edit box.	
Field Oriented Control / Current Loop:		
KP	Change the setting value of the QKP command in the edit box.	
KI	Change the setting value of the QKI command in the edit box.	
KD	Change the setting value of the QKD command in the edit box.	
Bipolar	Use the check box to change the type of output pulse when the "Pulse" button is pressed.	
	ON	Bipolar pulse (positive and negative pulse)
	OFF	Unipolar pulse (positive pulse)
Pulse	Button to output pulse for tuning the current PI control gains. When pressed, execute the ENABLE command and OFF command in sequence, and change the setting value of the IQCMD command.	
Current [mA]	Change the value (amplitude of the output pulse) to be set by the IQCMD command in the edit box. The setting is confirmed when the "Pulse" button is pressed.	
Time [ms]	Use the edit box to change the wavelength of the output pulse when the "Pulse" button is pressed.	

6.1.2.5 Motion

"Motion" tab (Figure 6-11) allows users to execute position control.

Table 6-8 shows the function of each widget.

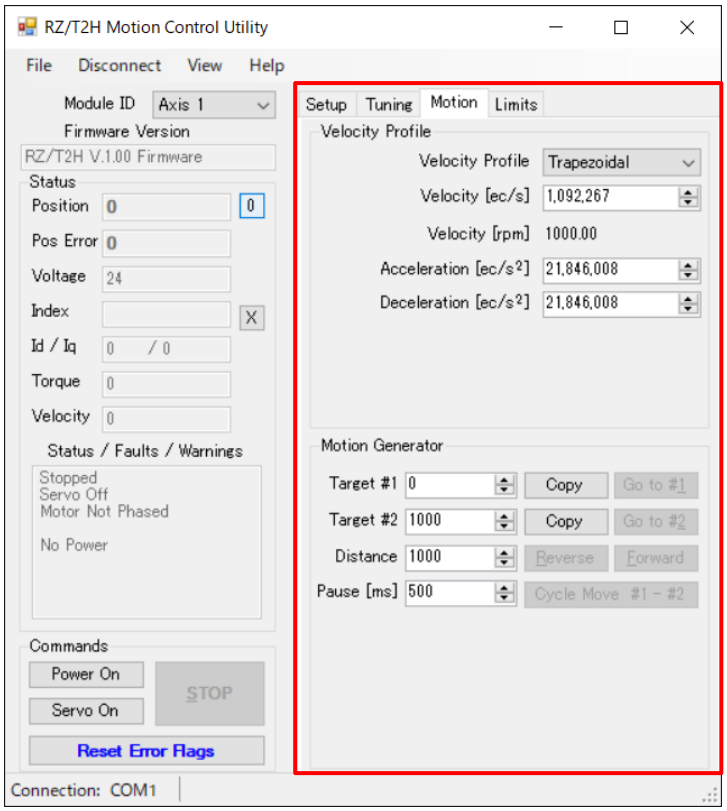


Figure 6-11 "Motion" Tab

Table 6-8 "Motion" Tab

Item	Description
Velocity Profile:	
Velocity Profile	Change the setting value of the PRO command in the drop-down list.
Velocity [ec/s]	Change the setting value (input value x 3.2768 x Setting value for DS command (2) + 0.5) of the VEL command in the edit box.
Velocity [rpm]	Display the value of "Velocity [ec/s]" / "Enc Counts/Revolution" x 60
Acceleration [ec/s^2]	Change the setting value (input value x 0.00016384 x Setting value for DS command (2)^2 + 0.5) of the ACC command in the edit box.
Deceleration [ec/s^2]	Change the setting value (input value x 0.00016384 x Setting value for DS command (2)^2 + 0.5) of the DEC command in the edit box.
Acc Jerk Factor [0-1000]	Change the setting value of the AJERK command (reserved) in the edit box.
Dec Jerk Factor [0-1000]	Change the setting value of the DJERK command (reserved) in the edit box.
PVT Time Slice [ms]	Change the setting value (input value / (0.05 x Setting value for DS command (2))) of the ITIME command (reserved) in the edit box.
Motion Generator:	
Target #1, #2	Change the value to be set by the ABS command in the edit box. The setting is confirmed when the "Go to #1, #2" button is pressed.
Copy	Copy the value of the POS command into the edit box.
Go to #1, #2	Button to execute position control. When pressed, change the setting value of the ABS command and execute the GO command.
Distance	Change the value to be set by the ABS command in the edit box. The setting is confirmed when the "Reverse" button or the "Forward" button is pressed.
Reverse	Button to execute position control. When the "Reverse" button is pressed, change the setting value (value of the POS command - input value) of the ABS command and execute the GO command. When the "Forward" button is pressed, change the setting value (value of the POS command + input value) of the ABS command and execute the GO command.
Forward	
Pause [ms]	Use the edit box to change the cycle for updating the target position when the "Cycle Move #1 - #2" button is pressed.
Cycle Move #1 - #2 /Stop Cycle	Toggle button to start/stop position control to automatically update the target position. When the "Cycle Move #1 - #2" button is pressed, change the setting value of the VEL command, and update the target position at the cycle of "Pause [ms]". The target position is updated by alternately executing processes equivalent to pressing the "Go to #1" button and the "Go to #2" button. When the "Stop Cycle" button is pressed, stop updating the target.

