# User's guide

# RD4

CANopen

Position measurement & control

# General contents

# Subject Index

# Typographic and iconographic conventions

In this guide, to make it easier to understand and read the text the following typographic and iconographic conventions are used:

- parameters and objects both of Lika device and interface are coloured in ORANGE;
- alarms are coloured in RED;
- states are coloured in FUCSIA.

When scrolling through the text some icons can be found on the side of the page: they are expressly designed to highlight the parts of the text which are of great interest and significance for the user. Sometimes they are used to warn against dangers or potential sources of danger arising from the use of the device. You are advised to follow strictly the instructions given in this guide in order to guarantee the safety of the user and ensure the performance of the device. In this guide the following symbols are used:

| | |
|---|---|
|  | This icon, followed by the word **WARNING**, is meant to highlight the parts of the text where information of great significance for the user can be found: user must pay the greatest attention to them! Instructions must be followed strictly in order to guarantee the safety of the user and a correct use of the device. Failure to heed a warning or comply with instructions could lead to personal injury and/or damage to the unit or other equipment. |
|  | This icon, followed by the word **NOTE**, is meant to highlight the parts of the text where important notes needful for a correct and reliable use of the device can be found. User must pay attention to them! Failure to comply with instructions could cause the equipment to be set wrongly: hence a faulty and improper working of the device could be the consequence. |
|  | This icon is meant to highlight the parts of the text where suggestions useful for making it easier to set the device and optimize performance and reliability can be found. Sometimes this symbol is followed by the word **EXAMPLE** when instructions for setting parameters are accompanied by examples to clarify the explanation. |

# Preliminary information

This guide is designed to provide the most complete information the operator needs to correctly and safely install and operate the **ROTADRIVE positioning units RD4 model**.
RD4 units are positioning devices which integrate into one system a brushless motor fitted with gearbox, a drive, a multiturn absolute encoder and a position controller. They can be used in a variety of applications in any industrial sector and are suitable to drive secondary axes such as in mold changers, mobile stops, tools changers, suction cups motion units, conveyor and spindle positioning devices on packaging & woodworking machineries, among others.

The available interfaces for fieldbus communication are: **Modbus RTU**, **Profibus-DP** and **CANopen DS 301**.

To make it easier to read the text, this guide can be divided into two main sections.
In the first section general information concerning the safety, the mechanical installation and the electrical connection as well as tips for setting up and running properly and efficiently the unit are provided.
While in the second section, entitled **CANopen Interface**, both general and specific information is given on the CANopen interface. In this section the interface features and the parameters implemented in the unit are fully described.

# 1 Safety summary

## 1.1 Safety

- Always adhere to the professional safety and accident prevention regulations applicable to your country during device installation and operation;
- installation and maintenance operations have to be carried out by qualified personnel only, with power supply disconnected and stationary mechanical parts;
- device must be used only for the purpose appropriate to its design: use for purposes other than those for which it has been designed could result in serious personal and/or the environment damage;
- high current, voltage and moving mechanical parts can cause serious or fatal injury;
- warning ! Do not use in explosive or flammable areas;
- failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the equipment;
- Lika Electronic s.r.l. assumes no liability for the customer's failure to comply with these requirements.

## 1.2 Electrical safety

- Turn OFF power supply before connecting the device;
- connect according to explanation in section "Electrical connections";
- a safety push-button for emergency power off has to be installed to shut off motor power supply in case of emergency situations;
- in compliance with 2004/108/EC norm on electromagnetic compatibility, following precautions must be taken:
  - before handling and installing the equipment, discharge electrical charge from your body and tools which may come in touch with the device;
  - power supply must be stabilized without noise; install EMC filters on device power supply if needed;
  - always use shielded cables (twisted pair cables whenever possible);
  - avoid cables runs longer than necessary;
  - avoid running the signal cable near high voltage power cables;
  - mount the device as far as possible from any capacitive or inductive noise source; shield the device from noise source if needed;
  - to guarantee a correct working of the device, avoid using strong magnets on or near by the unit;

- minimize noise by connecting the shield and/or the connector housing and/or the frame to ground. Make sure that ground is not affected by noise. The connection point to ground can be situated both on the device side and on user's side. The best solution to minimize the interference must be carried out by the user.

### 1.3 Mechanical safety

- Install the device following strictly the information in the section "Mounting instructions";
- mechanical installation has to be carried out with stationary mechanical parts;
- do not disassemble the unit;
- do not tool the unit or its shaft;
- delicate electronic equipment: handle with care; do not subject the device and the shaft to knocks or shocks;
- respect the environmental characteristics of the product;
- unit with solid shaft: in order to guarantee maximum reliability over time of mechanical parts, we recommend a flexible coupling to be installed to connect ROTADRIVE and user's shaft; make sure the misalignment tolerances of the flexible coupling are respected;
- unit with hollow shaft: ROTADRIVE can be mounted directly on a shaft whose diameter has to respect the technical characteristics specified in the purchase order and clamped by means of the collar and the hole into which an anti-rotation pin has to be inserted.

**WARNING**
The unit has been adjusted by performing a no-load mechanical running test; thence default values which has been set refer to an idle device, i.e. running disengaged from the load. Furthermore they are intended to ensure a standard and safe operation which not necessarily results in smooth running and optimum performance. Thus to suit the specific application requirements it may be advisable and even necessary to enter new parameters instead of the factory default settings; in particular it may be necessary to change velocity, acceleration, deceleration and gain values.

**WARNING**
The counter-electromotive force (back EMF) generated by the motor in case the shaft is forced to rotate due to a manual external force can cause irreparable damages to the internal circuitry.

# 2 Identification

Device can be identified through the **ordering code** and the **serial number** printed on the label applied to its body. Information is listed in the delivery document too. Please always quote the ordering code and the serial number when reaching Lika Electronic s.r.l. for purchasing spare parts or needing assistance. For any information on the technical characteristics of the product refer to the technical catalogue.

# 3 Mechanical installation

**WARNING**
Installation and maintenance operations have to be carried out by qualified personnel only, with power supply disconnected. Motor and shaft must be in stop.

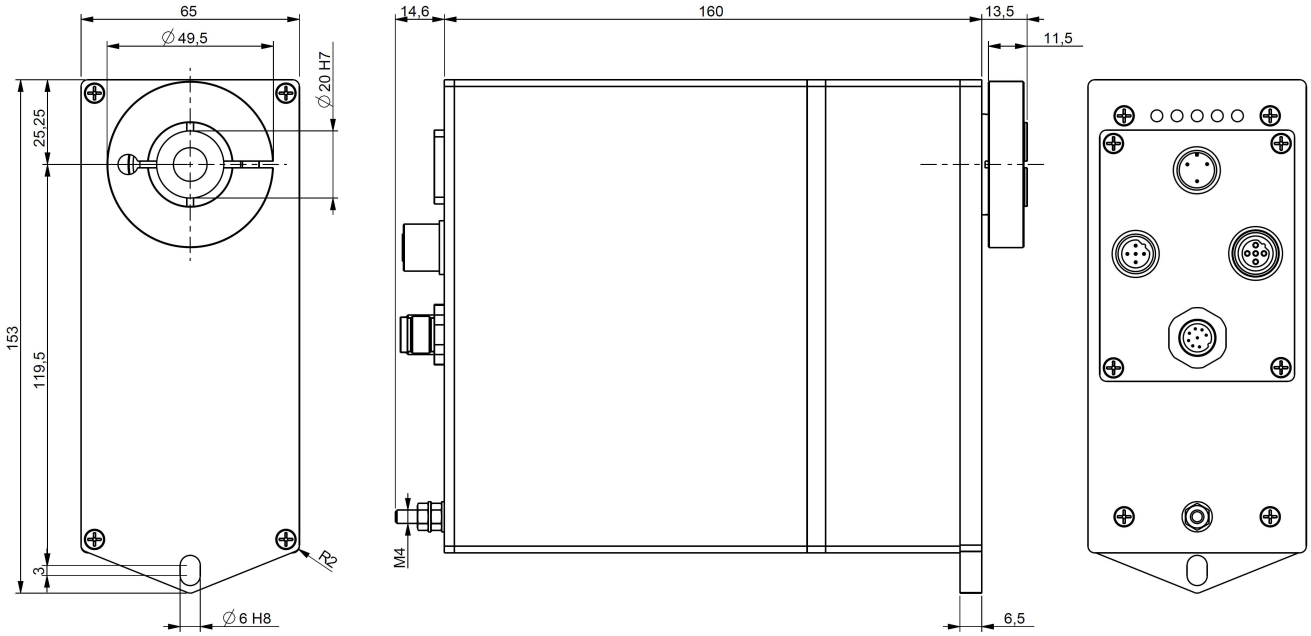



**Figure 1 - RD4 unit – Overall dimensions**

ROTADRIVE unit must be secured firmly only to the user's shaft using the provided collar. ROTADRIVE unit is supplied with a screw insulation and an anti-rotation pin; the anti-rotation pin (TE M5 screw) has to be inserted into the screw insulation. This will provide to the unit both stability and the mobility needed to absorb the mechanical tensions produced during operation. Do not fasten firmly the anti-rotation pin to the flange or the fixed support on user's side without using the screw insulation! If this occurs, the mechanical tensions would be transmitted completely to the motor shaft and this would lead to bearings damages and mechanical breakdowns!

