JP177-ROSBODYREFZ

ROS-based Robot Body Controller

Rev.1.00

Introduction

This manual describes usage and specifications of JP177-ROSBODYREFZ ROS-based robot body controller. The below parts are utilized for this PoC (Proof-of-Concept) based on the winning combination.

Winning Combination for JP177-ROSBODYREFZ ROS-based robot body controller
https://www.renesas.com/us/en/application/key-technology/motor-control-robotics/ros-based-robot-body-controller

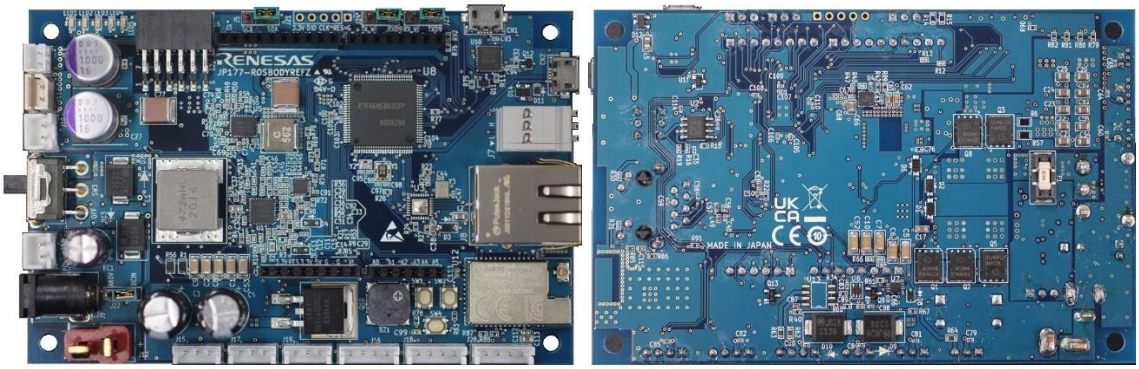
RA6M5:	200MHz Arm® Cortex®-M33 TrustZone®, Highest Integration with Ethernet and CAN FD
RAA211650:	60V 5A Integrated Switching Regulator
ISL81401:	40V Bidirectional 4- Switch Synchronous Buck-Boost Controller
ISL9021:	250mA Single LDO with Low IQ, Low Noise and High PSRR LDO
ISL32458E:	±60V Fault Protected, 3.3V to 5V, ±20V CMR, 20Mbps Half-Duplex RS-485/RS-422
ISL88002:	Ultra Low Power 3 Ld Voltage Supervisors in SC-70 and SOT-23 Packages
DA16200MOD:	Ultra-Low Power Wi-Fi Modules for Battery Powered IoT Devices

When applying the sample program covered in this document to your system, modify the program according to the specifications for the target system and conduct an extensive evaluation of the modified program. It should be fully evaluated if replace the analog or power supply devices in this system to other.

Contents

1. Description

This system enables to control multi servos based on Robot Operating System (ROS). RA6M5 incorporates the high-performance Arm® Cortex® -M33 and communication interfaces like Ethernet and USB, that can be used for Pub/Sub messaging between ROS nodes. ISL81401 and other power devices supply appropriate voltage to multi servos and an entire system.



1.1 About ROS

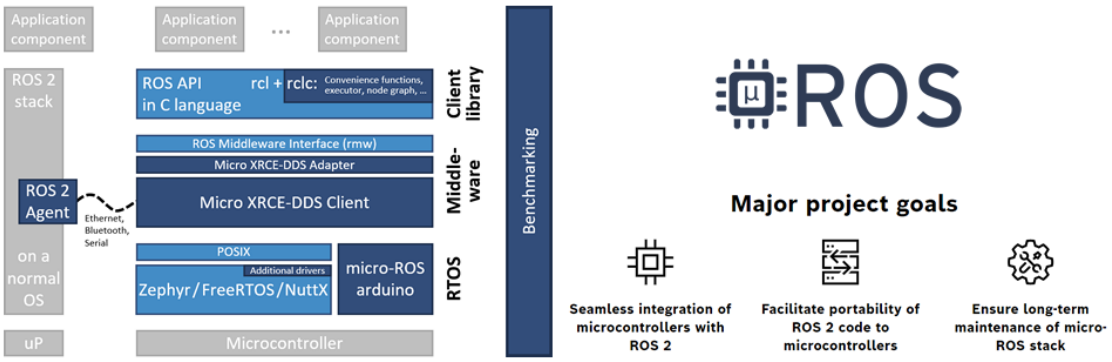
ROS (Robot Operating System) provides libraries and tools to help software developers create robot applications on the following framework. ROS is provided as open source based on Apache 2.0.
Refer to http://docs.ros.org/en/rolling/

