HIGH PRECISION GEARED
# SERVO MOTORS
## RDrive 85

# USER MANUAL



**ROZUM** ROBOTICS

**RDrive**
RDRIVE BY ROZUM ROBOTICS

# INTRODUCTION

Rozum Robotics has designed its RDrive servo motors to enable precision motion control in industrial and commercial applications.

This manual is intended for technicians and engineers who design, build, and operate systems and machinery that use RDrive servo motors for actuation. In this document, you will find the following information:

- basic features and components of RDrive servo motors
- requirements on additional equipment for correct and safe operation of RDrive servo motors
- specifications of the RDrive 85 servo motor, as well as its allowable radial and axial loads
- requirements and instructions on mechanical and electrical integration of the RDrive 85 servo motor
- instructions and recommendations on implementing motion control of RDrive servos
- maintenance, transportation, and storage recommendations

# WARNING SIGNS AND THEIR MEANINGS

Below, you can see the warning symbols used throughout the manual and their meaning.

*The sign denotes important information that is not directly related to safety, but that the user should be aware of.*

*The sign indicates important safety precautions the user should follow.*

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# 1. PRODUCT OVERVIEW

## 1.1. Basic features and components

RDrive servo motors are intended to ensure high-precision rotary motion. Their *basic features* are as follows:

- a compact hollow-shaft design allowing for easy integration
- a built-in strain-wave gearhead with an almost-zero backlash
- an integrated controller supporting CAN communication
- two 19-bit absolute magnetic encoders providing motion feedback

Figure 1-1 is an exploded view of an RDrive servo motor in a housing.
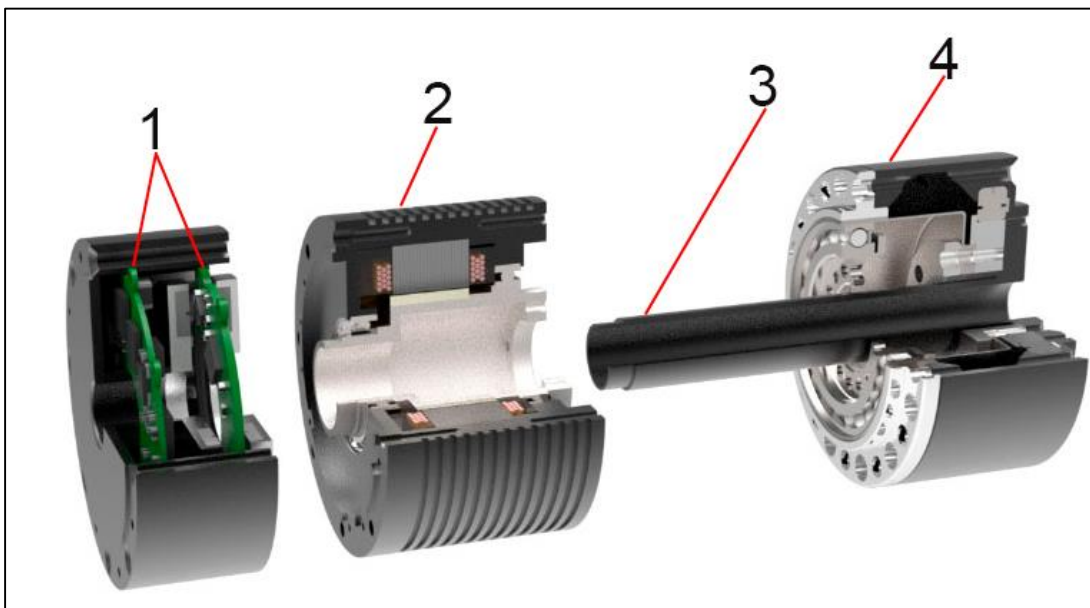


**Figure 1-1: The components of an RDrive servo motor**

| | |
|---|---|
| **(1)** | Two printed circuit boards (PCBs) connected with each other by means of a BiSS line (not visible in Figure 1-1). One of the PCBs incorporates a controller and the other—two encoders. |
| **(2)** | A frameless brushless alternating current (AC) motor comprising a rotor and a stator, as well as a negative temperature coefficient (NTC) thermistor (fitted into the stator winding). |
| **(3)** | A hollow shaft for laying the cables to connect the servo to a machine. |
| **(4)** | A strain-wave gearhead that reduces rotation speed (RPM) and increases motor torque. |