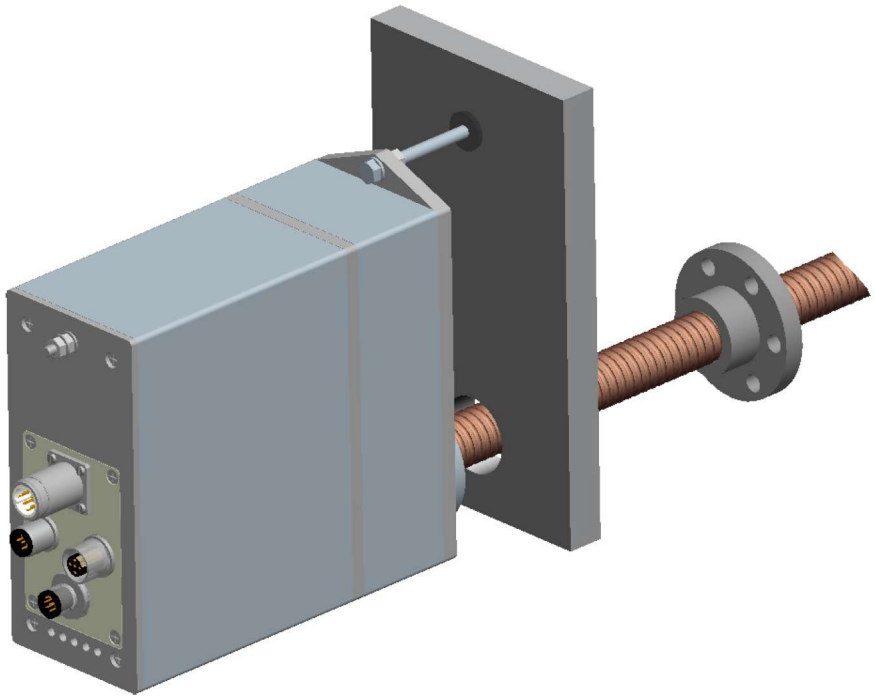
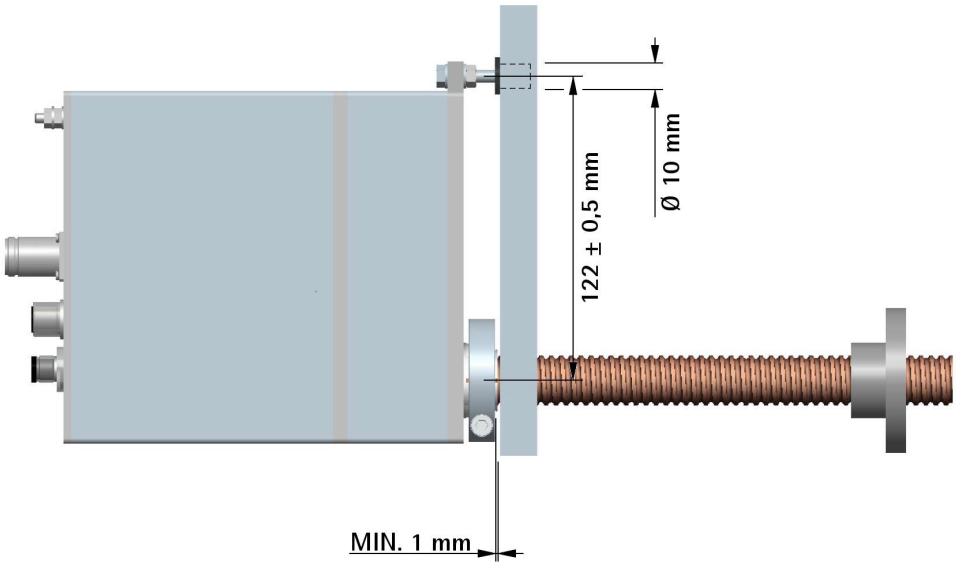


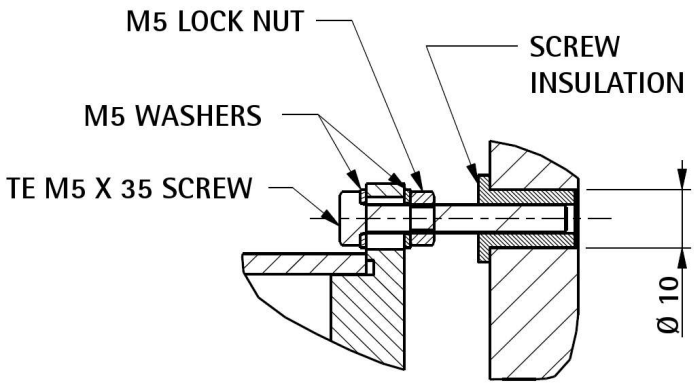
**Figure 2 - Typical installation example of RD4 unit on worm screw**

To install properly the ROTADRIVE unit please read carefully and follow these instructions; anyway note that the unit can be installed in several manners and according to the specific user's application.

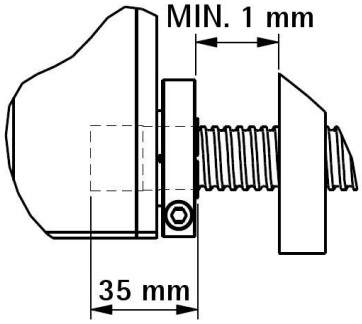
- Drill a 10-mm diameter hole in the flange or in the fixed support on user's side in order to insert the screw insulation and the anti-rotation pin. The



distance between the axis of the shaft and the axis of the hole must be 122 ± 0,5 mm. Make sure that the hole and the shaft are perfectly aligned on the vertical axis. If installation is not carried out properly, mechanical tensions would be produced on the motor shaft and this would lead to bearings damages and mechanical breakdowns!




- insert the screw insulation in the hole;
- insert the TE M5 x 35 UNI5739 screw and the two M5 washers in the hole designed in the flange of the ROTADRIVE unit; partially screw the M5 lock nut;
- insert the user's shaft in the hollow shaft of the ROTADRIVE unit; the maximum depth of the ROTADRIVE shaft is 35 mm; ascertain that the anti-rotation pin is inserted properly in the screw insulation; secure the user's shaft through the collar and the relevant fixing screw; the minimum distance between the collar and the fixed support on user's side must be not less than 1 mm in order to prevent the fixed parts from coming into contact;




- tighten the anti-rotation pin on the screw insulation;
- tighten the M5 lock nut in order to secure the anti-rotation pin to the flange of the ROTADRIVE unit.

**ATTENTION**

Never force manually the rotation of the shaft not to cause permanent damages! The counter-electromotive force (back EMF) generated by the motor in case the shaft is forced to rotate due to a manual external force can cause irreparable damages to the internal circuitry.

# 4 Electrical connections

**WARNING**

When you send Start, Jog + or Jog - commands, the unit and the shaft start moving! Make sure there are no risks of personal injury and mechanical damages.

Each Start routine has to be checked carefully in advance!

Never force manually the rotation of the shaft not to cause permanent damages!

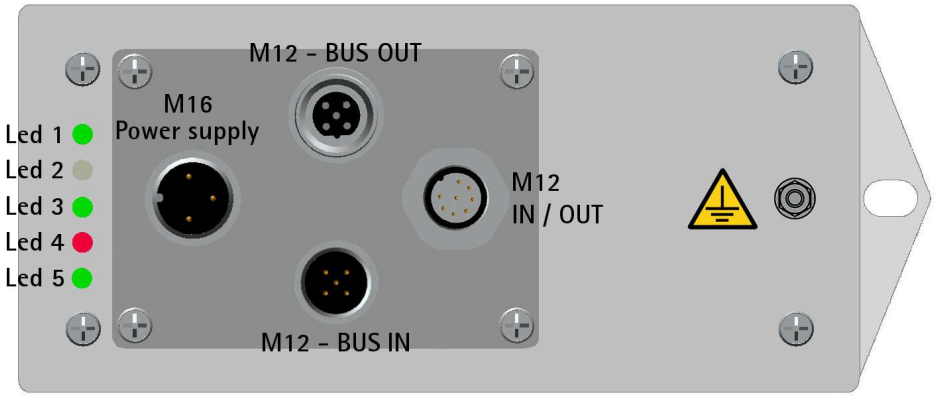


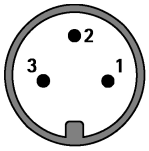

**Figure 3: Electrical connections and diagnostic LEDs**

### 4.1 Ground connection (Figure 3)

To minimize noise connect properly the frame to ground; we suggest using the ground screw provided in the frame (see Figure above). Connect properly the cable shield to ground on user's side. Lika's EC- pre-assembled cables are fitted with shield connection to the connector ring nut in order to allow grounding through the body of the device. Lika's E- connectors have a plastic gland, thus grounding is not possible. If metal connectors are used, connect the cable shield properly as recommended by the manufacturer. See also note in the next paragraph. Anyway make sure that ground is not affected by noise. It is recommended to provide the ground connection as close as possible to the device.

## 4.2 Connectors (Figure 3)

**Power supply**
M16 3-pin male connector




(frontal side)

| Pin | Description |
|---|---|
| 1 | +24VDC ±10% motor power supply |
| 2 | +24VDC ±10% controller power supply |
| 3 | motor and controller 0 VDC supply voltage |

**Interface**
M12 5-pin connectors
A coding
(frontal side)


male
(BUS IN)


female
(BUS OUT)

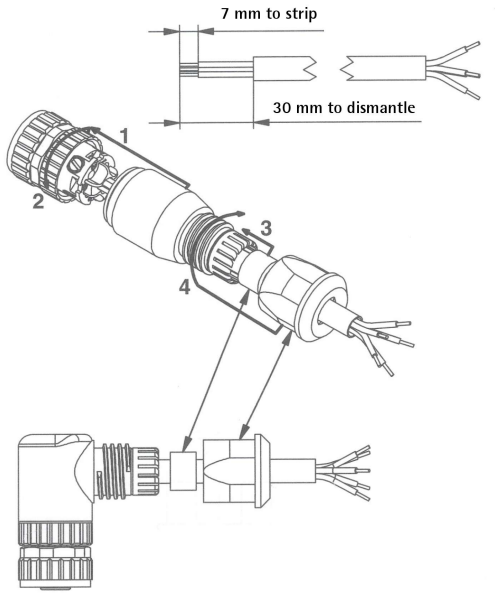
| Pin | Description |
|---|---|
| 1 | n.c. |
| 2 | n.c. |
| 3 | CAN GND[1] |
| 4 | CAN High |
| 5 | CAN Low |
| Case | Shielding[2] |

[1] CAN GND is the 0 VDC reference of CAN signals, it is not connected to 0 VDC supply voltage.
[2] Lika's EC- pre-assembled cables only.
n.c. = not connected

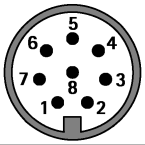
We recommend CANopen certified cables to be used.

**NOTE**

We suggest always connecting the cable shield to ground on user's side.
Lika's EC- pre-assembled cables are fitted with shield connection to the connector ring nut in order to allow grounding through the body of the device. Lika's E- connectors have a plastic gland, thus grounding is not possible (see Figure below). If metal connectors are used, connect the cable shield properly as recommended by the manufacturer.




**Inputs / outputs (optional)**
M12 8-pin male connector
(frontal side)




| Pin | Description |
|---|---|
| 1 | 0 VDC |
| 2 | Input 1 |
| 3 | Input 2 |
| 4 | Input 3 |
| 5 | Output 1 |
| 6 | Output 2 |
| 7 | Output 3 |
| 8 | n.c. |

n.c.: not connected

### 4.3 Diagnostic LEDs (Figure 3)

Five LEDs located next to the M16 power supply connector (see Figure 3) are meant to show visually the operating or fault status of the CANopen interface and the device as well. The meaning of each LED is explained in the following table:

| LED 1 GREEN | Description |
|---|---|
| ON | Indicates the power supply of the controller is turned on |
| OFF | Indicates the power supply of the controller is turned off |

| LED 2 | Not used |
|---|---|

| LED 3 GREEN RUN | Description |
|---|---|
| ON | Device in Operational state |
| Single flash | Device in Stopped state |
| Blinking led | Device in Pre-Operational state |

| LED 4 RED ERR | Description |
|---|---|
| ON | Bus off |
| Double flash | Node guarding error (see on page 68) |
| Single flash | Maximum number of warning errors |
| Blinking led | General error or Flash memory error |
| OFF | No error |

| LED 5 GREEN | Description |
|---|---|
| ON | Indicates the motor is enabled (control loop activated) |
| OFF | Indicates the motor is disabled (control loop deactivated) |

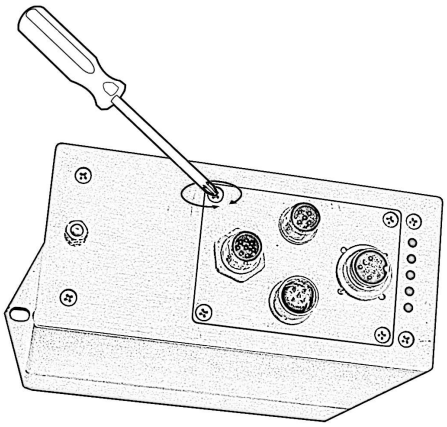
During initialisation, system checks the diagnostic LEDs for proper operation; therefore they blink for a while.

