

## RZ/T2M Group

R01AN5986EJ0101

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### RZ/T2M Motor Solution Board Hardware Manual

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#### Abstract

This document describes the specifications of the RZ/T2M motor solution board equipped with the MPU of the RZ/T2M group manufactured by Renesas Electronics. We provide an environment for evaluating RZ/T2M without the need for customers to prepare their own hardware.

#### Target Device

RZ/T2M Group

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## 1. Overview

### 1.1 RZ/T2M Motor Solution Board Overview

The RZ/T2M Motor Solution Board (hereinafter referred to as the RZ/T2M Motor Board) is a solution board for motor drive systems equipped with Renesas Electronics' RZ/T2M and related products. This board is equipped with RX72N manufactured by Renesas Electronics, and it is also possible to equip the functional safety software. The RZ/T2M motor board consists of two boards, an RZ/T2M motor controller board (hereinafter referred to as the controller board) and an inverter board.

### 1.2 Board appearance

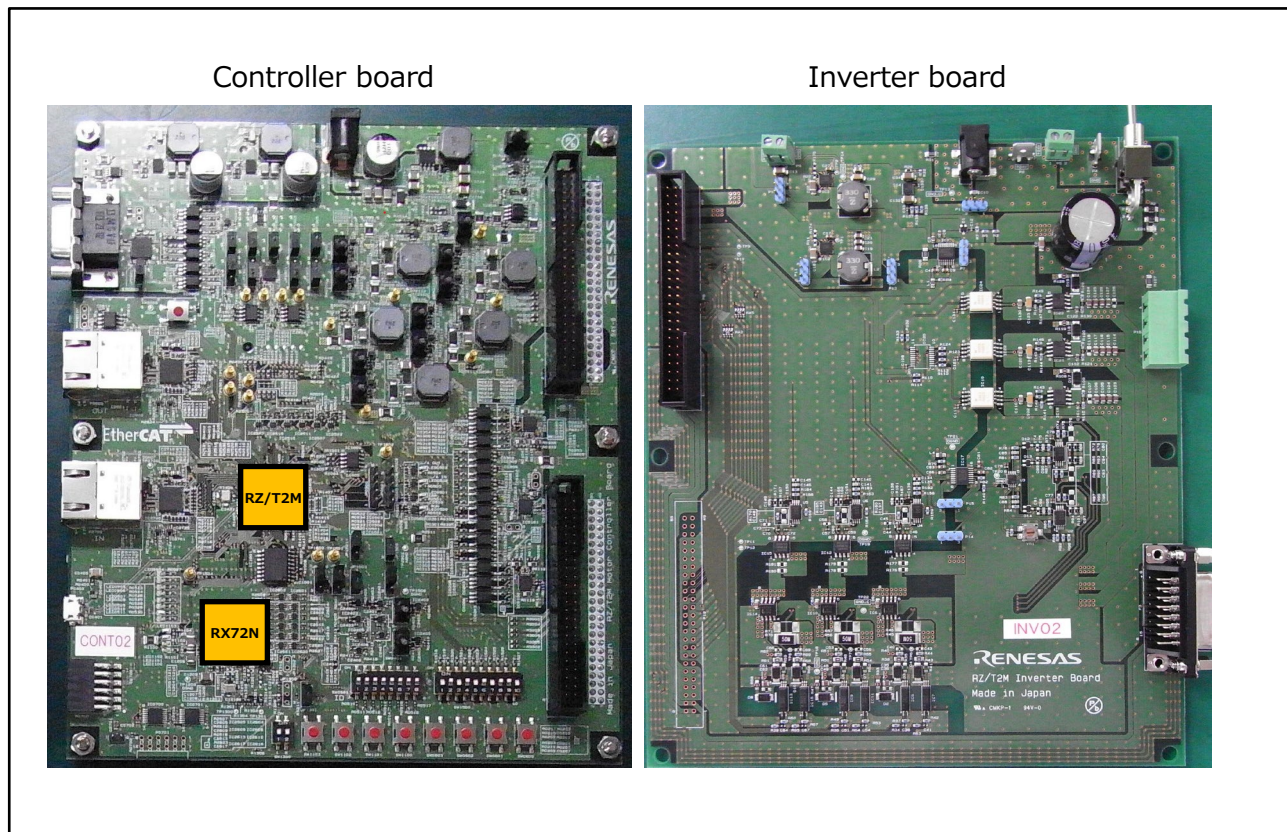


Figure 1.1 Overview configuration of motor solution board

### 1.3 Block Diagram

Figure 1.2 is shown a block diagram of the controller board and inverter board.

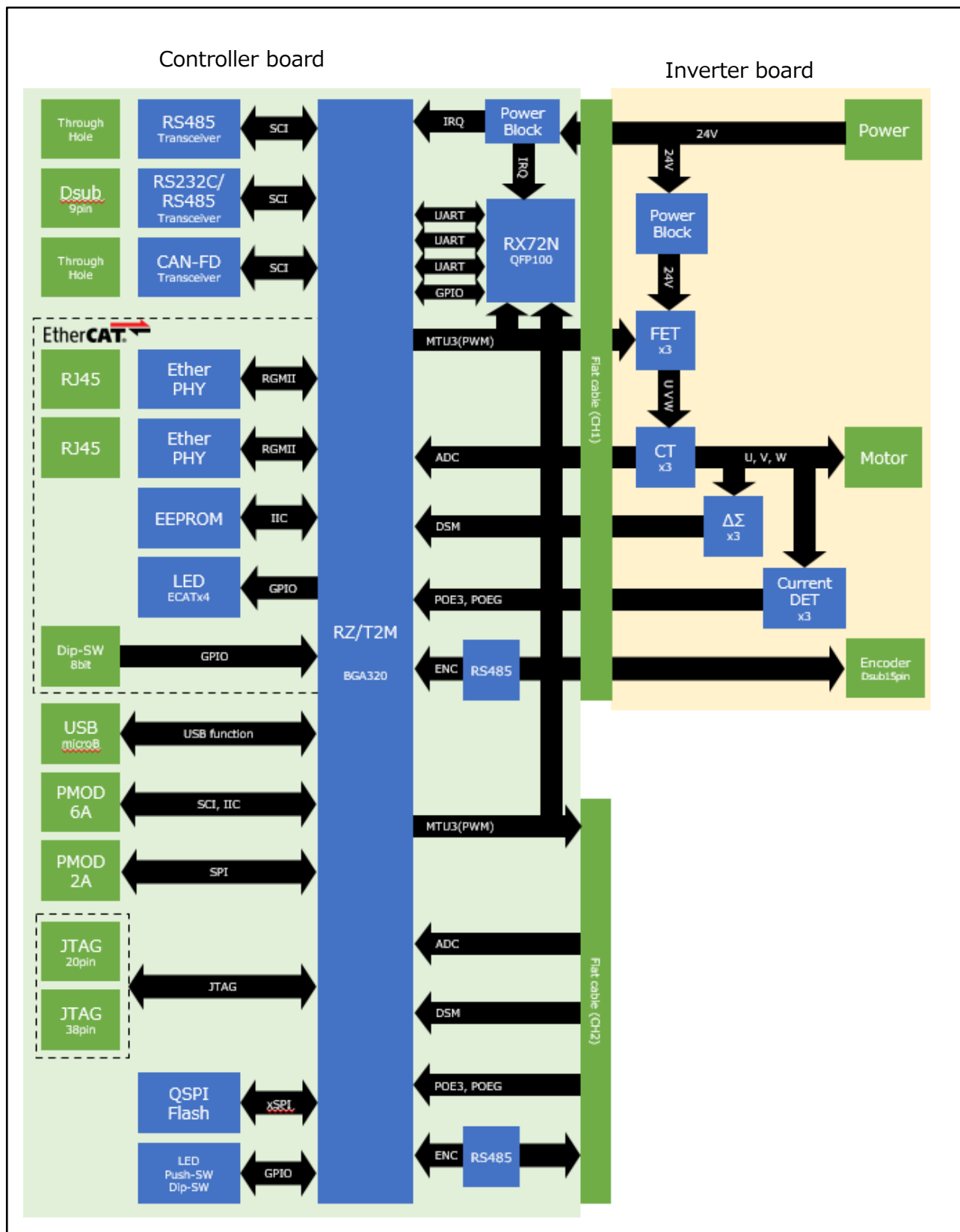


Figure 1.2 Block diagram of motor solution board

## 2. General specifications

### 2.1 Electrical specifications

**Table 2.1 Electrical specifications**

| Item                         | Specification                                                                                                    | Remarks                                |
|------------------------------|------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| Rated voltage                | DC24V                                                                                                            | DC24V±5% (DC22.8~25.2V)                |
| Power supply connector       | Select one of the following on the inverter board<br>·FASTON Terminal<br>·Terminal block<br>·Center plus DC jack |                                        |
| Internal current consumption | 3A or less                                                                                                       | Excluding external motors and encoders |
| Status LED (Power)           | Red                                                                                                              |                                        |

\* When using only the controller board, supply 24V DC from the center plus DC jack (P1701) of the controller board.

\* When supplying 24V DC to each of the inverter board and the control board, switch the jumper (P1) of the inverter board to the 2nd to 3rd short side before use (do not supply 24V DC to the control board).

### 2.2 Environmental specifications

**Table 2.2 Environmental specifications**

| Item                        | Specification | Remarks               |
|-----------------------------|---------------|-----------------------|
| Operating temperature limit | 0~40°C        | At normal temperature |
| Operating humidity range    | 80% or less   | No condensation       |

### 2.3 Board Size

**Table 2.3 Board size**

| Item             | Specification        | Remarks                                                |
|------------------|----------------------|--------------------------------------------------------|
| Controller board | 170(W)×200(D)×1.6(T) | NO include protrusions,<br>NO include component height |
| Inverter board   | 170(W)×200(D)×1.6(T) | NO include protrusions,<br>NO include component height |

## 2.4 External interface, communication specifications

**Table 2.4 RS485(Fieldbus) communication specifications**

| Item                     | Specification         | Remarks |
|--------------------------|-----------------------|---------|
| Communication method     | RS485 (half duplex)   | ~20Mbps |
| Communication control IC | RZ/T2M                |         |
| Transceiver              | ISL3178E from Renesas |         |
| Termination resistor     | Available (140Ω)      |         |
| External interface       | 3pin Through Hole     | P0900   |

**Table 2.5 RS232C/RS485 communication specifications**

| Item                     | Specification                 | Remarks                            |
|--------------------------|-------------------------------|------------------------------------|
| Communication method     | RS485 (half duplex)<br>RS232C | RS485: ~20Mbps<br>RS232C: ~650kbps |
| Communication control IC | RZ/T2M                        |                                    |
| Transceiver              | ISL41387IRZ from Renesas      |                                    |
| Termination resistor     | Not Available                 | Pin header not implemented         |
| External interface       | D-Sub 9pin                    | P0800                              |

\* To switch between RS485 / RS232C, use the jumper (JP0801) on the controller board before turning on the power.

\* If you need a terminating resistor, mount a pin header (P0800).