By design, the RDrive servo motor also comprises a **cable gland** (not visible in Figure 1-1) located on its rear flange. The gland includes four wires:

- two wires for connecting the servo to a power supply
- two wires for enabling CAN communication

## 1.2. Supply package

The supply package for an RDrive servo motor comprises the following:

- one or more RDrive servos
- one CAN-USB dongle

*Each supply package includes one CAN-USB dongle only, irrespective of the total quantity of servos in it. However, users can order more dongles for an extra charge.*

## 1.3. CAN-USB dongle

A CAN-USB dongle is a special adapter coupled to a USB port of a personal computer (PC) to provide CAN connectivity between an RDrive servo and the PC.

The dongle has two connectors (see Figure 1-2):

**(1)** for connecting the device to a CAN bus (type: Molex 0022035045 Connector)

**(2)** for connecting a Micro USB-USB A cable
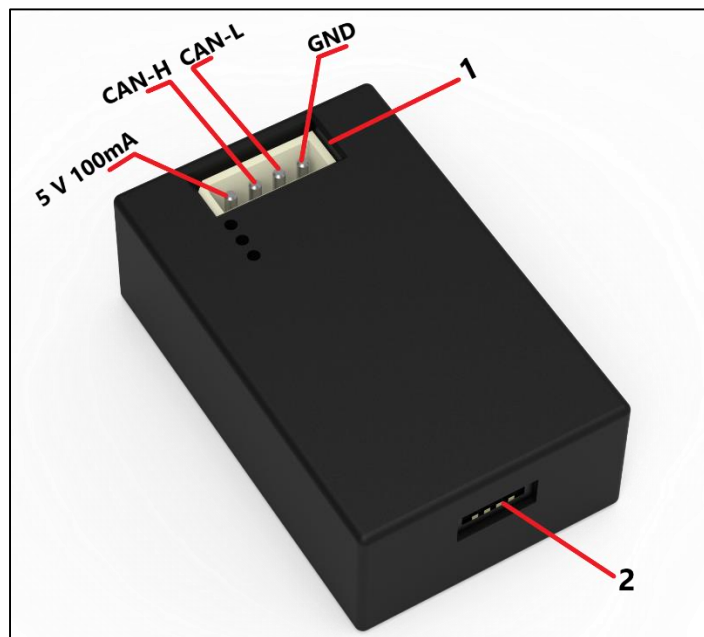


**Figure 1-2: The CAN-USB dongle in the RDrive supply package**

The supply package for a CAN-USB dongle comprises:

- a CAN-USB dongle (see Figure 1-2)
- a Micro USB-USB A cable
- a Molex 0050375043 connector housing and Molex 08-70-1039 pins for providing CAN bus connection

## 1.4. Required additional equipment

For **safe and correct operation** of RDrive servo motors, **it is obligatory** to integrate the following components into the power supply circuit:

- at least one **energy eater** to dissipate dynamic braking energy

⚠️ *When not dissipated, dynamic braking energy can cause servos to generate voltages in excess of the power supply voltage, which can damage servos beyond repair.*

- at least one **capacitor** to compensate for short-term power consumption peaks due to inductive resistance

To address the requirement, we offer a **servobox solution**, available for ordering as an option. For more information about the servobox, refer to the **Rozum Robotics Servobox Manual**. The document is available at https://rozum.com/support/docs/servo-api/group__hw__manual.html.

ℹ️ *In the servo box manual, users can also find instructions how to assemble a similar solution on their own.*

## 1.3. Intended use and operating conditions

RDrive motors are designed for industrial and commercial use. Possible applications are as follows:

- robots or drones
- model aircrafts
- conveyor belts, sorting and assembly lines
- packing equipment
- solar batteries
- metal-cutting, molding, woodworking, and other industrial machines
- rotary antennas
- automated door-opening mechanisms (doors, gates, etc.)
- 3D printers
- and other mechanisms where you need to provide high-precision rotary motion

**Inadmissible applications** include explosive or otherwise hazardous areas, as well as locations with highly corrosive atmospheres.

