Rhino Industrial 250W Brushless DC Motor Drive with RTU Modbus (Model No: RMCS – 3001)

Operating Manual v1.0

Contents

Introduction – Salient Features

Rhino Motion Controls RMCS-3001 is 250W RTU Modbus high performance brushless dc drive. It supports (15–48V DC) and it is designed for optimized operation of Rhino brushless DC motors with Hall sensor. This is an amazing cost effective solution to provide closed loop / open loop control for various applications. The salient features of this drive:

- This drive provides a closed loop / open loop speed control for the brushless dc system.
- This drive has speed feedback (Hz) and current feedback (A).
- This drive have option to control the length of motion, once the length of that motion is exceed the motor will automatically enter brake condition.
- The drive will provide full torque at all speeds within the range.
- This drive is designed for smooth and quiet operation without compromising on torque and control at higher speeds.
- There is an LED indication for power and error state in this drive.
- It is possible to run the motor in five different modes.
- It has short-circuit protection for the motor outputs, over-voltage and under-voltage protection and will survive accidental motor disconnects while powered-up.
- This drive is configured using MODBUS RTU protocol through RS485 Communication.
- There is a function in the drive for setting the Modbus Slave Address from 1 to 247 using MODBUS Tool Device (Software Setting).
- There is an onboard Potentiometer to control speed of motor in Analog control mode.
- There are five user modes in the drive :
    - Mode 0: Analog Open Loop Mode
    - Mode 1: Digital Closed Loop Mode
    - Mode 2: Digital Open Loop Mode
    - Mode 3: Analog Closed Loop Mode
    - Mode 4: Analog Closed Loop Minimum Speed Control Mode

Technical specifications and Pindescription

Supply Voltage and Current

Specification	Min	Max	Units	Comments
Supply Voltage	15	48	Volts DC	Between +Ve and GND
Phase Current	0.5	5	Amps	Peak 5 Amps per phase

Pin description of the drive is as per below image:

Pin No.	Description
1	RS485(D-)
2	RS485(D+)
3	BRK(+5V)
4	DIR(+5V)
5	ENA(+5V)
6	GND

(Pins 1-6 are used for drive and RS485 Configuration)

Pin No.	Description
7	GND
8	+5V
9	HW
10	HV
11	HU
12	Shield Cable

(Pins 7 - 12 are Hall encoder)

Pin No.	Description
13	W
14	V
15	U
16	+Ve
17	GND

(Pins 13 - 17 are connected to motor and power supply as described)

Modbus Registers

Register	Data Address (Decimal)	Access	Size (bit)	Function	Range /Command And Default value in HEX (Decimal)	Specification	Description
40001	0	Read / Write	16 bit	Write Parameters to EEPROM	FF (255)		To save parameters in Drive (EEPROM) send Hex value XXFF to Address 0. Where XX is **slave ID** ranging from 1 to F7(1 - 247) For example: If slave id is 7 then write 07FF.
				Modbus Slave Address	Range:1-F7 (1-247) Default: 1 (1)		Slave ID can be changed using Modbus tool software
				Reset default parameters	0008(8)		Writing 0008 in address 0 will load default values in drive.
40003	2	Read / Write	16 bit	**Modes (Default value: 0)**			
				Analog Open Loop Mode **(Mode 0)**	0001(1)	Mode byte:00 Control byte:01	Enable motor For analog mode use onboard potentiometer.
					0000(0)	Mode byte:00 Control byte:00	Disable motor
					0003(3)	Mode byte:00 Control byte:03	Brake
				Digital Closed Loop Mode **(Mode 1)**	0101(257)	Mode byte:01 Control byte:01	Enable motor in CW
					0100(256)	Mode byte:01 Control byte:00	Disable motor
					0109(265)	Mode byte:01 Control byte:09	Enable Motor in CCW
					0103(259)	Mode byte:01 Control byte:03	Brake
				Digital Open loop Mode **(Mode 2)**	0201(513)	Mode byte:02 Control byte:01	Enable motor in CW
					0200(512)	Mode byte:02 Control byte:00	Disable motor
					0209(521)	Mode byte:02 Control byte:09	Enable Motor in CCW
					0203(515)	Mode byte:02 Control byte:03	Brake
				Analog Closed Loop Mode **(Mode 3)**	0301(769)	Mode byte:03 Control byte:01	Enable Motor
					0300(768)	Mode byte:03 Control byte:00	Disable Motor
					0303(771)	Mode byte:03 Control byte:03	Brake

