

## RZ/T2M Group

### RZ/T2M Motor Solution Kit Startup Manual(for RZ/T2M Motion Control Utility)

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#### Introduction

This application note is a quick start manual (for RZ/T2M Motion control Utility) for RZ/T2M Motor Solution Kit equipped with MPU of RZ/T2M group by Renesas Electronics Corporation.

#### Target Device

RZ/T2M Group

When applying the sample program covered in this application note to another microcomputer, modify the program according to the specifications for the target microcomputer and conduct an extensive evaluation of the modified program.

## Contents

1. Overview .....	5
1.1 RZ/T2M Motor Solution Kit overview .....	5
1.2 Connection configuration .....	5
1.3 Connection Equipment .....	6
1.3.1 BLDC/AC Servo .....	6
1.3.1.1 FH6S20E-X81 .....	6
1.3.1.2 MB057GA140 .....	6
1.3.1.3 TSM3101N2001E020 .....	7
1.3.2 Encoder .....	8
1.3.2.1 Absolute Encoder .....	8
1.3.2.2 incremental .....	10
1.3.3 Communication with the PC .....	11
1.3.3.1 USB to RS-232C Cable .....	11
1.3.3.2 USB to RS-422 Board .....	11
1.3.3.3 Ethernet Cable .....	11
1.3.4 ICE .....	12
1.3.4.1 RZ/T2M .....	12
1.3.4.2 RX72N .....	12
1.3.5 Power Supply .....	13
2. Operating Environment .....	14
2.1 Motor Solution Kit: Motor Control + EtherCAT (CiA402) Edition: .....	14
2.1.1 RZ/T2M .....	14
2.1.2 RX72N .....	15
2.2 Motor Solution Kit: Motor Control Edition .....	16
2.2.1 RZ/T2M .....	16
2.2.2 RX72N .....	16
2.3 Motor Solution Kit: Motor Control + PL-SW + EtherCAT (CiA402) + FSoE + Encoder Diagnosis Edition .....	17
2.3.1 RZT2M .....	17
2.3.2 RX72N .....	18
2.4 Motor Solution Kit: Motor Control + PL-SW + Encoder Diagnosis Edition .....	19
2.4.1 RZ/T2M .....	19
2.4.2 RX72N .....	19
3. Related Application Notes .....	20
4. RZ/T2M Motor Solution Board setting .....	21
4.1 Switches .....	21
4.1.1 Controller Board .....	21

4.1.2	Inverter Board .....	21
4.2	Jumpers .....	22
4.2.1	Controller Board .....	22
4.2.2	Inverter Board .....	22
5.	RZ/T2M Motor Solution Kit Execution procedure .....	23
5.1	Motor Solution Board Starting .....	23
5.2	RZ/T2M Motion Control Utility Execution .....	24
5.2.1	Installation .....	24
5.2.2	Demonstration Mode .....	24
5.2.2.1	Motor Parameter Setting .....	24
5.2.2.2	Starting the RZ_T2M Motion Utility.exe .....	24
5.2.2.3	Demonstrations Mode .....	25
5.2.3	Tuner/Analyze Mode .....	30
5.2.3.1	RZ_T2M Motion Utility.exe Starting .....	30
5.2.3.2	Position control Execution .....	31
5.3	Tuner/Analyzer Mode Specification.....	33
5.3.1	Menu.....	34
5.3.1.1	File.....	34
5.3.1.2	Connect/Disconnect .....	34
5.3.1.3	View.....	35
5.3.1.4	Help .....	36
5.3.2	Main Screen .....	37
5.3.3	Control Panel.....	39
5.3.3.1	Setup Tab.....	39
5.3.3.2	Tuning Tab .....	43
5.3.3.3	Motion Tab .....	45
5.3.3.4	Digital I/O Tab .....	49
5.3.3.5	Encoder Tab.....	50
5.3.3.6	Limits tab .....	50
5.3.4	Motion Scope.....	54
5.3.5	Terminal.....	56
6.	Variables .....	57
7.	Motor Parameters .....	58
8.	Appendix .....	60
8.1	Program Writing Procedure.....	60
8.2	Integrated development environment Installation .....	60
8.2.1	EWARM.....	60
8.2.2	e <sup>2</sup> studio.....	60
8.2.2.1	e <sup>2</sup> studio Installation .....	60

8.2.2.2   J-Link.dll replacement ..... 60

Revision History .....61

## 1. Overview

### 1.1 RZ/T2M Motor Solution Kit overview

The RZ/T2M motor solution kit consists of the following boards and software.

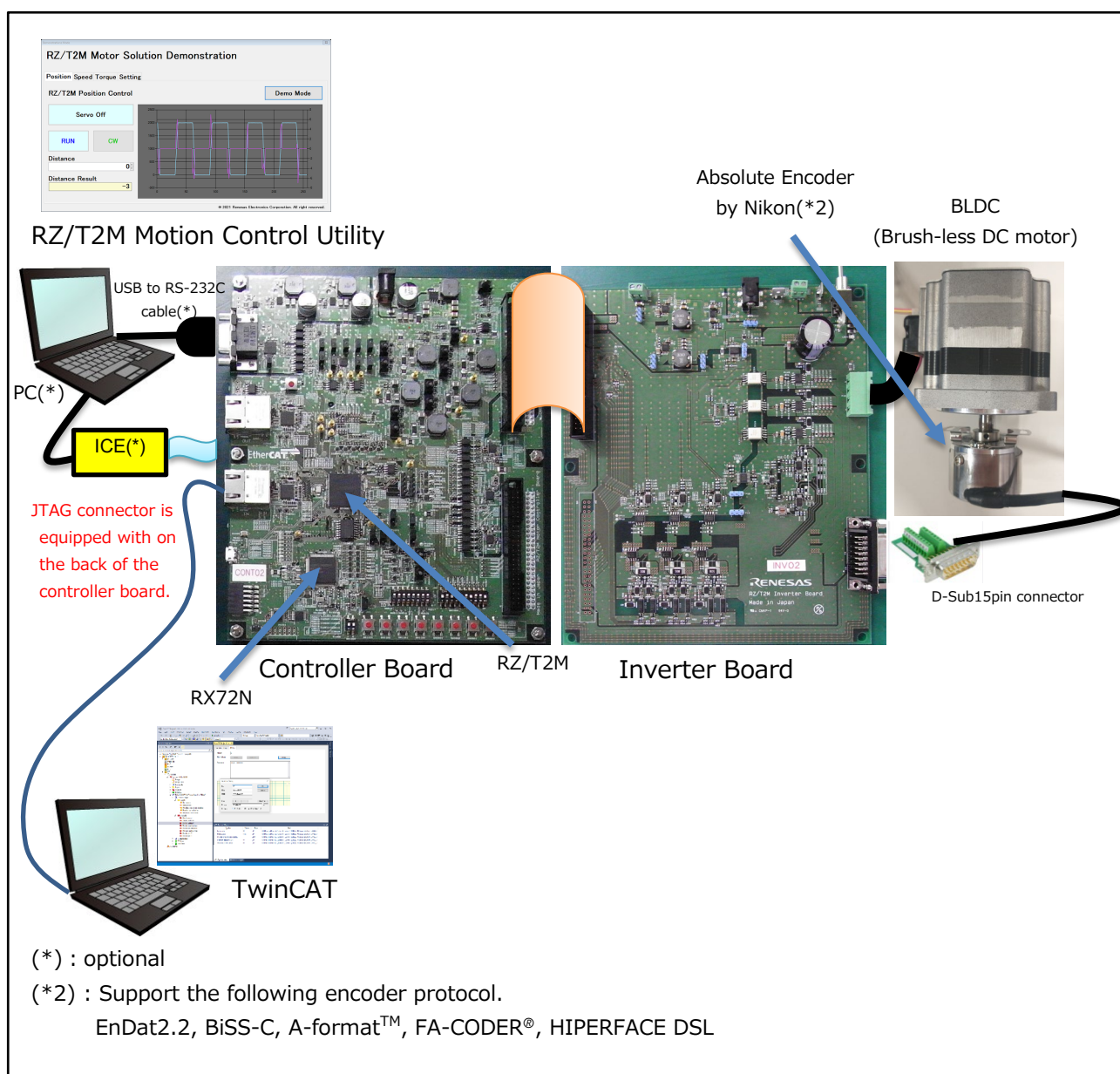
- Controller board equipped with RZ/T2M and RX72N
- Inverter board
- Firmware for motor control and EtherCAT communication
- RZ/T2M Motion Control Utility
- Circuit diagram of controller board and inverter board

The function of the CiA402 drive profile via EtherCAT® can be checked by connecting PC to the solution board via an Ethernet cable.

By using this RZ/T2M motor solution kit, it is possible to easily perform initial evaluation and advance development of industrial motor equipment development using RZ/T2M.

### 1.2 Connection configuration

Figure 1.1 is shown the RZ/T2M Motor Solution Kit connection configuration.



**Figure 1.1 RZ/T2M Motor Solution Kit connection configuration**

### 1.3 Connection Equipment

Table 1.1 is shown the connection equipment list.

**Table 1.1 connection equipment list**

Item	Model	Remarks
BLDC	<ul style="list-style-type: none"> <li>FH6S20E-X81 from Nidec Servo</li> <li>MB057GA140 from Exmek</li> <li>TSM3101N2001E020 from Tamagawa Seiki</li> </ul>	-
Encoder	<ul style="list-style-type: none"> <li>MAR-M50A from Nikon</li> <li>8.F3663.4311.C742 from Kubler</li> <li>EQN1035 from HEIDENHAIN</li> <li>ROC425 from HEIDENHAIN</li> <li>TS5710N40 from Tamagawa Seiki</li> <li>EKM36-2KF0A020A from SICK</li> </ul>	A-format™ BiSS-C EnDat2.2 EnDat2.2 Safety FA-CODER® HIPERFACE DSL
Communication with the PC	USB to RS-232C Cable	The equipment on the left is for reference.
	USB to RS-422 Board	
<ul style="list-style-type: none"> <li>BSUSRC06 from Buffalo</li> <li>USB-COM422-Plus1 from FTDI</li> </ul>		
ICE	<ul style="list-style-type: none"> <li>I-jet from IAR Systems</li> <li>J-Link Base Ver.11.0 from SEGGER</li> <li>E1 Emulator/E2 Lite Emulator from RENESAS</li> </ul>	-

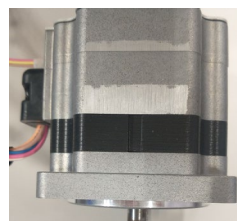
#### 1.3.1 BLDC/AC Servo

##### 1.3.1.1 FH6S20E-X81



4pin Connector by Phoenix Contact

Pin	Cable Color
1	Brown
2	Red
3	Orange
4	N.C



FH6S20E-X81

##### 1.3.1.2 MB057GA140



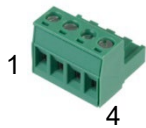
4pin Connector by Phoenix Contact

Pin	Cable Color
1	White
2	Red
3	Black
4	Black



MB057GA140

1.3.1.3    **TSM3101N2001E020**



Pin		Cable Color
1	↔	Red
2	↔	White
3	↔	Black
4		N.C



4pin Connector by Phoenix Contact

TSM3101N2001E020

### 1.3.2 Encoder

#### 1.3.2.1 Absolute Encoder

##### (1) MAR-M50A



D-sub 15pinConnector

Pin		Cable Color
7	↔	White
9	↔	Black
6	↔	Purple
14	↔	Blue



MAR-M50A by Nikon

##### (2) 8.F3663.4311.C742



D-sub 15pinConnector

Pin		Cable Color	Signal
7	↔	Brown/Green	+5V
8	↔	Blue	+5V
2	↔	White/Green	GND
9	↔	White	GND
14	↔	Gray	Data+
6	↔	Pink	Data-
13	↔	Purple	Clock+
5	↔	Yellow	Clock-


8.F3663.4311.C742  
by Kubler

##### (3) EQN1035 606688-01



D-sub 15pinConnector

Pin		Cable Color	Signal
7	↔	Brown/Green	+5V
8	↔	Blue	+5V
2	↔	White/Green	GND
9	↔	White	GND
14	↔	Gray	Data+
6	↔	Pink	Data-
13	↔	Purple	Clock+
5	↔	Yellow	Clock-


EQN1035 606688-01  
HEIDENHAIN

##### (4) ROC425 Functional Safety



D-sub 15pinConnector

Pin		Cable Color	Signal
7	↔	Brown/Green	+5V
8	↔	Blue	+5V
2	↔	White/Green	GND
9	↔	White	GND
14	↔	Gray	Data+
6	↔	Pink	Data-
13	↔	Purple	Clock+
5	↔	Yellow	Clock-


HEIDENHAIN  
ROC425 Safety

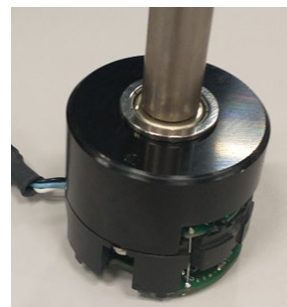


(5) **TS5710N40**



D-sub 15pinConnector

Pin		Cable Color	Signal
14	↔	Blue	SD+
6	↔	Purple	SD-
8	↔	White	+5V
9	↔	Black	GND



TS5710EN40  
by Tamagawa Seiki

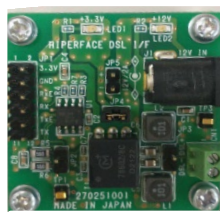
(6) **EFM50-OKF0A023A**



D-sub 15pinConnector

(\*) Optional

Pin		JP2
14	↔	1(DSL+)
6	↔	2(DSL-)



RS-485 board (\*)

12V DC

CN1	
1(DSL+)	↔
2(DSL-)	↔

Pin	
2(DSL+)	↔
3(DSL-)	↔



EKM36-2KF0A020A  
by SICK

(7) **TSM3101N2001E020**



D-sub 15pinConnector

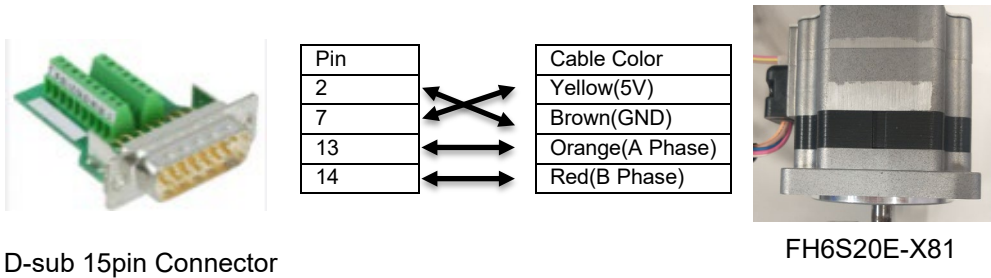
Pin		Cable Color	Signal
14	↔	Blue	SD+
6	↔	Blue/Black	SD-
8	↔	Red	+5V
9	↔	Black	GND



TSM3101N2001E020  
by Tamagawa Seiki

1.3.2.2 incremental

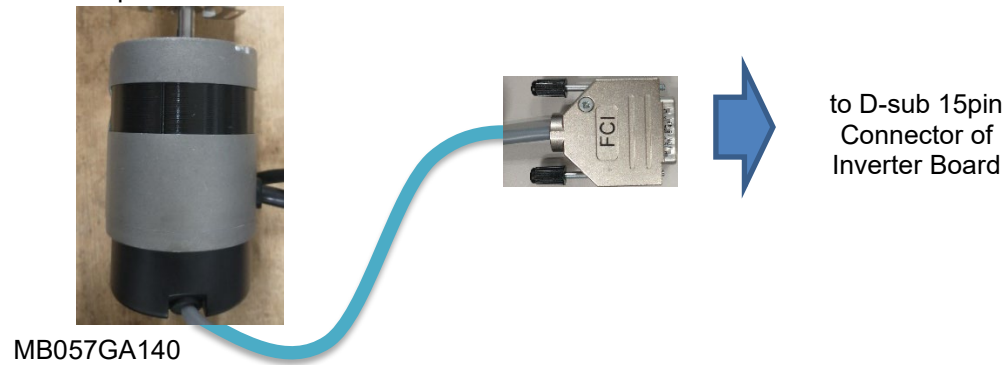
(1) FH6S20E-X81



Short the 4pin, 5pin, 6pin, 12pin and 15pin of D-sub 15pin Connector.  
Short the 7pin and 8pin of D-sub 15pin Connector.