**Table 1-1: Operating conditions of RDrive servo motors**

| Parameter | Value |
|---|---|
| Altitude | Not higher than 1,000 m above the sea |
| Operating temperature | 0°C to +35°C |
| Operating humidity | 80% max at 25°C (90% at 20°C) |
| IP protection | IP20 |

⚠️ *Avoid exposing servo motors to any operating conditions outside of the above specifications. This can damage their components and/or reduce their service life.*

# 2. PRODUCT SPECIFICATIONS

## 2.1. Specifications of the RDrive 85 servo motor

Table 2-1 contains performance, electrical, and mechanical specifications, as well as dimensions of the RDrive 85 servo motor.

**Table 2-1: Specifications of the RDrive 85 servo motor**

| PERFORMANCE DATA | | |
|---|---|---|
| Rated rotation speed | 40 | RPM |
| RMS current | 8.8 | A |
| Rated torque | 108 | N·m |
| Peak torque | 157 | N·m |
| Torque const (Kt) at 20°C | 112 | mN·m/A |
| Service life | 35,000 | hours |
| **ELECTRICAL DATA** | | |
| Rated power | 450 | W |
| Supply voltage | 48 | V |
| **MECHANICAL DATA** | | |
| Gear motor inertia | 0.32 | kg·cm² |
| Weight | 2.1 | kg |
| IP rating | IP 21* | |
| **DIMENSIONS** | | |
| Length (L): | 112,5 | mm |
| Max diameter (D): | 88 | mm |
| Hollow shaft diameter (d): | 13 | mm |

*Upon request, RDrive servo motors can be supplied with a higher IP rating.*

In Table 2-2, you will find basic specifications of the gearhead integrated into the RDrive servo.

**Table 2-2: The RDrive gearhead data**

| GEARHEAD DATA | | |
|---|---|---|
| Gearhead type | Strain-wave | |
| Gearhead ratio | 1:100 | |
| Gearhead backlash | 0.3 | arcmin |

## 2.2. Allowable axial and radial loads

The gearhead in the RDrive servo motor incorporates a high-rigidity crossed roller bearing to support output loads. The bearing can withstand high axial and radial forces, as well as high tilting moments. It keeps the gearhead protected from external loads, which guarantees long life and consistent performance of the gearhead.

Table 2-3 lists allowable axial and radial loads for RDrive 85 servo motors.

**Table 2-3: Allowable axial and radial loads for RDrive 85 servos**

| Allowable axial load, $F_a$ [N][1][2] | 2,000 |
|---|---|
| Allowable radial load, $F_r$ [N] [1][2] | 1,330 |

[1] These data are valid for n = 15 RPM and $L_{lo}$ = 25,000 h, where $L_{lo}$ is the operating life of the output bearing.
[2] These data are valid, only provided the following conditions are met:

For:
- **Fa**: M = 0; **Fr** = 0;
- **Fr**: M = 0; **Fa** = 0,
where **M** is the tilting moment.

# 3. MOTION CONTROL

## 3.1. Motion control principle

The motion control system of RDrive servo motors is of the closed-loop type: it not only receives motion control commands from a control device, but also provides feedback on their execution. The system consists of a self-designed controller and two encoders (see Section 3.2).

The operation of the motion control system involves the following interactions:

- The controller receives a control command from a control device (e.g., a PC or a CAN master) and applies current to a frameless AC motor to produce motion with required parameters.

- The two encoders monitor the absolute positions of the rotor and output shaft and send feedback to the controller.

- The controller processes the feedback, compares the resulting values with the control command, and sends a signal to adjust the motor position, if needed.

- In addition, the controller receives and processes feedback signals from the NTC thermistor in the motor winding. When the value based on the thermistor reading exceeds the maximum temperature limit, the controller cuts the servo off.

## 3.2. Motion feedback

RDrive servo motors comprise two integrated feedback devices—absolute magnetic encoders. The two encoders are mounted on a separate PCB connected with the controller PCB by means of a flat cable (a BiSS line). One of the encoders delivers information about the absolute position of the output shaft and the other—about that of the rotor.