**Table 2.6 CAN-FD communication specifications**

| Item                     | Specification        | Remarks |
|--------------------------|----------------------|---------|
| Communication method     | CAN-FD               | ~5Mbps  |
| Communication control IC | RZ/T2M               |         |
| Transceiver              | TJA1042AT/3 from NXP |         |
| External interface       | 3pin Through Hole    | P0801   |

**Table 2.7 Ethernet communication specifications**

| Item                     | Specification                                                  | Remarks      |
|--------------------------|----------------------------------------------------------------|--------------|
| Communication protocol   | EtherCAT®                                                      |              |
| Communication control IC | RZ/T2M                                                         |              |
| EtherCAT PHY             | KSZ9131 from Microchip                                         |              |
| Communication method     | IEEE802.3                                                      | 1000BASE     |
| Insulation method        | Pulse transformer insulation                                   |              |
| Status LED               | RUN (green), ERR (red), L / A IN (green),<br>L / A OUT (green) |              |
| External interface       | RJ45 ×2                                                        | P2700, P2800 |
| EEPROM                   | BR24T16FJ(2KB) from ROHM                                       |              |

**Table 2.8 USB communication specifications**

| Item                 | Specification   | Remarks                     |
|----------------------|-----------------|-----------------------------|
| Standard             | USB2.0 Function | HS: ~480Mbps<br>FS: ~12Mbps |
| Communication method | RZ/T2M          |                             |
| External interface   | USB micro-B     | P0900                       |

**Table 2.9 Pmod Type 6A communication specifications**

| Item                     | Specification         | Remarks       |
|--------------------------|-----------------------|---------------|
| Communication protocol   | IIC<br>SCI (UART/SPI) | IIC: ~400kbps |
| Communication control IC | RZ/T2M                |               |
| External interface       | Pin socket 12pin      | P0700         |

**Table 2.10 Pmod Type 2A communication specifications**

| Item                     | Specification      | Remarks |
|--------------------------|--------------------|---------|
| Communication protocol   | SPI                |         |
| Communication control IC | RZ/T2M             |         |
| External interface       | 12pin Through Hole | P0701   |

### 3. Specifications

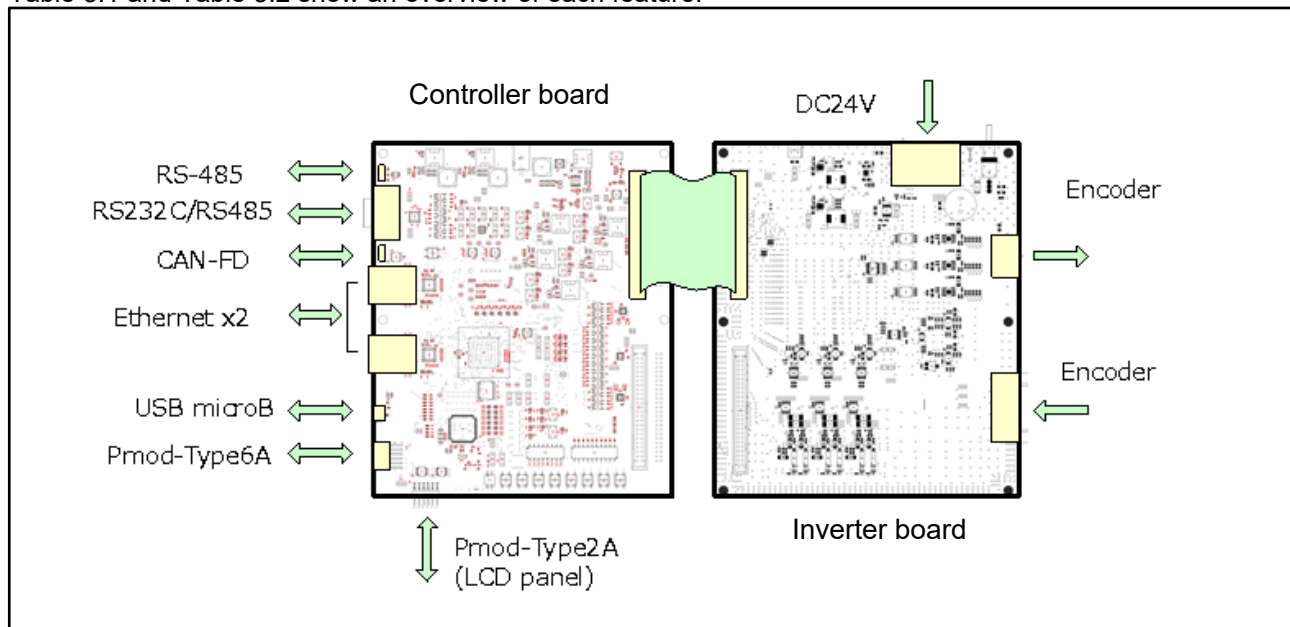
#### 3.1 Overview

Figure 3.1 is shown the overview configuration of the RZ/T2M motor solution board.

The controller board is equipped with MPU (RZ/T2M) to control the motor and each external interface, and is equipped with MCU (RX72N) to perform functional safety control.

The inverter board is equipped with a motor drive circuit, an encoder input circuit, and a voltage / current monitoring circuit.

Table 3.1 and Table 3.2 show an overview of each feature.



**Figure 3.1 Overview configuration of RZ/T2M motor solution board**

**Table 3.1 Functional overview of RZ/T2M motor controller board**

| No | Item                           | Content                                                | Remarks                                                                   |
|----|--------------------------------|--------------------------------------------------------|---------------------------------------------------------------------------|
| 1  | MPU                            | Product Group                                          | RZ/T2 Group                                                               |
| 2  |                                | CPU max. operating frequency                           | Dual Arm® Cortex®-R52 (max.operating frequency : CPU0:800MHz,CPU1:400MHz) |
| 3  |                                | Input power supply voltages                            | DC 3.3V/ DC 1.8V/ DC 1.1V                                                 |
| 4  |                                | Package / Pin count                                    | FBGA (17mm)/320-pin                                                       |
| 5  |                                | Memory                                                 | xSPI Flash memory MX25L51245GMI (64MB) from Macronix                      |
| 6  | MCU<br>(For Functional Safety) | Product Group                                          | RX72N Group                                                               |
| 7  |                                | CPU max. operating frequency                           | Single RXv3 (max operating frequency:240MHz)                              |
| 8  |                                | Input power supply voltage                             | DC 3.3V                                                                   |
| 9  |                                | Package / Pin count                                    | LFQFP (14mm)/100-pin                                                      |
| 10 | Connectors                     | Inverter Board connectors x 2 (Motor 2ch)              | LCD panel =RX72N Envision KIT.                                            |
| 11 |                                | USB micro-B connector x 1                              |                                                                           |
| 12 |                                | D-Sub9pin connector x 1 (RS-232C/ RS-485)              |                                                                           |
| 13 |                                | CAN connector (CAN FD Transceiver) x 1 (Through holes) |                                                                           |
| 14 |                                | RS-485 connector x 1(Through holes)                    |                                                                           |
| 15 |                                | RJ45 connector x 2(EtherCAT/ Ethernet)                 |                                                                           |



| No | Item        | Content                                                                         | Remarks                              |
|----|-------------|---------------------------------------------------------------------------------|--------------------------------------|
| 16 |             | Pmod connector x 1                                                              |                                      |
| 17 |             | LCD Panel connector x 1(Unimplemented)                                          |                                      |
| 18 |             | ARM JTAG connector x 1<br>(20 pins and 38 pins) (for RZ/T2)                     |                                      |
| 19 |             | JTAG connector x 1 (for Functional Safety)                                      |                                      |
| 20 |             | DC jack x 1 (Power Supply)                                                      |                                      |
| 21 | Switches    | DIP switch(8bit) x 1                                                            | For Device ID                        |
| 22 |             | Boot mode DIP switch x 1                                                        |                                      |
| 23 | LEDs        | General purpose LED x 8                                                         | Red x 4, Green x 4                   |
| 24 |             | ESC status LED                                                                  | EtherCAT Slave Controller status LED |
| 25 |             | Power supply LED                                                                | RED                                  |
| 26 | Encoder I/F | Incremental encoder x 2                                                         |                                      |
| 27 |             | Absolute encoder x 2<br>A-Format, EnDat2.2, BiSS-C, HIPERFACE DSL, FA-CODER etc |                                      |

Table 3.2 Inverter board function overview

| No | Item                    | Content                                       | Remarks                                                             |
|----|-------------------------|-----------------------------------------------|---------------------------------------------------------------------|
| 1  | Operating input voltage | DC24V                                         | DC24V±5%                                                            |
| 2  | Rated output current    | 2A                                            |                                                                     |
| 3  | Switching frequency     | ≥ 20kHz                                       |                                                                     |
| 4  | Dead time               | ≥ 2us                                         |                                                                     |
| 5  | Current detection       | CT: Current Transducer                        |                                                                     |
| 6  | method                  | 3 Shunt resistor method: ΔΣ Modulator         | The shunt resistors are inserted in series to the three-phase line. |
| 7  | Shunt resistor          | 50mΩ                                          |                                                                     |
| 8  | Detection               | Bus voltage detection                         |                                                                     |
| 9  |                         | Three-phase current detection                 |                                                                     |
| 10 | Connectors              | Controller board connectors x 2               | Unmount ch2 connector                                               |
| 11 |                         | Motor connector                               |                                                                     |
| 12 |                         | Encoder connector (D-Sub15pin connector) x 1  |                                                                     |
| 13 |                         | Power Supply connectors                       | FASTON terminal<br>Terminal block<br>DC jack                        |
| 14 | Switches                | Current cutoff switch                         | Toggle switch                                                       |
| 15 | LEDs                    | LED for Inverter circuit control power supply |                                                                     |
| 16 | Motors                  | PMSM/BLDC Motor x 1(DC24V, Current:2A)        |                                                                     |

## 3.2 Various functions

### 3.2.1 Switches

Figure 3.2 is shown an overview of each switch. The functions are shown in Table 3.3 and Table 3.4