(2) MB057GA140

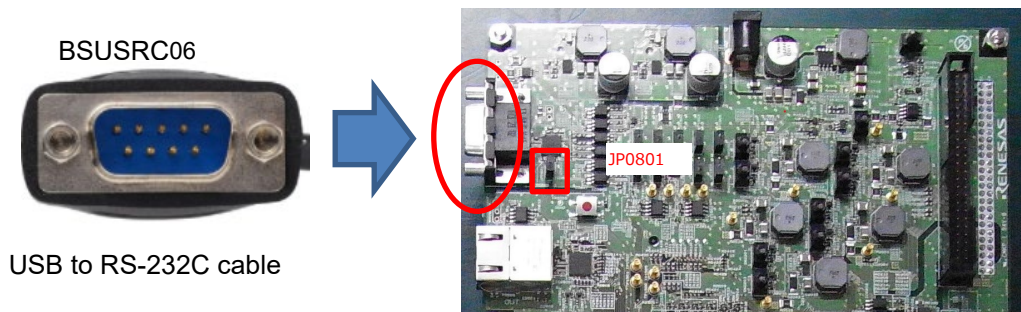
Connect to D-sub 15pin Connector of Inverter Board.



**1.3.3    Communication with the PC**

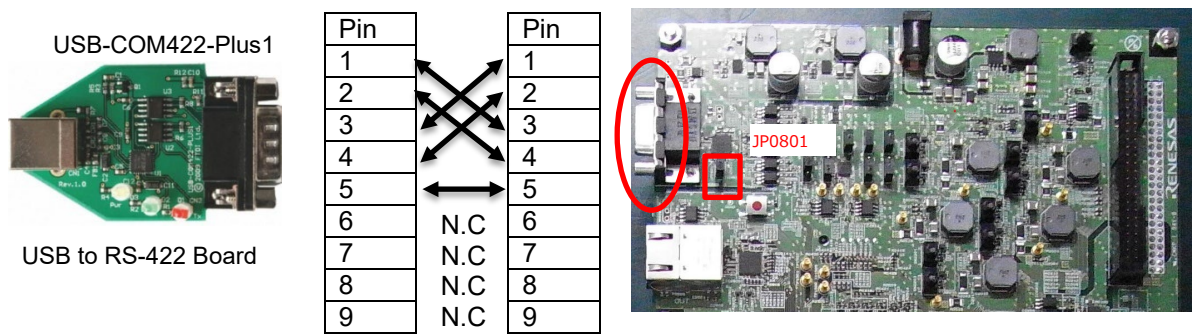
**1.3.3.1    USB to RS-232C Cable**

The USB to RS-232C cable is connected to the D-sub 9pin connector on the controller board. JP0801 on the controller board is shorted.



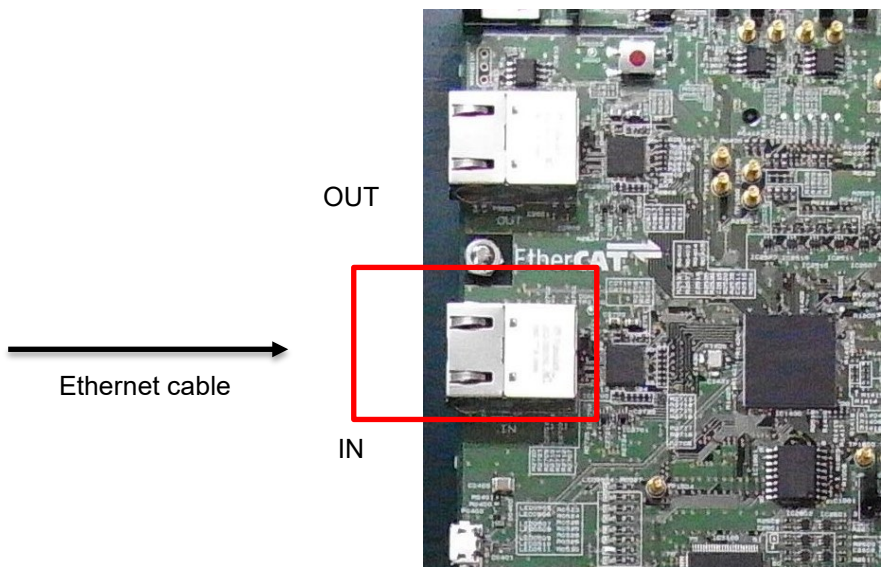
**1.3.3.2    USB to RS-422 Board**

The USB to RS-422 board is connected to the D-sub 9pin connector on the controller board. JP0801 on the controller board is opened.



**1.3.3.3    Ethernet Cable**

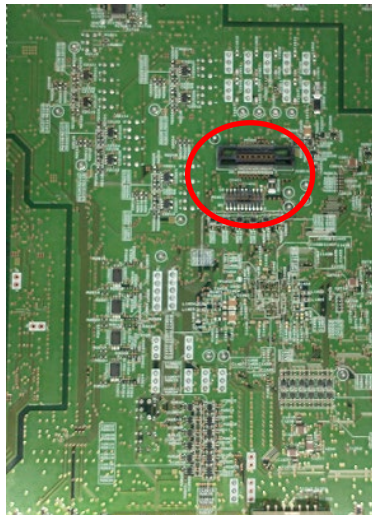
When connecting to the EtherCAT master, connect the Ethernet cable to the IN side of RJ45 connector.



### 1.3.4 ICE

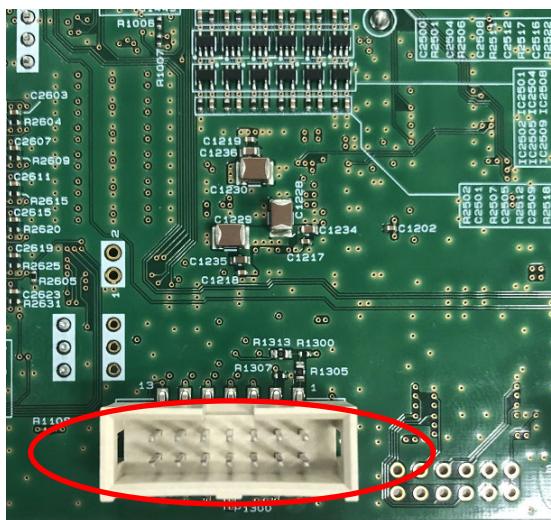
#### 1.3.4.1 RZ/T2M

ARM JTAG connector (20 pins) or ARM JTAG connector (38 pins) on the back of the controller board is connected.



#### 1.3.4.2 RX/72N

JTAG connector (14 pins) on the back of the controller board is connected.





### 1.3.5 Power Supply

If the controller board and the inverter board are connected, supply 24V DC to the inverter board. DC 24V is supplied to either the DC Power Jack (schematic: P6), + 24V (schematic: P2 / P4) faston terminal, or + 24V (schematic: P5) terminal.

When DC24V is supplied from the inverter board to the controller board, don't apply DC24V to the DC24V DC Power Jack (P1701) on the controller board.

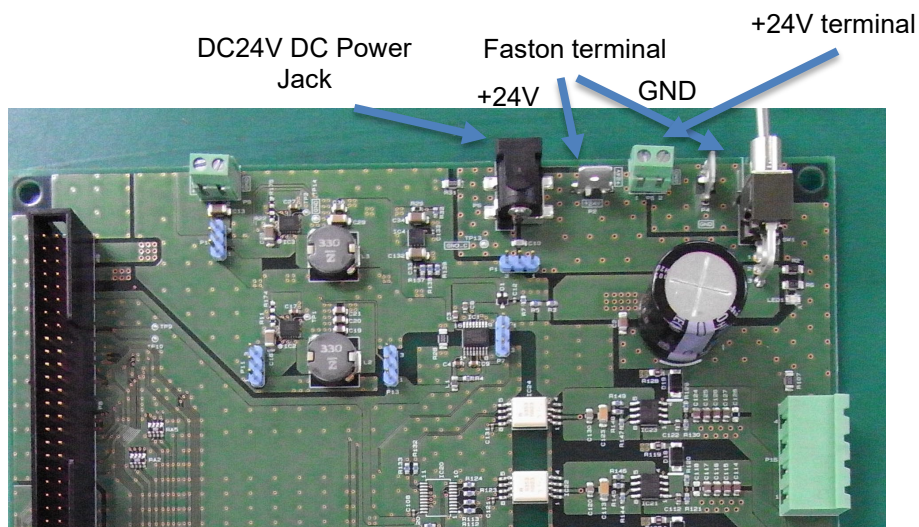


Figure 1.2 Inverter Board

## 2. Operating Environment

The motor solution kit has the following four firmwares. This document describes each operating environment.


For how to write each program, please refer to “RZ/T2M Motor Solution Kit Serial Flash ROM Programming Guide”.

1. Motor Solution Kit: Motor Control + EtherCAT (CiA402) Edition:
2. Motor Solution Kit: Motor Control Edition
3. Motor Solution Kit: Motor Control + PL-SW + EtherCAT (CiA402) + FSoE + Encoder Diagnosis Edition
4. Motor Solution Kit: Motor Control + PL-SW + Encoder Diagnosis Edition

### 2.1 Motor Solution Kit: Motor Control + EtherCAT (CiA402) Edition:

#### 2.1.1 RZ/T2M

**Table 2.1 Operating environment**

Item	Content
Board	Controller Board / Inverter Board
MPU	RZ/T2M Group R9A07G075M28GBG: 320pinFBGA
Operating frequency	CPU Core0 : 800MHz (Arm® Cortex®-R52) CPU Core1 : 800MHz (Arm® Cortex®-R52)
Operating voltage	3.3V/1.8V/1.1V
Operating mode	xSPI0 boot mode(x1 boot serial flash)
Device	Serial Flash ROM (64Mbyte) Macronix MX25L51245GMI-10G (sector size: 64Kbyte)
Communication protocol	EtherCAT® 
Integrated development environment	IAR Systems Embedded Workbench® for Arm Version 9.30.1 RENESAS e² studio 2022-04 (22.4.0) (R20220331-2313)
Emulator	IAR Systems I-jet SEGGER J-Link Base Ver.11.0
RZ/T2M Motion Control Utility (PC tool)	RENESAS RZ/T2M Motion Control Utility
SSC Tool	Provided by EtherCAT Technology Group (ETG) Slave Stack Code (SSC) Tool Version 5.12
Software PLC	Beckhoff Automation TwinCAT® 3
Flexible Software Package (FSP)	Version.1.0.0

**2.1.2 RX72N****Table 2.2 Operating environment**

Item	Content
Board	Controller Board / Inverter Board
MPU	RZ/T2N Group R5F572NNDDFP: 100pin LFQFP
Operating frequency	RXv3 : 240MHz
Operating voltage	3.3V
Integrated development environment	RENESAS e <sup>2</sup> studio 2020-10 (20.10.0) or over
Emulator	RENESAS E1 Emulator/E2 Lite Emulator

## 2.2 Motor Solution Kit: Motor Control Edition

### 2.2.1 RZ/T2M

**Table 2.3 Operating environment**

Item	Content
Board	Controller Board / Inverter Board
MPU	RZ/T2M Group R9A07G075M28GBG: 320pinFBGA
Operating frequency	CPU Core0 : 800MHz (Arm® Cortex®-R52) CPU Core1 : 800MHz (Arm® Cortex®-R52)
Operating voltage	3.3V/1.8V/1.1V
Operating mode	xSPI0 boot mode(x1 boot serial flash)
Device	Serial Flash ROM (64Mbyte) Macronix MX25L51245GMI-10G (sector size: 64Kbyte)
Integrated development environment	IAR Systems Embedded Workbench® for Arm Version 9.30.1 RENESAS e² studio 2022-04 (22.4.0) (R20220331-2313)
Emulator	IAR Systems I-jet SEGGER J-Link Base Ver.11.0
RZ/T2M Motion Control Utility (PC tool)	RENESAS RZ/T2M Motion Control Utility
Flexible Software Package (FSP)	Version.1.0.0

### 2.2.2 RX72N

**Table 2.4 Operating environment**


Item	Content
Board	Controller Board / Inverter Board
MPU	RZ/T2N Group R5F572NNDDFP: 100pin LQFP
Operating frequency	RXv3 : 240MHz
Operating voltage	3.3V
Integrated development environment	RENESAS e² studio 2020-10 (20.10.0) or over
Emulator	RENESAS E1 Emulator/E2 Lite Emulator



## 2.3 Motor Solution Kit: Motor Control + PL-SW + EtherCAT (CiA402) + FSoE + Encoder Diagnosis Edition

### 2.3.1 RZT2M

**Table 2.5 Operating environment**

Item	Content
Board	Controller Board / Inverter Board
MPU	RZ/T2M Group R9A07G075M28GBG: 320pinFBGA
Operating frequency	CPU Core0 : 800MHz (Arm® Cortex®-R52) CPU Core1 : 800MHz (Arm® Cortex®-R52)
Operating voltage	3.3V/1.8V/1.1V
Operating mode	xSPI0 boot mode(x1 boot serial flash)
Device	Serial Flash ROM (64Mbyte) Macronix MX25L51245GMI-10G (sector size: 64Kbyte)
Communication protocol	EtherCAT® 
Integrated development environment	IAR Systems Embedded Workbench® for Arm Version 9.20.3
Emulator	IAR Systems I-jet
RZ/T2M Motion Control Utility (PC tool)	RENESAS RZ/T2M Motion Control Utility
SSC Tool	Provided by EtherCAT Technology Group (ETG) Slave Stack Code (SSC) Tool Version 5.12
Software PLC	Beckhoff Automation TwinCAT® 3
Safe Master + Safe IO	Beckhoff Automation EK1100+EL6900+EL9011
Flexible Software Package (FSP)	Version.1.0.0

**2.3.2 RX72N****Table 2.6 Operating environment**

Item	Content
Board	Controller Board / Inverter Board
MPU	RZ/T2N Group R5F572NNDDFP: 100pin LQFP
Operating frequency	RXv3 : 240MHz
Operating voltage	3.3V
Integrated development environment	RENESAS e <sup>2</sup> studio 2022-10 (22.10.0) (R20221013-1357)
Emulator	RENESAS E1 Emulator/E2 Lite Emulator

**2.4 Motor Solution Kit: Motor Control + PL-SW + Encoder Diagnosis Edition****2.4.1 RZ/T2M****Table 2.7 Operating environment**

Item	Content
Board	Controller Board / Inverter Board
MPU	RZ/T2M Group R9A07G075M28GBG: 320pinFBGA
Operating frequency	CPU Core0 : 800MHz (Arm® Cortex®-R52) CPU Core1 : 800MHz (Arm® Cortex®-R52)
Operating voltage	3.3V/1.8V/1.1V
Operating mode	xSPI0 boot mode(x1 boot serial flash)
Device	Serial Flash ROM (64Mbyte) Macronix MX25L51245GMI-10G (sector size: 64Kbyte)
Integrated development environment	IAR Systems Embedded Workbench® for Arm Version 9.20.3
Emulator	IAR Systems I-jet
RZ/T2M Motion Control Utility (PC tool)	RENESAS RZ/T2M Motion Control Utility
Flexible Software Package (FSP)	Version.1.0.0

**2.4.2 RX72N****Table 2.8 Operating environment**

Item	Content
Board	Controller Board / Inverter Board
MPU	RZ/T2N Group R5F572NNDDFP: 100pin LFQFP
Operating frequency	RXv3 : 240MHz
Operating voltage	3.3V
Integrated development environment	RENESAS e² studio 2022-10 (22.10.0) (R20221013-1357)
Emulator	RENESAS E1 Emulator/E2 Lite Emulator

### 3. Related Application Notes

The application notes related to this application note are listed below for reference.