6.1.2.6 Limits

"Limits" tab (Figure 6-12) allows users to change the interlock (system protection function) thresholds and check the abnormal status.

Table 6-9 shows the function of each widget.

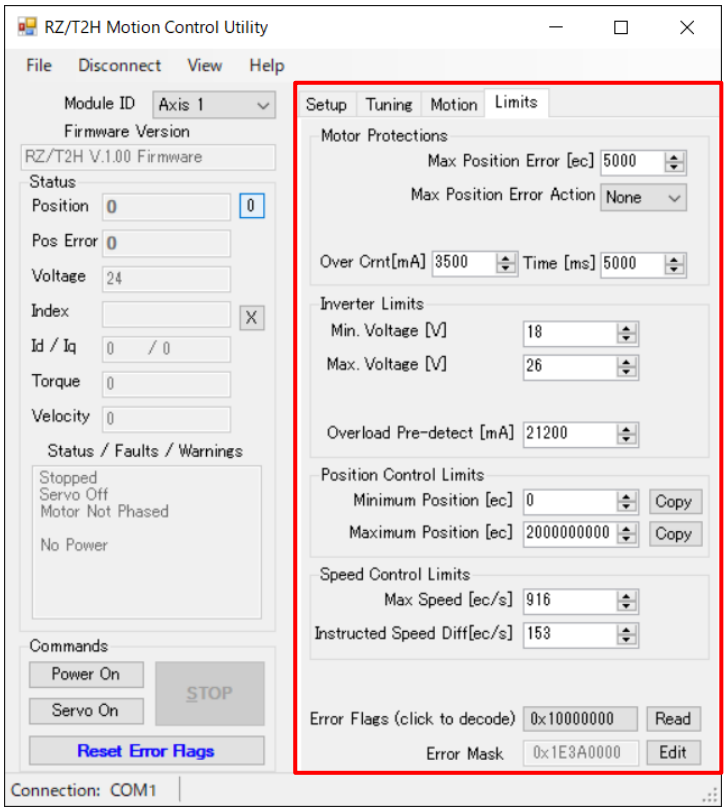


Figure 6-12 "Limits" Tab

Table 6-9 "Limits" Tab

Item	Description
Motor Protections:	
Max Position Error [ec]	Change the setting value of the MAX command in the edit box.
Max Position Error Action	Change the setting value of the ASTOP command in the drop-down list.
Over Crnt [mA]	Change the setting value of the CLIMIT command in the edit box.
Time [ms]	Change the setting value of the CTIME command in the edit box.
Inverter Limits:	
Min. Voltage [V]	Change the setting value of the ELVOLT command in the edit box.
Max. Voltage [V]	Change the setting value of the EHVOLT command in the edit box.
Overload Pre-detect [mA]	Change the setting value of the EOVC command in the edit box.
Position Control Limits:	
Minimum Position [ec]	Change the setting value of the EWPOSMIN command in the edit box.
Maximum Position [ec]	Change the setting value of the EWPOSMAX command in the edit box.
Copy	Copy the value of the POS command into the edit box.
Speed Control Limits:	
Max Speed [ec/s]	Change the setting value (input value x 3.2768 x Setting value for DS command (2) + 0.5) of the EOVS command in the edit box.
Instructed Speed Diff [ec/s]	Change the setting value (input value x 3.2768 x Setting value for DS command (2) + 0.5) of the EWOVS command in the edit box.
Error Flags (click to decode)	Displays the value of the EQUERY command gotten. When pressed, display the "Error Handling Setup" dialog (Figure 6-13). In this dialog, users can check the abnormal status detected (in bold red text).
Read	Get the value of the EQUERY command.
Error Mask Edit	When the "Edit" button is pressed, display the "Error Handling Setup" dialog (Figure 6-13). In this dialog, change the setting value of the ERRMASK command by using the check button. The setting is confirmed when the "OK" button is pressed.