### 4.4 Dip-Switches (Figure 4)

**WARNING**
Power supply must be turned off before performing this operation!

**NOTE**
When performing this operation be careful not to damage the connection wires.

To access DIP-Switches loosen the four screws and remove the connectors metal cover. Handle the cover with care not to stretch or pull out the connection wires. Be careful to replace the metal cover at the end of the operation.



The DIP-switches are just beneath.

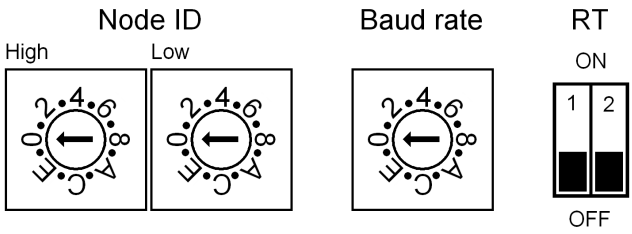



Figure 4: Dip-Switches

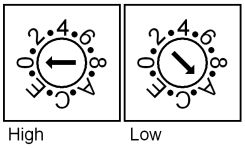
### 4.4.1 Setting the node address: Node ID (Figure 4)

**WARNING**
Power supply must be turned off before performing this operation!

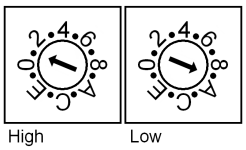
Set the node address expressed in hexadecimal notation.
The range of node addresses is between 1 and 127 (127 = 7F hex).

**Example**

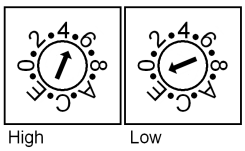
Address 10 = 0A hex:




Address 25 = 19 hex:




Address 95 = 5F hex:




**NOTE**
The default address is 1.
If you set the address to 0, device will be set to 1 automatically (address 0 is reserved for Master).
If you set an address higher than 127, device will be set to 127 automatically.

### 4.4.2 Setting the data transmission rate: Baud rate (Figure 4)

**WARNING**
Power supply must be turned off before performing this operation!

Set the hexadecimal value of the transmission rate according to the following table.

Available baud rate values:

| Data byte | Baud rate |
|---|---|
| 00h | 20 Kbit/s |
| 01h | 50 Kbit/s |
| 02h | 100 Kbit/s |
| 03h | 125 Kbit/s |
| 04h | 250 Kbit/s |
| 05h (default) | 500 Kbit/s |
| 06h | 800 Kbit/s |
| 07h | 1000 Kbit/s |

### 4.4.3 RT bus termination (Figure 4)

A bus termination resistor is provided and has to be activated as line termination in the last device of the transmission line.
Use RT Switch to activate or deactivate the bus termination.

| RT | Description |
|---|---|
| 1 = 2 = ON | Activated: when the device is at the end of the transmission line |
| 1 = 2 = OFF | Deactivated: when the device is not at the end of the transmission line |

# 5 Quick reference

Following instructions are given to allow the operator to set up the device for standard operation in a quick and safe manner.

- Mechanically install the device;
- execute electrical connections;
- set data transmission rate (baud rate; see on page 23);
- set the node address (node ID; see on page 22);
- switch +24VDC power supply on (in both motor and controller);
- set a proper value in **3120-00 Distance per revolution** (object 3120h; see on page 59);
- set a proper value in **3114-00 Jog speed** (object 3114h; see on page 58);
- set a proper value in **3115-00 Work speed** (object 3115h; see on page 58);
- set a proper value in **3300-00 Preset** (object 3300h; see on page 60);
- set proper values in **310F Delta space** (objects **Positive delta** 310Fh sub 1 and **Negative delta** 310Fh sub 2; see on page 57);
- save new setting values (object **1010-01 Save Parameters** 1010h sub 1; see on page 48).

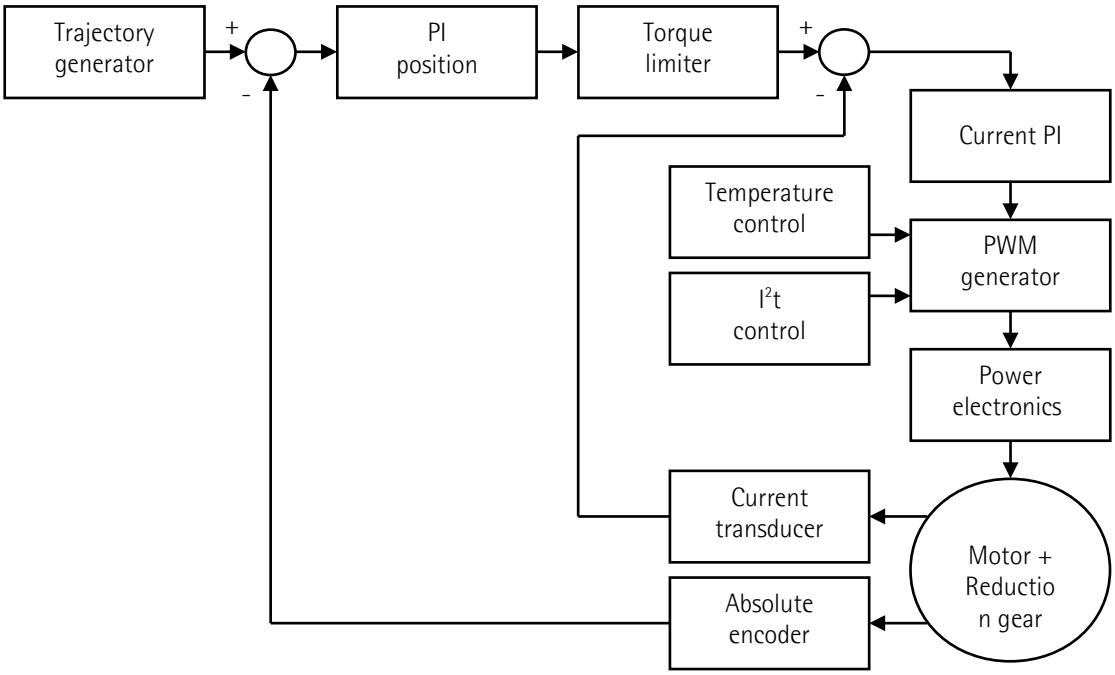
**NOTE**

Parameters **3120-00 Distance per revolution**, **3114-00 Jog speed**, **3115-00 Work speed**, **3300-00 Preset** and **310F Delta space** are closely related, hence you have to be very attentive when you need to change the value in one of them. For any further information please refer to page 28.

# 6 Functions

## 6.1 Working principle

The following scheme is intended to show schematically the working principle of system control logic.



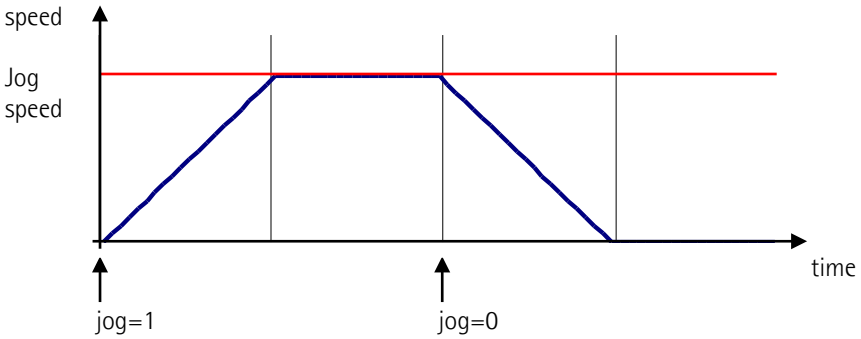
### 6.2 Movements: jog and positioning

Two kinds of movement are available in the ROTADRIVE positioning unit, they are:

- Jog: speed control;
- Positioning: position and speed control.

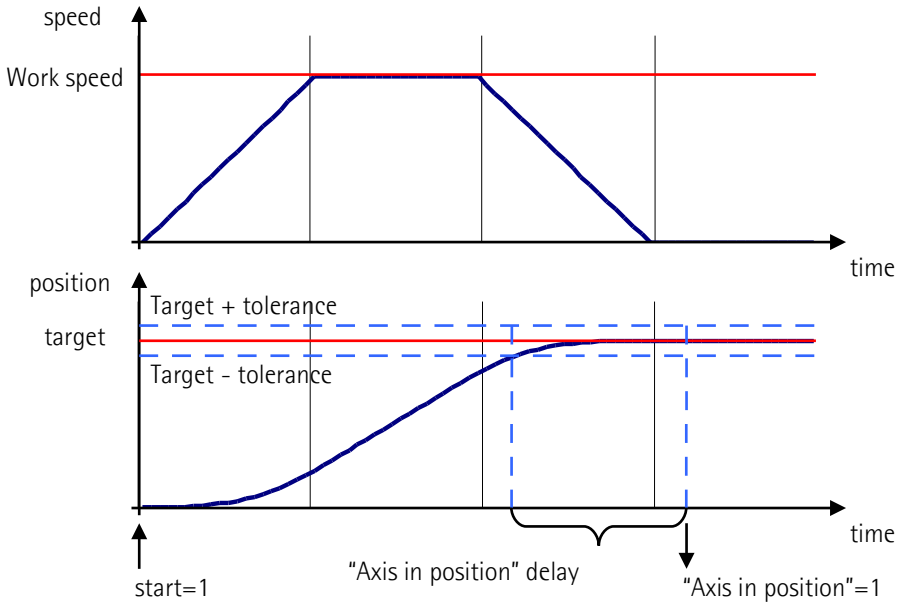
#### Jog: speed control

This kind of control is intended to generate a speed trajectory which is able to make the maximum rotation speed of the ROTADRIVE unit shaft to be equal to the value set in **3114-00 Jog speed**.




#### Positioning: position and speed control

This kind of control is a point-to-point movement and the maximum reachable speed is equal to the value set in **3115-00 Work speed**; set speed can be reached only if space is long enough.