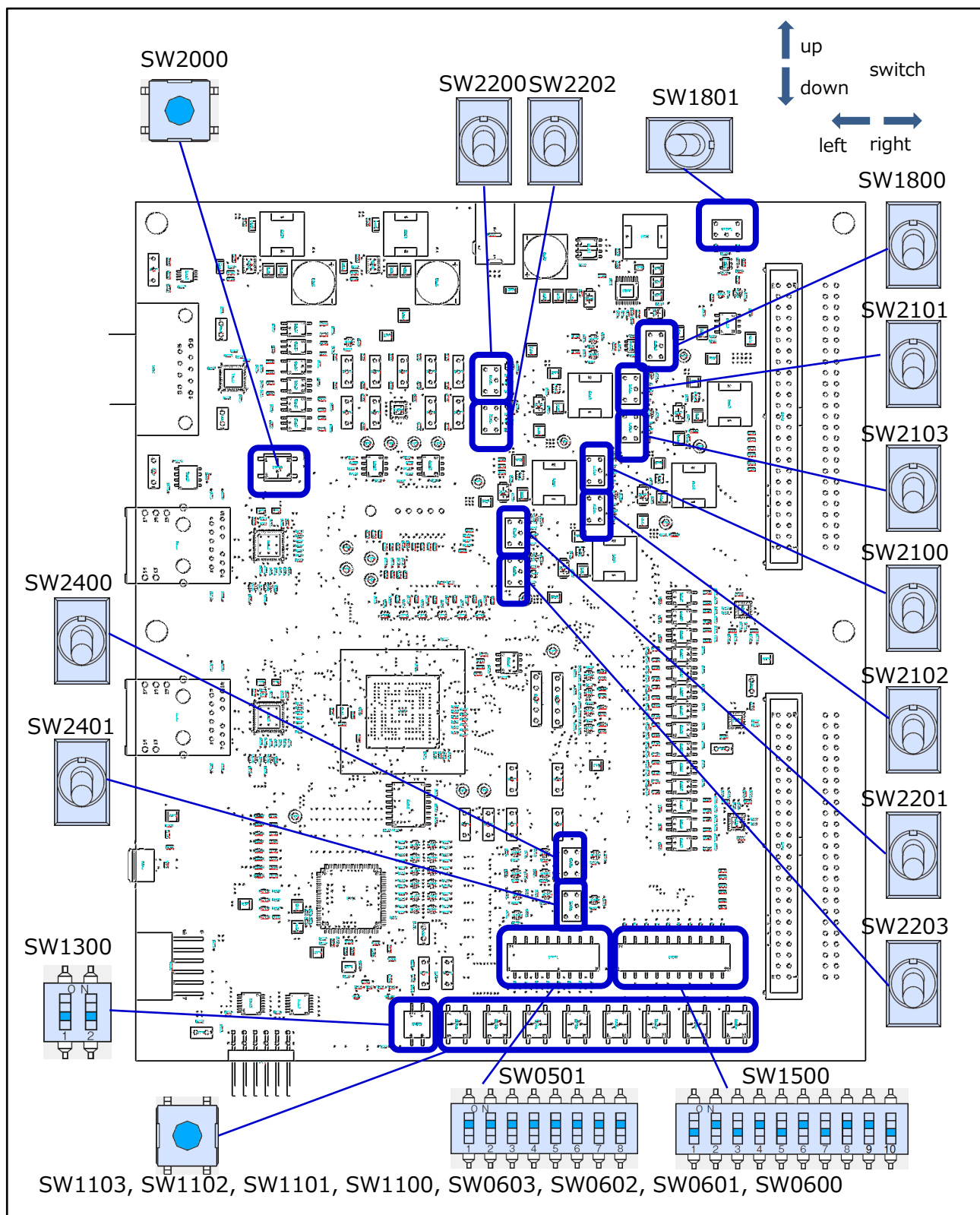


Figure 3.2 RZ/T2M motor controller board switch

Table 3.3 RZ/T2M Switch function of motor controller board

| No | SW                    | Item                 | Content                                                     | Default<br>(When shipment)                                  |
|----|-----------------------|----------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| 1  | SW2000                | Reset switch         | ON: Reset                                                   | -                                                           |
| 2  | SW2200                | RZ1.8V HVD toggle SW | Up: Test mode (RZ1.8V HVD Error)<br>Down: Normal mode       | Down                                                        |
| 3  | SW2202                | RZ1.8V LVD toggle SW | Up: Test mode (RZ1.8V LVD Error)<br>Down: Normal mode       | Down                                                        |
| 4  | SW1801                | 5.0V LVD toggle SW   | Right: Test mode (5.0V LVD Error)<br>Left: Normal mode      | Left                                                        |
| 5  | SW1800                | 5.0V HVD toggle SW   | Up: Test mode (5.0V HVD Error)<br>Down: Normal mode         | Down                                                        |
| 6  | SW2101                | RX3.3V HVD toggle SW | Up: Test mode (RX3.3V HVD Error)<br>Down: Normal mode       | Down                                                        |
| 7  | SW2103                | RX3.3V LVD toggle SW | Up: Test mode (RX3.3V LVD Error)<br>Down: Normal mode       | Down                                                        |
| 8  | SW2100                | RZ3.3V HVD toggle SW | Up: Test mode (RZ3.3V HVD Error)<br>Down: Normal mode       | Down                                                        |
| 9  | SW2102                | RZ3.3V LVD toggle SW | Up: Test mode (RZ3.3V LVD Error)<br>Down: Normal mode       | Down                                                        |
| 10 | SW2201                | RZ1.1V HVD toggle SW | Up: Test mode (RZ1,1V HVD Error)<br>Down: Normal mode       | Down                                                        |
| 11 | SW2203                | RZ1.1V LVD toggle SW | Up: Test mode (RZ1,1V LVD Error)<br>Down: Normal mode       | Down                                                        |
| 12 | SW2400                | RX_RXD5 toggle SW    | Up: RX_RXD5=L<br>Middle: RX_RXD5=H<br>Down: RX_RXD5=RZ_TXD5 | Down                                                        |
| 13 | SW2401                | RZ_RXD5 toggle SW    | Up: RZ_RXD5=L<br>Middle: RZ_RXD5=H<br>Down: RZ_RXD5=RX_TXD5 | Down                                                        |
| 14 | SW0501<br>(Device ID) | 1                    | CFG [7:0] DIP SW                                            | ON: CFG0 =L/ OFF: CFG0 =H                                   |
|    |                       | 2                    |                                                             | ON: CFG1 =L/ OFF: CFG1 =H                                   |
|    |                       | 3                    |                                                             | ON: CFG2 =L/ OFF: CFG2 =H                                   |
|    |                       | 4                    |                                                             | ON: CFG3 =L/ OFF: CFG3 =H                                   |
|    |                       | 5                    |                                                             | ON: CFG4 =L/ OFF: CFG4 =H                                   |
|    |                       | 6                    |                                                             | ON: CFG5 =L/ OFF: CFG5 =H                                   |
|    |                       | 7                    |                                                             | ON: CFG6 =L/ OFF: CFG6 =H                                   |
|    |                       | 8                    |                                                             | ON: CFG7 =L/ OFF: CFG7 =H                                   |
| 15 | SW1500<br>(Boot mode) | 1, 2                 | RZ/T2 DIP SW MD0                                            | ON, OFF: MD0 =H<br>OFF, ON: MD0 =L                          |
|    |                       | 3, 4                 | RZ/T2 DIP SW MD1                                            | ON, OFF: MD1 =H<br>OFF, ON: MD1 =L                          |
|    |                       | 5, 6                 | RZ/T2 DIP SW MD2                                            | ON, OFF: MD2 =H<br>OFF, ON: MD2 =L                          |
|    |                       | 7, 8                 | RZ/T2 DIP SW MDD                                            | ON, OFF: MDD =H<br>OFF, ON: MDD =L                          |
|    |                       | 9, 10                | RZ/T2 DIP SW MDW                                            | ON, OFF: MDW =H<br>OFF, ON: MDW =L                          |
| 16 | SW1300                | 1, 2                 | RX72N DIP SW Mode                                           | OFF, don't care: Single Chip Mode<br>ON, OFF: SCI Boot Mode |
| 17 | SW1103                |                      | RX72N tact SW SW3                                           | ON: SW3 =L/ OFF: SW3= H                                     |
| 18 | SW1102                |                      | RX72N tact SW SW2                                           | ON: SW2 =L/ OFF: SW2= H                                     |
| 19 | SW1101                |                      | RX72N tact SW SW1                                           | ON: SW1 =L/ OFF: SW1= H                                     |
| 20 | SW1100                |                      | RX72N reset SW                                              | ON: MCU(RX72N) Reset                                        |
| 21 | SW0603                |                      | RZ/T2 tact SW IRQ9                                          | ON: IRQ9 =L/ OFF: IRQ9= H                                   |
| 22 | SW0602                |                      | RZ/T2 tact SW IRQ7                                          | ON: IRQ7 =L/ OFF: IRQ7= H                                   |
| 23 | SW0601                |                      | RZ/T2 tact SW IRQ8                                          | ON: IRQ8 =L/ OFF: IRQ8= H                                   |
| 24 | SW0600                |                      | RZ/T2 tact SW NMI                                           | ON: NMI=L/ OFF: NMI= H                                      |

**Table 3.4 Inverter board switch function**

| No | SW  | Item                                        | Content                               | Default |
|----|-----|---------------------------------------------|---------------------------------------|---------|
| 1  | SW1 | In case of abnormality + 24V cut off switch | ON(Up): 24V ON/ OFF(Down): 24VCut off | ON(Up)  |

### 3.2.1.1 Selection of operation mode

The operation mode supported by this board is xSPI0 boot mode (x1 boot Serial flash) only (MD0 to MD2: All low settings).

Table 3.5 is shown the SW1500 setting.

**Table 3.5 SW1500 Setting**

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

Select the operation mode before turning on the power.

### 3.2.2 Jumpers

Figure 3.3, Figure 3.4 show the outline of the jumper, Table 3.3, Table 3.4 show the function of the jumper.