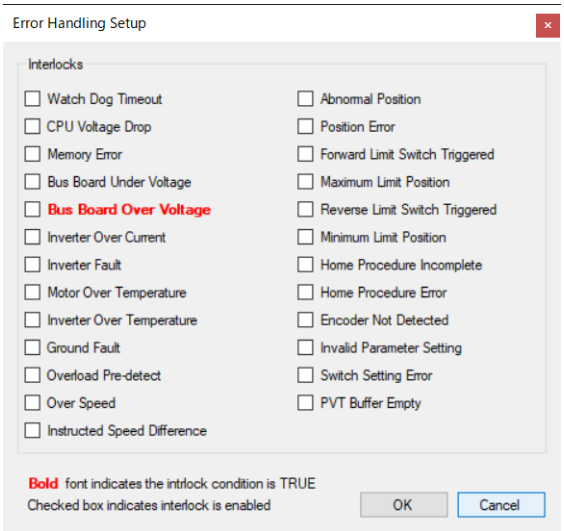


Figure 6-13 "Error Handling Setup " Dialog

6.1.3 Motion Scope

"Motion Scope" window (Figure 6-14) appears when users select "Motion Scope" from the "View" menu. In this window, users can check waveform graphs of up to four channels in real time.

Users can zoom in on the graph by dragging the left mouse button to select the range, and can zoom out on each of the vertical/horizontal axes by pressing the  buttons on the scrollbar that appears when zoomed in.

Table 6-10 shows the function of each widget.