**Table 3-1: Encoder data**

| Type | rotary magnetic single-turn |
|------|------|
| **Output** | absolute position |
| **Resolution** | 19-bit |

## 3.3. Motion control implementation

You can implement motion control of RDrive servo motors in either of the two ways:

- based on CANOpen communication
- via Application Programming Interface (API)

### 3.3.1. CANOpen communication

CANOpen communication implemented for RDrive servos relies on the Controller Area Network (CAN) for its physical infrastructure. CAN is a two-wire bus line (see Section 4.2.4) that transmits differential signals—$CAN_{HIGH}$ and $CAN_{LOW}$.

On a higher level, CANOpen communication for RDrive servos is implemented as a stack of CANOpen protocols. The protocols monitor the network states and transmit and/or read CAN data frames containing various types of data (e.g., commands, parameters, servo telemetry) in the binary format.

For a detailed description of the CANOpen communication interface implemented for RDrive servos and related application cases, refer to **"RDrive Servo Motors. CANOpen Communication Guide."**

### 3.3.2. User API

For enabling motion control of RDrive servos via API, you need the following:

- an appropriate CAN-to-PC connection (see Section 4.2.4.1)
- a CAN-USB dongle (see Section 1.3)

  *If your PC runs Windows 8 or earlier versions of the operating system, you will need to download and install a driver to be able to work with the CAN-USB dongle. For the downloading link and installation instructions, go to the webpage: https://www.st.com/en/development-tools/stsw-stm32102.html.*

- a standard Micro USB-USB A cable to connect the dongle to a computer (included into the supply package of the CAN-USB dongle)

- a special software library to be installed on your computer

    The library is written in the C language and is available for downloading at the following GitHub repository: https://github.com/rozum-robotics/Rozum-Servo-Drives-API. In the repository, you will also find wrappers for Java, Python, and Ruby, as well as library compilation and installation requirements and instructions.

For details of controlling RDrive motors with API function calls and tutorials with sample programs, refer to the User API Guide for RDrive Servo Motors (also available for downloading at: https://rozum.com/support/docs/servo-api/RR-UserAPI.pdf).

# 4. INTEGRATION INTO AN APPLICATION

## 4.1. Installation requirements

⚠️ *Magnetic-sensitive objects, such as banking cards, pacemakers, or other magnetic information carriers, should be kept away at a distance of 1 m from the motor.*

RDrive servo motors are intended for installation as part of a motion system or a machine. You can mount the actuators in any required position — vertical, horizontal, or at an angle. The installation site should meet the following requirements:

- Well-ventilated and free from dust, moisture, and vibration
- Ambient temperature, altitude, and other environmental conditions as specified in Table 1-1
- Easy access for inspection and dismantling

## 4.2. Installation procedure

The procedure for installing an RDrive servo motor includes the following steps:

1. Preparing for installation
2. Mechanical integration
3. Connecting to a power supply
4. Providing CAN or CAN-to-PC connection
5. Pre-commissioning checks

### 4.2.1. Preparation

The preparation sequence is as follows:

1. Unpack the servo motor.

⚠️ *Never lift or pull servo motors by cables!*

⚠️ *Make sure to avoid shocks as this can damage high-precision encoders inside servos.*

2.  Check the fitting surfaces of both the servo and the machine for visible damages.

⚠️ ***Using damaged servos is forbidden because it can result in unintended operation of the machine and endanger the operator.***

3.  Clean the fitting surfaces with a lint-free cloth and a suitable cleaning agent, if needed, and degrease them.

### 4.2.2. Mechanical integration

ℹ️ *For mating dimensions and surfaces, see the confirmation drawings available for downloading at* https://rozum.com/servomotors-documentation/.

For mechanical integration, proceed as below:

1.  Fasten the servo to a mounting surface. To do this, you can proceed in either of the two ways:

    **A.** Insert twelve M4 screws into the holes on the rear mounting flange and tighten them to the torque of 4 N·m max.

    **B.** Screw the servo down on its front cover with twelve M4 screws. The tightening torque should be 4 N·m max.

ℹ️ *Allow for sufficient clearance around the servo for proper heat dissipation.*

2.  Attach a load to the output shaft. To do this, use the twelve M4 holes on the shaft, applying the tightening torque of 4.5(*) N·m max.

ℹ️ *(*) The tightening torque value is indicated for 12.9 class screws.*

⚠️ ***Make sure not to apply excessive impact or force to the output flange.***

### 4.2.3. Connecting to a power supply

⚠️ ***Before starting any wiring works, make sure that no power is supplied to the circuit you are assembling.***

The power supply wiring of RDrive servo motors comprises two wires. For the color scheme, cable arrangement, and protective earthing, refer to the installation drawing available at: https://rozum.com/servomotors-documentation/.