- RZ/T2M User's Manual: Hardware (XXXX: version)  
Document name: r01uh0916ejXXXX-rzt2.pdf
- RZ/T2M Motor Solution Board Hardware Manual (XXXX: version)  
Document name: r01an5986jjXXXX-rzt2-hw-manual.pdf (Japanese)  
r01an5986ejXXXX-rzt2-hw-manual.pdf (English)
- RZ/T2M Motor Solution Kit Startup Manual (for EtherCAT) (XXXX: version)  
Document name: r01an6470jjXXXX-rzt2-startup-manual-ecat.pdf (Japanese)  
r01an6470ejXXXX-rzt2-startup-manual-ecat.pdf (English)
- RZ/T2M Motor Solution Kit Firmware (Motor Control, EtherCAT) (XXXX: version)  
Document name: r01an6731jjxxxx-rzt2-firmware-motorctrl-ecat.pdf (Japanese)  
r01an6731ejxxxx-rzt2-firmware-motorctrl-ecat.pdf (English)
- RZ/T2M Motor Solution Kit Firmware (FuSa) (XXXX: version)  
Document name: r01an6765jjxxxx-rzt2-firmware-fusa.pdf (Japanese)  
r01an6765ejxxxx-rzt2-firmware-fusa.pdf (English)
- RZ/T2M Motor Solution Kit Program Writing Guide (XXXX: version)  
Document name: r01an6799jjxxxx-rzt2-program-writing-guide.pdf (Japanese)  
r01an6799ejxxxx-rzt2-program-writing-guide.pdf (English)
- CiA402 Documents:
  - IEC 61800-7-201 Edition 1.0

Adjustable speed electrical power drive systems Part 7-201: Generic interface and use of profiles for power drive systems Profile type 1 specification

- IEC 61800-7-301 Edition 1.0

Adjustable speed electrical power drive systems Part 7-301: Generic interface and use of profiles for power drive systems Mapping of profile type 1 to network technologies

## 4. RZ/T2M Motor Solution Board setting

### 4.1 Switches

#### 4.1.1 Controller Board

Switches of Controller Board are checked to be set as shown in Table 4.1.

**Table 4.1 Switches setting of RZ/T2M Motor Controller Board**

No	SW	Item	Setting
1	SW2200	RZ1.8V HVD toggle switch	Down(↓): Normal mode
2	SW2202	RZ1.8V LVD toggle switch	Down(↓): Normal mode
3	SW1801	5.0V LVD toggle switch	Left(←): Normal mode
4	SW1800	5.0V HVD toggle switch	Down(↓): Normal mode
5	SW2101	RX3.3V HVD toggle switch	Down(↓): Normal mode
6	SW2103	RX3.3V LVD toggle switch	Down(↓): Normal mode
7	SW2100	RZ3.3V HVD toggle switch	Down(↓): Normal mode
8	SW2102	RZ3.3V LVD toggle switch	Down(↓): Normal mode
9	SW2201	RZ1.1V HVD toggle switch	Down(↓): Normal mode
10	SW2203	RZ1.1V LVD toggle switch	Down(↓): Normal mode
11	SW2400	RX_RXD5 toggle switch	Down(↓): RX_RXD5=RZ_TXD5
12	SW2401	RZ_RXD5 toggle switch	Down(↓): RZ_RXD5=RX_TXD5
13	SW0501 (Device ID)	1	CFG[7:0] DIP switch
		2	ON
		3	ON
		4	ON
		5	ON
		6	ON
		7	ON
		8	ON
14	SW1500 (Boot mode)	1, 2	RZ/T2M DIP switch MD0
		3, 4	RZ/T2M DIP switch MD1
		5, 6	RZ/T2M DIP switch MD2
		7, 8	RZ/T2M DIP switch MDD
		9, 10	RZ/T2M DIP switch MDW

For detail of Controller Board, refer to the “RZ/T2M Motor Solution Board Hardware Manual”.

#### 4.1.2 Inverter Board

Switches of Inverter Board are checked to be set as shown in Table 4.2.

**Table 4.2 Switches setting of Inverter Board**

No	SW	Item	Setting
1	SW1	+24V shut down switch	ON(↑): 24V ON

For detail of Inverter Board, refer to the “RZ/T2M Motor Solution Board Hardware Manual”.

## 4.2 Jumpers

### 4.2.1 Controller Board

Jumpers of Controller Board are checked to be set as shown in Table 4.3.

**Table 4.3 Jumpers setting of RZ/T2M Motor Controller Board**

No	JP	Item	Setting
1	JP1906	Power sequencer drive power supply	1-2 short
2	JP1900	Power sequencer (DONA)	2-3 short
3	JP1904	Power sequencer (DOFFA)	2-3 short
4	JP1902	Power sequencer (DONC)	2-3 short
5	JP1903	Power sequencer (DOND)	2-3 short
6	JP1905	Power sequencer (DOFFB)	2-3 short
7	JP1907	Power sequencer (DOFFC)	2-3 short
8	JP1901	Power sequencer (DONB)	2-3 short
9	JP1908	Power sequencer (DOFFD)	2-3 short
10	JP1501 /JP1500	PWM_V-/W+ swapping	JP1501: 2-3 short
			JP1500: 1-2 short
11	JP1503 /JP1502	PWM_V2-/W2+ swapping	JP1503: 2-3 short
			JP1502: 1-2 short
12	JP0700	Pmod power supply	Jumper open
13	JP1301	RX72N boot mode	2-3 short
14	JP1600	POE_FOV selection	1-2 short
15	JP1601	POE_FOV2 selection	1-2 short

For detail of Controller Board, refer to the “RZ/T2M Motor Solution Board Hardware Manual”.

### 4.2.2 Inverter Board

Jumpers of Inverter Board are checked to be set as shown in Table 4.4.

**Table 4.4 Jumpers setting of Inverter Board**

No	JP	Item	Setting
1	P10/P11/P13	Gate driver power selection	JP10: 1-2 short
			JP11: 1-2 short
			JP13: 1-2 short
2	P1	Power supply to RZ/T2M motor controller board	1-2 short
3	P7	Bus voltage detection insulated / non-insulated selection	1-2 short
4	P15/P14	Overcurrent detection insulated / non-insulated selection	JP15: 1-2 short
			JP14: 1-2 short

For detail of Inverter Board, refer to the “RZ/T2M Motor Solution Board Hardware Manual”.

## 5. RZ/T2M Motor Solution Kit Execution procedure

### 5.1 Motor Solution Board Starting

- ① Connect BLDC to the inverter board

The BLDC is connected to 4pin connector and 4pin connector is connected to P16 connector of the inverter board.

- ② Connect the encoder to the inverter board

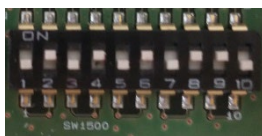
The encoder is connected to the D-Sub15pin connector and D-Sub15pin connector is connected to the P3 connector of the inverter board.

- ③ Connect the USB to RS-232C cable or USB to RS-422 board

The USB to RS-232C cable or USB to RS-422 board is connected to PC and the controller board.

- ④ xSPI0 boot mode setting

Set SW1500 of the controller board to the following.



- ⑤ Power supply of DC24V

DC24V is applied to the inverter board.

Check that LED1100 on the controller board is blinking every 500ms.

- ⑥ Push the RESET SW

Push the RESET SW of the controller board

\* : If the program is not stored in the serial Flash ROM, the program is written to the serial Flash ROM. Refer to "RZ/T2M Motor Solution Kit Serial Flash ROM Program Writing Guide".

## 5.2 RZ/T2M Motion Control Utility Execution

### 5.2.1 Installation

Copy the following ZIP file to any folder (\*) and unzip the zip file.

\\Software\\MotionUtility\\RZ\_T2 Motion Utility.zip

\* The folder path name to expand RZ\_T2 Motion Utility.zip should be alphanumeric characters.

### 5.2.2 Demonstration Mode

#### 5.2.2.1 Motor Parameter Setting

This kit has the following motor parameters.

Encoder	Motor		
	FH6S20E-X81	MB057GA140	TSM3101N2001E020
Incremental	default_nidec_inc.mtr	default_Speeder_inc.mtr	-
EnDat2.2	default_nidec_endat.mtr	default_Speeder_endat.mtr	-
BiSS-C	default_nidec_biss.mtr	default_Speeder_biss.mtr	-
FA-CODER	default_nidec_fac.mtr	default_Speeder_fac.mtr	default_tsm3101_fac.mtr
A-format	default_nidec_aas.mtr	default_Speeder_aas.mtr	-
HIPERFACE DSL	default_nidec_hfdsl.mtr(*1)	default_Speeder_hfdsl.mtr(*1)	-

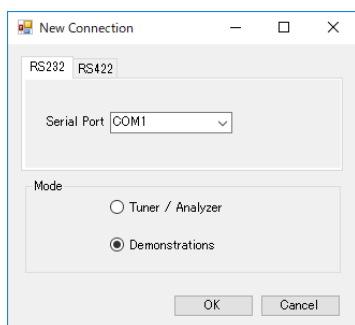
Change the file name of the motor parameter of the connected motor to "default.mtr".

(\*1): When using the RZ/T2M Motion Control Utility, connect with RS-422 at a baud rate of 1500000bps. RS-422 connection at a baud rate other than 1500000bps or RS-232C connection is not supported.

#### 5.2.2.2 Starting the RZ\_T2M Motion Utility.exe

■ When RS-232C is connected

Select the COM port number and "Demonstration". Push the "OK" button.

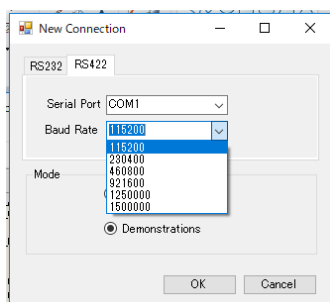


■ When RS-422 is connected

Select the COM port number, baudrate and "Demonstration". Push the "OK" button.

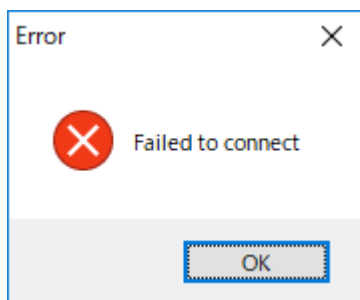
The following baud rates are supported.

115200bps/230400bps/460800bps/921600bps/1250000bps/1500000bps





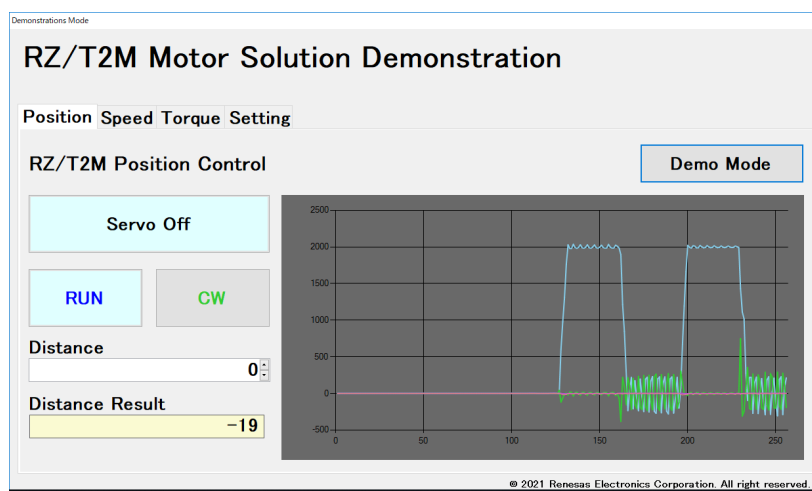
### ■ Display the connection error



Double-check the RZ/T2M Motor Solution Kit connection (refer to “4 RZ/T2M Motor Solution Board setting”), restart the RZ/T2M Motion Control Utility.

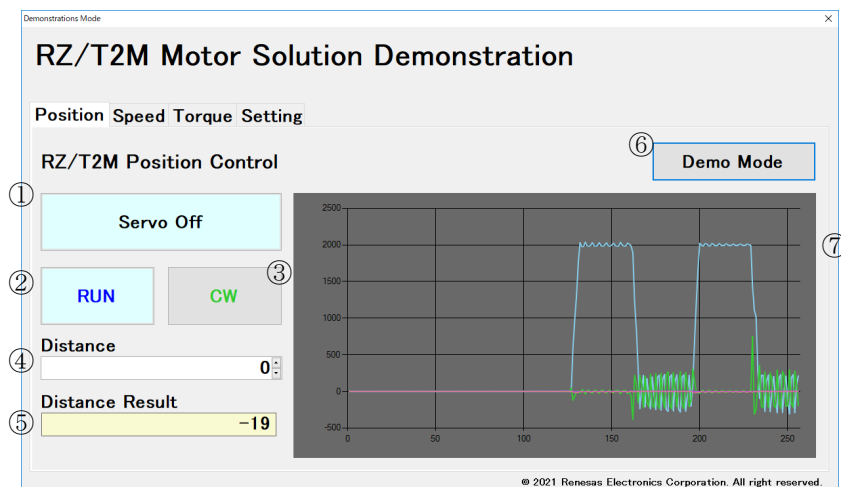
### 5.2.2.3 Demonstrations Mode

In Demonstrations Mode, it is possible to check the operation of speed control/ torque control / position control. To display with PC/tablet, the scaling of various toolboxes is changed according to the screen size. The speed control/torque/position control screen is switched by tab. “Demo Mode” button is had at each control screen and is controlled automatically by pushing this button.



**(1) Position Control Screen**

Figure 5.1 is shown the Position Control screen.