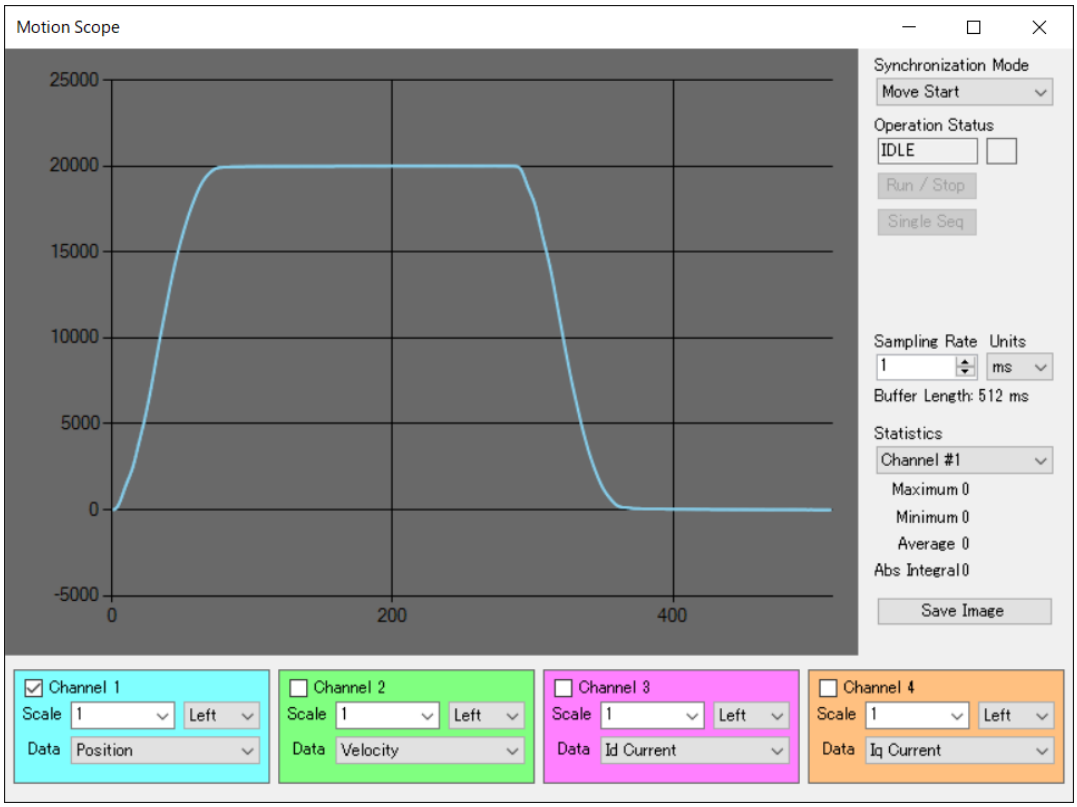


Figure 6-14 "Motion Scope" Window

Table 6-10 "Motion Scope" Window

Item	Description
Synchronization Mode	Change the setting value of the TRACE command in the drop-down list.
Operation Status	Display the operation status of sampling. IDLE: Waiting TRANSFER: Sampling in progress RECORD: Sampling completed Select "Manual" in the "Synchronization Mode" drop-down list and press the "Run / Stop" button or the "Single Seq" button to update.
Run / Stop	Start/stop sampling. When "Manual" is selected in the "Synchronization Mode" drop-down list, the button can be pressed.
Single Seq	Execute sampling only once. When "Manual" is selected in the "Synchronization Mode" drop-down list, the button can be pressed.
Sampling Rate, Units	Change the setting value (input value [us] / 50) of the TRATE command in the edit box.
Statistics	Display statistical data (maximum value, minimum value, average value, and integral value of the sampled data (absolute value)) for the channel selected from the drop-down list.
Save Image	Save the waveform graph in PNG or CSV format.
Channel 1 to 4	Use the check box to show (ON)/hide (OFF) the waveform graph.
Scale	Specify the scale of the graph using the combo box.
Left/Right	Select the axis to be used for the waveform graph from the drop-down list. Users can select the primary axis (Left) and the secondary axis (Right).
Data	Select the data for the waveform graph from the drop-down list.

6.1.4 Demonstrations Mode

"Demonstrations Mode" window (Figure 6-15) appears when users select Demonstrations Mode in the "New Connection" dialog. In this window, users can execute position control and speed control with simple operations, with the first axis motor as the control target.

This window has tabs for switching between position control, speed control and graph settings. Each tab is explained in 6.1.4.1 to 6.1.4.3.

In addition, Table 6-11 shows the process when this window opens/closes.