### Safe power supply requirement

For correct and safe operation of RDrive servo motors, their power supply circuit should include:

-   at least one energy eater

- one capacitor

For detailed requirements and a schematic to provide a safe power supply circuit with an eater and a capacitor, refer to the **Rozum Robotics Servobox Manual**. The document is available in a web version at https://rozum.com/support/docs/servo-api/group__hw__manual.html.

### 4.2.4. CAN connection

### 4.2.4.1. CAN connection requirements

Whether you connect RDrive servos directly to a CAN bus or provide a CAN-to-PC connection, make sure to comply with the following requirements:

- CAN bus lines of less than 40 m long should be terminated with 120 Ohm resistors at both ends. For bus lines of over 40 m long, use 150-300 Ohm resistors.

  *In a CAN-to-PC connection, you have to provide only one resistor because one is already integrated into the CAN-USB dongle included in the RDrive supply package.*

- The bus line cable must be a twisted pair cable with the lay length of 2 to 4 cm.

- The configuration should be as shown in Figure 4-1 (for direct CAN connection) and Figure 4-2 (for CAN-to-PC connection).

- For the cross section of the bus line, see Table 4-1.

- To ensure the baud rate required for your application, $L\Sigma$ should meet the specific values as indicated in Table 4-1.

**Table 4-1: CAN line parameters**

| Baud Rate | 50 kbit/s | 100 kbit/s | 250 kbit/s | 500 kbit/s | 1 Mbit/s |
|---|---|---|---|---|---|
| Total line length, $L\Sigma$, m | < 1000 | < 500 | < 200 | < 100 | < 40 |
| Cross-section, mm2 | 0.75 to 0.8 | 0.5 to 0.6 | 0.34 to 0.6 | 0.34 to 0.6 | 0.25 to 0.34 |
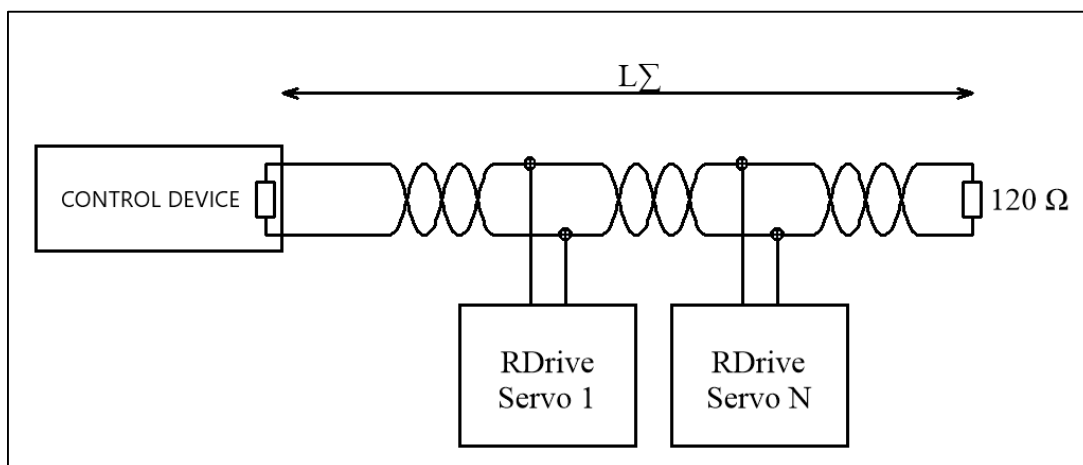