				Analog Closed Loop Minimum Speed Control Mode **(Mode 4)**	0401(1025)	Mode byte:04 Control byte:01	Enable Minimum Speed Control Mode. Set PWM speed in address 4.
40005	4	Read / Write	16 bit	PWM	Range: 0000-12C0 (0-4800) Default: 0 (0)		Set PWM for digital open loop Mode and Analog Closed Loop Minimum Speed Control Mode
40007	6	Read/ Write	16 bit	Frequency (Hz)	Range: 0000 – 0190 (0 - 400) Default: 0(0)		Set Frequency for digital closed loop mode ***Speed [rpm] = 60 * freq [Hz] / number of pair poles***
40009	8	Read only	16 bit	Speed Feedback	Range:0000-FFFF (0-65535)		Current Speed of motor (Hz)
40011	10	Read only	16 bit	Current Feedback	Range:0000-FFFF (0-65535)		Current Feedback (A)
40013	12	Read / Write	16 bit	Movement limit	Range:(0 to 32767) Default: 7FFF(32767)		Control length of motion

Modbus Register_Mapping

- **Device Modbus Address(MOD _ID)**

Address: 0x00 (40001)
Default value: 0x01FF

MOD_ID[15:8]								SP[7:0]							
rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw	rw

Bits 15:8 **MOD_ID [15:8]:** Modbus address register bits
Default: 0x01
Maximum value: 0xF7
Minimum value: 0x01

Bits 7:0 **SP [7:0]:** Save parameters
Default: 0x00

If slave id is 7 then by writing 07FF in this address will save parameters in eeprom and writing 0800 will load default value in drive.

- **Control and Mode Register**

Address: 0x02(40003)
Default value: 0x0000

MODE[15:8]								CRTL[7:0]							
0	0	0	0	rw	rw	rw	rw	0	0	0	0	DIR	0	BRK	EN

Bits 15:8 **MODE [15:8]:** Mode byte
Default: 0x00

Bits [11:8] **0000**: Analog Open Loop Mode
0001: Digital Closed Loop Mode
0010: Digital Open Loop Mode
0011: Analog Closed Loop Mode

Bits 7:0 **CRTL [7:0]:** Control Byte
Default: 0x00

Bit 1 **BRK**: Brake
0: Disable Brake
1: Enable Brake

Bit 3 **DIR:** Direction (only Digital mode)
0: Clockwise direction
1: Counter-clockwise direction

Bit 0 **EN**: Enable bit
0: Disable mode
1: Enable mode

Brake has more priority than enable.

- **PWM Register(PWM)**

Address: 0x04 (40005)
Default value: 0x0000

PWM[15:0]
rw

Bits 15:0 **PWM [15:0]:** PWM
Default: 0x0000
Maximum value: 0x12C0
Minimum value: 0x0000

PWM Signal depends on the application. PWM range of this drive is 0-4800 (decimal) value. Set PWM for open loop mode.

- **Frequency Register(FRQ)**

Address: 0x06 (40007)
Default value: 0x0000

FRQ[15:0]
rw

Bits 15:0 **FRQ [15:0]:** Frequency
Default: 0x0000
Maximum value: 0x0190
Minimum value: 0x0000

- **Speed Feedback Register(SPD)**

Address: 0x08 (40009)
Default value: 0x0000

SPD[15:0]
r

Bits 15:0 **SPD [15:0]:** Speed Feedback Register

This register stores current frequency to find current speed of motor use below equation. Find number of poles from datasheet of motor.