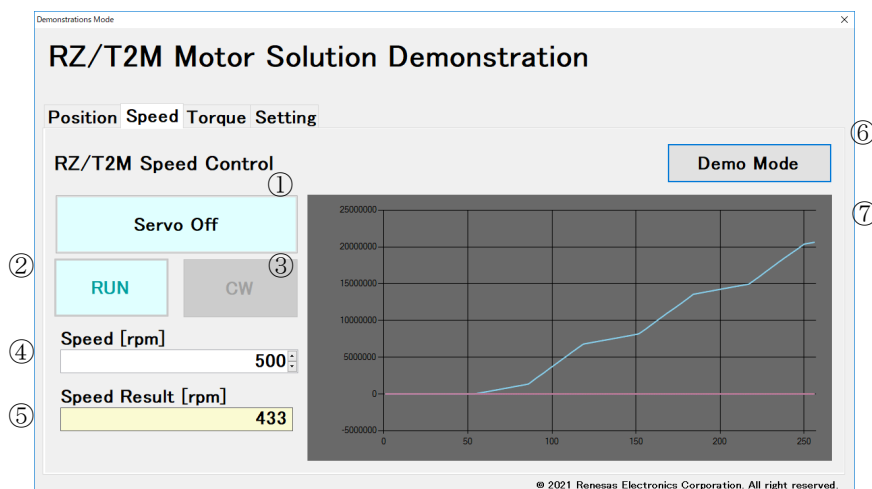


**Figure 5.1 Position Control Screen**

No.	Item	Description
①	Servo On/Off	This toggle button is controlled the power supply on/off. <ul style="list-style-type: none"> <li>When this button is pressed while "Servo On" is displayed, the motor power is turned on.</li> <li>When this button is pressed while "Servo Off" is displayed, the motor power is turned off.</li> </ul>
②	RUN/STOP	This toggle button is started/stopped the position control. <ul style="list-style-type: none"> <li>When this button is pressed while "RUN" is displayed, the motor rotates to distance(target distance) and stops by applying a torque when reaching the target distance. When stopping, this toggle button is displayed "STOP" -&gt; "RUN".</li> <li>When this button is pressed while "STOP" is displayed, the motor stops emergency. When stopping, this toggle button is displayed "STOP" -&gt; "RUN".</li> </ul>
③	CW/CCW	This toggle button is controlled the direction of motor rotation. <ul style="list-style-type: none"> <li>When this button is pressed while "CW" is displayed, the motor rotates forward (clockwise when viewed from the output shaft side).</li> <li>When this button is pressed while "CCW" is displayed, the motor rotates reverse (counter clockwise when viewed from the output shaft side).</li> </ul>
④	Distance	Target distance is set. 0 to 2000 (1 step) can be set. This value cannot be changed while motor rotates.
⑤	Distance Result	The movement distance (result) is displayed at 100ms intervals.
⑥	Demo Mode	This toggle button is operated the Position Control automatically. When this button is pressed while "Demo Mode" is displayed, the following operations are performed. <ol style="list-style-type: none"> <li>Start the Position Control toward the target position: 20000.</li> <li>After 10 seconds, restart toward the certain target distance: 0.</li> <li>Repeat the above No.1 and No.2.</li> </ol> <p>When this button is pressed again, the motor stops. While operating Demo Mode, other buttons (RUN / STOP button, etc.) cannot be used. If other tab (Torque tab/Speed tab) is pressed while operating Demo Mode, Demo Mode is stopped emergency.</p>
⑦	Graph	Waveform of current motor speed value (Red) and Id/Iq value (Blue/Green) are displayed at 100ms intervals. The scaling of graph can be changed.

**(2) Speed Control Screen**

Figure 5.2 is shown the Speed Control screen.

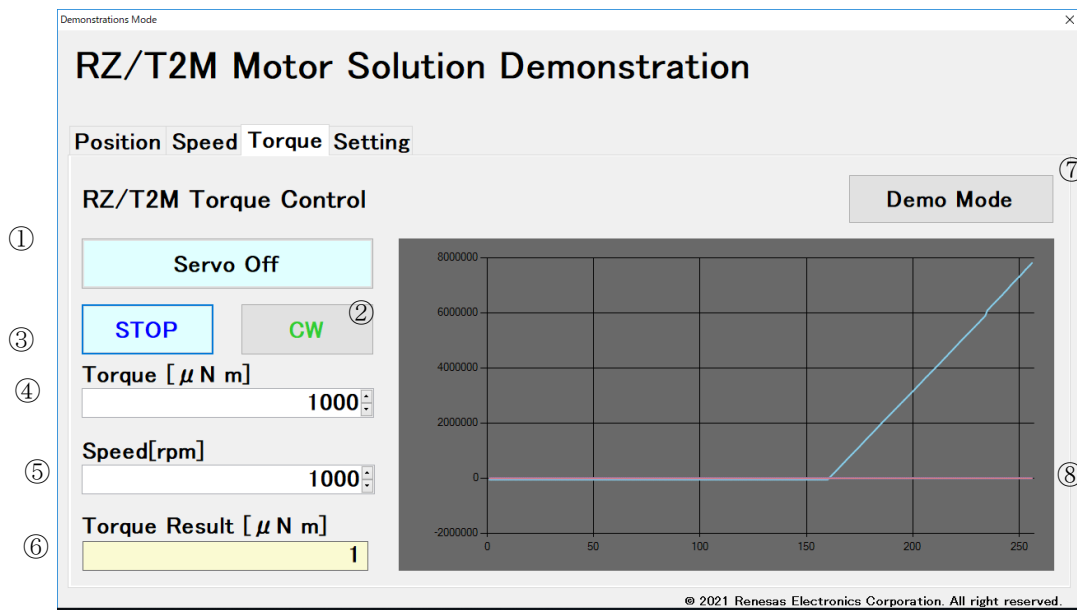


**Figure 5.2 Speed Control Screen**

No.	Item	Description
①	Servo On/Off	This toggle button is controlled the power supply on/off. <ul style="list-style-type: none"> <li>When this button is pressed while "Servo On" is displayed, the motor power is turned on.</li> <li>When this button is pressed while "Servo Off" is displayed, the motor power is turned off.</li> </ul>
②	RUN/STOP	This toggle button is started/stopped the speed control. <ul style="list-style-type: none"> <li>When this button is pressed while "RUN" is displayed, the motor rotates at speed[rpm] (target speed). When rotating, this toggle button is displayed "RUN" -&gt; "STOP".</li> <li>When this button is pressed while "STOP" is displayed, the motor stops emergency. When stopping, this toggle button is displayed "STOP" -&gt; "RUN".</li> </ul>
③	CW/CCW	This toggle button is controlled the direction of motor rotation. <ul style="list-style-type: none"> <li>When this button is pressed while "CW" is displayed, the motor rotates forward (clockwise when viewed from the output shaft side).</li> <li>When this button is pressed while "CCW" is displayed, the motor rotates reverse (counter clockwise when viewed from the output shaft side).</li> </ul>
④	Speed[rpm]	Target speed is set. 0 to 2000 [rpm] (1 step) can be set. This value can be changed while motor rotates.
⑤	Speed Result[rpm]	The current speed (result) is displayed at 100ms intervals.
⑥	Demo Mode	This toggle button is operated the Speed Control automatically. When this button is pressed while "Demo Mode" is displayed, the following operations are performed. <ol style="list-style-type: none"> <li>Start the Speed Control at the target speed: 500.</li> <li>After 5 seconds, restart at the certain target speed: 2000.</li> <li>Repeat the above No.1 and No.2.</li> </ol> <p>When this button is pressed again, the motor stops. While operating Demo Mode, other buttons (RUN / STOP button, etc.) cannot be used. If other tab (Torque tab/Position tab) is pressed while operating Demo Mode, Demo Mode is stopped emergency.</p>
⑦	Graph	Waveform of target speed (Yellow), current motor speed value (Red) and Id/Iq value (Blue/Green) are displayed at 100ms intervals. The scaling of graph can be changed.

**(3) Torque Control Screen**

Figure 5.3 is shown the Torque Control screen.

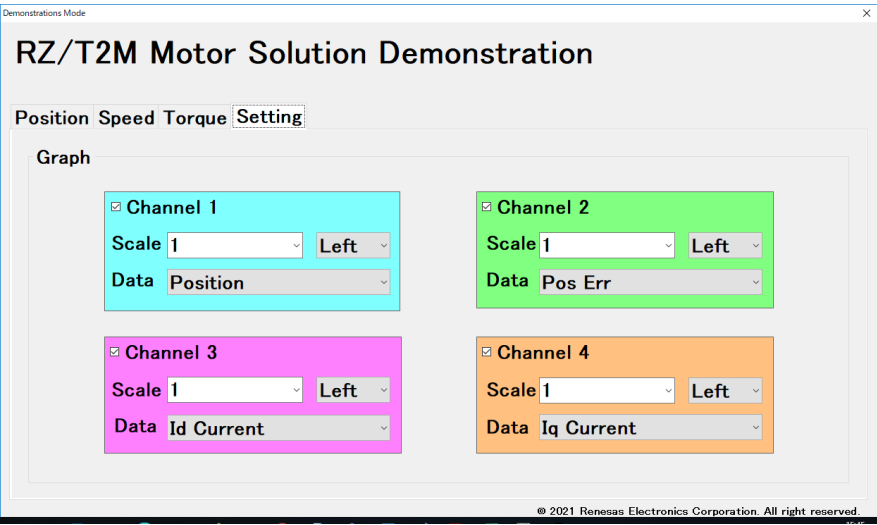


**Figure 5.3 Torque Control Screen**

No.	Item	Description
①	Servo On/Off	This toggle button is controlled the power supply on/off. <ul style="list-style-type: none"> <li>When this button is pressed while "Servo On" is displayed, the motor power is turned on.</li> <li>When this button is pressed while "Servo Off" is displayed, the motor power is turned off.</li> </ul>
②	RUN/STOP	This toggle button is started/stopped the torque control. <ul style="list-style-type: none"> <li>When this button is pressed while "RUN" is displayed, the motor rotates at torque[mNm] (target torque). When rotating, this toggle button is displayed "RUN" -&gt; "STOP".</li> <li>When this button is pressed while "STOP" is displayed, the motor stops emergency. When stopping, this toggle button is displayed "STOP" -&gt; "RUN".</li> </ul>
③	CW/CCW	This toggle button is controlled the direction of motor rotation. <ul style="list-style-type: none"> <li>When this button is pressed while "CW" is displayed, the motor rotates forward (clockwise when viewed from the output shaft side).</li> <li>When this button is pressed while "CCW" is displayed, the motor rotates reverse (counter clockwise when viewed from the output shaft side).</li> </ul>
④	Torque[uNm]	Target torque is set. 0 to 2000 [uNm](1 step) can be set. This value can be changed while motor rotates.
⑤	Speed[rpm]	Target speed is set. 0 to 2000 [rpm](1 step) can be set. This value can be changed while motor rotates.
⑥	Torque Result[uNm]	The current torque (result) is displayed at 100ms intervals.
⑦	Demo Mode	This toggle button is operated the Torque Control automatically. When this button is pressed while "Demo Mode" is displayed, torque control is started at the certain torque.  When this button is pressed again, the motor stops. While operating Demo Mode, other buttons (RUN / STOP button, etc.) cannot be used. If other tab (Position tab/Speed tab) is pressed while operating Demo Mode, Demo Mode is stopped emergency.
⑧	Graph	Waveform of target torque (Yellow), current torque value (Red) and Id/Iq value (Blue/Green) are displayed at 100ms intervals. The scaling of graph can be changed.

**(4) Setting Screen**

Figure 5.4 is shown the Setting screen. Contents of Position tab/Speed tab/Torque tab can be configured.



**Figure 5.4 Setting Screen**

■ Graph

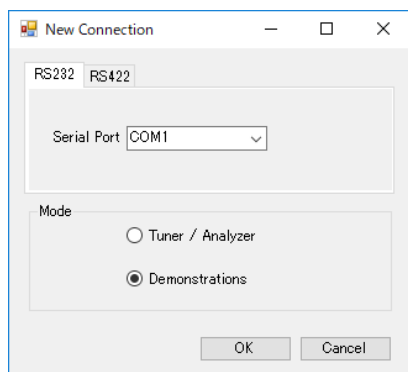
No.	Item	Description
1	Channel1~Channel4	The show/hide of Channel1 to Channel4 graphs is set. And the graph display is valid when the check box is checked.
2	Scale	Scale is set in 0.125 units. And primary axis (left side) / secondary axis (right side) of Y axis is set with "Left" / "Right".
3	Data	The displayed data (variable) is set. Refer to "6 Variables".

## 5.2.3 Tuner/Analyze Mode

### 5.2.3.1 RZ\_T2M Motion Utility.exe Starting

■ When RS-232C is connected

Select the COM port number and “Tuner/Analyzer”. Push the “OK” button.

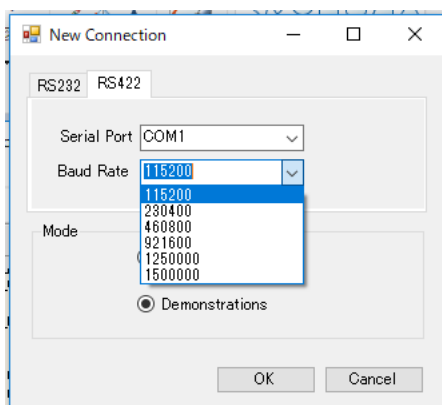


■ When RS-422 is connected

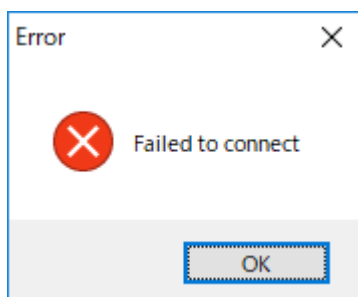
Select the COM port number, baud rate and “Tuner/Analyzer”. Push the “OK” button.

The following baud rates are supported.

115200bps/230400bps/460800bps/921600bps/1250000bps/1500000bps



■ Display the connection error



Double-check the RZ/T2M Motor Solution Kit connection (refer to “4 RZ/T2M Motor Solution Board setting”), restart the RZ/T2M Motion Control Utility.

### 5.2.3.2 Position control Execution

This chapter shows an execution example of Position Control. About detail specification, refer to “5.3 Tuner/Analyzer Mode Specification”.

#### (1) Import of the Motor Parameters

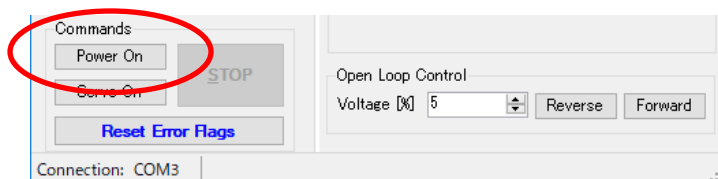
Select the [File]>[Import] of the menu and select the motor parameters in the same folder as RZ\_T2M Motion Utility.exe.

Motor: FH6S20E-X81 -> default\_nidec.mtr

Motor: MB057GA140 -> default\_Speeder.mtr

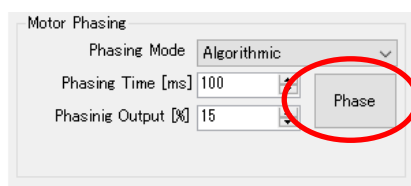
#### (2) Power ON

Push the “Power ON” button.



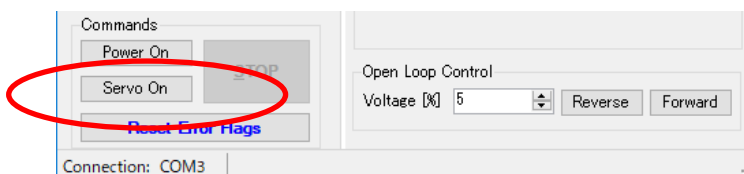
#### (3) Phasing operation

Select the “Setup” tab, push the “Phase” button.