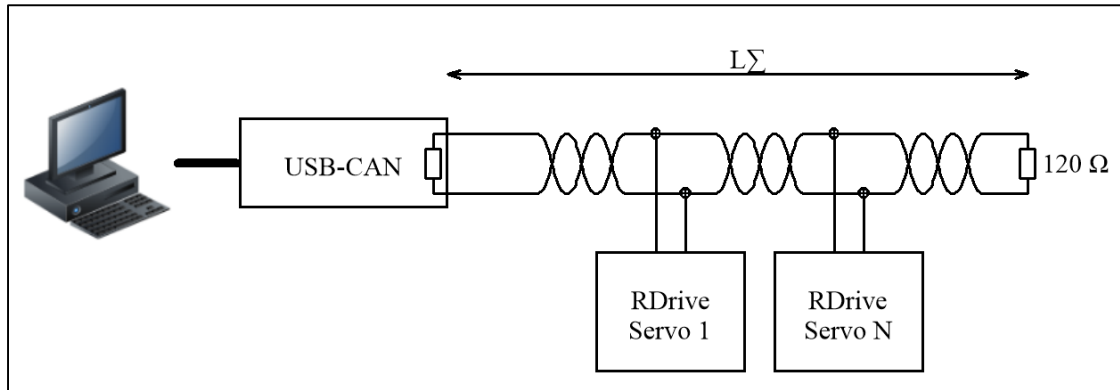**Figure 4-1: Direct CAN connection**

**Figure 4-2: CAN-to-PC connection**

### 4.2.4.2. Connecting multiple servos

To avoid collisions, each servo connected to a CAN bus line must have a unique CAN identifier. However, RDrive servo motors are all supplied with the same **default ID—32**. Therefore, an important step of connecting multiple RDrive servos to a single CAN bus line is to change their default IDs to unique ones.

Start with connecting each of your multiple servos, one by one, to a CAN bus line, following the sequence as described below:

⚠️ *Never connect or disconnect servos when power supply is on!*

1. Take a servo and connect it to the CAN bus line as described in Section 4.2.4.1.
2. Change the default ID of the connected servo as detailed in the corresponding User API tutorial (available at https://rozum.com/support/docs/servo-api/)**.**
3. Remember or write down the newly assigned CAN ID and disconnect the servo.
4. Repeat Steps 1 to 3 for all the servos you want to connect to the same CAN bus line.

Once you have changed all CAN IDs as appropriate, you can connect all the servos back to the CAN bus line and start working with them.

### 4.2.5. Pre-commissioning checks

Before commissioning a servo, it is advisable to check whether the following is up to requirements:

- Mechanical integration (refer to Section 4.2.2)
- Electrical integration (see Section 4.2.3):
  - protective earthing
  - tight connection and integrity of power supply and communication wires
  - at least one energy eater and one capacitor integrated into the supply circuit of the servo (see Section 1.4 and the Rozum Robotics Servobox Manual)
- CAN connection (see Section 4.2.4)
- Operating conditions (refer to Table 1-1 and Section 4.1)

# 5. MAINTENANCE

RDrive servo motors contain no parts that users need to service. Therefore, the maintenance scope is limited to the following:

- Visual inspection of electrical connections for damages

- Checking screw connections and tightening the loosened ones

- Monitoring vibration and noise levels, as well as heating during daily operation

*The above-listed maintenance procedures are not mandatory. It is up to the user to decide to follow the recommendations or not, depending on the application-specific conditions (e.g., whether a servo is accessible for visual inspection).*

# 6. TROUBLESHOOTING

Table 6-1 describes the most common problems that can occur during operation of RDrive servo motors, their possible causes, and recommended user actions.

**Table 6-1: Possible servo problems, their causes, and recommended actions**

| Problem | Possible cause | Recommended action |
|---|---|---|
| The motor won't start. | Improper connection. | Check the motor connections. |
| | Incorrect motor control settings. | Check the motor control settings or contact our service department. |
| The motor is overheating. | Excessive accumulation of dirt. | Clean the outside of the motor. |
| | Ambient temperature is too high. | Provide adequate cooling. |
| | Air pressure is too low because of the altitude. | Provide adequate cooling. |
| | The motor is too hot. | Check the power supply is up to the specifications (Table 2-1) or contact our service department. |
| Increased noise during operation. | Damaged bearing. | Contact our service department. |
| Sporadic failure. | Damaged cable. | Contact our service department. |

*Only qualified service personnel can perform repair works.*

# 7. TRANSPORTATION AND STORAGE

For transporting the RDrive servo motor, always use the original packaging. In case you have no plans to put the servos into operation immediately upon delivery, make sure to meet the following storage requirements:

- Store servo motors in a dry, dust- and vibration-free location.
- The admissible storage temperature range—from +5°C to +40°C.
- The storage humidity should be 80% max at 25°C (90% at 20°C).