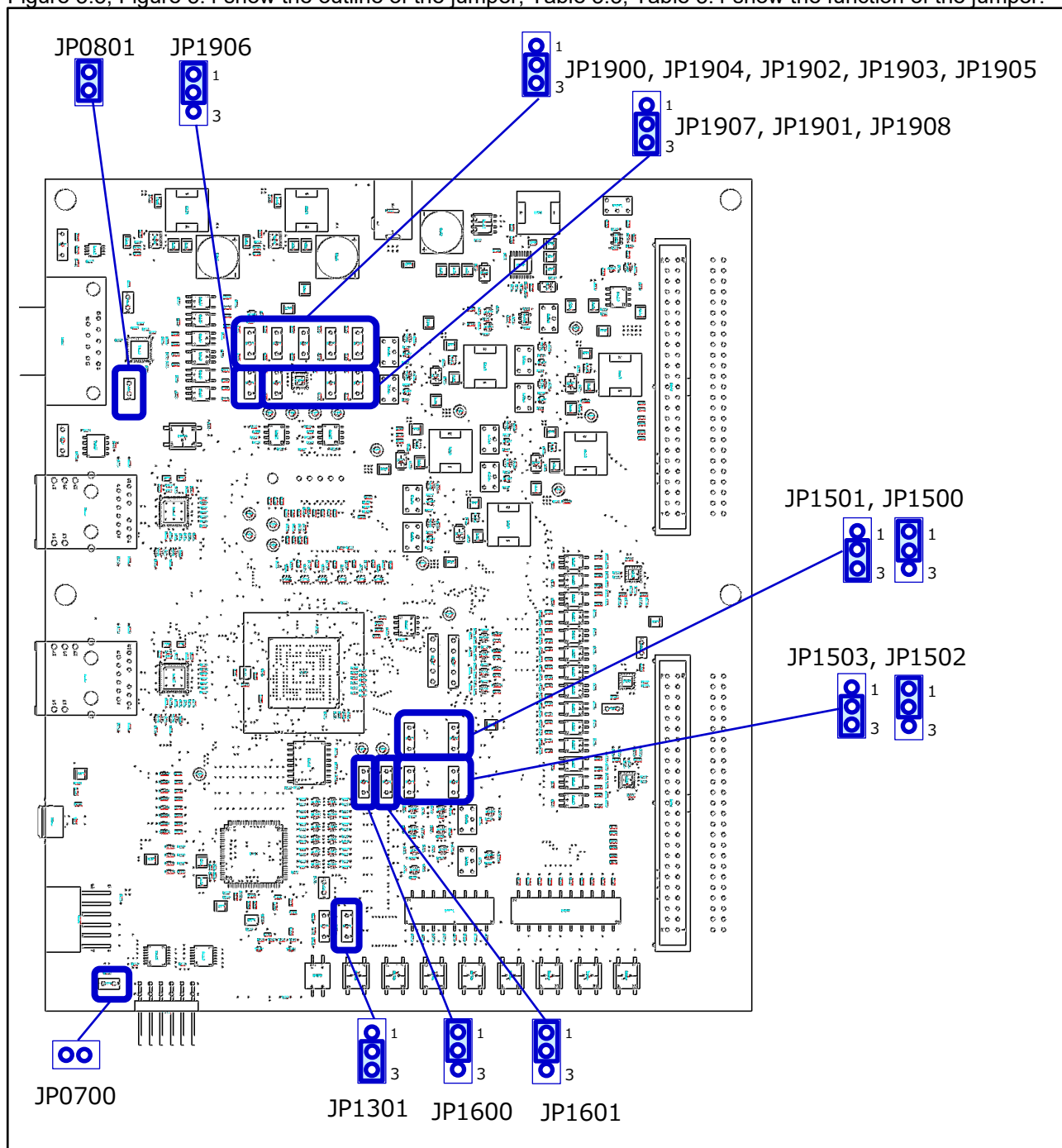


Figure 3.3 RZ/T2M motor controller board jumper

**Table 3.6 RZ/T2MJumper function of motor controller board**

| No | JP                | Item                                  | Content                                                                                           | Default         | Remarks                            |
|----|-------------------|---------------------------------------|---------------------------------------------------------------------------------------------------|-----------------|------------------------------------|
| 1  | JP0801            | RS232C/485                            | With jumper: RS232C<br>no jumper: RS485                                                           | With Jumper     |                                    |
| 2  | JP1906            | Power sequencer<br>Drive power supply | Jumper1-2: 5V<br>Jumper2-3: 3.3V                                                                  | Jumper1-2       |                                    |
| 3  | JP1900            | Power sequencer<br>(DONA)             | Jumper1-2: Reserved<br>Jumper2-3: Normal mode                                                     | Jumper2-3       |                                    |
| 4  | JP1904            | Power sequencer<br>(DOFFA)            | Jumper1-2: Reserved<br>Jumper2-3: Normal mode                                                     | Jumper2-3       |                                    |
| 5  | JP1902            | Power sequencer<br>(DONC)             | Jumper1-2: Reserved<br>Jumper2-3: Normal mode                                                     | Jumper2-3       |                                    |
| 6  | JP1903            | Power sequencer<br>(DOND)             | Jumper1-2: Reserved<br>Jumper2-3: Normal mode                                                     | Jumper2-3       |                                    |
| 7  | JP1905            | Power sequencer<br>(DOFFB)            | Jumper1-2: Reserved<br>Jumper2-3: Normal mode                                                     | Jumper2-3       |                                    |
| 8  | JP1907            | Power sequencer<br>(DOFFC)            | Jumper1-2: Reserved<br>Jumper2-3: Normal mode                                                     | Jumper2-3       |                                    |
| 9  | JP1901            | Power sequencer<br>(DONB)             | Jumper1-2: Reserved<br>Jumper2-3: Normal mode                                                     | Jumper2-3       |                                    |
| 10 | JP1908            | Power sequencer<br>(DOFFD)            | Jumper1-2: Reserved<br>Jumper2-3: Normal mode                                                     | Jumper2-3       |                                    |
| 11 | JP1501<br>/JP1500 | PWM_V-<br>/W+ Swap                    | JP1501Jumper2-3, JP1500Jumper1-2: Normal mode                                                     | JP1501Jumper2-3 | PWM_V- =H16Pin<br>PWM_W+ =D2Pin    |
|    |                   |                                       | JP1501Jumper1-2, JP1500Jumper2-3: Swap                                                            | JP1500Jumper1-2 | PWM_V- =D2Pin<br>PWM_W+ =H16Pin    |
| 12 | JP1503<br>/JP1502 | PWM_V2-<br>/W2+Swap                   | JP1503Jumper2-3, JP1502Jumper1-2: Normal mode                                                     | JP1503Jumper2-3 | PWM_V2- =G16Pin<br>PWM_W2+ =G15Pin |
|    |                   |                                       | JP1503Jumper1-2, JP1502Jumper2-3: Swap                                                            | JP1502Jumper1-2 | PWM_V2- =G15Pin<br>PWM_W2+ =G16Pin |
| 13 | JP0700            | PMOD Power supply                     | With Jumper: LCD Panel connector I/F Power supply<br>No Jumper: Uses power from the counter board | No Jumper       |                                    |
| 14 | JP1301            | RX72N<br>Boot mode                    | Jumper1-2: Reserved<br>Jumper2-3: Normal mode                                                     | Jumper2-3       |                                    |
| 15 | JP1600            | POE_FOV Option                        | Jumper1-2: H5Pin (POE0#)<br>Jumper2-3: H19Pin (GTETRG)                                            | Jumper1-2       | POE_FOV=H5Pin                      |
| 16 | JP1601            | POE_FOV2 Option                       | Jumper1-2: F18Pin (POE4#)<br>Jumper2-3: J16Pin (GTETRGB)                                          | Jumper1-2       | POE_FOV2=F18Pin                    |

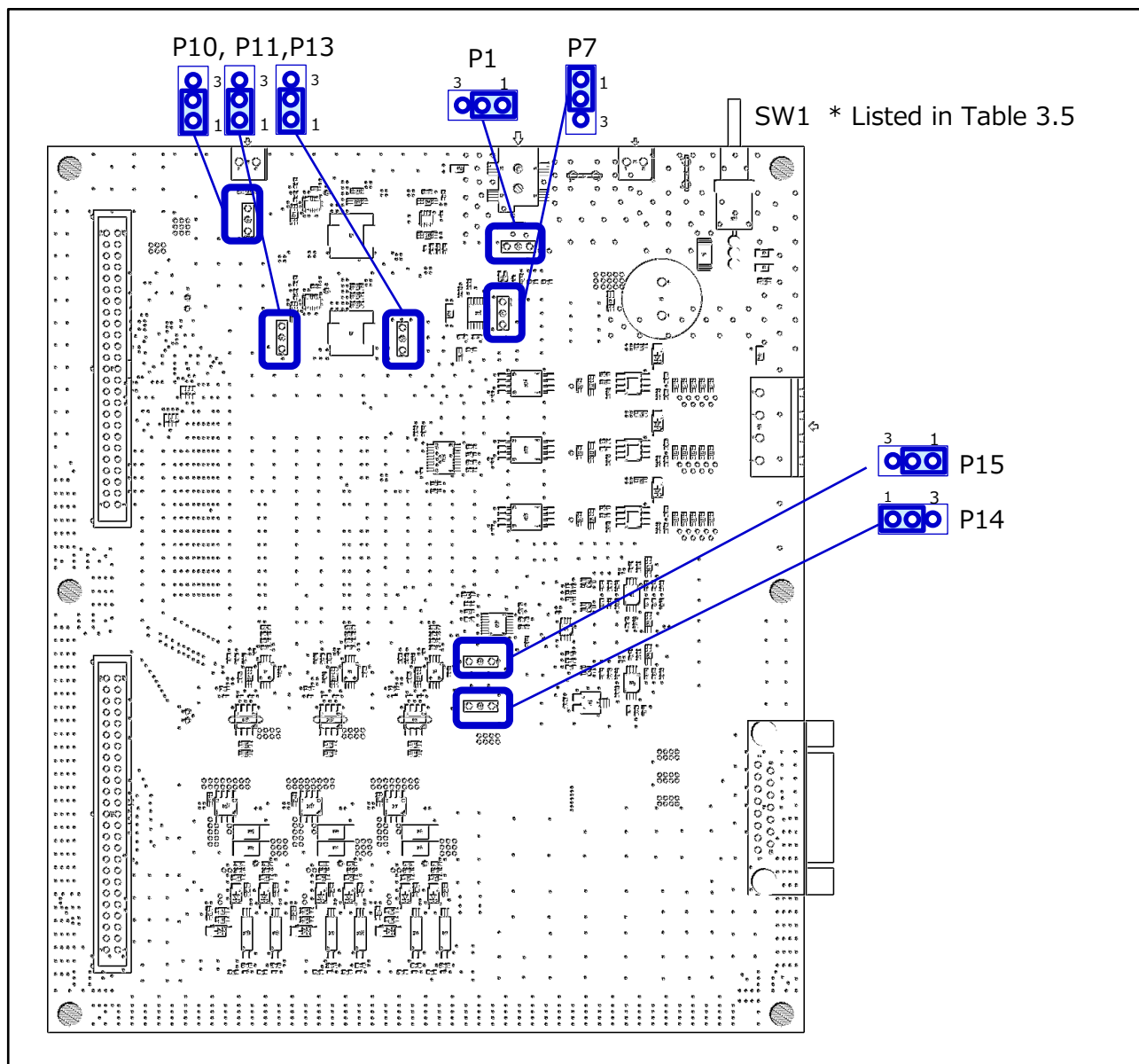


Figure 3.4 Inverter board jumper

Table 3.7 Inverter board jumper function

| No | JP          | Item                                                      | Content                                                                                                                                                                | Default                                          | Remarks                                        |
|----|-------------|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|------------------------------------------------|
| 1  | P10/P11/P13 | Gate driver power selection                               | P10Jumper1-2, P11Jumper1-2, P13Jumper1-2:<br>Generates + 24V to + 15V on board<br><br>P10Jumper2-3, P11Jumper2-3, P13Jumper2-3:<br>Supply + 15V from the external (P9) | JP10Jumper1-2/JP11Jumper1-2<br><br>JP13Jumper1-2 | +15V                                           |
| 2  | P1          | Power supply to RZ / T2 motor controller board            | Jumper1-2: Supply + 24V<br>Jumper2-3: Do not supply + 24V                                                                                                              | Jumper1-2                                        |                                                |
| 3  | P7          | Bus voltage detection<br>Insulated / non-insulated option | Jumper1-2: non-insulated<br>Jumper2-3: Insulated                                                                                                                       | Jumper1-2                                        | AD_BUS, Insulated by connect via insulated AMP |
| 4  | P15/P14     | Overcurrent detection insulation / non-insulation option  | P15Jumper1-2, P14Jumper1-2: Non-insulated<br>/P15Jumper2-3, P14Jumper2-3: Insulated                                                                                    | JP15Jumper1-2<br>JP14Jumper1-2                   | Insulated by connect via insulated AMP         |



### 3.2.3 LEDs

Figure 3.5, Figure 3.6 show the LED overview of the controller board and inverter board, Table 3.8, Table 3.9 show the LED list of the controller board and inverter board.