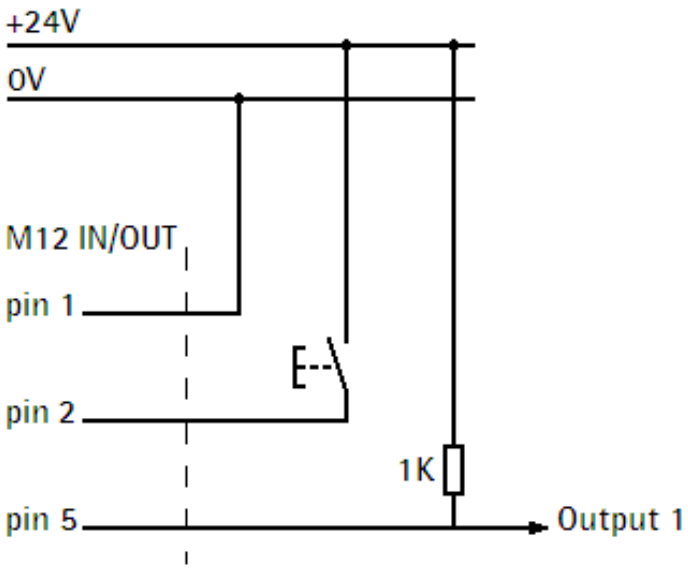
### 6.3 Digital inputs and outputs

RD4 unit is fitted with **three digital inputs and three digital outputs**.

Inputs are read by the Slave device and transmitted to the Master through **Status word** (bits 13-15; see on page 42) when the device is running in **Operational** state.
"High" logic value is read when voltage is equal to +24VDC ±10%.

Slave outputs are operated by the Master through **Control Word** (bits 13-15; see on page 38) when the device is running in **Operational** state.
Outputs are "open collector" type having Imax = 150mA.

Example of connection scheme:



### 6.4 Objects 3120-00 Distance per revolution, 3114-00 Jog speed, 3115-00 Work speed, 3300-00 Preset and 310F Delta space

Objects **3120-00 Distance per revolution**, **3114-00 Jog speed**, **3115-00 Work speed**, **3300-00 Preset** and **310F Delta space** are closely related, hence you have to be very attentive every time you need to change the value in any of them.
Should that be necessary, you have to operate in compliance with the following procedure:

- set a proper value in **3120-00 Distance per revolution** (object 3120h, see on page 59);
- set a proper value in **3114-00 Jog speed** (object 3114h; see on page 58);
- set a proper value in **3115-00 Work speed** (object 3115h; see on page 58);
- set a proper value in **3300-00 Preset** (object 3300h, see on page 60);
- check the value in **310F Delta space** sub 1 **Positive delta** is set properly (object 310Fh sub 1, see on page 57);
- check the value in **310F Delta space** sub 2 **Negative delta** is set properly (object 310Fh sub 2, see on page 57);
- save new values (object **1010-01 Save Parameters** 1010h sub 1, see on page 48).

**WARNING**
Each time you change the value in **3120-00 Distance per revolution** you must then set new values also in **3114-00 Jog speed** and **3115-00 Work speed** as speed values are expressed in pulses per second (PPS). To calculate the speed values you have always to adhere to the following ratio:

$$\frac{\text{Min. speed} * \text{Distance per revolution}}{1024} \leqslant \text{Speed} \leqslant \frac{\text{Max. speed} * \text{Distance per revolution}}{1024}$$

where:

- **Distance per revolution**: this is the new value you want to set in **3120-00 Distance per revolution**, expressed in pulses
- **Min. speed**: minimum speed 1 [PPS] for all RD4 units
- **Max. speed**: maximum speed 1600 [PPS] for RD4-...-T32-... model
  1066 [PPS] for RD4-...-T48-... model
- **1024**: this is the maximum value you can set in **3120-00 Distance per revolution** (expressed in pulses).

Each time you change the value in **3120-00 Distance per revolution** you must then update the value in **3300-00 Preset** in order to define the zero of the axis as the system reference has now changed.
After having changed the parameter in **3300-00 Preset** it is not necessary to set new values for travel limits as the Preset function then calculates them automatically and initializes again the positive and negative limits according to the values set in **310F Delta space**.

The number of revolutions managed by the system is 511 in negative direction and 511 in positive direction assuming **3300-00 Preset** as reference.
Value set in parameter **310F Delta space** plus value set in parameter **3300-00 Preset** is the maximum forward travel (positive travel) starting from the preset (value is expressed in pulses).
Value set in parameter **310F Delta space** subtracted from value set in parameter **3300-00 Preset** is the maximum backward travel (negative travel) starting from the preset (value is expressed in pulses).

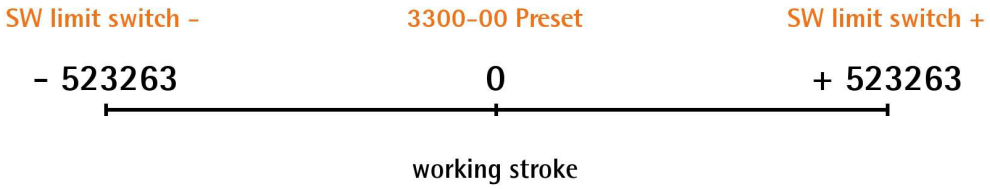
**WARNING**
Please note that the parameters listed hereafter are closely related to the **3120-00 Distance per revolution** parameter; hence when you change the value in **3120-00 Distance per revolution** also the value expressed by each one is necessarily redefined. They are: **3108-00 Acceleration**, **3109-00 Deceleration**, **310C-00 Max following error**, **310D-00 Position window**, **310F Delta space**, **3116-00 Max speed**, **3343-00 Positive absolute limit switch**, **3344-00 Negative absolute limit switch**, **3103-00 Current position value**, **3105-00 Current velocity value**, **3106-00 Target position** and **3107-00 Target speed**. See for instance the relationship between **3120-00 Distance per revolution** and the speed values, explained in the previous page.

**Example 1**

Default values:
**3120-00 Distance per revolution** = 1024 steps per revolution
Max. **3115-00 Work speed**:
- = 1600 pulses per second for RD4-...T32-... model (1600*1024/1024 = 1600)
- = 1066 pulses per second for RD4-...T48-... model (1066*1024/1024 = 1066)

**3300-00 Preset** = 0

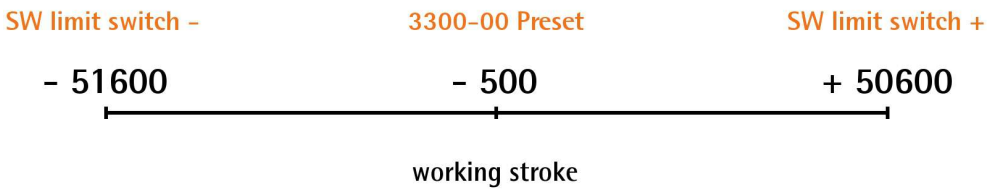
**310F Delta space** sub 1 **Positive delta** and **310F Delta space** sub 2 **Negative delta** max. values = 523263 = (1024 steps per revolution x 511 revolutions) - 1 when **3300-00 Preset** value = 0
Max. **SW limit switch +** = 0 + 523263 = + 523263 pulses (forward travel)
Max. **SW limit switch -** = 0 - 523263 = - 523263 pulses (backward travel)
Therefore, when **3300-00 Preset** = 0, the working stroke of the axis will span the maximum positive and negative limits range, that is **SW limit switch +** = 523263 and **SW limit switch -** = - 523263.



### Example 2

ROTADRIVE RD4-...T32-... positioning unit is joined to a worm screw having a 1 mm pitch and you need to have a hundredth of a millimetre resolution.
**3120-00 Distance per revolution** = 100 steps per revolution
Max. **3115-00 Work speed** = 156 pulses per second (1600*100/1024 = 156, rounded off to the nearest integer)
**3300-00 Preset** = -500 (ex. thickness of the tool)

**310F Delta space** sub 1 **Positive delta** and **310F Delta space** sub 2 **Negative delta** max. values = 100 steps per revolution x 511 revolutions = 51100 pulses
Max. **SW limit switch +** = (-500) + 51100 = + 50600 pulses (forward travel)
Max. **SW limit switch -** = (-500) - 51100 = - 51600 pulses (backward travel)
Therefore, when **3300-00 Preset** = - 500, the working stroke of the axis will span the maximum positive and negative limits range, that is **SW limit switch +** = + 50600 and **SW limit switch -** = - 51600.



# 7 CANopen® interface

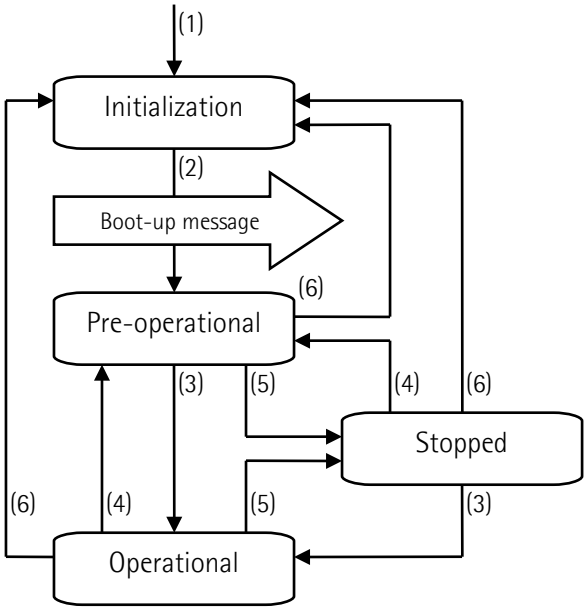
Lika ROTADRIVE positioning units are Slave devices and are designed in compliance with the "Application Layer and Communication Profile DS301".
For any further information or omitted specifications please refer to "CiA Draft Standard 301" document available at www.can-cia.org.

## 7.1 EDS files

CANopen® devices are supplied with their own EDS file **LIKA_RD4_Tx_I2_Vx.EDS** (see enclosed documentation or click **www.lika.biz > ROTARY ACTUATORS > ROTARY ACTUATORS (DRIVECOD) > RD4**). EDS file has to be installed on CANopen® Master device.
Install **LIKA_RD4_T32_I2_Vx.EDS** file for devices fitted with T32 reduction gear.
Install **LIKA_RD4_T48_I2_Vx.EDS** file for devices fitted with T48 reduction gear.
EDS files are available in both English version (_en) and Italian version (_it).

### 7.2 NMT states

CANopen® devices are designed to operate using different states. Transition from one state to another is achieved by sending specific NMT messages (see Figure below).




| | |
|---|---|
| (1) | Power turned on |
| (2) | Initialization carried out, boot-up message is sent automatically |
| (3) | NMT message: **Start remote node** |
| (4) | NMT message: **Enter pre-operational** |
| (5) | NMT message: **Stop remote node** |
| (6) | NMT message: **Reset node** or **Reset communication** |

#### 7.2.1 Initialization

This is the first state the CANopen® device enters after power is turned on or after performing a hardware reset by means of a **Reset node** command. During initialization, device reads and loads the parameters saved on EPROM. As soon as the basic CANopen® device initialization is carried out, device sends a boot-up message and then switches automatically to **Pre-operational** state.