#### (4) Servo ON

Push the “Servo On” button.



## (5) Position Control

Push the “Cycle Move P1-P2” button. The position of the motor is repeated 0 or 10000.

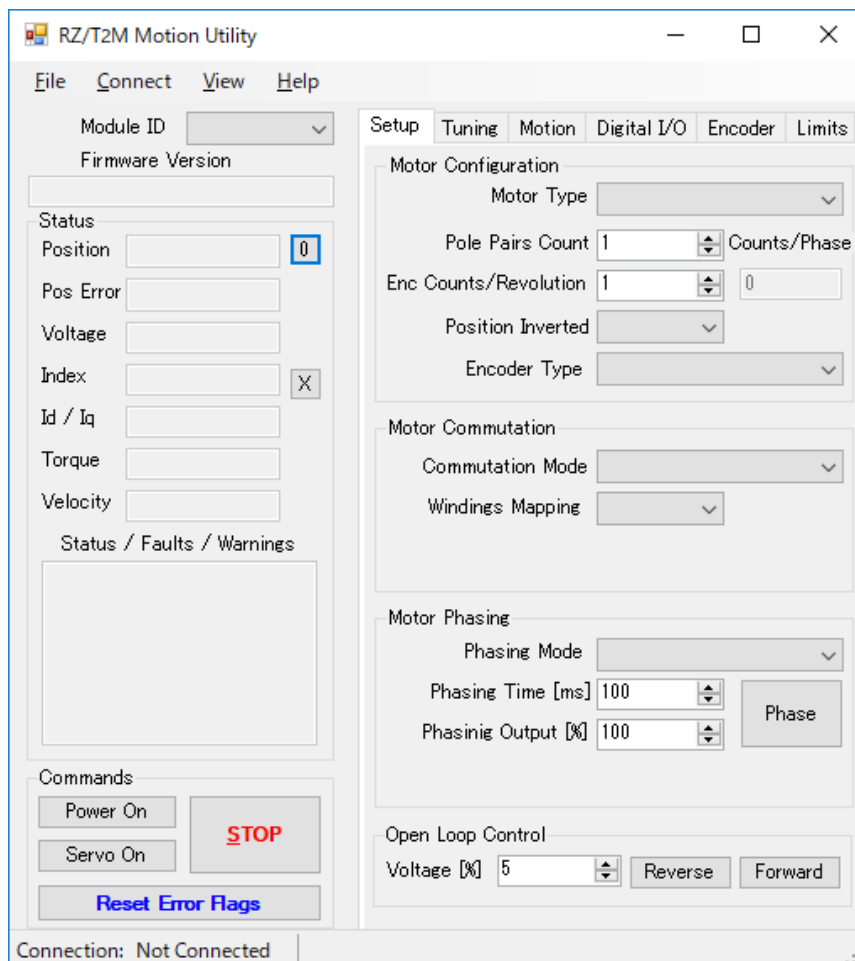
The screenshot displays the 'Motion' tab of the RZ/T2M Motion Control Utility. It features two main sections: 'Velocity Profile' and 'Motion Generator'. The 'Velocity Profile' section is expanded, showing a dropdown menu set to 'Trapezoidal'. Below this, four numerical input fields are visible: 'Velocity [Enc Counts/s]' with a value of 305,200, 'Velocity [RPM]' with a value of 279.42, 'Acceleration [EC/s/s]' with a value of 457,764, and 'Deceleration [EC/s/s]' with a value of 457,764. The 'Motion Generator' section is also expanded, showing four input fields: 'Target #1' (0), 'Target #2' (10000), 'Distance' (1000), and 'Pause [ms]' (2000). To the right of these fields are several buttons: 'Copy', 'Go to #1', 'Go to #2', 'Reverse', 'Forward', and a 'Stop Cycle' button. The 'Stop Cycle' button is highlighted with a red circle.



### 5.3 Tuner/Analyzer Mode Specification

Figure 5.5 is shown the main screen of Tuner/Analyzer mode.

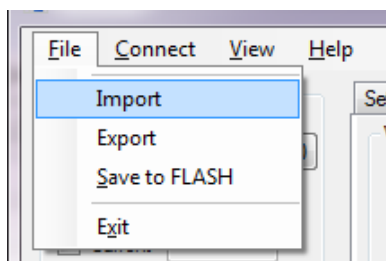
Tuner/Analyzer mode is set the configuration of motor parameter, tuning and diagnostic of the 2x RZ/T2M Motor Solution Kit. This mode is had GUI (: graphical user interface) that displays various parameters and commands and is had the terminal emulator that can read and write variables dynamically. In addition, a Motion Scope is displayed linear graphs of important controller variables.

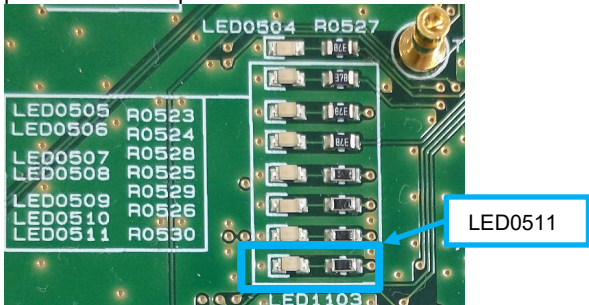


**Figure 5.5 Main Screen**

### 5.3.1 Menu

#### 5.3.1.1 File



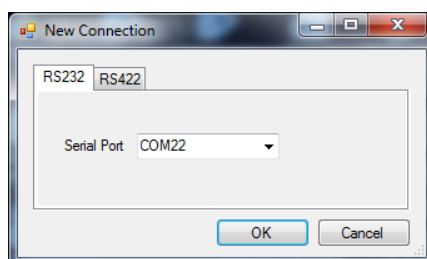
No.	Item	Description
1	Import	Motor parameters are imported. (Extension: *.mtr)
2	Export	Motor parameters are exported. (Extension: *.mtr)
3	Save to Flash	<p>Motor parameters are written to the FlashROM of RZ/T2M Motor Solution Board. (Address (:0xA00000~(ch1 of motor) and 0xA10000~(ch2 of motor)) of FlashROM that firmware of RZ/T2M Motor Solution Board is stored. )</p> <p>* Execute when the power is turned off (motor stopped).            * After writing the motor parameters, turn off the power of the motor solution board and restart.            * If LED0511 is turned on after writing the motor parameters, writing of motor parameters has failed.            While LED0511 is turned on, the power of the board is not turned off and writing of motor parameters is repeated.</p> 

About motor parameters, refer to “7 Motor Parameters”.

#### 5.3.1.2 Connect/Disconnect

##### ■ Connect

The connection dialog offers entering connection string which describes the communication interface. The string format also defines the type of the communication protocol.

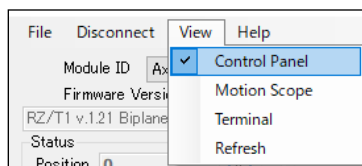


- The RS-232C connection is implied by specifying COM followed by a number such as COM5. The baud rate is fixed at 115,200 bps
- The RS-422 connection allows selection of the desired baud rate.

### ■ Disconnect

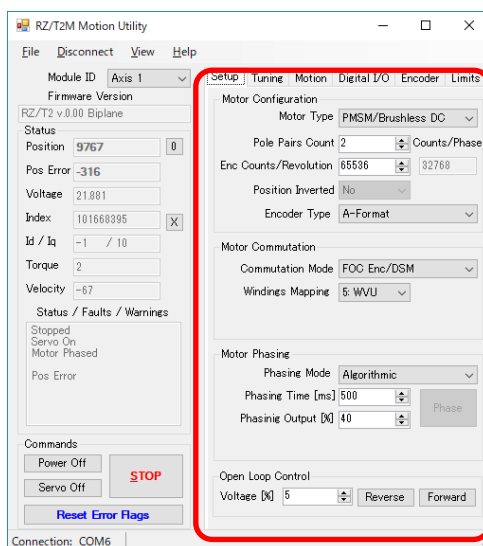
The communication is disconnected. If connecting again, “Connect” is selected.

### 5.3.1.3 View



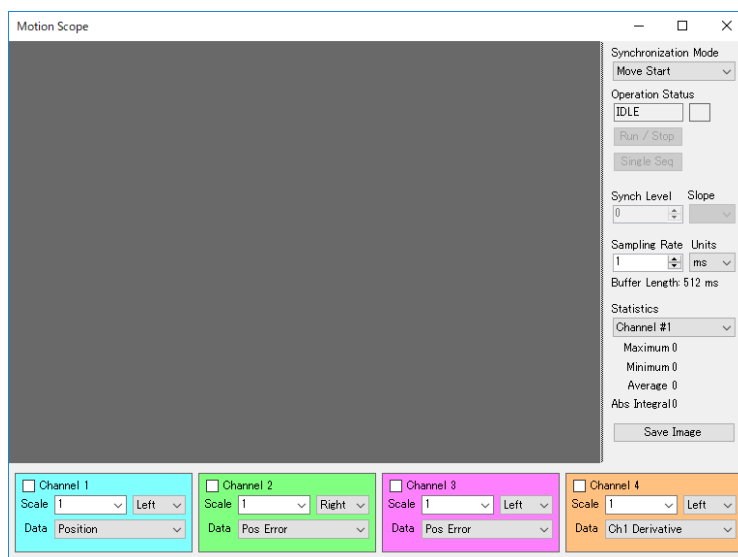
### ■ Control Panel

Part of the red frame is shown/ hidden.



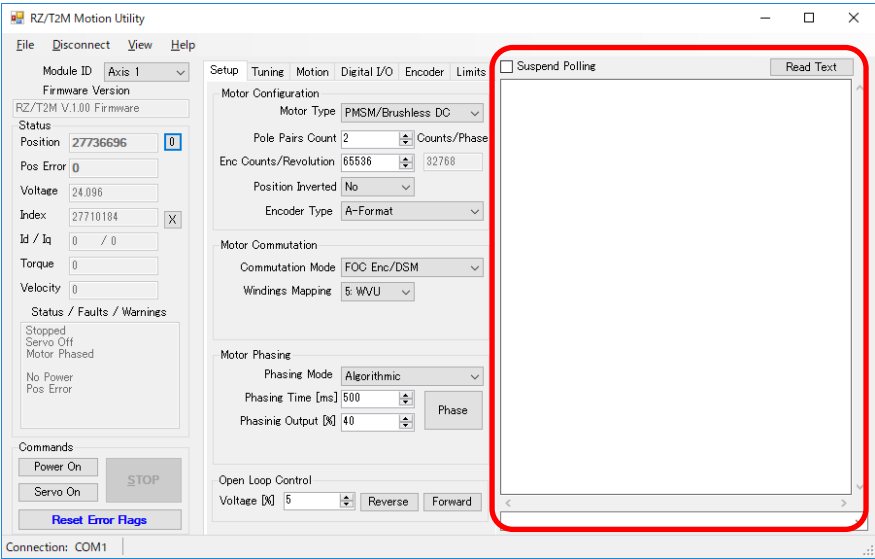
### ■ Motion Scope

Motion Scope screen is shown/ hidden.



■Terminal

Part of the red frame is shown/ hidden.



■Refresh

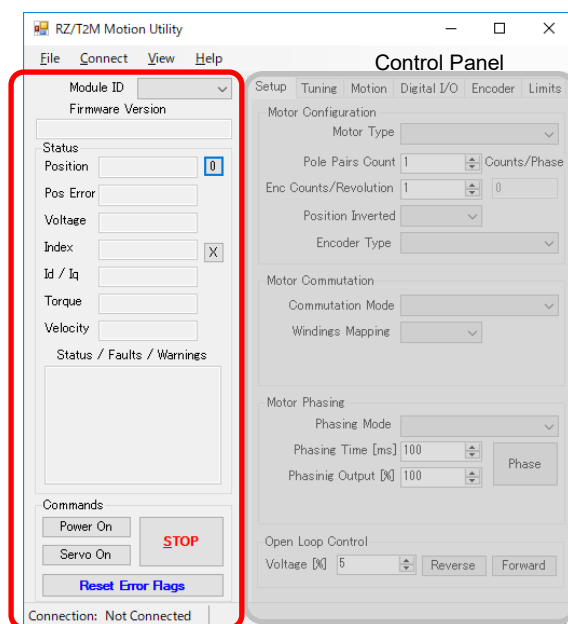
Motor parameters of default (when shipping) are refreshed.

5.3.1.4 Help

■About



### 5.3.2 Main Screen



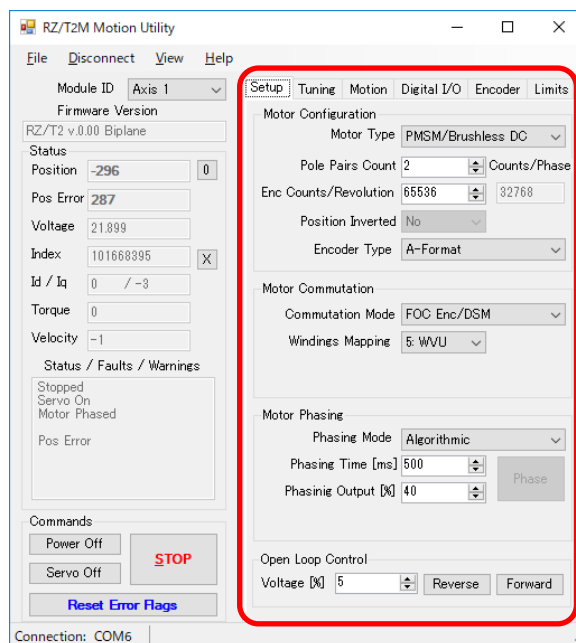
No.	Item		Description
1	Module ID		Axis number of motor to be controlled is selected.
2	Firmware Version		Version of RZ/T2M Motor Solution Kit firmware is displayed.
3	Status	Position	The current coordinates of the motor are displayed. If pushing "0" button, the current coordinates is 0.
4		Pos Error	The actual coordinates and the distance to the target coordinates are displayed.
5		Voltage	DC bus voltage is displayed.
6		Index	The encoder counter value (Position value) (absolute value) is displayed. Every pressing the X button is updated. Incremental encoder is displayed 0.
7		Id/Iq	The current Id/Iq value are displayed.
8		Torque	The current torque value is displayed.
9		Velocity	The current speed[rpm] is displayed.
10		Status/ Faults/Warnings	The current status, faults and warnings are displayed. About detail, refer to "■Status/ Faults/ Warnings".
11	Commands	Power On	This toggle button is controlled the power supply on/off.
12		Servo On	This toggle button is controlled the servo on/off.
13		STOP	This button is stopped the rotation of the motor.
14		Reset Error Flags	This button is released the status of Faults/Warnings. By releasing the status of Faults/Warnings, "Servo On" button is valid.