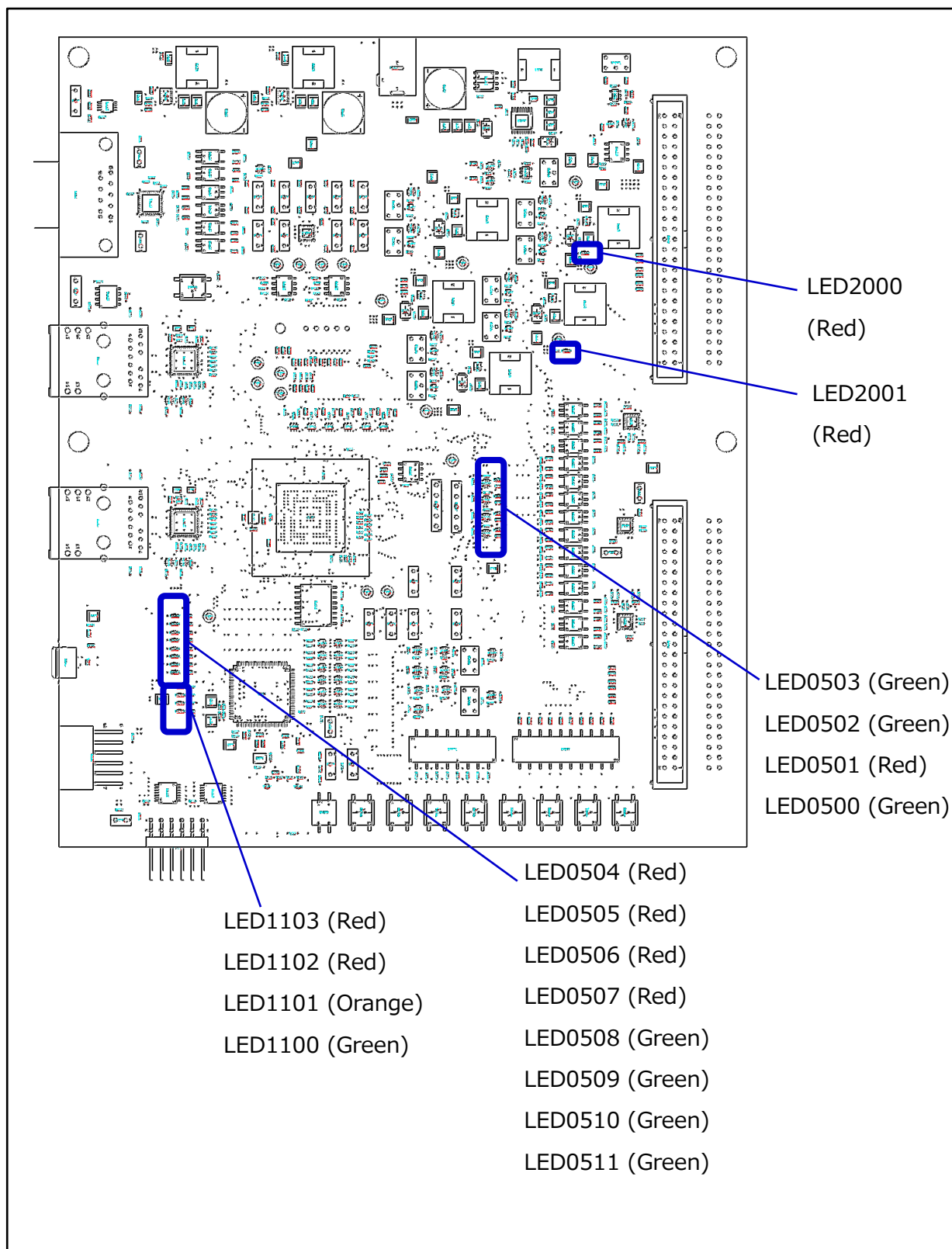


Figure 3.5 RZ/T2M Motor controller board LED



**Table 3.8 RZ/T2M LED list of motor controller board**

| No | Item                           |            | Circuit number | Color  | Using                           |
|----|--------------------------------|------------|----------------|--------|---------------------------------|
| 1  | Power supply LED               | VDD3.3V_RX | LED2000        | Red    | VDD3.3V_RX Energized: Lights up |
| 2  |                                | VDD3.3V_RZ | LED2001        | Red    | VDD3.3V_RZ Energized: Lights up |
| 3  | ESC status LED                 | ETH_LED3   | LED0503        | Green  | L/A OUT                         |
| 4  |                                | ETH_LED2   | LED0502        | Green  | L/A IN                          |
| 5  |                                | ETH_LED1   | LED0501        | Red    | ERR                             |
| 6  |                                | ETH_LED0   | LED0500        | Green  | RUN                             |
| 7  | General purpose LED<br>(RZ/T2) | GPLED5     | LED0504        | Red    | H: Light on/L: Light off        |
| 8  |                                | GPLED1     | LED0505        | Red    | H: Light on/L: Light off        |
| 9  |                                | GPLED2     | LED0506        | Red    | H: Light on/L: Light off        |
| 10 |                                | GPLED6     | LED0507        | Red    | H: Light on/L: Light off        |
| 11 |                                | GPLED3     | LED0508        | Green  | H: Light on/L: Light off        |
| 12 |                                | GPLED7     | LED0509        | Green  | H: Light on/L: Light off        |
| 13 |                                | GPLED4     | LED0510        | Green  | H: Light on/L: Light off        |
| 14 |                                | GPLED8     | LED0511        | Green  | H: Light on/L: Light off        |
| 15 | General purpose LED<br>(RX72N) | LED3       | LED1103        | Red    | L: Light on/H: Light off        |
| 16 |                                | LED2       | LED1102        | Red    | L: Light on/H: Light off        |
| 17 |                                | LED1       | LED1101        | Orange | L: Light on/H: Light off        |
| 18 |                                | LED0       | LED1100        | Green  | L: Light on/H: Light off        |

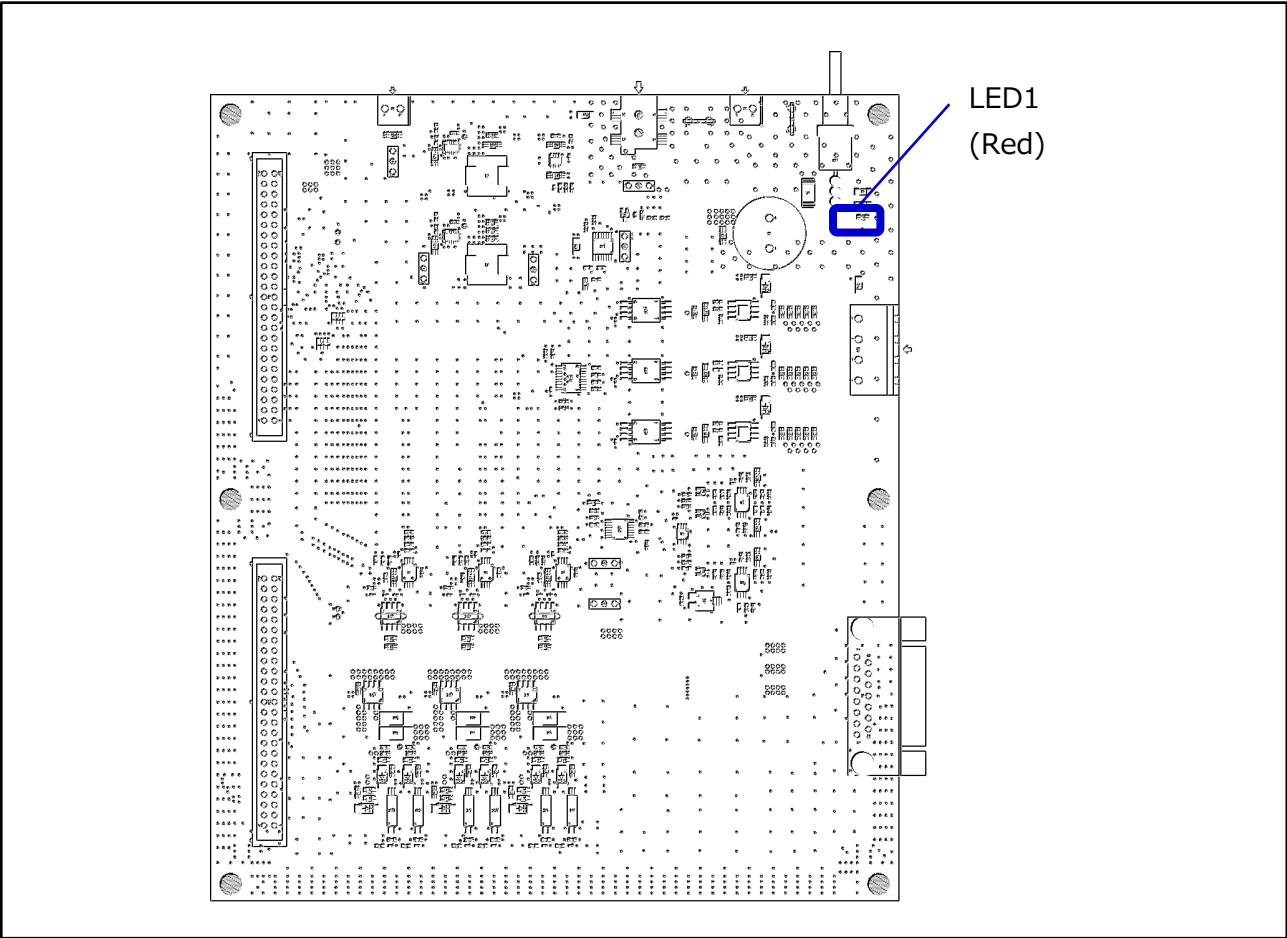


Figure 3.6 Inverter board LED

Table 3.9 Inverter board LED list

| No | Item             |       | Circuit number | Color | Using                      |
|----|------------------|-------|----------------|-------|----------------------------|
| 1  | Power supply LED | M+24V | LED1           | Red   | M+24V Energized: Lights up |

### 3.2.4 Connectors

#### 3.2.4.1 Controller board

##### ■RS-485

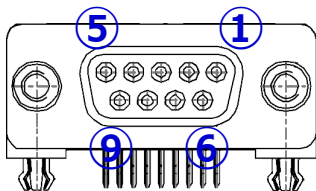
[Through holes] (P0900)



| No | Name     | I/O |
|----|----------|-----|
| 1  | RS485_N  | I/O |
| 2  | RS485_P  | I/O |
| 3  | ISO_GND1 | -   |

##### ■RS-232C/ RS-485 (D-Sub9pin) (P0800)

FCI D09S13A4GV00LF



| No | Name       | I/O |
|----|------------|-----|
| 1  | RS422_TX_P | O   |
| 2  | RS422_TX_N | O   |
| 3  | RS422_RX_N | I   |
| 4  | RS422_RX_P | I   |
| 5  | ISO_GND1   | -   |
| 6  | NC         | -   |
| 7  | NC         | -   |
| 8  | NC         | -   |
| 9  | NC         | -   |

##### ■CAN (CAN FD Transceiver)

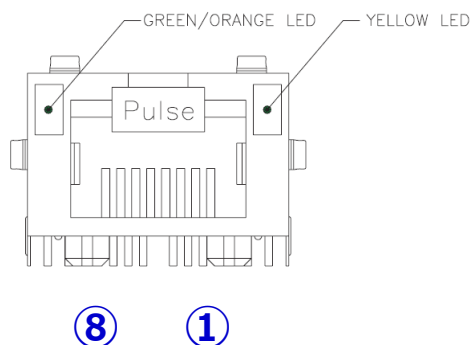
[Through holes] (P0801)



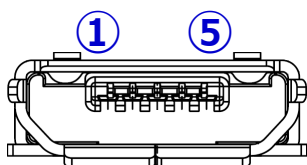
| No | Name  | I/O |
|----|-------|-----|
| 1  | CAN_H | I/O |
| 2  | CAN_L | I/O |
| 3  | DGND  | -   |

##### ■RJ45 connector (EtherCAT/ Ethernet) (P2700/P2800)

Pulse J0G-0001NL

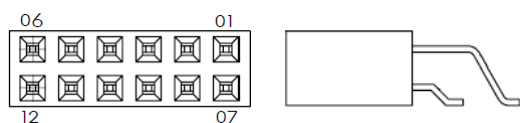


■ USB Micro B (P0400)  
FCI 10118192-0001LF



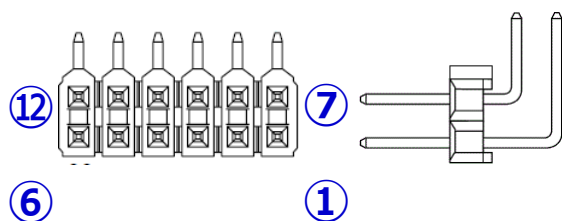
| No | Name     | I/O |
|----|----------|-----|
| 1  | USB_VBUS | I   |
| 2  | USB_DM   | I/O |
| 3  | USB_DP   | I/O |
| 4  | USBID    | I   |
| 5  | DGND     | -   |