- **Hardware abstraction**: Unified development framework →Applicable to arms, rovers, and drones
- **Libraries**: 3D coordinate solving, self-localization, path planning, inverse kinematics problem solving
- **Visualization tools**: 3D physics simulation, Qt-based debugging, visualization tools
- **Message communication**: Pub/Sub communication by DDS (*1), QoS (*2)
- **Package Management**: Cross-platform build, test, release for C++, Python, Java, etc.

*1 DDS: Data Distribution Service (developed by OMG)
*2 QoS: Quality of Service

1.2 micro-ROS and ROS 2

JP177-ROSBODYREFZ is assumed to run as micro-ROS client which can bridge to ROS 2 agent as below image. Refer to the below web site for the detail of micro-ROS and resources for developers such as videos and GitHub links. Renesas micro-ROS solutions: https://www.renesas.com/us/en/application/key-technology/motor-control-robotics/micro-ros-solutions

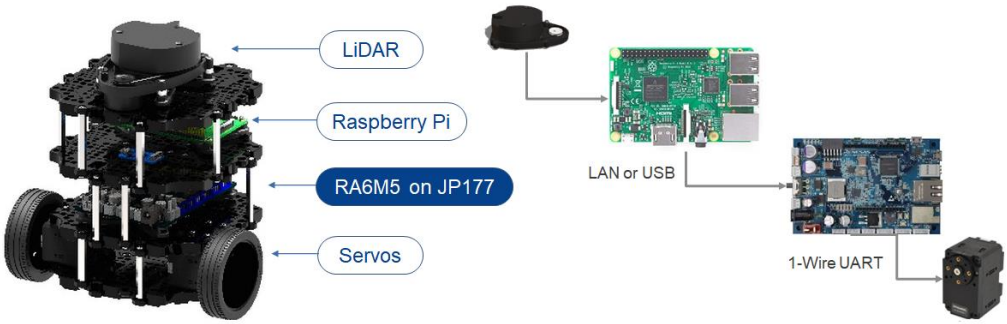


2. Usage

2.1 Preparation

To get started to ROS 2 application, the below items are recommended.

- JP177-ROSBODYREFZ (this board)
- Turtlebot3, reference robot for ROS
- Laptop with Wi-Fi connection, which needs same network with Raspberry Pi Short
- LAN cable to connect between JP177-ROSBODYREFZ and Raspberry Pi (option)



It is necessary to install software on Raspberry Pi as following.

- Ubuntu Server 20.04.5 to micro SD
- ROS 2 (Refer to https://docs.ros.org/en/foxy/Installation/Ubuntu-Install-Debians.html)
- micro-ROS Agent (Refer to https://micro.ros.org/docs/tutorials/core/first_application_linux/)
- Docker (this is selectable. Once installed, getting easier to run ROS2 and micro-ROS Agent)
- Network setting for LAN (e.g. 192.168.1.100/24)

2.2 Get Started

1. Turn on the switch on JP177-ROSBODYREFZ . Then the power is supplied to the entire system, JP177-ROSBODYREFZ board, Raspberry Pi, Lidar and servos.