**■ Status/ Faults/ Warnings**

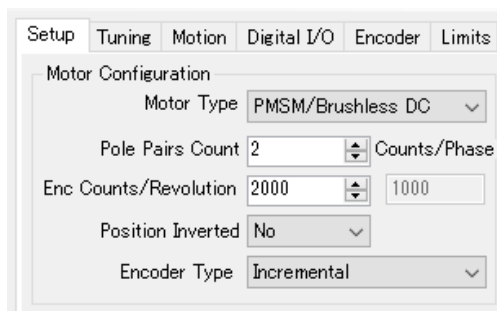
No.	Indication	Description
1	"Moving"/"Stopped"	"Moving" or "Stopped" is displayed to 1st line. "Moving": The motor is rotating. "Stopped": The motor is stopping.
2	"Servo On"/ "Servo Off"	"Servo On" or "Servo Off" is displayed to 2nd line. "Servo On": The servo control is started. "Servo Off": The servo control is stopped.
3	"Power On" / "Power Off"	"Power On" or "Power Off" is displayed to 3rd line. "Power On": Power is turned ON. "Power Off": Power is turned OFF.
4	"Motor Phased"/ "Motor Not Phased"	"Motor Phased" or "Motor Not Phased" is displayed to 4th line. "Motor Phased": Motor phasing is completed. "Motor Not Phased": Motor phasing is not completed.
5	"Position Captured"	The encoder count was acquired.
6	"PVT Buffer Error"	PVT buffer capacity were less than threshold.
7	"Overcurrent"	Over current was detected.
8	"Amplifier Inhibit"	Error by "5.3.3.6(5)Other".
9	"PVT Buffer Empty"	PVT buffer empty were detected.
10	"Overtemperature"	Overheating was detected.
11	"Amplifier Fault"	Fault error from Current Sensor.
12	"Position Error"	The Max Position Error.
13	"Wraparound Error"	Position Counter Wraparound

### 5.3.3 Control Panel

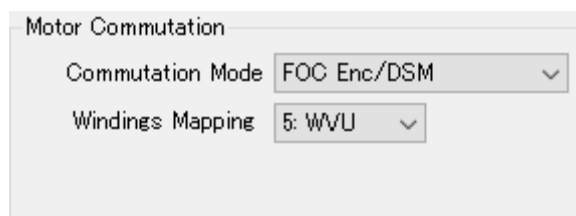
#### 5.3.3.1 Setup Tab



#### (1) Motor Configuration



No.	Item	Description
1	Motor Type	Motor type is selected. • PMSM/Brushless DC (PMSM/ Brushless DC)
2	Pole Pairs Count	Motor pole pairs count is set. (1 to 16 can be selected.)
3	Enc Counts/Revolution	Encoder count for one revolution is set.
4	Counts/Phase	Electrical cycle (= the encoder counts per revolution divided by the number of pole pairs) is displayed.
5	Position Inverted	The position feedback can be inverted if needed. This option eliminates the need of changing the wiring of an incremental encoder if the direction motion does not correspond to the decoded position.
6	Encoder Type	Encoder Type is selected. 0: Incremental 1: EnDat2.2 2: BiSS-C 3: FA-CODER® 4: A-format™ 5: HIPERFACE DSL

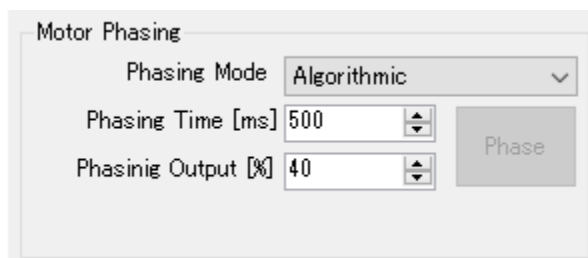
**(2) Motor Commutation**


Motor Commutation

Commutation Mode: FOC Enc/DSM

Windings Mapping: 5: W/U

No.	Item	Description
1	Commutation Mode	Motor commutation mode is set. • "FOC Enc/DSM": Sinusoidal vector control with encoder and Delta Sigma Modulator
2	Windings Mapping	Windings Mapping (U/V/W placement.) is selected.

**(3) Motor Phasing**


Motor Phasing

Phasing Mode: Algorithmic

Phasing Time [ms]: 500

Phasing Output [%]: 40

Phase

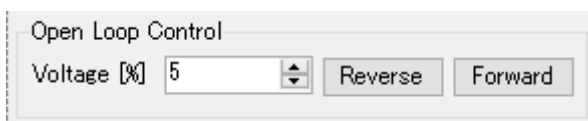
No.	Item	Description
1	Phasing Mode	Phasing mode is selected. About detail, refer to the following ■RZ/T1 Solution Kit Firmware Application Note.  1. Algorithmic an algorithm is executed upon power up of the controller. It energizes the windings creating known flux orientation that rotates the motor. After a small delay that allows the motor to settle the motor position is taken as a reference for the poles orientation. The advantage of using Algorithmic phasing is it does not need additional hardware and wiring and its accuracy is pretty good. The disadvantage is that it executes small (half electrical cycle) but uncontrolled motion upon power up that may not be acceptable.  2. Dithering algorithm moves the magnetic flux at various angles and identifies the direction of movement based on the encoder. This algorithm may not be available in all firmware versions. The advantage of this approach is same as the algorithmic phasing and in addition it minimizes the robot motion to several encoder counts. The disadvantage is its accuracy is affected by the motor load, so it is not applicable to gravity or spring loaded axes. The phasing process can be initiated at any time by pressing the Phase button. The controller power must be turned on.
2	Phasing Time[ms]	Phasing time is set. The voltage is applied with magnitude defined by the motor variable motor power for a duration defined in the motor variable phasing time. When Phasing Mode is Hall-Based, this item cannot be selected.
3	Phasing Output[%]	Phasing Output is set. The voltage is applied with magnitude defined by the motor variable motor power for a duration defined in the motor variable phasing time. When Phasing Mode is Hall-Based, this item cannot be selected.
4	Phase Button	Phasing is started.



## ■ RZ/T1 Solution Kit Firmware Application Note (R11AN0086EU0102 Rev.1.02)

Phasing Procedure	Description
<b>Forced Phasing</b>  <b>phasing_mode == 0</b>	<p>In this mode the firmware forms a voltage vector a known angle. It is formed by applying appropriate PWM duty cycle to each of the three phase outputs.</p> <p>The voltage is applied with magnitude defined by the motor variable <b>motor_power</b> for a duration defined in the motor variable <b>phasing_time</b>. These two variables have to be configured so that they will cause the motor to rotate its rotor such that it is oriented along the orientation of the magnetic flux. Once the time expires, the algorithm stores the current position and sets the phase origin 90degrees back from it.</p> <p>This procedure is implemented in the function <b>forced_phasing()</b> in the file <b>m_phasing.c</b></p> <p>The pros of this function are its simplicity and robustness. The cons are the small move in random direction the motor would make during the procedure execution. Another disadvantage is that the motor should have no static friction or gravity load that would affect the proper rotor orientation.</p>
<b>Dithering Based Phasing</b>  <b>phasing_mode == 2</b>	<p>The dithering algorithm is derived from the Forced phasing algorithm – identifying the rotor position by observing its position after known flux is applied for a certain time.</p> <p>Unlike the Forced phasing algorithm, the Dithering algorithm does not wait for a certain time – instead it monitors the position change of the rotor. Once the motion direction is detected, the flux orientation is changed so that it cause change in the opposite direction. The magnitude of the flux angle changes is gradually reduced until the motion is no longer detected. The end result is motor phasing that only includes small motor vibrations for a short time as part of the phasing.</p> <p>This algorithm has the benefits of the Forced Phasing algorithm but without the drawback of unwanted motion. The cons are the need of carefully tuning the algorithm parameter in order to match the dynamic characteristics of the mechanical system the motor is attached to. The presence of static friction and gravity load are also undesired.</p> <p>The algorithm is implemented by the function <b>dither_phasing()</b> in the file <b>m_phasing.c</b></p>

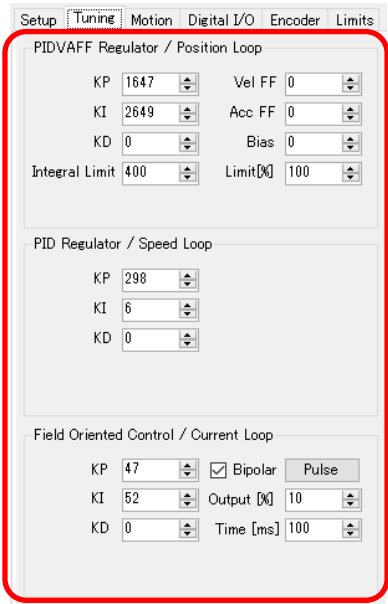
#### (4) Open Loop Control



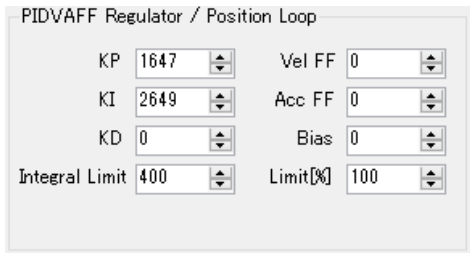
No.	Item	Description
1	Voltage[%]	The voltage (speed) to rotate is set. 1 to 99% can be set. If increasing this value, rotation of motor is fast.
2	Reverse Button	The motor rotates with Voltage (reverse). Motor reverses while the "Reverse" button is pushed. Motor stops when the "Reverse" button is released.
3	Forward Button	The motor rotates with Voltage (forward). Motor forwards while the "Forward" button is pushed. Motor stops when the "Forward" button is released.

5.3.3.2    **Tuning Tab**

Set the position loop, speed loop, and current loop on the Tuning tab.



(1)    **PIDVAFF Regulator/Position Loop**



No.	Item	Description
1	KP	Proportional Gain in the position control loop algorithm (0 - 32767).
2	Vel FF	Velocity Feed Forward in the position control loop algorithm (0 - 32767).
3	KI	Integral Gain in the position control loop algorithm (0 - 32767).
4	Acc FF	Acceleration Feed Forward in the position control loop algorithm (0 - 32767).
5	KD	Differential Gain in the position control loop algorithm (0 - 32767).
6	Bias	Value to be added to the output of the PID regulator continuously.
7	Integral Limit	Integral Limit in the position control loop algorithm (0 - 32767).
8	Limit[%]	Motor output limit from the position loop PID regulator (0 - 32767)

■ PID regulator of position control

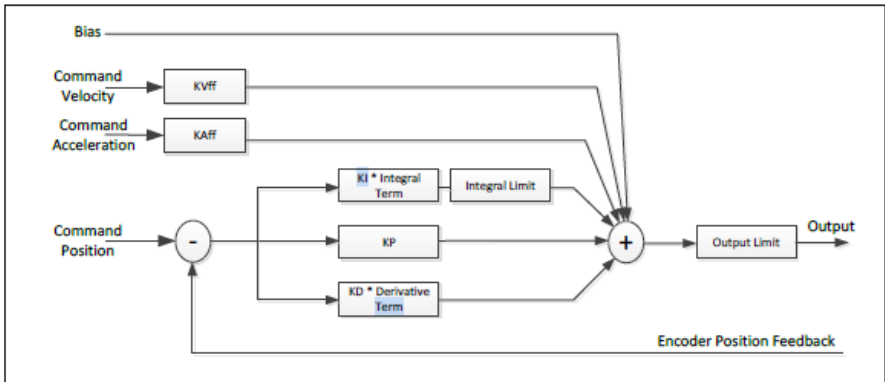


Figure 5.6    **PID regulator**

**(2) PID Regulator/Speed Loop**

PID Regulator / Speed Loop

KP 298

KI 6

KD 0

No.	Item	Description
1	KP	Proportional Gain in the velocity control loop (0 - 32767).
2	KI	Integral Gain in the velocity control loop (0 - 32767).
3	KD	Differential Gain in the velocity control loop (0 - 32767).

**(3) Field Oriented Control/Current Loop**

Field Oriented Control / Current Loop

KP 47 ☒ Bipolar

KI 52 Output [%] 10

KD 0 Time [ms] 100

No.	Item	Description
1	KP	Proportional gain in the Quadrature current control loop (0 - 32767).
2	Bipolar/Pulse Button	When this button is pushed, a pulse of the specified magnitude (Output [%]) for the specified time (Time [ms]) is output. When "Bipolar" is checked, bipolar pulses (positive pulse and negative pulse) are output. When "Bipolar" is not checked, a unipolar pulse (positive pulse) is output.
3	KI	Integral gain in the Quadrature current control loop (0 - 32767).
4	Output[%]	Output voltage set as PWM duty cycle (32767 = 100%). Requires that the servo control is turned off.
5	KD	Differential Gain in the Quadrature current control loop (0 - 32767).
6	Time[ms]	Time of PWM output is set.

**5.3.3.3 Motion Tab**

Setup | Tuning | **Motion** | Digital I/O | Encoder | Limits

**Velocity Profile**

Velocity Profile: S-Curve Bezier

Velocity [Enc Counts/s]: 3,052

Velocity [RPM]: 91.56

Acceleration [EC/s/s]: 457,764

Deceleration [EC/s/s]: 457,764

Acc Jerk Factor [0-1000]: 500

Dec Jerk Factor [0-1000]: 800

**Motion Generator**

Target #1: 0 [Copy] [Go to #1]

Target #2: 10000 [Copy] [Go to #2]

Distance: 1000 [Reverse] [Forward]

Pause [ms]: 500 [Cycle Move P1 - P2]

☐ Electronic Gearing

IN: 1 [Axis 1]

OUT: 1 [Axis 2]

**(1) Velocity Profile**

About Velocity Profile, "Trapezoidal", "Spline-Curve", "Bezier-Curve" and "PVT Streaming" are selected.

**(a) Velocity Profile : Trapezoidal and Spline-Curve**

**The Trapezoidal Profile:** The definition of maximum velocity, acceleration and deceleration are set. Note that the motion parameters are maximum values that may not be achievable given the distance to the target position and the abilities of the motor.

**The Spline-Curve Profile:** Provides smooth velocity profile curve and eliminates the vibrations caused by the sudden start and stop of acceleration typical for the Trapezoidal velocity profile. The smooth motion comes at the expense of extended time to execute the same motion.

**Velocity Profile**

Velocity Profile: Trapezoidal

Velocity [Enc Counts/s]: 3,052

Velocity [RPM]: 91.56

Acceleration [EC/s/s]: 457,764

Deceleration [EC/s/s]: 457,764

No.	Item	Description
1	Velocity[Enc Counts/s]	Maximum velocity is set.
2	Velocity[rpm]	The value converted the maximum speed to rpm is displayed.
3	Acceleration[EC/s/s]	Maximum acceleration is set.
4	Deceleration[EC/s/s]	Maximum deceleration is set.

**(b) Velocity Profile : Bezier-Curve**

**Bezier-Curve Profile:** Setting of acceleration and deceleration jerk parameters are valid. These values can be set in the range between 0 and 1000 and change the shape of the respective acceleration and deceleration profile phases. The configurable jerk allows tradeoff between the performance and the settle time affected by aggressive deceleration.

The PVT Streaming Profile is intended to demonstrate the use of PVT mode which employs the host computer as master velocity profile generator. This approach is valuable for the synchronization of multiple axes and complex mechanisms.