Calculate RPM from frequency:
Speed [rpm] = 60 * freq [Hz] / number of pair poles
Note: **There is 10% error in output RPM of the motor. If gear box is attached then output rpm is different.**

- **Current Feedback Register(CUR)**

Address: 0x0A (40011)
Default value: 0x0000

CUR[15:0]
r

Bits 15:0 **CUR [15:0]:** Curent Feedback Register
This register stores current drawn value. Unit is A (Ampere).

- **Movement Limit(MVL)**

Address: 0x0C (40013)
Default value: 0x7FFF

MVL[15:0]
rw

Bits 15:0 **MVL [15:0]:** Movement Limit Register

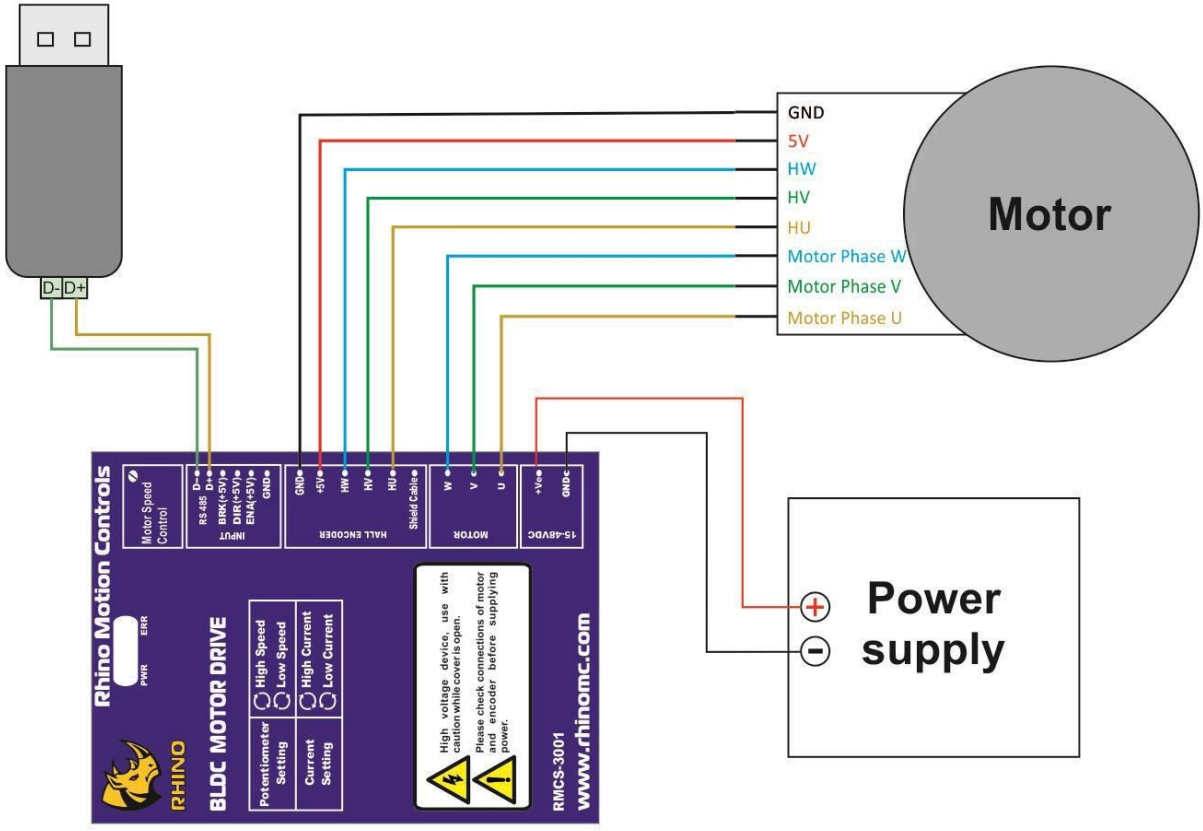
In digital closed loop mode (01) there is option to control the length of motion, once the length of that motion is exceed the motor will automatical
enter in brake condition. Range of this address is -32767 to +32767.