### 7.2.2 Pre-operational state

In this state communication between Master and Slave is possible using SDO messages. They allow working parameters to be set. Slave cannot send PDO messages.
To switch the Slave device to **Operational** state the Master must send a **Start remote node** command using a NMT message.

### 7.2.3 Operational state

In this state the Slave device is active and all communication objects are available. The Slave device can use the parameters available in the "Object dictionary" and is allowed to send process data using PDO messages. "Object dictionary" can be accessed using SDO messages. To switch the Slave device to **Pre-operational** state the Master must send an **Enter pre-operational** command using a NMT message.

**WARNING**
For safety reasons, in **Operational** state the Master must check the Slave device continuously and in a proper way. For a description of the correct procedure see section "7.6 PDO messages" on page 37.

### 7.2.4 Stopped state

In this state the Slave device is forced to interrupt communication with the Master altogether (except node guarding, if active).
Communication using PDO and SDO messages is not allowed.
To switch the Slave device to **Pre-Operational** or **Operational** state the Master must send the specific commands **Enter pre-operational** or **Start remote node** using a NMT message.

### 7.3 Communication messages

Four different kinds of communication messages are used in a CANopen® network:

- Network management **NMT** service: through node control services, the NMT Master controls the NMT state of the NMT Slaves; see "7.4 NMT messages" section on page 36.
- **Process Data Object PDO** service: the real-time data transfer is performed by means of "Process Data Objects (PDO)". The PDOs correspond to entries in the object dictionary and provide the interface to the application objects; see "7.6 PDO messages" section on page 37.
- **Service Data Object SDO** service: SDOs used to provide direct access to entries of a CANopen® device "Object dictionary" (page 46); they allow to read and set parameters; see "7.7 SDO messages" section on page 45.
- **Special Function Object** services:
  - SYNC: synchronization object provides the basic network synchronization mechanism and is used by the Master to enable the Slave devices to transmit process data (position and velocity; see on page 47);
  - Emergency EMCY: emergency objects are triggered by the occurrence of a CANopen® device internal error situation, see on page 67;
  - Node guarding protocol: it is used to detect remote errors in the network, see on page 68.

Relation between device states and communication objects:

| | Initialization | Pre-operat. | Operational | Stopped |
|---|---|---|---|---|
| NMT | | X | X | X |
| PDO | | | X | |
| SDO | | X | X | |
| SYNC | | | X | |
| EMCY | | X | X | |
| Boot-up | X | | | |
| Nodeguard | | X | X | X |

### 7.3.1 Generic pre-defined connection set

| Broadcast objects of the generic pre-defined connection set | | |
|---|---|---|
| Type of COB (Object) | Function code (binary) | COB-ID (hex) |
| NMT | 0000 | 000 |
| SYNC | 0001 | 080 |

| Peer-to-peer objects of the generic pre-defined connection set | | |
|---|---|---|
| EMERGENCY | 0001 | 081 - 0FF |
| PDO 1 (tx) | 0011 | 181 - 1FF |
| PDO 1 (rx) | 0100 | 200 - 27F |
| SDO (tx) | 1011 | 581 - 5FF |
| SDO (rx) | 1100 | 601 - 67F |
| Nodeguard | 1110 | 701 - 77F |
| Boot-up | 1110 | 701 - 77F |

The type of COB (tx means COB-ID sent; rx means COB-ID received) is viewed from the Slave device.

### 7.4 NMT messages

Structure of NMT messages:

| COB-ID (11 bit) | |
|---|---|
| Func.code | Node ID |
| 0000 | 0 |

| 2 CAN Data Bytes | |
|---|---|
| Command | Slave ID |
| NMT function | Slave ID |

If Slave ID = 00h, the NMT message is issued to all network nodes.

| Command | NMT service | Node state |
|---|---|---|
| 01 hex | Start remote node | Operational |
| 02 hex | Stop remote node | Stopped |
| 80 hex | Enter pre-operational | Pre-operational |
| 81 hex | Reset node | Pre-operational |
| 82 hex | Reset communication | Pre-operational |

### 7.5 Boot-up messages

Structure of Boot-up messages:

| COB-ID(hex) | 1 CAN Data Byte |
|---|---|
| 700+Node ID | 00 |

### 7.6 PDO messages

**WARNING**
For safety reasons, when the ROTADRIVE unit is on a continuous data exchange between the Master and the Slave has to be planned in order to be sure that the communication is always active; this is intended to prevent danger situations from arising in case of failures in the communication network.

For monitoring the communication state in the network, among the possible methods the Node guarding protocol can be implemented (complying with DS301 specifications, see on page 68).

ROTADRIVE positioning unit sends PDO messages to the Master according to the set cyclic or synchronous work mode (see object **1800 Transmit PDO Communication Parameter 1**).

PDO messages have always a 8 CAN Data Bytes format. Please note that the structure of sent messages and received messages is different anyway.

Structure of **RECEIVE PDO1** messages received by the Slave device (sent by the Master):

| IDENTIFIER | | 8 CAN data byte | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| COB-ID (hex) | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| F.C. | Node-ID | Control Word | | | | Target position | | | |
| 200+ Node ID | | Low | ... | ... | High | Low | ... | ... | High |

Structure of **TRANSMIT PDO1** messages sent by the Slave device (received by the Master):

| IDENTIFIER | | 8 CAN data byte | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| COB-ID (hex) | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| F.C. | Node-ID | **Status word** | | **Current velocity** | | **Current position** | | | |
| 180+ Node ID | | Low | High | Low | High | Low | ... | ... | High |

Structure of bytes:

| bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| | M.S.bit | | | | | | | L.S.bit |

### 7.6.1 "RECEIVE PDO1" message sent by the Master to the Slave

**Control Word**

Index 0x3100-00. 32 bits. It contains the commands to be sent in real time to the Slave in order to manage it. See also **3100-00 Control word** on page 63.

**Byte 0**

**Jog +**

bit 0

If bit 4 **Incremental jog** = 0, as long as **Jog +** = 1, the Slave moves toward positive direction; otherwise if bit 4 **Incremental jog** = 1, the activation of this bit causes at rising edge the execution of a single step toward positive direction having the length, expressed in pulses, set next to the **3117-00 Jog step length** item; then the slave stops and waits for another issue. Velocity, acceleration and deceleration are set in objects **3114-00 Jog speed**, **3108-00 Acceleration** and **3109-00 Deceleration** respectively. For a detailed description of jog control see on page 26.

**Jog -**

bit 1

If bit 4 **Incremental jog** = 0, as long as **Jog -** = 1, the Slave moves toward negative direction; otherwise if bit 4 **Incremental jog** = 1, the activation of this bit causes at rising edge the execution of a single step toward negative direction having the length, expressed in pulses, set next to the **3117-00 Jog step length** item; then the slave stops and waits for another issue. Velocity, acceleration and

deceleration are set in objects **3114-00 Jog speed**, **3108-00 Acceleration** and **3109-00 Deceleration** respectively. For a detailed description of jog control see on page 26.

**Stop**

bit 2

If set to "=1" the Slave is allowed to execute the movements as commanded. If, while the unit is running, this bit switches to "=0" then the Slave must stop executing the deceleration procedure set in **3109-00 Deceleration**. For an immediate halt in the movement, use bit 7 **Emergency**.

**Alarm reset**

bit 3

Setting this bit to "1" causes the normal work status of the device to be restored. This command is used to reset an alarm condition of the Slave but only if the faulty condition has ceased. Using SDO messages you can read further information about the alarm in the index **1003 Pre-defined Error Field**.

Please note that should the alarm be caused by wrong object values (**Machine data not valid**) normal work status can be restored only after having set proper values. **Flash memory error** alarm cannot be reset.

**Incremental jog**

bit 4

If set to "=0", the activation of bits **Jog +** and **Jog -** causes the slave to move as long as **Jog +** / **Jog -** = 1. Setting this bit to 1 the incremental jog function is enabled, that is: the activation of bits **Jog +** and **Jog -** causes at rising edge the execution of a single step toward positive or negative direction having the length, expressed in pulses, set next to the **3117-00 Jog step length** item; then the slave stops and waits for another issue.

bit 5

Not used.

**Start**

bit 6

If set to "=1" device moves in order to reach the set target position. For a complete description of the position control see on page 25. For any information on target position see **Target position** on page 41.

**Emergency**

bit 7

This bit has to be normally high ("=1"), otherwise it will cause the device to stop immediately. For a normal halt (not immediate) which respects the set deceleration see above bit 2 **Stop**.

**Byte 1**

bit 8 ... 11 Not used.

**Axis torque**

bit 12 When the axis has reached the commanded position, it keeps the torque.
If set to "=0", when the axis is in position, PWM is deactivated.
If set to "=1", when the axis is in position, PWM is kept active.

**OUT 1**

bit 13 This is intended to activate / deactivate the operation of the digital output 1. The meaning of the available outputs is described in section "Programming parameters" on page 46.
OUT 1 = 0 output 1 low (not active)
OUT 1 = 1 output 1 high (active)

**OUT 2**

bit 14 This is intended to activate / deactivate the operation of the digital output 2. The meaning of the available outputs is described in section "Programming parameters" on page 46.
OUT 2 = 0 output 2 low (not active)
OUT 2 = 1 output 2 high (active)

**OUT 3**

bit 15 This is intended to activate / deactivate the operation of the digital output 3. The meaning of the available outputs is described in section "Programming parameters" on page 46.
OUT 3 = 0 output 3 low (not active)
OUT 3 = 1 output 3 high (active)

**Bytes 2 and 3** Not used.

**Bytes 4 ... 7**

**Target position**

Position to be reached, otherwise referred to as commanded position. When the **Start** command is sent while **Stop** and **Emergency** bits are "=1" and the alarm condition is off, device moves in order to reach the target position.

**Position override function**

It is possible to change the target position value even while the device is still reaching it; to do this, send a **Start** command and the new target value in **Target position**.

**NOTE**

**Jog +**, **Jog -** and **Start** functions cannot be enabled simultaneously. For instance: if a **Jog +** command is sent to the Slave while it is moving to target position, jog command will be ignored; if **Jog +** and **Jog -** commands are sent simultaneously, device does not move or, if already moving, it stops its movement.

### 7.6.2 "TRANSMIT PDO1" message sent by the Slave to the Master

**Status word**

Index 0x3101-00. 16 bits. In these bytes the status of the PI controller in Operational work mode is shown. See also 3101-00 Status word on page 63.

**Byte 0**

**Axis in position**

bit 0 — If value is "=1" device has reached the set position for the time set in 310E-00 Position window time. It is kept active until the position error is lower than 310D-00 Position window.

bit 1 — Not used.