■ Pmod-Type 6A (P0700)  
SAMTEC SMH-106-02-L-D



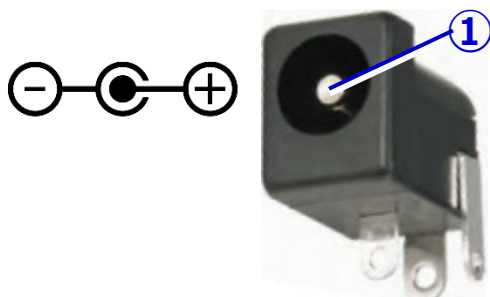
| No | Name        | I/O | No | Name       | I/O |
|----|-------------|-----|----|------------|-----|
| 1  | INT_6A_RZ   | I/O | 7  | RTS0#_SS0# | I/O |
| 2  | RESET_6A_RZ | I/O | 8  | TXD0_MOSI  | O   |
| 3  | SCL0        | O   | 9  | RXD0_MISO  | I   |
| 4  | SDA0        | I/O | 10 | PM7_SCK0   | I/O |
| 5  | DGND        | -   | 11 | DGND       | -   |
| 6  | VDD3.3V_RZ  | -   | 12 | VDD3.3V_RZ | -   |

■ Pmod- Type 2A (P0701) [Through holes]  
SAMTEC TSW-106-25-L-D-RA



| No | Name       | I/O | No | Name         | I/O |
|----|------------|-----|----|--------------|-----|
| 1  | SSL30      | O   | 7  | INT_2A_RZ    | I/O |
| 2  | MOSI3      | O   | 8  | RESET_2A_RZ  | I/O |
| 3  | MISO3      | I   | 9  | PMOD_PG_4_RZ | I/O |
| 4  | RSPCK3     | O   | 10 | PMOD_PG_7_RZ | I/O |
| 5  | DGND       | -   | 11 | DGND         | -   |
| 6  | VDD3.3V_RZ | -   | 12 | VDD3.3V_RZ   | -   |

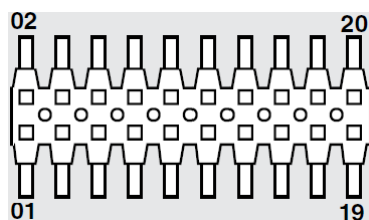
■ DC24V DC Power Jack (P1701)  
Kycon KLDX-0202-A



| No | Name  | I/O |
|----|-------|-----|
| 1  | DC24V | I   |
| 2  | GND   | -   |

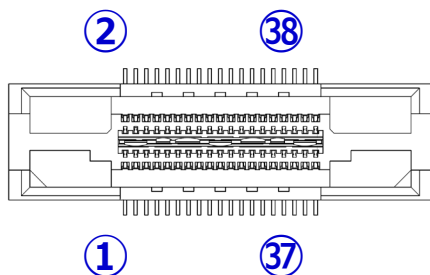
**Caution:** When supplying 24V DC from the inverter board, do not apply 24V DC to this connector.

- ARM JTAG connector (P0401)  
20 pins, for RZ/T2  
SAMTEC FTSH-110-01-F-DV-007-K



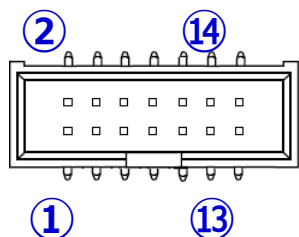
| No | Name       | I/O | No | Name        | I/O |
|----|------------|-----|----|-------------|-----|
| 1  | VDD3.3V_RZ | -   | 2  | S_SWDIO_TMS | I   |
| 3  | DGND       | -   | 4  | S_SWCLK_TCK | I   |
| 5  | DGND       | -   | 6  | S_TDO       | O   |
| 7  | NC         | -   | 8  | S_TDI       | I   |
| 9  | DGND       | -   | 10 | DBG_RESET#  | I/O |
| 11 | VDD5V_SW   | -   | 12 | 1.65V       | O   |
| 13 | VDD5V_SW   | -   | 14 | 1.65V       | O   |
| 15 | DGND       | -   | 16 | TRST#       | I   |
| 17 | DGND       | -   | 18 | NC          | -   |
| 19 | DGND       | -   | 20 | NC          | -   |

- ARM JTAG connector (P0402)  
38 pins, for RZ/T2  
TE Connectivity 2-5767004-2



| No | Name        | I/O | No | Name       | I/O |
|----|-------------|-----|----|------------|-----|
| 1  | NC          | -   | 2  | NC         | -   |
| 3  | NC          | -   | 4  | NC         | -   |
| 5  | DGND        | -   | 6  | TRACE_CLK  | O   |
| 7  | DGND        | -   | 8  | DBGACK     | -   |
| 9  | DBG_RESET#  | I/O | 10 | EXTTRG     | -   |
| 11 | S_TDO       | O   | 12 | VTREF      | -   |
| 13 | 1.65V       | O   | 14 | VTSUPPLY   | O   |
| 15 | S_SWCLK_TCK | I   | 16 | TRACE_D7   | I/O |
| 17 | S_SWDIO_TMS | I   | 18 | TRACE_D6   | I/O |
| 19 | S_TDI       | I   | 20 | TRACE_D5   | I/O |
| 21 | TRST#       | I   | 22 | TRACE_D4   | I/O |
| 23 | DGND        | -   | 24 | TRACE_D3   | I/O |
| 25 | DGND        | -   | 26 | TRACE_D2   | I/O |
| 27 | DGND        | -   | 28 | TRACE_D1   | I/O |
| 29 | DGND        | -   | 30 | DGND       | -   |
| 31 | DGND        | -   | 32 | DGND       | -   |
| 33 | DGND        | -   | 34 | VDD3.3V_RZ | -   |
| 35 | DGND        | -   | 36 | TRACE_CTL  | O   |
| 37 | DGND        | -   | 38 | TRACE_D0   | I   |

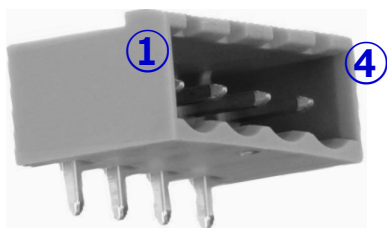
- JTAG connector (P1300)  
for RX72N (Functional Safety)  
SAMTEC HTST-107-01-T-DV



| No | Name        | I/O | No | Name       | I/O |
|----|-------------|-----|----|------------|-----|
| 1  | TCK/FINEC   | I   | 2  | DGND       | -   |
| 3  | EMU-TRSTN   | I   | 4  | EMLE       | I/O |
| 5  | EMU-TDO_TXD | O   | 6  | NC         | -   |
| 7  | MD_FINED    | I/O | 8  | VDD3.3V_RX | -   |
| 9  | EMU-TMS     | I   | 10 | EMU-UB     | I/O |
| 11 | EMU-TDI_RXD | I   | 12 | DGND       | -   |
| 13 | RESN        | I/O | 14 | DGND       | -   |

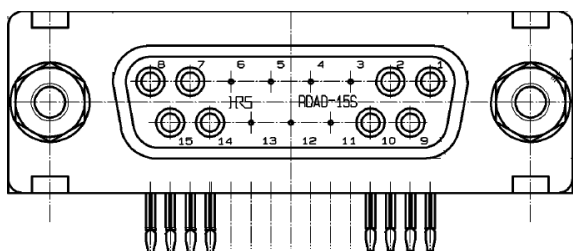
### 3.2.4.2 Inverter board

- Motor connection connector (P16)  
1757268 from phoenix contact



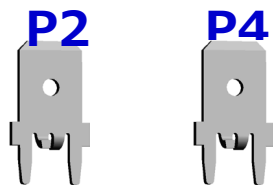
| No | Name   | I/O |
|----|--------|-----|
| 1  | MOT_U  | O   |
| 2  | MOT_V  | O   |
| 3  | MOT_W  | O   |
| 4  | SHIELD | -   |

- For encoder connection (P3) D-Sub15pin  
RDAD-15S-LNA (4-40)(55) from Hirose:



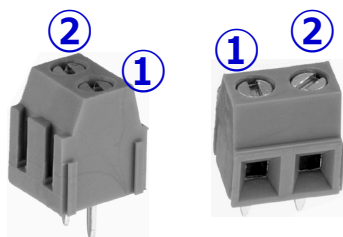
| No | Name     | I/O | No | Name     | I/O |
|----|----------|-----|----|----------|-----|
| 1  | NC       | -   | 9  | ISO_GND2 | -   |
| 2  | ISO_GND2 | -   | 10 | NC       | -   |
| 3  | NC       | -   | 11 | NC       | -   |
| 4  | Z-       | I   | 12 | Z+       | I   |
| 5  | B-       | I   | 13 | B+       | I   |
| 6  | A-       | I   | 14 | A+       | I   |
| 7  | 5V1A     | O   | 15 | 3.3V1A   | O   |
| 8  | 5V1A     | O   |    |          |     |

- +24V (P2/P4) FASTON terminal  
connectivity 63824-1 from TE



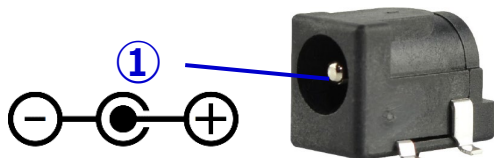
| No | Name  | I/O |
|----|-------|-----|
| P2 | +24V  | I   |
| P4 | GND_C | -   |

- +24V (P5) Terminal block  
691214310002 from Würth Elektronik



| No | Name  | I/O |
|----|-------|-----|
| 1  | +24V  | I   |
| 2  | GND_C | -   |

- +24V (P6) DC Power Jack  
PJ-002AH-SMT-TR from Cuidevices



| No | Name  | I/O |
|----|-------|-----|
| 1  | +24V  | I   |
| 2  | GND_C | -   |

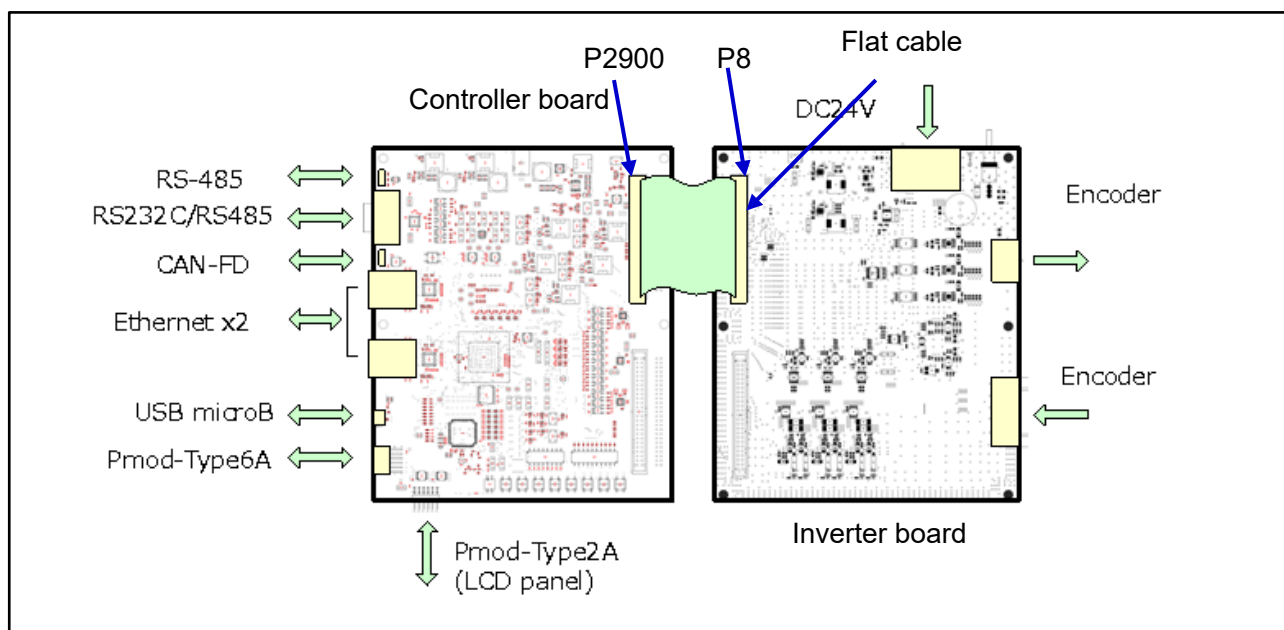
#### 4. Controller board, inverter board connection configuration

By connecting the RZ/T2M motor controller board and the inverter board, it is possible to expand the controlled motor to 1 channel and 2 channel. Table 4.1 is shown a list of controller board and inverter board connection configurations.