Velocity Profile

Velocity Profile S-Curve Bezier

Velocity [Enc Counts/s] 8,052

Velocity [RPM] 91.56

Acceleration [EC/s/s] 457,764

Deceleration [EC/s/s] 457,764

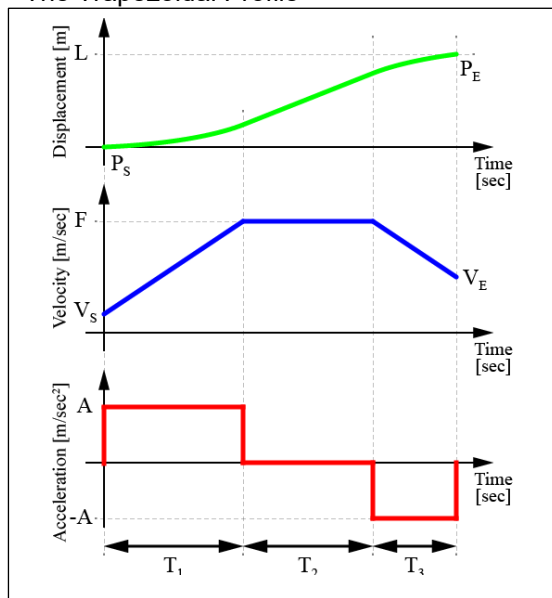
Acc Jerk Factor [0-1000] 0

Dec Jerk Factor [0-1000] 0

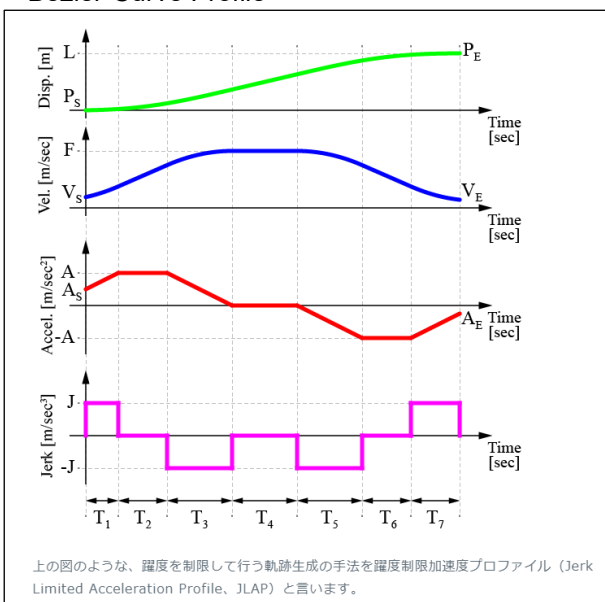
No.	Item	Description
1	Velocity[Enc Counts/s]	Maximum velocity is set.
2	Velocity[rpm]	The value converted the maximum speed to rpm is displayed.
3	Acceleration[EC/s/s]	Maximum acceleration is set.
4	Deceleration[EC/s/s]	Maximum deceleration is set.
5	Acc Jerk Factor[0-1000]	Acceleration Jerk (0 - 1000) is set.
6	Dec Jerk Factor[0-1000]	Deceleration Jerk (0 - 1000) is set.

**■References:**

## &lt; The Trapezoidal Profile &gt;



## &lt; Bezier-Curve Profile &gt;



**(c) Velocity Profile : PVT Streaming**

**PVT Streaming Profile (PVT= position Velocity Time):** Since the communication bandwidth between the host and the controller is inherently limited, the velocity profiles are presented as sets of Position and Velocity over a fixed time slices (typically 5ms to 20ms). Hence the name Position-Velocity-Time for these profile time. The PVT points are streamed to each of the controllers which in turn execute interpolation algorithm to generate the desired position and velocity set-points each 50 microseconds.

No.	Item	Description
1	Velocity[Enc Counts/s]	Maximum velocity is set.
2	Velocity[rpm]	The value converted the maximum speed to rpm is displayed.
3	Acceleration[EC/s/s]	Maximum acceleration is set.
4	Deceleration[EC/s/s]	Maximum deceleration is set.
5	Acc Jerk Factor[0-1000]	Acceleration Jerk (0 - 1000) is set.
6	Dec Jerk Factor[0-1000]	Deceleration Jerk (0 - 1000) is set.
7	PVT Time Slice[ms]	PVT Time is set.

This kit supports the Trapezoidal Profile only, but not the Spline-Curve Profile and Bezier-Curve Profile and PVT Streaming Profile.

**(2) Motion Generator**

Motion Generator

Target #1

Target #2

Distance

Pause [ms]

☐ Electronic Gearing

IN  Axis 1

OUT  Axis 2

No.	Item	Description
1	Target #1/ Copy Button/ Goto to #1 Button	Position of target #1 is set. When pushing "Copy" button, Current position is copied. When pushing "Go to #1" button, the motor rotates to the Position of Target #1.
2	Target #2/ Copy Button/ Goto to #2 Button	Position of target #2 is set. When pushing "Copy" button, Current position is copied. When pushing "Go to #2" button, the motor rotates to the Position of Target #2.
3	Distance/ Reserve Button/ Forward Button	Distance (Position) is set. When pushing "Reserve" button, the motor rotates reverse to the "Distance". When pushing "Forward" button, the motor rotates forward to the "Distance".
4	Pause[ms]/ Cycle Move P1-P2 Button	When pushing "Cycle Move P1-P2" button, repeat the following. ① The motor rotates to the Target #1. ② Pause ③ The motor rotates to the Target #2. ④ Pause  When pushing "Cycle Move P1-P2" button again, the motor stops.



**5.3.3.4 Digital I/O Tab**

No.	Item	Description
1	Input0	Indicates the status of the ID DIP SW (SW0501) 1 pin on the RZ/T2M motor solution board. Green is displayed when the DIP SW 1 pin is ON, White is displayed when the DIP SW 1pin is OFF.
2	Input1	Indicates the status of the ID DIP SW (SW0501) 2 pin on the RZ/T2M motor solution board. Green is displayed when the DIP SW 2 pin is ON, White is displayed when the DIP SW 2pin is OFF.
3	Input2	Indicates the status of the ID DIP SW (SW0501) 3 pin on the RZ/T2M motor solution board. Green is displayed when the DIP SW 3 pin is ON, White is displayed when the DIP SW 3pin is OFF.
4	Input3	Indicates the status of the ID DIP SW (SW0501) 4 pin on the RZ/T2M motor solution board. Green is displayed when the DIP SW 4 pin is ON, White is displayed when the DIP SW 4pin is OFF.
5	Input4	Indicates the status of the ID DIP SW (SW0501) 5 pin on the RZ/T2M motor solution board. Green is displayed when the DIP SW 5 pin is ON, White is displayed when the DIP SW 5pin is OFF.
6	Input5	Indicates the status of the ID DIP SW (SW0501) 6 pin on the RZ/T2M motor solution board. Green is displayed when the DIP SW 6 pin is ON, White is displayed when the DIP SW 6pin is OFF.
7	Input6	Indicates the status of the ID DIP SW (SW0501) 7 pin on the RZ/T2M motor solution board. Green is displayed when the DIP SW 7 pin is ON, White is displayed when the DIP SW 7pin is OFF.
8	Input7	Indicates the status of the ID DIP SW (SW0501) 8 pin on the RZ/T2M motor solution board. Green is displayed when the DIP SW 8 pin is ON, White is displayed when the DIP SW 8pin is OFF.

### 5.3.3.5 Encoder Tab

The screenshot shows the 'Encoder' tab in the RZ/T2M Motion Control Utility. It contains the following fields and controls:

- Encoder Type:** A dropdown menu set to 'FA Coder'.
- Version:** A text input field containing '1.0'.
- Encoder ID:** A text input field containing 'N/A'.
- Status (hex):** A text input field containing '0000'.
- Status (text):** A large empty text area for displaying error status in characters.
- Update:** A button next to the Status (hex) field.
- Bit Rate [KHz]:** A dropdown menu set to '2500'.
- EEPROM Addr:** A text input field containing '0'.
- Read:** A button next to the EEPROM Addr field.
- EEPROM Data:** A text input field containing '0'.
- Write:** A button next to the EEPROM Data field.

No.	Item	Description
1	Encoder Type	Encoder Type is displayed. When customer uses custom encoder, "Custom" is displayed.
2	Version	Encoder version is displayed.
3	Encoder ID	Encoder ID is displayed.
4	Status(hex)	Error Status of Encoder is displayed in 16-bit HEX.
5	Status(text)	Error Status of Encoder is displayed in character.
6	update Button	Error Status of encoder is updated.
7	Bit Rate[KHz]	Bit Rate[kHz] of encoder (Absolute Encoder) is selected.
8	Read Button	The value of the EEPROM address of Absolute Encoder is read. When pushing the "Read" button, the value of the "EEPROM Addr" is read and the read result is displayed in "EEPROM Data".
9	Write Button	When pushing the "Write" button, the value of the "EEPROM Data" is written to address of "EEPROM Addr".

#### ■ Encoder Error Status

Bit	Indication
0	Overspeed Error
1	Initialization Error
2	Counting Error
3	Multi-turn Overflow
4	N.C
5	Multi-turn Error
6	Battery Error
7	Battery Alarm
8	EEPROM Busy
9	EEPROM Error
10	N.C
11	N.C
12	N.C
13	N.C
14	N.C
15	N.C

### 5.3.3.6 Limits tab

The follow error detection can be set.

- Motor position deviation
- Overcurrent
- Over voltage of DC bus voltage
- Under voltage of DC bus voltage
- Motor overload pre-detection
- Motor position error (upper limit / lower limit)
- Motor upper limit speed
- Motor speed deviation
- PVT buffer empty

## (1) Motor Protections/I2t Limits

Motor Protections / I2t Limits

Max Position Error [ec] 800

Max Position Error Action None

I2t Crnt [mA] 0 Time [ms] 0

Over Crnt[mA] 200 Time [ms] 10

No.	Item	Description
1	Max Position Error[ec]	Max Position Error is set.
2	Max Position Error Action	When the position is greater than or equal to the Max Position Error, the action is set. 0: "None": No action. 1: "Stop": Servo Off 2: "Off": Servo Off and Power Off
3	I2t Crnt[mA]/ Time[ms]	Motor overheating current [mA] and overheating time [ms] are set. This protection is slow because it integrates the square of the current exceeding the nominal over. Once this protection is activated the output current is limited, but the motions is not stopped.
4	Over Crnt[mA]/ Time[ms]	The over current [mA] and the over current detection time [ms] are set.

## (2) Inverter Limits

Inverter Limits

Min. Voltage [V] 0.000

Max. Voltage [V] 0.000

Overload pre-detect [mA] 0

No.	Item	Description
1	Min.Voltage[V]	Under voltage of DC bus voltage is set.
2	Max.Voltage[V]	Over voltage of DC bus voltage is set.
3	Overload pre-detect[mA]	The Overload pre-detect is set.

### (3) Position Control Limits

Position Control Limits

Minimum Position [EC] -150000

Maximum Position [EC] 150000

No.	Item	Description
1	Minimum Position[EC]	The lower limit of position error detection is set. When pushing "Copy" button, position of "5.3.2 Main Screen" is copied.
2	Maximum Position[EC]	The upper limit of position error detection is set. When pushing "Copy" button, position of "5.3.2 Main Screen" is copied.

### (4) Speed Control Limits

Speed Control Limits

Max Speed [EC/s] 45776

Instructed Speed Diff[EC/s] 1526

No.	Item	Description
1	Max Speed [EC/s]	Max speed is set.
2	Instructed Speed Diff [EC/s]	The motor speed deviation is set.

**(5) Other**

PVT Buffer Empty Level	30	
Error Flags (click to decode)	0x02000000	Read
Error Mask	0x00000000	Edit

No.	Item	Description
1	PVT Buffer Empty Level	PVT buffer empty level is set.
2	Error Flags/ Read Button	Current detected Error is displayed. When pushing "Read" button, detected Error is updated. About errors for bits, refer to " ■ Error detection setting screen".
3	Error Mask/ Edit Button	Enables / disables for each error are set. When pushing "Edit" button, Enables / disables for each error can be set.

**■ Error detection setting screen**

For items checked in the check box, motor stop when error detection is activated. The item whose item name is bold is the item where the error is currently detected.

Error Handling Setup

Interlocks

<input type="checkbox"/> Watch Dog Timeout	<input type="checkbox"/> Abnormal Position
<input type="checkbox"/> CPU Voltage Drop	<input type="checkbox"/> Position Error
<input type="checkbox"/> Memory Error	<input type="checkbox"/> Forward Limit Switch Triggered
<input type="checkbox"/> Inverter Under Voltage	<input type="checkbox"/> Maximum Limit Position
<input type="checkbox"/> Inverter Over Voltage	<input type="checkbox"/> Reverse Limit Switch Triggered
<input checked="" type="checkbox"/> Inverter Over Current	<input type="checkbox"/> Minimum Limit Position
<b><input checked="" type="checkbox"/> Inverter Fault</b>	<input type="checkbox"/> Home Procedure Incomplete
<input type="checkbox"/> Motor Over Temperature	<input type="checkbox"/> Home Procedure Error
<input type="checkbox"/> Inverter Over Temperature	<input type="checkbox"/> Encoder Not Detected
<input type="checkbox"/> Ground Fault	<input type="checkbox"/> Invalid Parameter Setting
<input type="checkbox"/> <b>Overload pre-detect</b>	<input type="checkbox"/> Switch Setting Error
<input type="checkbox"/> Over Speed	<input type="checkbox"/> PVT Buffer Empty
<input type="checkbox"/> Instructed speed difference	

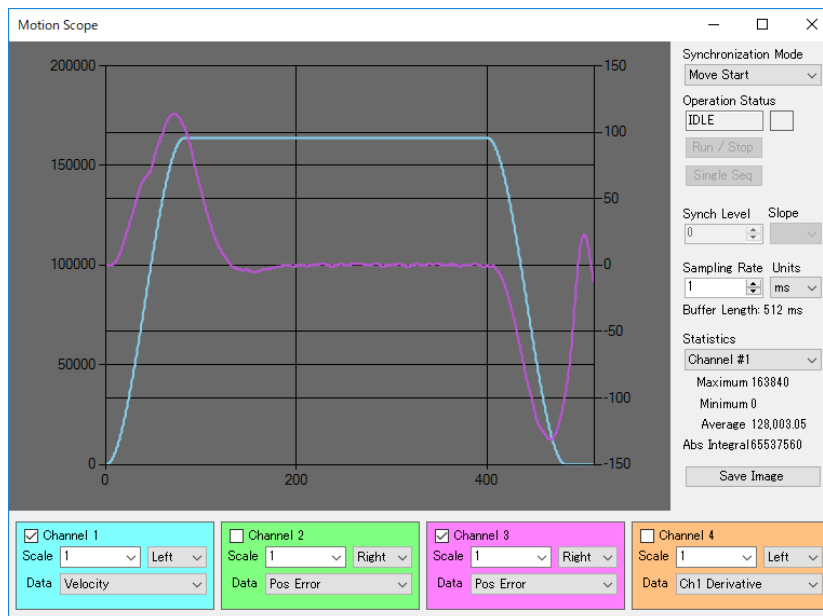
**Bold** font indicates the interlock condition is TRUE  
Checked box indicates interlock is enabled

OK Cancel

Bit	Item	Bit	Item
0	N.C	16	Forward Limit Switch Triggered
1	N.C	17	Position Error
2	N.C	18	Abnormal Position
3	N.C	19	Instructed speed difference
4	N.C	20	Over Speed
5	N.C	21	Overload pre-detect
6	N.C	22	Ground Fault
7	PVT Buffer Empty	23	Inverter Over Temperature
8	Switch Setting Error	24	Motor Over Temperature
9	Invalid Parameter Setting	25	Inverter Fault
10	Encoder Not Detected	26	Inverter Over Current
11	Home Procedure Error	27	Inverter Over Voltage
12	Home Procedure Incomplete	28	Inverter Under Voltage
13	Minimum Limit Position	29	Memory Error
14	Reverse Limit Switch Triggered	30	CPU Voltage Drop
15	Maximum Limit Position	31	Watch Dog Timeout

### 5.3.4 Motion Scope

The Motion Scope can be resized and positioned independently from the main control window. The Motion Scope has four channels that can be configured to visualize various motion controller variables in line chart form. It is important to note that the data capture always takes place in the motion controller and the Motion Scope only visualizes the result from the data capture. This is done in order to allow very high rate of data acquisition independent from the communication bandwidth between the controller and the Windows application.