**Axis enabled**

bit 2 — It shows the enabling status of the motor. This bit is "=1" when the motor is enabled, that is: PWM is active and the axis is under closed-loop control (while reaching a target position or using a jog, for instance). It is "=0" when the motor is disabled, that is when the controller is off after a positioning or jog movement or because of an alarm condition.

**SW limit switch +**

bit 3 — If value is "=1" device has reached the maximum positive limit (positive limit switch). See object 310F Delta space sub 1 Positive delta.

**SW limit switch -**

bit 4 — If value is "=1" device has reached the maximum negative limit (negative limit switch). See object 310F Delta space sub 2 Negative delta.

**Alarm**

bit 5 — If value is "=1" an alarm has occurred, see details at indexes 1003 Pre-defined Error Field and 3200-00 Alarms.

**Axis running**

bit 6 — If value is "=0" device is not moving.
If value is "=1" device is moving.

**Executing a command**

bit 7 — If value is "=0" controller is not executing any command.
If value is "=1" controller is executing a command.

**Byte 1**

**Target position reached**

bit 8 — If value is "=1" device has reached the target position (see **Target position**). Bit is kept active until new **Target position** value or **Alarm reset** commands are sent.

bits 9 ... 11 — Not used.

**DAC Saturation**

bit 12 — The current supplied by power electronic for controlling the motor has reached the maximum value and cannot be increased further.

**IN 1**

bit 13 — This is meant to show the status of the digital input 1. The meaning of the available inputs is described in section "Programming parameters" on page 46.

**IN 1** = 0 input 1 low (not active)

**IN 1** = 1 input 1 high (active)

**IN 2**

bit 14 — This is meant to show the status of the digital input 2. The meaning of the available inputs is described in section "Programming parameters" on page 46.

**IN 2** = 0 input 2 low (not active)

**IN 2** = 1 input 2 high (active)

**IN 3**

bit 15 — This is meant to show the status of the digital input 3. The meaning of the available inputs is described in section "Programming parameters" on page 46.

**IN 3** = 0 input 3 low (not active)

**IN 3** = 1 input 3 high (active)

**Bytes 2 and 3**

**Current velocity**

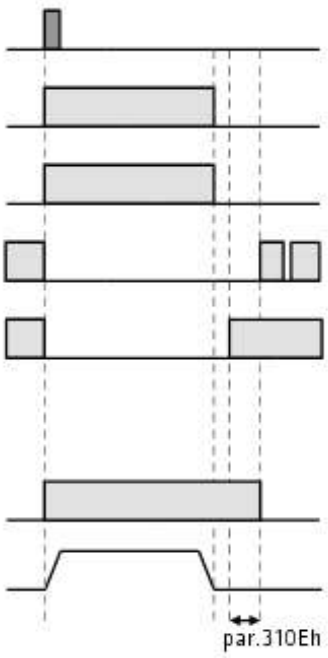
Speed of the device expressed in pulses per second [PPS], updated at every second.

**Bytes 4 ... 7**

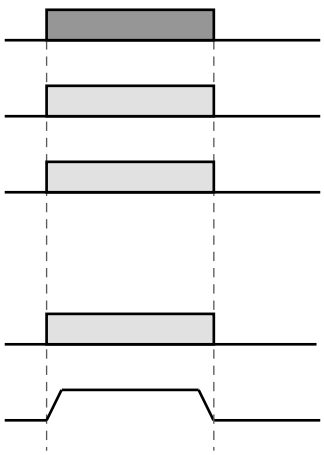
**Current position**

Absolute position of the device when the PDO message is sent.

## Example 1

| Positioning | RD4 |
|---|---|
| Start (bit 6 - Control Word)<br>Executing a command (bit 7 - Status word)<br>Axis running (bit 6 - Status word)<br>Axis in position (bit 0 - Status word)<br>Target position reached (bit 8 - Status word)<br>Axis enabled (bit 2 - Status word: PWM is active)<br>Theoretical velocity |  |

## Example 2

| Jog + | RD4 |
|---|---|
| Jog + (bit 0 - Control Word)<br>Executing a command (bit 7 - Status word)<br>Axis running (bit 6 - Status word)<br>Axis enabled (bit 2 - Status word: PWM is active)<br>Theoretical velocity |  |

### 7.7 SDO messages

SDO messages are used to set new values to and read values from the device. These parameters are described in the "Object dictionary" (see on page 46).
4 bytes at the most are used for CAN data, other 4 bytes are used for Command, Index and Sub-index fields. SDO messages always need confirmation from the Slave. It follows that when the Master sends a SDO message to the Slave, the Slave always sends a reply (and a warning, should an error occur).

SDO structure:

| IDENTIFIER | | from 4 to 8 CAN data bytes | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| COB-ID(hex) | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| F.C. | Node-ID | Com | Index | | Sub | Data | | | |
| | | 1 byte | LSB | MSB | 1 byte | LSB | ... | ... | MSB |

**Com** command
**Index** parameter index
**Sub** parameter sub-index
**Data** parameter value (set or read value)

#### 7.7.1 Command

Command byte contains the type of COB telegram transmitted to the CAN network.
Three types of telegram are available:

- **Set**: used to send configuration parameters to the Slave;
- **Req**: used by the Master to read data from the Slave;
- **Warnings**: used by the Slave to send error messages to the Master (e.g. "Index does not exist", "Process data value not valid", etc.).

| Command | COB | COB type | Data length |
|---|---|---|---|
| 22h | Set | M → S request | not specif. |
| 23h | Set | M → S request | 4 byte |
| 2Bh | Set | M → S request | 2 byte |
| 2Fh | Set | M → S request | 1 byte |
| 60h | Set | S → M confirmation | 0 byte |
| 40h | Req | M → S request | 0 byte |
| 42h | Req | S → M reply | non specified |
| 43h | Req | S → M reply | 4 byte |
| 4Bh | Req | S → M reply | 2 byte |
| 4Fh | Req | S → M reply | 1 byte |
| 41h | Req | S → M reply | segmented SDO |
| 80h | Warning | S → M reply | 4 byte |

# 8 Programming parameters

## 8.1 Objects dictionary

In the following pages the objects implemented are listed and described as follows:

**Index-subindex Object name**
[data types, attribute]

- Index and subindex are expressed in hexadecimal notation.
- Attribute:
  ro = read only access
  rw = read and write access
  const = ro + constant value

Unsigned16 data type:

| Data byte | |
|---|---|
| byte 4 | byte 5 |
| LSByte | MSByte |

Unsigned32 data type:

| Data byte | | | |
|---|---|---|---|
| byte 4 | byte 5 | byte 6 | byte 7 |
| LSByte | ... | ... | MSByte |

### 8.1.1 Standard objects (DS 301)

#### 1000-00 Device type
[Unsigned32, const]
Default = 0000012Dh

#### 1001-00 Error register
[Unsigned8, ro]
Should an error occur, bit 0 of this object will be set to "1".
Default = 00h

### 1003 Pre-defined Error Field

This object contains the list of the five previous errors which generated an EMCY emergency message.

- **00** Number of current errors [Unsigned8, rw]
  Enter 00h to delete the errors list.
- **01** Last error occurred [Unsigned32, ro]
- **02...05** Previous errors occurred [Unsigned32, ro]

### 1005-00 COB-ID SYNC messages

[Unsigned32, rw]
Default = 0000 0080h

### 1008-00 Device name

[String, const]
It shows the name of the device.
Default = "RD4"

### 1009-00 Hardware Version

[String, const]
It shows the hardware version of the device.

### 100A-00 Software Version

[String, const]
It shows the software version of the device.

### 100C-00 Guard Time

[Unsigned16, rw]
It contains the "node guard time" value expressed in msec (milliseconds). The Master polls each Slave at regular time intervals issuing RTR messages. This time-interval is called the "node guard time" and may be different for each Slave. For further details see section "8.4 Node guarding protocol" on page 68.
Default = 0

### 100D-00 Life Time Factor

[Unsigned8, rw]
Default = 0
100C-00 Guard Time and 100D-00 Life Time Factor objects are used in "Node guarding protocol" controlled by Master. For further details see section "8.4 Node guarding protocol" on page 68.

### 1010-01 Save Parameters

[Unsigned32, rw]
Use this object to save all parameters on non-volatile memory.
Write **save** (ASCII code in hexadecimal form) in the data bytes:

Master → Slave

| COB-ID | Cmd | Index | | Sub | Data bytes | | | |
|---|---|---|---|---|---|---|---|---|
| 600+ID | 23 | 10 | 10 | 01 | 73 | 61 | 76 | 65 |

Slave → Master (confirmation)

| COB-ID | Cmd | Index | | Sub | Data bytes | | | |
|---|---|---|---|---|---|---|---|---|
| 580+ID | 60 | 10 | 10 | 01 | 00 | 00 | 00 | 00 |

### 1011-01 Restore Default Parameters

[Unsigned32, rw]
This object allows you to restore all parameters to default values (they are set at the factory by Lika Electronic engineers to allow the operator to run the device for standard operation in a safe mode).
Write **load** (ASCII code in hexadecimal form) in the data bytes and then issue a Reset node command:

Master → Slave

| COB-ID | Cmd | Index | | Sub | Data bytes | | | |
|---|---|---|---|---|---|---|---|---|
| 600+ID | 23 | 11 | 10 | 01 | 6C | 6F | 61 | 64 |

Slave → Master (confirmation)

| COB-ID | Cmd | Index | | Sub | Data bytes | | | |
|---|---|---|---|---|---|---|---|---|
| 580+ID | 60 | 11 | 10 | 01 | 00 | 00 | 00 | 00 |

Master → Slave (reset node)

| COB-ID | Cmd | Slave ID |
|---|---|---|
| 000 | 81 | ID |

Slave → Master (Boot-up)

| COB-ID | Cmd |
|---|---|
| 700+ID | 00 |

**NOTE**
Save default values using **1010-01 Save Parameters** function.

### 1014-00 COB-ID EMCY

[Unsigned32, rw]
This object defines the COB-ID used to send emergency messages (EMCY).
When the power is turned on, this object always contains the default value.
For a complete list of the emergency messages refer to section "8.3 Emergency messages" on page 67.
Default = 80h+Node ID

### 1015-00 Inhibit Time Emergency

[Unsigned16, rw]
Inhibit time of emergency messages (EMCY), i.e. minimum interval between subsequent emergency messages expressed in multiples of 100 µs.
Default = 0

### 1018 Identity Object

- **01** Vendor Id [Unsigned32, ro]
- **02** Product code [Unsigned32, ro]
- **03** Revision number [Unsigned32, ro]
- **04** Serial number [Unsigned32, ro]

## 1400 Receive PDO Communication Parameter 1

This object contains the communication parameters for the PDOs the device is able to receive (Receive PDOs).