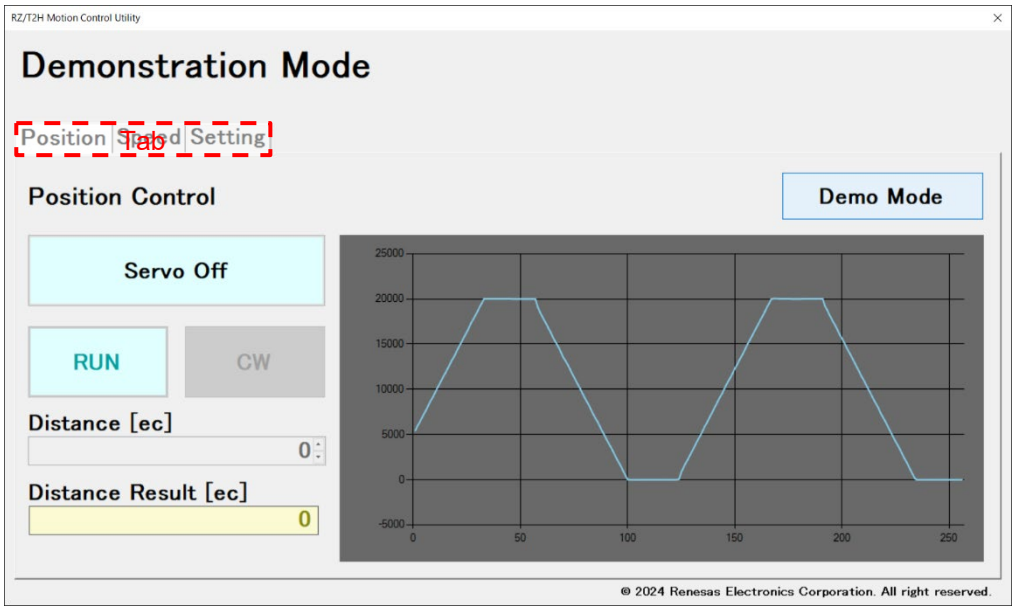


Figure 6-15 "Demonstrations Mode" Window

Table 6-11 "Demonstrations Mode" Window

Item	Description
When the window opens	Set the control target (axis number) to "Axis 1". Import the Motor Parameter (./default.mtr). Execute the DISABLE command and set 0 by the CTRLMODE command.
When the window closes	Execute the OFF command and DISABLE command in sequence.

6.1.4.1 Position (Control)

"Position (Control)" tab (Figure 6-16) allows users to execute position control.

Table 6-12 shows the function of each widget.