No.	Item	Description
1	Synchronization Mode	Synchronization Mode is selected. Move Start: Waveform data is collected by triggered the start of position control. Move End: Waveform data is collected by triggered the stop of position control. Manual: Waveform data is collected asynchronously with the operation of the motion controller.
2	Operation Status	Operation Status is displayed. IDLE: Idle status. The back color of the Status Panel on the right is transparent. TRANSFER: Under collecting waveform data. The back color of the Status Panel on the right is orange. RECORD: Waveform data collection completed. The back color of the Status Panel on the right is red.
3	RUN/STOP Button	Waveform data collection is started / stopped.
4	Single Seq	when pushing "Single Seq" button, waveform data is collected once.
5	Synch Level/Slope	Level and slope (Rising edge / Falling edge) are set. Synchronization Mode: Manual is valid only.
6	Sampling Rate/ Units	Sampling rate is set. Minimum is 50 $\mu$ s. "Units" is selected $\mu$ s or ms. The sampling number of waveform data are 512 or less. Ex: When the sampling rate is set to 50 $\mu$ s, the waveform for 25.6 ms (= 50 $\mu$ s x 512) is displayed.
7	Statistics	The statistical data (maximum value / minimum value / mean value / integral value of absolute value of sampling data) of the selected channel are displayed.
8	Save Image	Waveform is saved in PNG format or waveform data is saved in CSV format.

The graph can be changed scale by operating the mouse. Zoom in is clicked the corner of the graph and dragged to the desired range. Zoom out is clicked the edge of the scroll bar.

Motion scope can display waveform of 4 channels and show/hide at check box.

☒ Channel 1  
Scale 1 ▾ Left ▾  
Data Velocity ▾

☒ Channel 2  
Scale 1 ▾ Right ▾  
Data Pos Error ▾

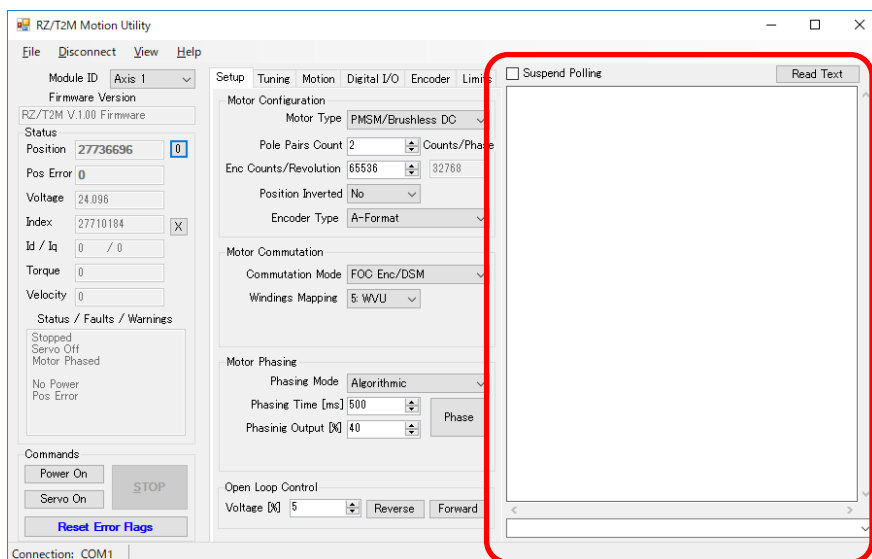
☒ Channel 3  
Scale 1 ▾ Right ▾  
Data Phase Angle ▾

☐ Channel 4  
Scale 1 ▾ Left ▾  
Data Ch1 Derivative ▾

No.	Item	Description
1	Scale	Scale is set at 0.125 units. And primary axis (left side) / secondary axis (right side) of Y axis is set with "Left" / "Right".
2	Data	Waveform data (variables) is selected. Refer to "6 Variables".

### 5.3.5 Terminal

The Terminal Emulator allows communicating the motion controllers using ASCII commands. This is helpful when certain command is not available as a button or when the status does not include information about some internal state. The commands are entered at the bottom of the screen and. The Up/Down arrow keys can bring the history of the recently issued commands. (Not supported on RS-422.)



No.	Item	Description
1	Suspend Polling	When checking "Suspend Polling", the acquisition of information (Position, DC bus voltage value, etc.) from the RZ/T2M Motor solution kit is stopped.
2	Read the text file Button	The text file that the command is written is executed.



## 6. Variables

Table 6.1 is shown the variables that can be displayed in a graph.

**Table 6.1 Variables that can be displayed in a graph**

No.	Variable	Description
1	Position	Motor Position
2	Velocity	Velocity
3	Acceleration	Acceleration
4	I2t Accumulator	I2t Integral
5	Pos Err	Position Error
6	PID Output	PID Regulator Output Value
7	Id Current	Direct Current
8	Iq Current	Quadrature Current
9	Id Current Err	Direct Current Error
10	Iq Current Err	Quadrature Current Error
11	ADC1 Value	U Phase A/D Converter Value
12	ADC2 Value	V Phase A/D Converter Value
13	ADC3 Value	W Phase A/D Converter Value
14	PVT Points	PVT FIFO Buffer Depth
15	D Voltage	FOC Voltage Output D
16	Q Voltage	FOC Voltage Output Q
17	RT Counter	-
18	Phase Angle	Phase Angle
19	Input Capture	Current C (Input Capture Value)
20	Position Err	Position Error (pos_error detail)
21	Pos Control Integral	Position Control Integral
22	Velocity Err	Velocity Error
23	Vel Control Integral	Velocity Control Integral
24	Id Control Integral	Id Control Integral
25	Iq Control Integral	Iq Control Integral
26	Torque Estimate	Motor Torque Estimate
27	Motor Electric Angle	Motor Electric Angle

## 7. Motor Parameters

Table 7.1 is shown the Motor Parameters of FH6S20E-X81, MB057GA140 and TSM3101N2001E020.

**Table 7.1 FH6S20E-X81/MB057GA140/TSM3101N2001E020 Motor Parameters**

① Incremental encoder

② Absolute encoder

No	Item	Description	FH6S20E-X81		MB057GA140		TSM3101N2001E020
			①	②	①	②	②
1	Version	N.C	0		0		0
2	ModelId	N.C	0		0		0
3	ModuleType	Module Type 2: Electronic gearing mode is valid 3: Electronic gearing mode is invalid	3		3		3
4	MotorType	Motor Type 3 : PMSM/Brushless DC 4: Induction Motor)	3		3		3
5	EncoderType	Encoder Type 0 : Incremental 1 : EnDat 2.2 2 : BiSS-C 3 : FA-CODER 4 : A-format™ 5 : Hiperface DSL 6 : Custom	0	(*)	3	(*)	3
6	CommutationMode	Communication Mode 4: Sinusoidal vector control with encoder and Delta Sigma Modulator 5: Sinusoidal vector control with encoder and CT 6: Sinusoidal vector control with CT	4		4		4
7	PhaseCounts	Electrical cycle (= the encoder counts per revolution divided by the number of pole pairs)	171	9362	1000	32768	13107
8	EncoderCounts	Encoder count for one revolution	1200	65536	2000	65536	65536
9	PolePairs	Motor pole pairs count	7		2		5
10	HallInvert	N.C	0		2		0
11	PosInvert	CW/ CCW of motor 0: CW, 1: CCW	0		0		0
12	PhaseOffset	N.C	0		0		0
13	PhaseMap	Windings Mapping (U/V/W placement.)	0		5		5
14	PhaseScale	N.C	-5		-5		-5
15	PhasingMode	Phasing Mode 0 : Algorithmic 2 : Dithering	0		0		0
16	PhasingTime	Phasing Time[ms]	500		500		500
17	PhasingPower	Phasing Output[%]	20		40		20
18	Ds	Desired position loop cycle time [us]	100(=50us)		100(=50us)		100(=50us)
19	Kp	Proportional Gain in the position control loop algorithm	1647		1674	1647	
20	Ki	Integral Gain in the position control loop algorithm	8		30		8
21	Kd	Differential Gain in the position control loop algorithm	0		0		0
22	Il	Integral Limit in the position control loop algorithm	1000		1000		1000
23	Vff	Velocity Feed Forward in the position control loop algorithm	0		0		0
24	Aff	Acceleration Feed Forward in the position control loop algorithm	0		0		0

No	Item	Description	FH6S20E-X81		MB057GA140		TSM3101N200 1E020
			①	②	①	②	②
25	Bias	Value to be added to the output of the PID regulator continuously.	0		0		0
26	Iqkp	Proportional gain in the Quadrature current control loop	9		15		3
27	Iyki	Integral gain in the Quadrature current control loop	8		37		12
28	Iykd	Differential Gain in the Quadrature current control loop	0		0		0
29	Vykp	Proportional Gain in the velocity control loop	811	15	298	5	16
30	Vyki	Integral Gain in the velocity control loop	16	1	6	1	1
31	Vykd	Differential Gain in the velocity control loop	0		0		0
32	MinVolt	Under voltage of DC bus voltage	1093		256		1093
33	MaxVolt	Over voltage of DC bus voltage	1421		4000		1421
34	MinPos	The lower limit of position error detection	- 6553600		-150000		- 6553600
35	MaxPos	The upper limit of position error detection	6553600		150000		6553600
36	MaxVel	Max speed	1000000		45776		1000000
37	MaxVelDiff	The motor speed deviation	1000000		1526		1000000
38	MaxTemp	N.C	0		0		0
39	OvrCmt	Overload pre-detect [mA]	400		190		400
40	MinBuffer	PVT buffer empty level	10		30		10
41	ErrMask	Error Mask	0		0		0
42	Vcomp	N.C	0		0		0
43	MaxErr	Max Position Error	32767		32767		32767
44	MaxErrTime	N.C	0		0		0
45	MaxOutput	Motor output limit from the position loop PID regulator	100		100		100
46	CurrentLimit	The over current [mA]	500		200		500
47	CurrentTime	over current detection time [ms]	10		110		10
48	I2TLimit	Motor overheating current [mA]	0		0		0
49	I2TTime	Motor overheating time [ms]	0		0		0
50	AutoBrake	N.C	0		0		0
51	ErrorInputMask	N.C	0		0		0
52	HomeFlagMask	Home Mask	0		0		0
53	AutoStopMode	Max Position Error Action 0: "None": No action. 1: "Stop": Servo Off 2: "Off": Servo Off and Power Off	0		0		0
54	HallShift	N.C	0		0		0
55	ApeBaudrate	Bit Rate[kHz] of encoder (Absolute Encoder)	0	4000	0	4000	2500
56	GearingIn	Input value of Electronic Gearing function	0		0		0
57	GearingOut	Output value of Electronic Gearing function	0		0		0

(\*) Encoder Type number

## 8. Appendix

### 8.1 Program Writing Procedure

For how to write a program, refer to "RZ/T2M Motor Solution Kit Serial Flash ROM Program Writing Guide".

### 8.2 Integrated development environment Installation

#### 8.2.1 EWARM

Please download from the website of IAR Systems.

<https://www.iar.com/products#/search?architecture=Arm>

#### 8.2.2 e<sup>2</sup> studio

##### 8.2.2.1 e<sup>2</sup> studio Installation

Please download and install the latest e<sup>2</sup> studio from the following URL.

However, if you have already installed the latest e2 studio, specify a different folder to install.

<https://github.com/renesas/rzt-fsp>

##### 8.2.2.2 J-Link.dll replacement

Replace J-LinkARM.dll according to the following steps.

- ① Select [Help] □ [About e2 studio] menu of e2 studio.
- ② In the [About e2 studio] dialog, click the [Installation Details] button at the bottom left of the dialog.
- ③ In the [e2 studio installation details] dialog, select the [Support Folders] tab.
- ④ Click the folder path to the right of the [e2 studio support area:] text.
- ⑤ The folder will be opened. Move to the "DebugComp\RZ\ARM\Segger\_v7.56.3" folder.
- ⑥ Rename the "JLinkARM.dll" file to "org\_JLinkARM.dll".
- ⑦ Extract the RZT2M\_SmartManual.zip file.
- ⑧ Copy the "Firmwares" folder and the "JLinkARM.dll" file to "DebugComp\RZ\ARM\Segger\_v7.56.3".

**Revision History**

Rev.	Date	Description	
		Page	Summary
0.90	Jul.30, 2021	-	Preliminary
1.00	Aug.30, 2021	P.8	2. Operating Environment Change the "Operating modes" column and "Devices" column.
		P.12	5.1 Motor Solution Board Starting # Change the Motor Solution Board Starting procedure. # Delete the 5.1.1.
		P.49	8.2 Program Writing Procedure Add the chapter.
1.10	Oct. 29,2021	P.6	1.3.2.2 incremental Add the section.
		P.10	1. Operating Environment Add development environment of e <sup>2</sup> studio.
		P.15	5.2.2.1 Motor Parameter Setting Add motor parameter for incremental encoder.
		P.30	5.3.3.1 Setup Tab Add "0: Incremental" in Encoder Type
		P.49	7. Motor Parameters Add motor parameter for incremental encoder.
		P.56	8.2.3 e2 studio Add the section.
1.12	May 31, 2022	P.10	2. Operating Environment Change Integrated development environment version.
2.00	Jun 30, 2022	P.4	Modify the Figure 8.1 RZ/T2M Motor Solution Kit connection configuration.
		P.10	Modify the 2. Operating Environment
		P.11	Modify the 3. Related Application Notes.
		P.52-P.55	Add the 8.1.2 Generating the Slave Stack Code
		P.56	Add the 8.1.3.1 CPU1 Project
		P.64	Add 8.2 Integrated development environment Installation
2.10	Aug.26, 2022	P.4-7, P.16, P.31, P.50-51	Add the following encoders EnDat2.2, BiSS-C, FA-CODER, HIPERFACE DSL
2.11	Sep.30, 2022	P.11	Support MPU: R9A07G075M28GBG and FSPv1.0.0.
3.20	May. 31,2023	P.6	1.3.2 Encoder Add ROC425 Functional Safety.
		P.11-P.15	2. Operating Environment Add Operating Environment of each programs
		P.16	3. Related Application Notes <ul style="list-style-type: none"> <li>● Add "RZ/T2M Motor Solution Kit Firmware (Motor Control, EtherCAT)"</li> <li>● Add "RZ/T2M Motor Solution Kit Firmware (FuSa)"</li> <li>● Add "RZ/T2M Motor Solution Kit Program Writing Guide"</li> </ul>
		P.56	8.1 Program Writing Procedure Change to refer to "RZ/T2M Motor Solution Kit Serial Flash ROM Programming Guide".
4.00	Aug.31, 2023	P.6-P.9	1.3 Connection Equipment

			Add TSM3101N2001E020
		P.22	5.2.2.1 Motor Parameter Setting Add motor parameters of TSM3101N2001E020
		P.58-P.59	7. Motor Parameters Add motor parameters of TSM3101N2001E020

## 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.).

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