- **01** COB-ID of PDO1 [Unsigned32, rw]

| Bit number | Value | Meaning |
|---|---|---|
| **31 (MSB)** | 0 | PDO exists / is valid |
| | 1 | PDO does not exist / is not valid |
| **30** | 0 | RTR allowed on this PDO **(not implemented)** |
| | 1 | no RTR allowed on this PDO |
| **29** | 0 | 11-bit ID (CAN 2.0A) |
| | 1 | 29-bit ID (CAN 2.0B) |
| **28 ... 11** | 0 | if bit 29 = 0 |
| | X | if bit 29 = 1: bits 28-11 of 29-bit-COB-ID |
| **10 ... 0 (LSB)** | X | bits 10-0 of COB-ID |

Default = 4000 0200h+Node ID (no RTR, COB-ID)

**WARNING**
It is mandatory to set the bit 30 of COB-ID to 1 (value 0 is not allowed). This means that "No RTR is allowed on the PDO".
At power on, this object always contains the default value.

- **02** Transmission Type [Unsigned8, rw]

| Transmission type | PDO transmission | |
|---|---|---|
| **00h (0)** | Acyclic, synchronous | **not implemented** |
| **01h ... F0h (1 ... 240)** | Cyclic, synchronous | **implemented** |
| **F1h ... FBh (241 ... 251)** | **not implemented - reserved** | |
| **FCh (252)** | Synchronous, RTR only | **not implemented** |
| **FDh (253)** | Asynchronous, RTR only | **not implemented** |
| **FEh (254)** | Asynchronous, manufacturer specific | **implemented** |
| **FFh (255)** | Asynchronous, device profile specific | **not implemented** |

Default = FEh (event-driven, asynchronous, manufacturer specific)

**WARNING**

Following an attempt to set the **Transmission Type** to 0, the PDO message is not sent; following an attempt to change the **Transmission Type** to any other value that is not supported by the device, an abort message (abort code = 0609 0030h: **Value range of parameter exceeded**) is generated.

**NOTE**

- Before altering the value of **COB-ID** it is compulsory to deactivate the receipt of PDO1, then enter the new COB-ID value, finally activate again the receipt of PDO1.
- PDO1 receipt can be activated (deactivated) by setting to "0" ("1") the most significant bit of the object **1400 Receive PDO Communication Parameter 1** sub 1 **COB-ID**.

### 1600 Receive PDO Mapping Parameter 1

This object indicates the kind of parameter contained in the Receive PDO message.

- **01** **3100-00 Control word** [Unsigned32, ro] Default = 3100 0020h.
- **02** **3106-00 Target position** [Unsigned32, ro] Default = 3106 0020h.

### 1800 Transmit PDO Communication Parameter 1

These objects contain the communication parameters of Transmit PDO.

- **01** **COB-ID** of PDO1 [Unsigned32, rw]

| Bit number | Value | Meaning |
|---|---|---|
| **31 (MSB)** | 0 | PDO exists / is valid |
| | 1 | PDO does not exist / is not valid |
| **30** | 0 | RTR allowed on this PDO **(not implemented)** |
| | 1 | no RTR allowed on this PDO |
| **29** | 0 | 11-bit ID (CAN 2.0A) |
| | 1 | 29-bit ID (CAN 2.0B) |
| **28 ... 11** | 0 | if bit 29 = 0 |
| | X | if bit 29 = 1: bits 28-11 of 29-bit-COB-ID |
| **10 ... 0 (LSB)** | X | bits 10-0 of COB-ID |

Default = 4000 0180h+Node ID (no RTR, COB-ID)

**WARNING**
It is mandatory to set the bit 30 of COB-ID to 1 (value 0 is not allowed). This means that "No RTR is allowed on the PDO".
At power on, this object always contains the default value.

- **02** Transmission Type [Unsigned8, rw]

| Transmission type | PDO transmission | |
|---|---|---|
| **00h (0)** | Acyclic, synchronous | **not implemented** |
| **01h ... F0h (1 ... 240)** | Cyclic, synchronous | **implemented** |
| **F1h ... FBh (241 ... 251)** | **not implemented - reserved** | |
| **FCh (252)** | Synchronous, RTR only | **not implemented** |
| **FDh (253)** | Asynchronous, RTR only | **not implemented** |
| **FEh (254)** | Asynchronous, manufacturer specific | **implemented** |
| **FFh (255)** | Asynchronous, device profile specific | **not implemented** |

Default = FEh ("status, position, velocity exchange" transmission or cyclic transmission, see hereafter and object 3110-00 Cyclic Time)

**WARNING**
Following an attempt to set the Transmission Type to 0, the PDO message is not sent; following an attempt to change the Transmission Type to any other value that is not supported by the device, an abort message (abort code = 0609 0030h: **Value range of parameter exceeded**) is generated.
If the value next to the object 3110-00 Cyclic Time ≠ 0, the PDO message is sent cyclically and the interval between two messages is the time set next to the object 3110-00 Cyclic Time; otherwise, if the value next to the object 3110-00 Cyclic Time = 0, the PDO message is sent only at each status exchange (see object 3101-00 Status word) and/or position exchange (see object 3103-00 Current position value) and/or velocity exchange (see object 3105-00 Current velocity value); in this case the minimum interval between two PDO transmissions is set next to the following parameter Inhibit Time object 1800h sub 3.

- **03** Inhibit Time [Unsigned16, rw]
  Minimum interval between two PDO transmissions when "status, position, velocity exchange" transmission is set (see the parameter Transmission Type object 1800h sub 2 and the NOTE just below); value is expressed in multiples of 100 µs.
  Default = 0190h (40ms)

**NOTE**

- Before altering the value of COB-ID it is compulsory to deactivate the transmission of PDO1, then enter the new COB-ID value, finally activate again the transmission of PDO1.
- PDO1 transmission can be activated (deactivated) by setting to "0" ("1") the most significant bit of the object 1800 Transmit PDO Communication Parameter 1 sub 1 COB-ID.
- Cyclic transmission or synchronous transmission can be modified by setting a suitable value in the object 1800 Transmit PDO Communication Parameter 1 sub 2 Transmission Type. To have a PDO1 transmission every "n" SYNC commands, set "n" value in the object 1800h, sub 2.
  01h = synchronous transmission at every SYNC command
  02h = synchronous transmission every two SYNC commands
  ...
  FEh = "cyclic transmission" or "status, position, velocity exchange transmission":
  if 3110-00 Cyclic Time ≠ 0 → "cyclic transmission": cycle time is set in object 3110h;
  if 3110-00 Cyclic Time = 0 → "status, position, velocity exchange" transmission: device issues a PDO message each time parameters mapped in PDO change (see object 1A00 TPDO Mapping Parameter 1) with a minimum interval not lower than 1800 Transmit PDO Communication Parameter 1 sub 3 Inhibit Time.

## 1A00 TPDO Mapping Parameter 1

This object indicates the kind of parameter contained in the Transmit PDO message.

- **01** 3101-00 Status word [Unsigned32, ro] Default = 3101 0010h.
- **02** 3105-00 Current velocity value [Unsigned32, ro] Default = 3105 0010h.
- **03** 3103-00 Current position value [Unsigned32, ro] Default = 3103 0020h.

**NOTE**

Save set values using **1010-01 Save Parameters** function.
Should the power be turned off or **Reset node** or **Reset communication** commands be sent all data not saved will be lost!

### 8.1.2 Manufacturer's specific objects

#### Communication parameters

**3000-00 Baud rate**

[Unsigned8, ro]

This object is meant to show the baud rate (transmission rate) set by means of the dedicated switch, according to the following table; for any information on setting the baud rate see section "4.4.2 Setting the data transmission rate: Baud rate (Figure 4)" on page 23.

| Data byte | Baud rate |
|---|---|
| 00h | 20 Kbit/s |
| 01h | 50 Kbit/s |
| 02h | 100 Kbit/s |
| 03h | 125 Kbit/s |
| 04h | 250 Kbit/s |
| 05h (default) | 500 Kbit/s |
| 06h | 800 Kbit/s |
| 07h | 1000 Kbit/s |

**3001-00 Node ID**

[Unsigned8, ro]

This object is meant to show the node identifier (address) of the device set by means of the dedicated switch; for any information on setting the node-ID see section "4.4.1 Setting the node address: Node ID (Figure 4)" on page 22. The default address is 1.

## Device profile objects

### 3108-00 Acceleration

[Unsigned32, rw]
This object defines the acceleration value that has to be used by the device. Parameter is expressed in pulses per second$^2$ [PPS$^2$].
Default = 1000

### 3109-00 Deceleration

[Unsigned32, rw]
This object defines the deceleration value that has to be used by the device. Parameter is expressed in pulses per second$^2$ [PPS$^2$].
Default = 1000

### 310C-00 Max following error

[Unsigned32, rw]
This object defines the maximum allowable difference between the real position and the theoretical position of the device. If the device detects a value higher than the one set in this object, the alarm **Following error** is triggered and the unit stops. Parameter is expressed in pulses.
Default = 1024

### 310D-00 Position window

[Unsigned16, rw]
This object defines the tolerance window for the **3106-00 Target position** value. When the axis is within the tolerance window limits for the time set in the object **310E-00 Position window time**, then the state is signalled through the **Axis in position** status bit. Parameter is expressed in pulses.
Default = 0

### 310E-00 Position window time

[Unsigned16, rw]
It represents the time for which the axis has to be within the tolerance window limits set in the object **310D-00 Position window** before the state is signalled through the **Axis in position** status bit. Parameter is expressed in milliseconds.
Default = 100

## 310F Delta space

- **01** Positive delta [Integer32, rw]
  This value is used to calculate the maximum forward (positive) limit the device is allowed to reach starting from the preset value. When the maximum forward limit is reached, a signalling is activated through the SW limit switch + status bit. Parameter is expressed in encoder pulses.
  SW limit switch + = 3300-00 Preset + 310F Delta space sub 1 Positive delta.
  Default = 523263
- **02** Negative delta [Integer32, rw]
  This value is used to calculate the maximum backward (negative) limit the device is allowed to reach starting from the preset value. When the maximum backward limit is reached, a signalling is activated through the SW limit switch - status bit. Parameter is expressed in encoder pulses.
  SW limit switch - = 3300-00 Preset - 310F Delta space sub 2 Negative delta.
  Default = 523263

**WARNING**
Every time 3120-00 Distance per revolution and 3300-00 Preset parameters are changed, 310F Delta space values has to be checked carefully. Each time you change the value in 3120-00 Distance per revolution you must then update the value in 3300-00 Preset in order to define the zero of the shaft as the system reference has now changed.
After having changed the parameter in 3300-00 Preset it is not necessary to set new values for travel limits as the Preset function then calculates them automatically and initializes again the positive and negative limits according to the values set in 310F Delta space. For a detailed explanation see on page 28.