2. Run the below command. Then you can control Turtlebot3 from your keyboard.

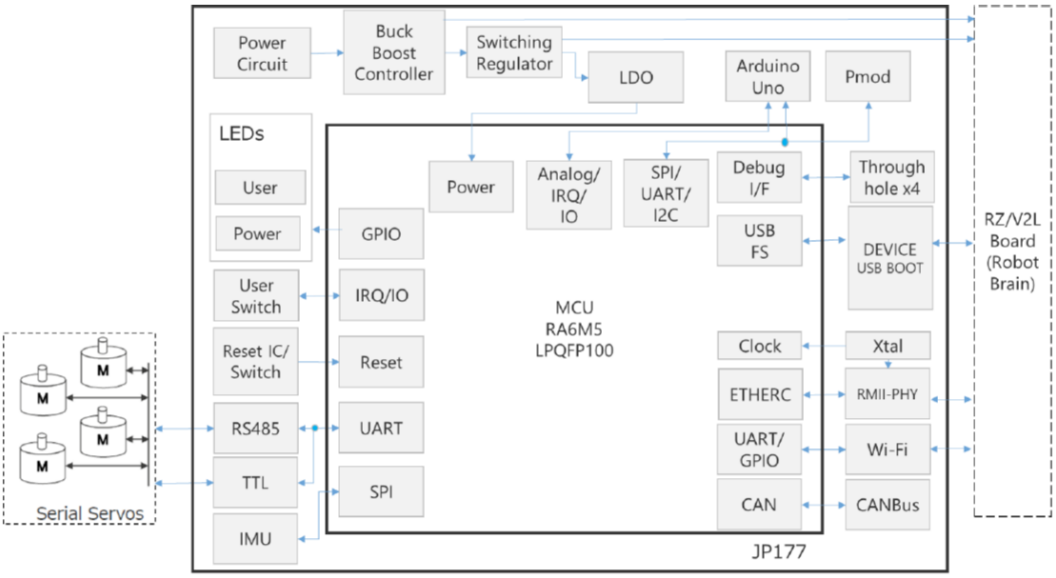
```
ros2 run micro_ros_agent micro_ros_agent udp4 --port 8888 -v6
ros2 run turtlesim turtle_teleop_key
```

3. Hardware

3.1 Specifications

Item		Specification	Remark
Parts number		JP177-ROSBODYREFZ	
MCU	Number	R7FA6M5BH3CFC	
	Package	100pins, LQFP package	
	Memory	2 MB Code Flash, 512 KB SRAM	
	Frequency	Up to 200 MHz	
Clock	Main	24MHz	
	Sub	32.768kHz	
Sensors	IMU	ICM-20648	
GPIOs	Arduino UNO	Digital 32 pins, Analog 6 pins	
	PMOD	Type 6A	
Communication I/F	USB	2 (micro-B type)	1. RA6M5 USB 2. USB Serial (FTDI)
	Servo	3 for TTL	1-wire UART
		3 for RS485	
	Ethernet	1	
	Wi-Fi	1	
	CAN	1	
User I/F	LED	4	Red 1, Orange 2, Green 1
	Button	1 for Reset	
		2 for User application	
	Switch	1 for power supply	
	Buzzer	1	
Power supply	Input	Battery	DEANS Connector
		SMPS 4.5V to 40V	Φ5.5/Φ2.5
		USB 5V	
	Output	12V 4.5A	SMW250-02 x 2
		5V 4A	5267-02A
		3.3V 800mA	20010WS-02

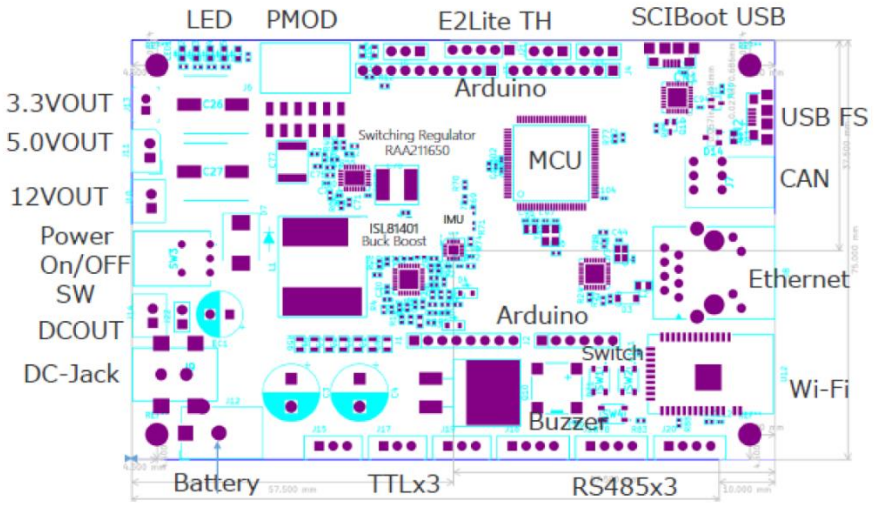
3.2 Block diagram



3.3 PCB Layout and dimension

Dimension JP177-ROSBODYREFZ

Board (WxDxH) :115 x 75 x 1.6(mm)