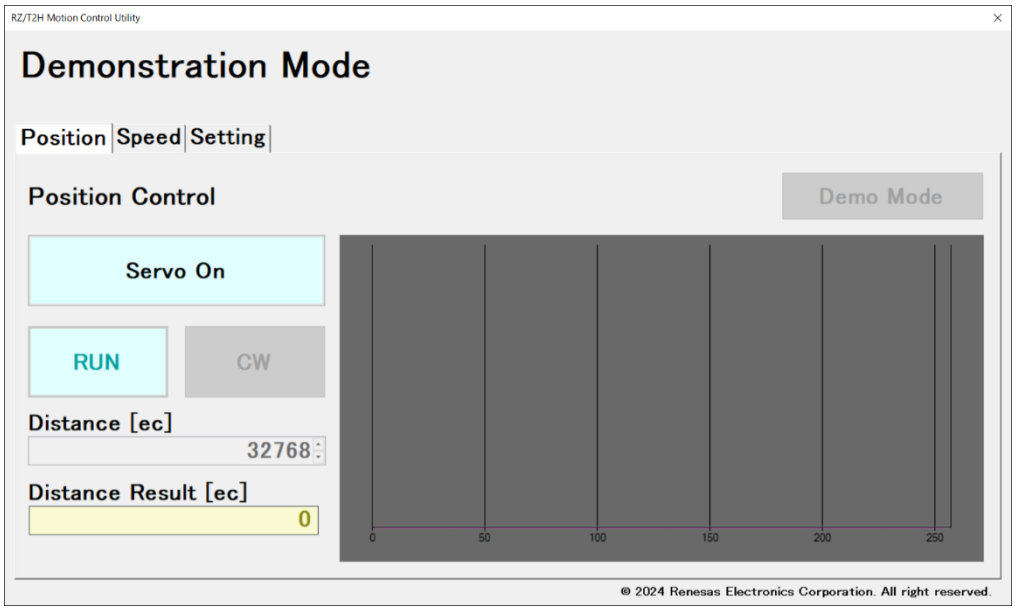


Figure 6-16 "Position (Control)" Tab

Table 6-12 "Position (Control)" Tab

Item	Description
Servo On/Off	Toggle button to enable/disable servo control. "Servo On" button: Enables servo control. When pressed, execute the ENABLE command, OFF command, ALIGN command, and ON command in sequence. "Servo Off" button: Disables servo control. When pressed, execute the OFF command and DISABLE command in sequence. When the "Servo On" button is pressed, the "Speed" tab cannot be pressed. In addition, the "RUN/STOP" button, "CW/CCW" button and "Demo Mode" button can be pressed, and the "Distance [ec]" edit box can be entered.
RUN/STOP	Toggle button to start/stop position control. "RUN" button: Rotates the motor to the target position and then stops it. When pressed, set the REL command and execute the GO command. "STOP" button: Stops the rotating motor immediately. When pressed, execute the STOP command. When the "RUN" button is pressed, the "Demo Mode" button cannot be pressed until the motor stops.
CW/CCW	Toggle button to set the direction (CW/CCW) of motor rotation. Change the sign (CW (+)/CCW (-)) of the value to be set by the REL command. The setting is confirmed when the "RUN" button is pressed.
Distance [ec]	Edit box to set the target position (relative position). Change the value to be set by the REL command. The setting is confirmed when the "RUN" button is pressed.
Distance Result [ec]	Display the current position. Get the value of the POS command at 100[ms] intervals.
Demo Mode	Button to execute position control to automatically update the target position. When pressed, execute the following. 1. Set the target position (absolute position) to 20000 by the ABS command and execute the GO command. 2. Wait 10 seconds. 3. Set the target position (absolute position) to 0 by the ABS command and execute the GO command. 4. Wait 10 seconds. 5. Return to 1. When pressed again, stop updating the target. The motor rotates to the target position and stops When the "Demo Mode" button is pressed, the "RUN" button and "CW/CCW" button cannot be pressed during execution.
Graph area	Show the waveform graph. Get the value of the RVAL command at 100[ms] intervals.

6.1.4.2 Speed (Control)

"Speed (Control)" tab (Figure 6-17) allows users to execute speed control.

Table 6-13 shows the function of each widget.