**Table 4.1 Controller board, inverter board connection configuration list**

| No | Constitution                              | Motor | Connection                                                                          | Jumper  | remarks                                           |
|----|-------------------------------------------|-------|-------------------------------------------------------------------------------------|---------|---------------------------------------------------|
| 1  | Constitution1<br>(Standard configuration) | 1ch   | Connect P2900 and P8 with a flat cable                                              | Default |                                                   |
| 2  | Constitution2                             | 1ch   | Connect P2901 and P8 (B to B connection)                                            | Default |                                                   |
| 3  | Constitution3                             | 2ch   | Connect P2901 and P12 (inverter board A)<br>Connect P3001 and P8 (inverter board B) | Default | Inverter board A / B has different mounting parts |

##### 4.1 Constitution1(Motor:1ch,Flat cable connection)



**Figure 4.1 Constitution1**



## 4.2 Constitution2 (Motor:1ch, B to B connection)

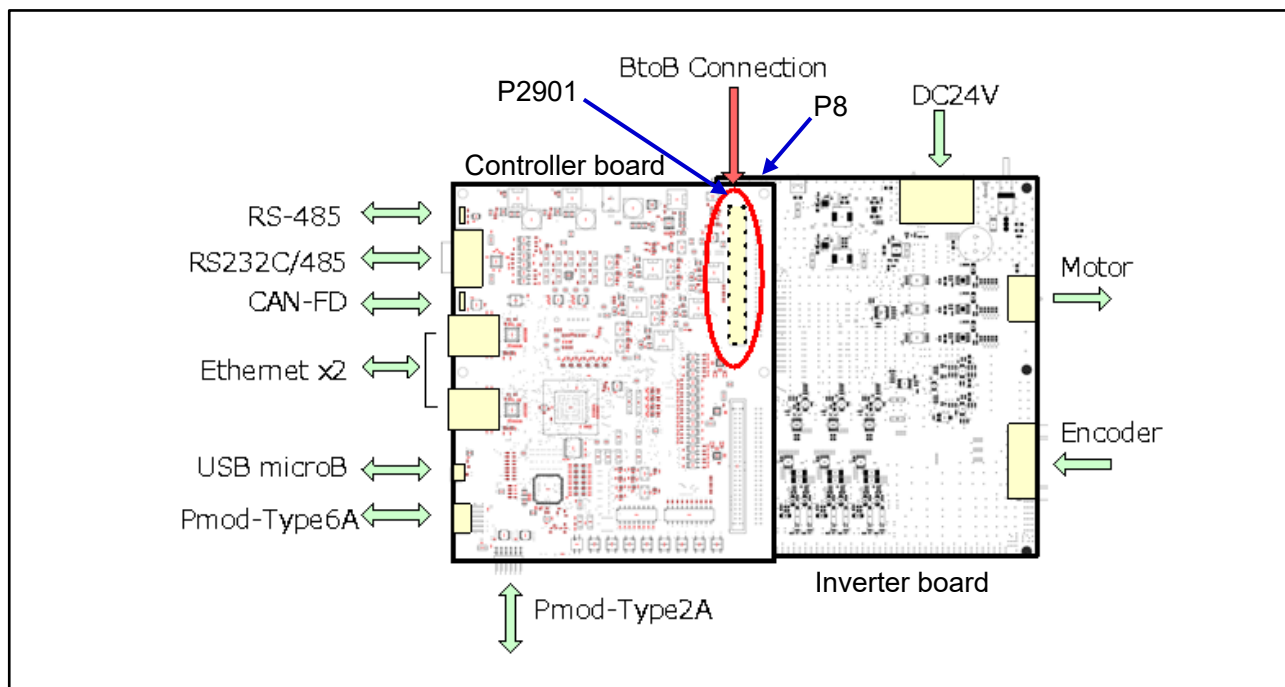
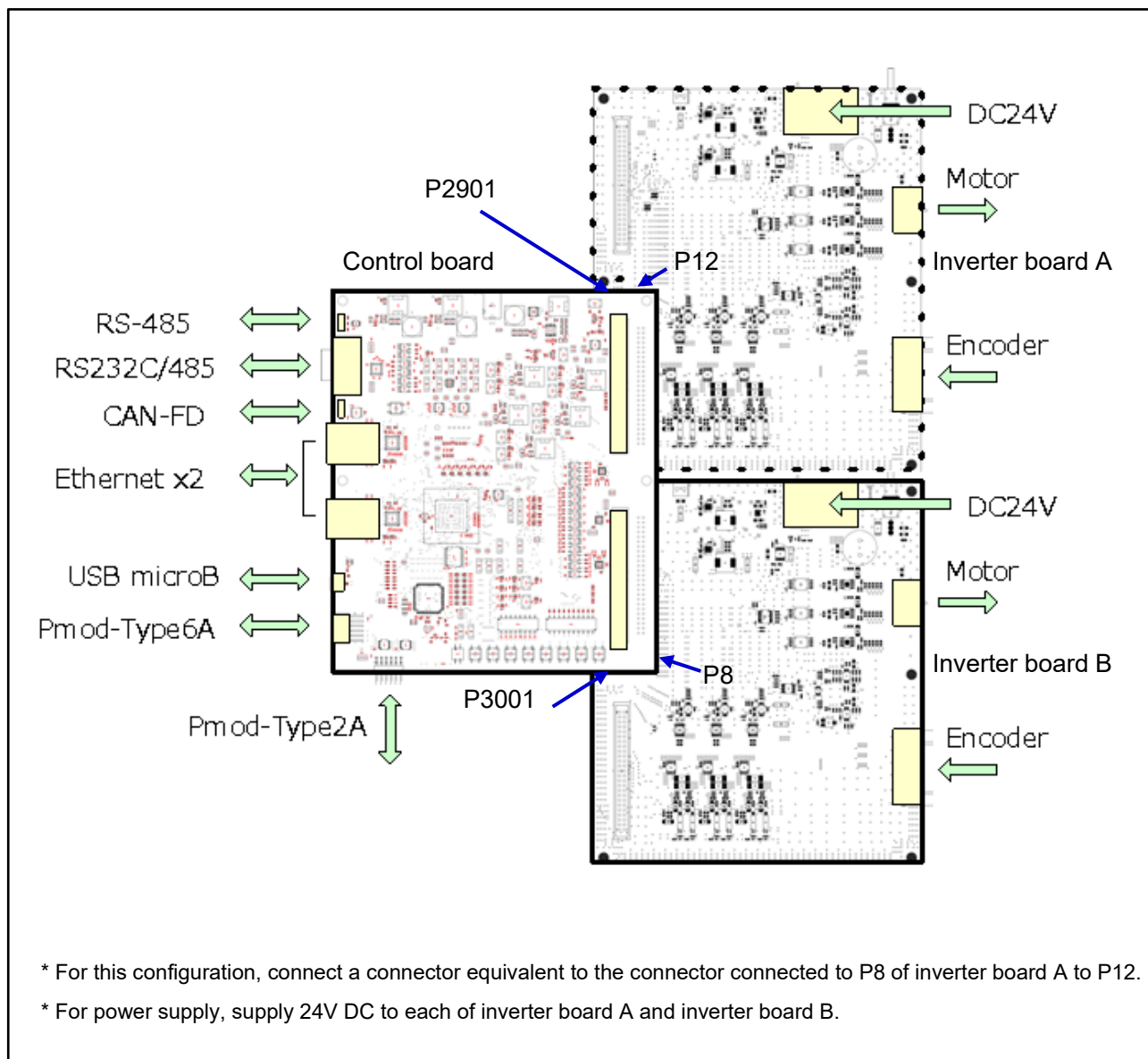


Figure 4.2 Constitution2

### 4.3 Constitution3(Motor:2ch, B to B connection)



**Figure 4.3 Constitution3**

## 5. Detection circuit

Table 5.1 is shown the current and voltage detection circuits mounted on the inverter board and the RZ/T2M connection destinations.

**Table 5.1 List of detection circuits**

| No | Circuit                                                    | Pin Number | Function | Circuit diagram silk name |
|----|------------------------------------------------------------|------------|----------|---------------------------|
| 1  | Overcurrent detection circuit                              | H5         | IRQ3-A   | POE_FOV_RZ                |
|    |                                                            | F18        | IRQ2-C   | POE_FOV2_RZ               |
| 2  | Current detection circuit 1<br>(Current Transducer)        | B17        | AN000    | AD_IU1_RZ                 |
|    |                                                            | C16        | AN001    | AD_IV1_RZ                 |
|    |                                                            | A18        | AN002    | AD_IW1_RZ                 |
|    |                                                            | F13        | AN100    | AD_IU2_RZ                 |
|    |                                                            | B16        | AN101    | AD_IV2_RZ                 |
|    |                                                            | E13        | AN102    | AD_IW2_RZ                 |
| 3  | Current detection circuit 1<br>( $\Delta\Sigma$ modulator) | G5         | MDAT0    | DSM_MDAT0_RZ              |
|    |                                                            | G6         | MCLK0    | DSM_MCLK0_RZ              |
|    |                                                            | A6         | MDAT1    | DSM_MDAT1_RZ              |
|    |                                                            | E3         | MCLK1    | DSM_MCLK1_RZ              |
|    |                                                            | E9         | MDAT2    | DSM_MDAT2_RZ              |
|    |                                                            | K2         | MCLK2    | DSM_MCLK2_RZ              |
|    |                                                            | B6         | MDAT3    | DSM_MDAT3_RZ              |
|    |                                                            | M6         | MCLK3    | DSM_MCLK3_RZ              |
|    |                                                            | C4         | MDAT4    | DSM_MDAT4_RZ              |
|    |                                                            | B3         | MCLK4    | DSM_MCLK4_RZ              |
|    |                                                            | P15        | MDAT5    | DSM_MDAT5_RZ              |
|    |                                                            | C3         | MCLK5    | DSM_MCLK5_RZ              |
| 4  | Busbar voltage detection circuit<br>(24V)                  | E16        | AN003    | AD_BUS1_RZ                |
|    |                                                            | A17        | AN103    | AD_BUS2_RZ                |

## 5.1 Overcurrent detection circuit

The overcurrent detection circuit in Figure 5.1 is used to detect overcurrent from the shunt resistance of each of the U, V, and W phases.

The overcurrent detection circuit determines that the current is overcurrent when any one of the currents flowing in the U, V, and W phases exceeds the threshold value.

The threshold is determined by the volume resistor VR1 and is set to full clockwise in the initial state.

Table 5.2 is shown the relationship between the volume resistor VR1 and the overcurrent detection current value. Adjust the volume resistor VR1 according to the application and set the threshold value.