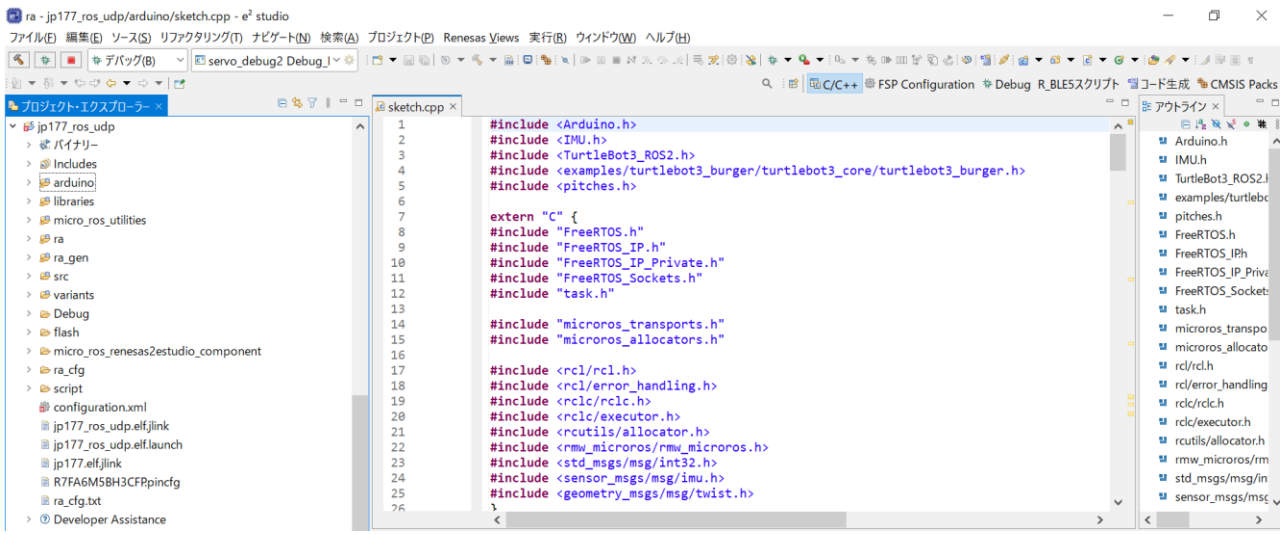


4. Software

4.1 micro-ROS client

There is the example project “jp177_ros_udp_xxxx” for micro-ROS client application for Turtlebot3, which can be compiled on e2studio windows and also enables to develop with Arduino libraries. Please contact to Renesas representative to get the example program.

The example program is based on the demo program provided by eProsima. Refer to the below GitHub link to build your own project. Note that Linux PC is needed to build all the source files.
https://github.com/micro-ROS/micro_ros_renesas_demos



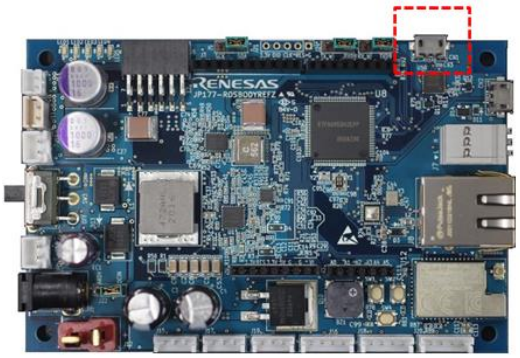
4.2 Command line for flash

There is the command line application “raflasher” which enables to flash MCU easily. The raflasher is included in the example project /root/flash/. Refer to “readme.txt” for how to command.

The below figure shows the image of command for flash on Windows command prompt.

```
>raflasher --version
v1.00
>raflasher --port
Valid ports: COM50
>raflasher ..\Debug\jp177_ros_udp.hex COM50 0 ra
2022/11/22 12:51:08: enter programming mode...OK
2022/11/22 12:51:08: init communication...OK
2022/11/22 12:51:08: ckeck authentication...OK
2022/11/22 12:51:09: erasing 0x00000000 - 0x0000ffff area...OK
2022/11/22 12:51:09: writing 0x00000000 - 0x0000ffff area...0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%...OK
2022/11/22 12:51:17: erasing 0x00010000 - 0x001fffff area...OK
2022/11/22 12:51:20: writing 0x00010000 - 0x0002c2ff area...0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%...OK
2022/11/22 12:51:34: exit programming mode...OK
```

The below USB connector is used for flash.



Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.00	Nov.22, 2022	—	First edition issued

General Precautions in the Handling of Micro processing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Micro processing 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 near the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals

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

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

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

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

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