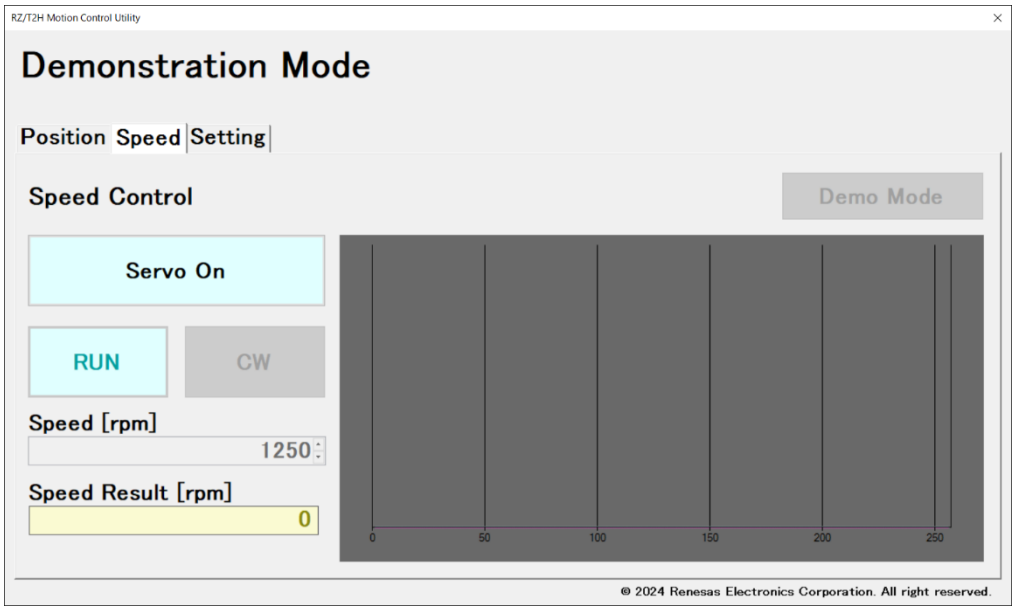


Figure 6-17 "Speed (Control)" Tab

Table 6-13 "Speed (Control)" Tab

Item	Description
Servo On/Off	Toggle button to enable/disable PWM output. "Servo On" button: Enables PWM output. When pressed, execute the ENABLE command, OFF command, and ALIGN command in sequence. "Servo Off" button: Disables PWM output. When pressed, execute the DISABLE command. When the "Servo On" button is pressed, the "Position" tab cannot be pressed. In addition, the "RUN/STOP" button, "CW/CCW" button and "Demo Mode" button can be pressed, and the "Speed [rpm]" edit box can be entered.
RUN/STOP	Toggle button to start/stop speed control. "RUN" button: Rotates the motor at the target rotation speed. When pressed, set the COMDIR command and COMVEL command, and execute the ON command. "STOP" button: Stops the rotating motor immediately. When pressed, execute the OFF command. When the "RUN" button is pressed, the "Demo Mode" button cannot be pressed until the motor stops.
CW/CCW	Toggle button to set the direction (CW/CCW) of motor rotation. Change the value to be set by the COMDIR command. The setting is confirmed when the "RUN" button is pressed.
Speed [rpm]	Edit box to set the target rotation speed. Change the value to be set by the COMVEL command. The setting is confirmed when the "RUN" button is pressed.
Speed Result [rpm]	Display the current rotation speed. Get the value of the CV command at 100[ms] intervals.
Demo Mode	Button to execute speed control to automatically update the target rotation speed. When pressed, execute the following. 1. Set 0 by the COMDIR command and set the target rotation speed to 500 by the COMVEL command. 2. Execute the ON command. 3. Wait 5 seconds. 4. Set the target rotation speed to 1500 by the COMVEL command. 5. Wait 5 seconds. 6. Set the target rotation speed to 500 by the COMVEL command. 7. Return to 3. When pressed again, execute the OFF command and stop updating the target. The motor stops immediately. When the "Demo Mode" button is pressed, the "RUN" button and "CW/CCW" button cannot be pressed during execution.
Graph area	Show the waveform graph. Get the value of the RVAL command at 100[ms] intervals.

6.1.4.3 (Graph) Setting

"(Graph) Setting" tab (Figure 6-18) allows users to change the graph settings.

Table 6-14 shows the function of each widget.

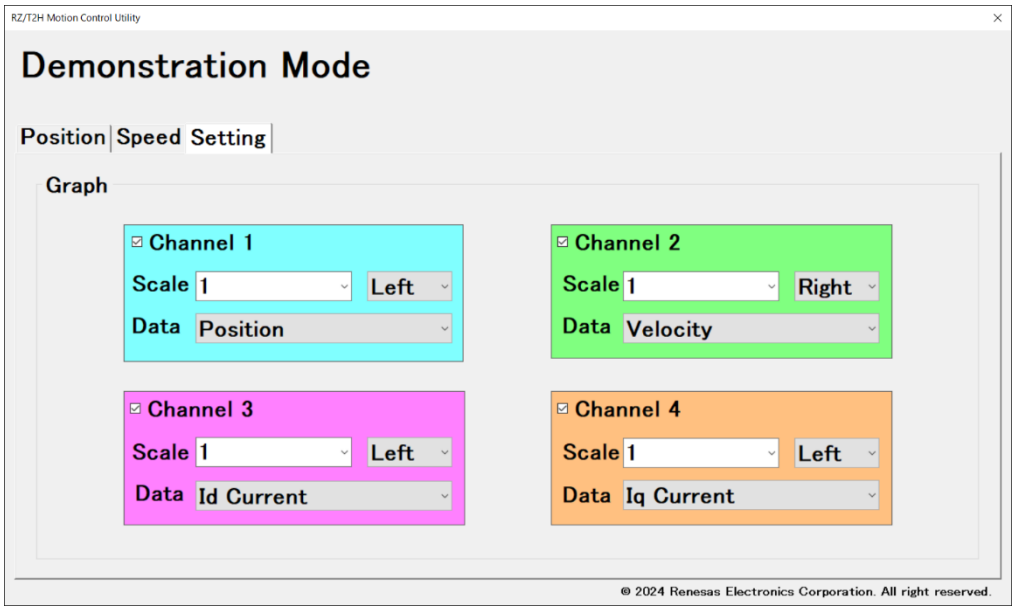


Figure 6-18 "(Graph) Setting" Tab

Table 6-14 "(Graph) Setting" Tab

Item	Description
Channel 1 to 4	Use the check box to show (ON)/hide (OFF) the waveform graph.
Scale	Specify the scale of the graph using the combo box. The scale is a minimum of 0.01x and a maximum of 50x, and the following rounding is performed. Scale = (int) ((specified value + 0.125 / 2) x 1000) / 125 x 125 / 1000
Left/Right	Select the axis to be used for the waveform graph from the drop-down list. Users can select the primary axis (Left) and the secondary axis (Right).
Data	Select the data for the waveform graph from the drop-down list.

6.1.5 Motor Parameter

Motor Parameter in this document is a generic term for motor/encoder specific parameters, parameters for various controls, etc. It is also used as the name for the file (*.mtr) that compiles those parameters and setting values. Each parameter is linked to the command, and multiple parameters can be set together by importing the file.