If the current value is within the threshold range, the terminal POE\_FOVx outputs High, and when an overcurrent is detected, it outputs Low. You can protect the RZ/T2M motor board and motor by monitoring terminal POE\_FOVx and forcing the PWM output to go into the Hi-Z state when the output is low.

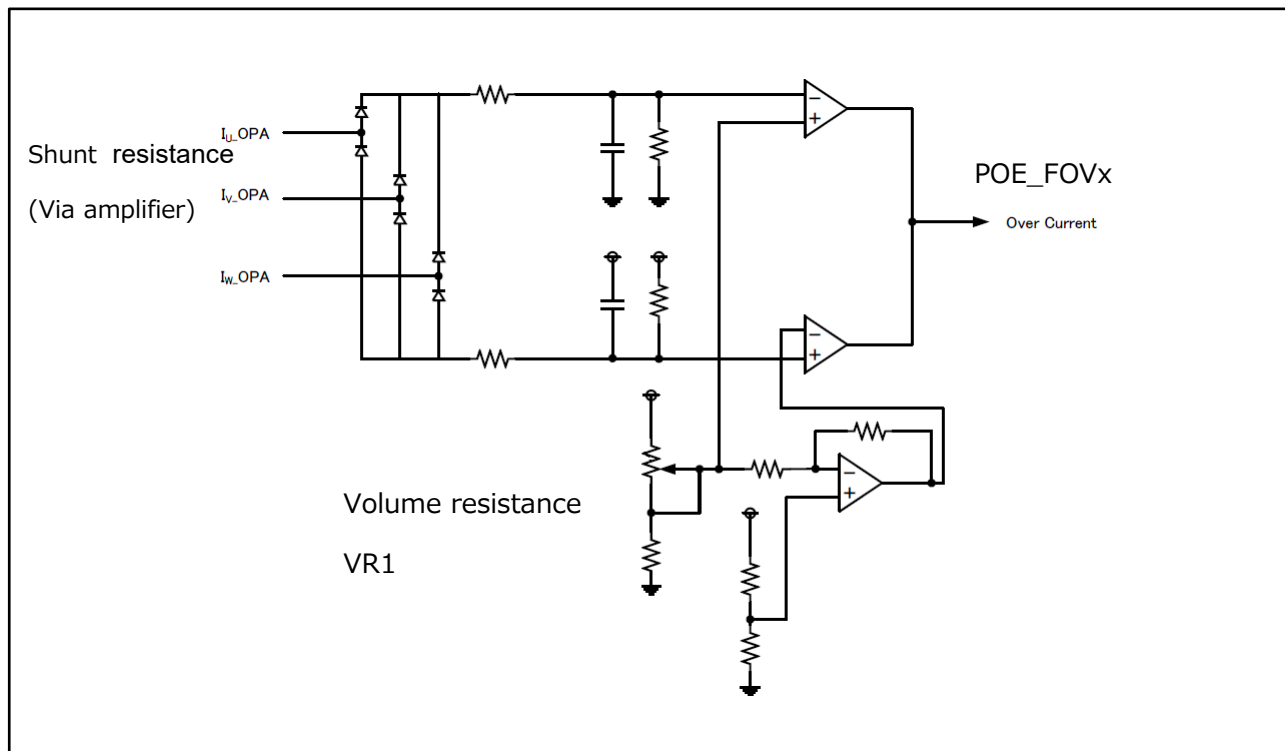


Figure 5.1 Outline of overcurrent detection circuit

Table 5.2 Volume resistor VR1 and overcurrent detection current value

| Volume resistance value [ $\Omega$ ] | Overcurrent detection current value [A] |
|--------------------------------------|-----------------------------------------|
| 0(Full clockwise)                    | $\pm 12$ A                              |
| 10k(Full counterclockwise)           | $\pm 2$ A                               |

## 5.2 Current detection circuit 1(Current Transducer)

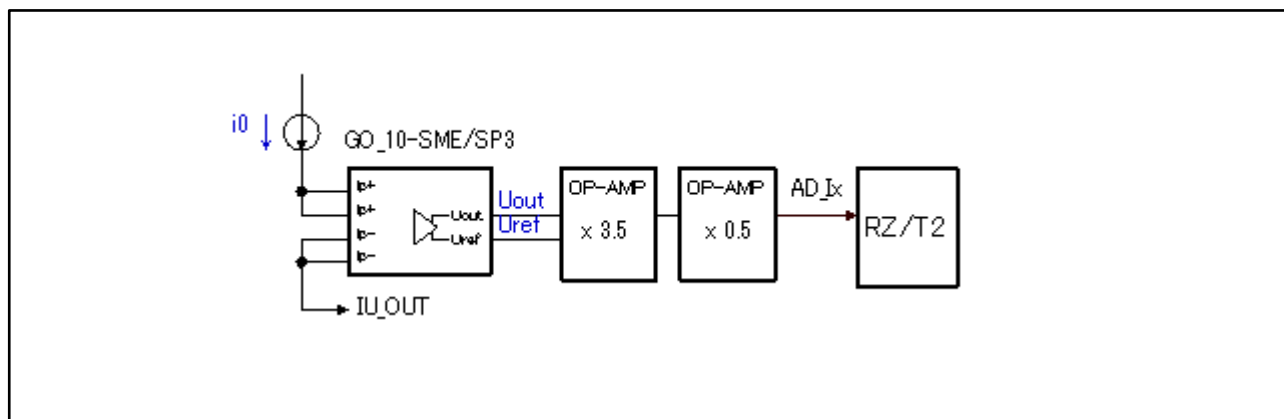


Figure 5.2 Current Transducer circuit

■ Current calculation formula by Current Transducer circuit

CT sensitivity = 0.05 [V / A]

$$V(AD\_Ix) = (0.05[V/A] \times i0[A] \times 3.5 + 1.65[V]) \times 0.5 \\ = 0.0875[V/A] \times i0[A] + 0.825[V]$$

RZ/T2M A/D converter Resolution: 12bit ( $VCC18\_ADC0/1=1.8[V]$ )

1LSB (A/D converter value) =  $1.8[V] / 0.00875[V/A] / 4095 = 5.024[mA]$

Current detection range:

$$i0[A] = (V(AD\_Ix) - 0.825[V]) / 0.0875[V/A]$$

$$i0[A] = -0.825[V] / 0.0875[V/A] = -9.429[A] \quad (V(AD\_Ix) = 0V)$$

$$i0[A] = (1.8[V] - 0.825[V]) / 0.0875[V/A] = 11.143[A] \quad (V(AD\_Ix) = 1.8V)$$

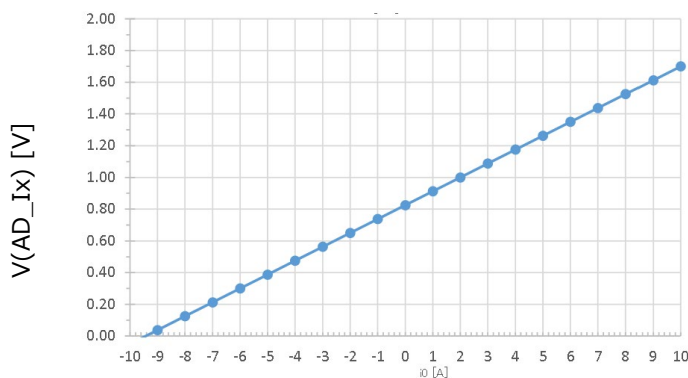


Figure 5.3 Current detection circuit 1 characteristics

### 5.3 Current detection circuit 2( $\Delta\Sigma$ Modulator)

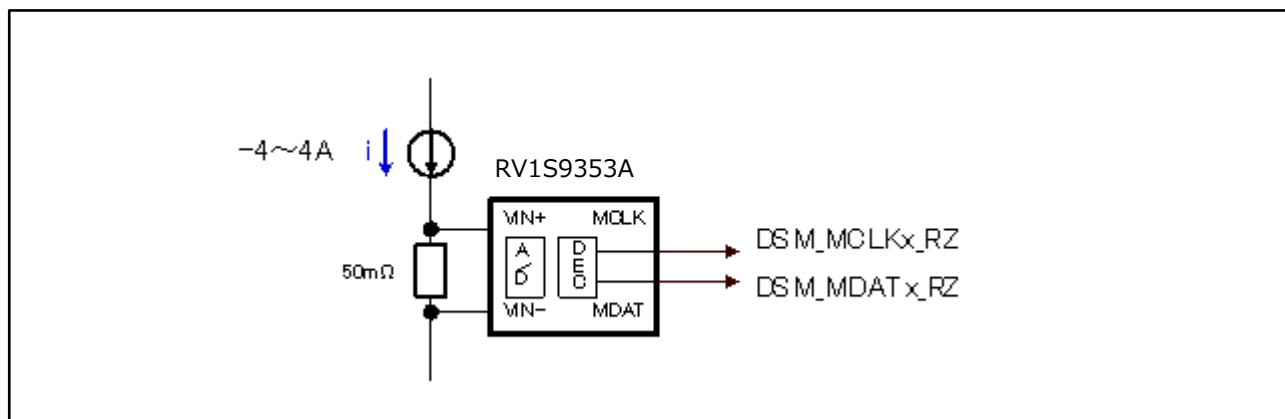


Figure 5.4  $\Delta\Sigma$  Modulator circuit

### 5.4 Bus voltage detection circuit

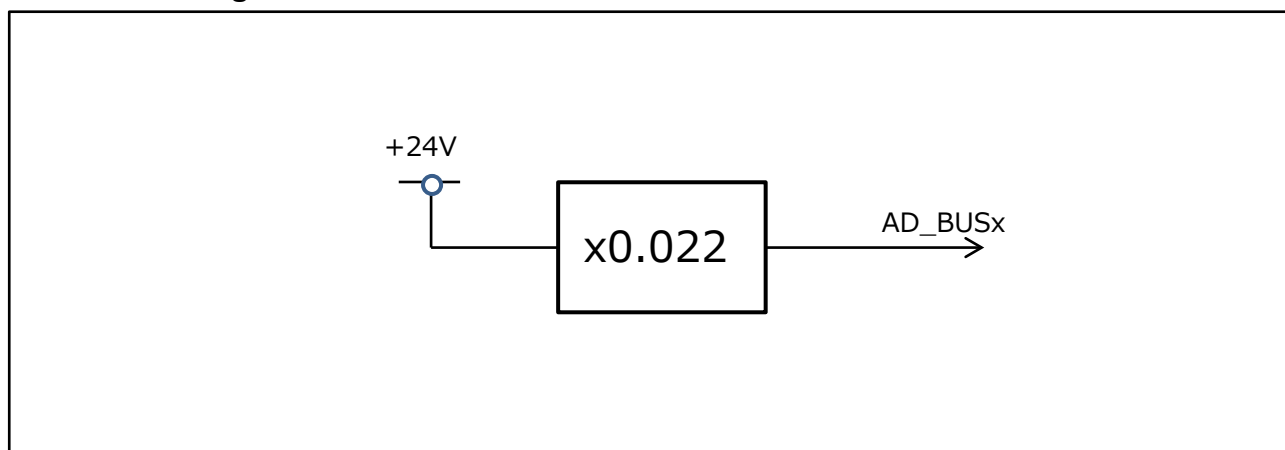


Figure 5.5 Bus voltage detection circuit

**Revision History**

| Rev. | Date      | Description |              |
|------|-----------|-------------|--------------|
|      |           | Page        | Summary      |
| 1.00 | 2021.7.31 | –           | Preliminary  |
| 1.01 | 2022.8.26 | P.1         | Modify error |
|      |           |             |              |

## 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

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