Control Modes

Motor can be run in 5 different modes:

- Mode 0: Analog Open Loop Mode
- Mode 1: Digital Closed Loop Mode
- Mode 2: Digital Open Loop Mode
- Mode 3: Analog Closed Loop Mode
- Mode 4: Analog Closed Loop Minimum Speed Control Mode

Hardware Connection:



Drive Pin outs	
Pin No.	Description
7	GND
8	+5V
9	HW
10	HV
11	HU
12	Shield Cable
13	W
14	V
15	U
16	+Ve
17	GND

Motor Pin outs	
Motor	Wire Color
GND	Black
+5V	Red
HW	Blue
HV	Green
HU	Yellow
W	Thick blue
V	Thick green
U	Thick Yellow

Power Supply Pin outs
VCC – 15 to 48V
GND

Drive Pin outs	
Pin No.	Description
1	D-
2	D+
3	BRK
4	DIR
5	ENA
6	GND

USB to RS485 Converter
D-
D+

Mode 0 Analog Open Loop Mode: for implementing pid controller

a. In this mode the speed of the Rhino BLDC motor can be controlled by using Potentiometer which is available at the corner side of drive.
b. User can increase or decrease the speed manually based on requirement by using Potentiometer.
c. Also the Enable, Brake and Direction Inputs are available in this drive for this mode.
d. Need to connect Enable pin with 5V and Gnd pin with Gnd to run motor in analog control mode.
e. Direction and brake can only be applied by connecting DIR or BRK pin to 5V.

Mode 1 Digital Closed Loop Mode:

a. In this mode the speed and direction of the Rhino BLDC Motor is settable / controllable via a Computer / Arduino Controller board / any other Modbus RTU compatible device.
b. Also in this mode the direction of the motor can be controlled digitally via modbus RTU commands to run the BLDC motor in both directions
c. In this mode there is option to control the length of motion, once the length of that motion is exceed the motor will automatically enter brake condition.
d. Example of position control mode:

- Set the speed frequency in register 6 to say 40 Hz
- Set the distance of travel in register 12 to say 100
- Set the mode in 40003 (2) and enable with hex value 0101 (257).
- The motor will travel 100 poles at speed of 40hz and then enter brake stat
- Once again set the distance of travel, the speed frequency as per steps 1 and 2
- Enable the motor with opposite direction motor in 40003(2) with 0109 hex value (265)

Mode 2 Digital Open Loop Mode: chance of making into closed loop used mpu6050 sensor as feedback

a. In this mode user can increase or decrease speed of motor as per PWM setting.
b. This mode is PWM Controlled Mode.
c. The use of pulse width modulation (PWM) to control a small motor has the advantage in that the power loss in the switching transistor is small because the transistor is either fully “ON” or fully “OFF”.
d. As a result the switching transistor has a much reduced power dissipation giving it a linear type of control which results in better speed stability.
e. Pulse width modulation is a great method of controlling the amount of power delivered to a load without dissipating any wasted power.

Mode 3: Analog Closed Loop Mode:

a. In this mode the speed of the Rhino BLDC motor can be controlled by PWM value.
b. As this is closed loop mode no need to connect enable pin to 5v.
c. The drive will provide full torque at all speeds within the range.
d. Brake can be applied through software setting.
e. Direction cannot be changed in this mode.

Mode 4: Analog Closed Loop Minimum Speed Control Mode:

a. In this mode user can set the **minimum speed** of the motor by software setting and the set speed will affect in analog mode.
b. Basically user can define minimum speed of motor in this mode.
c. The drive will provide full torque at all speeds within the range.
d. Direction cannot be changed in this mode.

Troubleshooting

a. If motor is not moving in digital closed loop mode read value in frequency register.

b. If motor is not moving in digital open loop mode read value in PWM register.

c. If motor is not running in analog mode check potentiometer position and check enable connection as it must be connected with 5V. Gnd is connected with Gnd.

d. If timeout error check hardware connections of motor, power supply, RS485 module connections. Also check slave id is correct or not.

e. If error light is blinking reset power and if any parameters are saved in drive then write reset command in drive.