Table 6-15 Motor Parameter

Item	Value	Description
Version	0	Setting value for VER command. : Reserved
NodeId	0	Setting value for ADDR command. : Reserved
ModuleType	3 (fixed value)	Setting value for TYPE command. : Reserved
MotorType	3 (fixed value)	Setting value for PHASES command.
EncoderType	3 (fixed value)	Setting value for ETYPE command.
CommutationMode	4 (fixed value)	Setting value for PCMODE command.
PhaseCounts	13107	Setting value for PCOUNTS command.
EncoderCounts	65536	Setting value for ECPR command.
PolePairs	5 (fixed value)	Setting value for PPAIRS command.
HallInvert	0	Setting value for HINVERT command. : Reserved
PosInvert	0 (fixed value)	Setting value for PINVERT command.
PhaseOffset	0	Setting value for PIOFFS command. : Reserved
PhaseMap	0 (fixed value)	Setting value for PMAP command.
PhasingMode	0 (fixed value)	Setting value for PIMODE command.
PhasingTime	500	Setting value for PITIME command (Value x 10).
PhasingPower	20	Setting value for PIOUT command (Value x 327.67).
Ds	100 (fixed value)	Setting value for DS command (Value / 50).
Kp	1500	Setting value for KP command.
Ki	1500	Setting value for KI command.
Kd	0	Setting value for KD command.
Il	32767	Setting value for IL command.
Vff	0	Setting value for VFF command.
Aff	0	Setting value for AFF command.
Bias	0	Setting value for BIAS command.
Iqkp	10	Setting value for QKP command.
Iqki	1	Setting value for QKI command.
Iqkd	0	Setting value for QKD command.
Vqkp	3	Setting value for VKP command.
Vqki	1	Setting value for VKI command.
Vqkd	0	Setting value for VKD command.
MinVolt	18	Setting value for ELVOLT command.
MaxVolt	26	Setting value for EHVOLT command.
MinPos	0	Setting value for EWPOSMIN command.
MaxPos	2147483647	Setting value for EWPOSMAX command.
MaxVel	916	Setting value for EOVS command (Value x 3.2768 x Setting value for DS command (2) + 0.5).
MaxVelDiff	76	Setting value for EWOVS command (Value x 3.2768 x Setting value for DS command (2) + 0.5).
MaxTemp	0	Setting value for EOVTEMP command. : Reserved
OvrCrnt	21200	Setting value for EOVC command.
MinBuffer	30 (fixed value)	Setting value for EEMP command. : Reserved
ErrMask	507117568	Setting value for ERRMASK command.
Vcomp	0	Setting value for VCOMP command. : Reserved

Item	Value	Description
MaxErr	5000	Setting value for MAX command.
MaxErrTime	0	Setting value for ETIME command.
MaxOutput	100	Setting value for MLIMIT command (Value x 327.67).
CurrentLimit	3500	Setting value for CLIMIT command.
CurrentTime	5000	Setting value for CTIME command.
I2TLimit	0	Setting value for PLIMIT command. : Reserved
I2TTime	0	Setting value for PTIME command (Value x 10). : Reserved
AutoBrake	0	Setting value for BRAKE command. : Reserved
ErrorInputMask	0	Setting value for EMASK command. : Reserved
HomeFlagMask	0 (fixed value)	Setting value for HMASK command. : Reserved
AutoStopMode	0 (fixed value)	Setting value for ASTOP command.
HallShift	0	Setting value for HSHIFT command. : Reserved
ApeBaudrate	2500 (fixed value)	Setting value for EBAUDRATE command.
GearingIn	0	Setting value for GEARIN command. : Reserved
GearingOut	0	Setting value for GEAROUT command. : Reserved

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	2024.11.26	-	First edition issued
1.10	2026.1.27	5	Updated Jumper Settings for the RZ/T2H Evaluation Board in Table 2-3.

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Precaution against Electrostatic Discharge (ESD)

   A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.
2. Processing at power-on

   The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power reaches the level at which resetting is specified.
3. Input of signal during power-off state

   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins

   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals

   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin

   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses

   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products

   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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