## 3111-00 Kp position loop

[Unsigned32, rw]
This object contains the proportional gain used by the PI controller for the position loop. Value has been optimized by Lika Electronic according to the technical characteristics of the device.
Default = 500

### 3112-00 Ki position loop

[Unsigned32, rw]
This object contains the integral gain used by the PI controller for the position loop. Value has been optimized by Lika Electronic according to the technical characteristics of the device.
Default = 60

### 3114-00 Jog speed

[Unsigned32, rw]
This object contains the maximum speed of the device when using **Jog +** and **Jog -** functions. Parameter is expressed in pulses per second.
Default = 1600 for RD4-...-T32-... model
Default = 1066 for RD4-...-T48-... model

### 3115-00 Work speed

[Unsigned32, rw]
This object contains the maximum speed of the device in automatic work mode (movements are controlled using **Start** command and are performed in order to reach the position set in **Target position**). Parameter is expressed in pulses per second.
Default = 1600 for RD4-...-T32-... model
Default = 1066 for RD4-...-T48-... model

**WARNING**
Each time you change the value in **3120-00 Distance per revolution** you must then set new values also in **3114-00 Jog speed** and **3115-00 Work speed** as speed values are expressed in pulses per second (PPS). To calculate the speed values you have always to adhere to the following ratio:

$$\frac{\text{Min. speed} * \text{Distance per revolution}}{1024} \leqslant \text{Speed} \leqslant \frac{\text{Max. speed} * \text{Distance per revolution}}{1024}$$

For a detailed explanation see on page 28.

### 3116-00 Max speed

[Unsigned32, ro]
This object shows the maximum speed you can set in the objects **3114-00 Jog speed** and **3115-00 Work speed**. Parameter is expressed in pulses per second.
Default = 1600 for RD4-...-T32-... model
Default = 1066 for RD4-...-T48-... model

### 3117-00 Jog step length

[Unsigned32, rw]
If the incremental jog function is enabled (bit 4 **Incremental jog** in **Control Word** = 1), the activation of bits **Jog +** and **Jog -** causes at rising edge the execution of a single step toward positive or negative direction having the length, expressed in pulses, set next to this item; then the slave stops and waits for another issue.
Default = 100

### 3118-00 Start Torque current time

[Unsigned32, rw]
This object defines the maximum time for which the motor is supplied with starting torque current when it starts its movement (see object **3341-00 Starting Torque current**). Parameter is expressed in milliseconds. Maximum value allowed is 5 seconds.
Default = 2000

### 3120-00 Distance per revolution

[Unsigned32, rw]
This object sets the number of pulses per each complete revolution of the shaft. This parameter is useful to relate the revolution of the shaft and a linear measurement. For example: unit is joined to a warm screw having a 5 mm pitch; by setting **3120-00 Distance per revolution** = 500, at each shaft revolution system performs a 5 mm pitch with one-hundredth of a millimetre resolution. Maximum value is 1024.
Default = 1024

**WARNING**
After having changed this parameter you must then set new values also in objects **3114-00 Jog speed**, **3115-00 Work speed** and **3300-00 Preset**. For a detailed explanation see on page 28 and relevant parameters.
Please note that the parameters listed hereafter are closely related to the **3120-00 Distance per revolution** parameter; hence when you change the value in

**3120-00 Distance per revolution** also the value expressed by each one is necessarily redefined. They are: **3108-00 Acceleration**, **3109-00 Deceleration**, **310C-00 Max following error**, **310D-00 Position window**, **310F Delta space**, **3116-00 Max speed**, **3343-00 Positive absolute limit switch**, **3344-00 Negative absolute limit switch**, **3103-00 Current position value**, **3105-00 Current velocity value**, **3106-00 Target position** and **3107-00 Target speed**. See for instance the relationship between **3120-00 Distance per revolution** and the speed values, explained on page 58.

**NOTE**
If **3120-00 Distance per revolution** is not a power of 2 (2, ..., 512, 1024), at position control a positioning error could occur having a value equal to one pulse.

### 3300-00 Preset

[Integer32, rw]
Use this object to set the Preset value. Preset function is meant to assign a certain value to a desired physical position of the axis. The chosen physical position will get the value set next to this item and all the previous and following positions will get a value according to it. The preset value will be set for the position of the axis in the moment when the value is entered.
Default = 0

**WARNING**
A new value has to be set in **3300-00 Preset** every time **3120-00 Distance per revolution** value is changed. After having entered a new value in **3300-00 Preset** it is not necessary to set new values for travel limits as the Preset function then calculates them automatically and initializes again the positive and negative limits according to the values set in objects **310F Delta space**. For a detailed explanation see on page 28.

### 3301-00 Offset

[Integer32, ro]
This object defines the difference between the position value transmitted by the device and the real position: real position – preset. Value is expressed in pulses.
Default = 0

### 3302-00 Code sequence

[Boolean, rw]
It sets the rotation direction of the encoder shaft and consequently defines whether the position value output by the encoder increases when the encoder shaft rotates clockwise (0) or counter-clockwise (1). Clockwise and counter-clockwise rotations are viewed from shaft.
**0** = clockwise rotation (default)
1 = counter-clockwise rotation

**WARNING**
Changing this value causes also the position calculated by the controller to be necessarily affected. Therefore it is compulsory to set a new value in **3300-00 Preset** parameter and then check the values set next to the **310F Delta space** item.

### 3330-00 Kp current loop

[Unsigned32, rw]
This object contains the proportional gain used by the PI controller for the current loop. Value has been optimized by Lika Electronic according to the technical characteristics of the device.
Default = 200

### 3331-00 Ki current loop

[Unsigned32, rw]
This object contains the integral gain used by the PI controller for the current loop. Value has been optimized by Lika Electronic according to the technical characteristics of the device.
Default = 60

### 3340-00 Max current

[Unsigned32, rw]
This object defines the maximum current supplied by the power electronic to control the motor. Parameter is expressed in mA (milliamperes). This value cannot be greater than the one in object **3341-00 Starting Torque current**. Maximum value is 5000.
Default = 5000

### 3341-00 Starting Torque current

[Unsigned32, rw]
This object defines the maximum current supplied to the motor only when it starts its movement and for the maximum time set in the object **3118-00 Start Torque current time**. Parameter is expressed in mA (milliamperes). Maximum value is 7000.
Default = 7000

### 3342-00 Gear ratio

[Unsigned32, ro]
It displays the gear ratio of the reduction gear installed between the motor and the encoder shaft. This is a read-only parameter.
Default = 32 for RD4-...-T32-... model
Default = 48 for RD4-...-T48-... model

### 3343-00 Positive absolute limit switch

[Integer32, ro]
This is the **SW limit switch +** value (maximum positive limit) calculated according to values set in parameters **3300-00 Preset** and **310F Delta space** sub 1 **Positive delta**. When the maximum forward limit is reached, a signalling is activated through the **SW limit switch +** status bit.
**SW limit switch +** = **3300-00 Preset** + **310F Delta space** sub 1 **Positive delta**.
Value is expressed in encoder pulses.

### 3344-00 Negative absolute limit switch

[Integer32, ro]
This is the **SW limit switch -** value (maximum negative limit) calculated according to values set in parameters **3300-00 Preset** and **310F Delta space** sub 2 **Negative delta**. When the maximum backward limit is reached, a signalling is activated through the **SW limit switch -** status bit.
**SW limit switch -** = **3300-00 Preset** – **310F Delta space** sub 2 **Negative delta**.
Value is expressed in encoder pulses.

**NOTE**
Save default values using **1010-01 Save Parameters** function.
Should the power be turned off or **Reset node** or **Reset communication** commands be sent all data not saved will be lost!

## Operating parameters

### 3005-00 Current value [mA]

[Integer16, ro]
This object shows the value of the current absorbed by the motor (rated current). Parameter is expressed in mA (milliamperes).

### 3006-00 Temperature value

[Integer16, ro]
This object shows the value of the internal temperature of the device as sensed by a probe. Value is expressed in °C (Celsius degrees). The minimum detectable temperature is -20°C.

### 3100-00 Control word

[Unsigned32, rw]
This object contains the commands to be sent in real time to the Slave in order to manage it. **3100-00 Control word** parameter is used to edit PDO messages received by the Slave (see further details in the section "7.6 PDO messages" on page 37).

### 3101-00 Status word

[Unsigned16, ro]
This object shows information about the device state. **3101-00 Status word** object is contained in the PDO messages sent by the Slave (see further details in the section "7.6 PDO messages" on page 37).

### 3102-00 Demanded position value

[Integer32, ro]
This object shows the value of the theoretical position calculated by the device while moving. This value is used by PI controller to control the motor.

### 3103-00 Current position value

[Integer32, ro]
This object shows the value of the current position. **3103-00 Current position value** object is contained in the PDO messages sent by the Slave (see further details in the section "7.6 PDO messages" page 37).

### 3105-00 Current velocity value

[Integer16, ro]

This object shows the value of the current speed. **3105-00 Current velocity value** object is contained in the PDO messages sent by the Slave (see further details in the section "7.6 PDO messages" on page 37). Parameter is expressed in pulses per second.

### 3106-00 Target position

[Integer32, rw]

This object defines the target position, otherwise referred to as commanded position. **3106-00 Target position** parameter is used to edit PDO messages received by the Slave (see further details in the section "7.6 PDO messages" page 37).

### 3107-00 Target speed

[Integer32, ro]

This object shows the value of the theoretical speed used by the device for generating the position trajectory. Parameter is expressed in pulses per second.

### 310B-00 Position following error

[Integer32, ro]

This object contains the difference between the target position and the current position step by step. If this value is greater than the one set in the object **310C-00 Max following error**, then the alarm **Following error** is triggered and the unit stops.

### 3110-00 Cyclic Time

[Unsigned16, rw]

**3110-00 Cyclic Time** is used in asynchronous work mode and sets the interval between two PDO transmissions.

If the value next to this object **3110-00 Cyclic Time** ≠ 0, the PDO message is sent cyclically and the interval between two messages is the time set here; otherwise, if the value next to this object **3110-00 Cyclic Time** = 0, the PDO message is sent only at each status exchange (see object **3101-00 Status word**) and/or position exchange (see object **3103-00 Current position value**) and/or velocity exchange (see object **3105-00 Current velocity value**); in this case the minimum interval between two PDO transmissions is set next to the parameter **Inhibit Time** object 1800h sub 3.

This parameter only concerns the PDO messages issued by the Slave, not by the Master. Parameter is expressed in milliseconds. For further information see object 1800 Transmit PDO Communication Parameter 1 on page 51.
Default = 0

### 3200-00 Alarms

[Unsigned16, ro]
This object is meant to show the alarms currently active in the device.
Structure of the alarms byte:

| byte | Data byte 4 | | | Data byte 5 | | |
|---|---|---|---|---|---|---|
| bit | 7 | ... | 0 | 15 | ... | 8 |
| | | | L.S.bit | M.S.bit | | |

Alarm codes available:

| | | |
|---|---|---|
| bit 0 : 0001h | **Machine data not valid** | One or more parameters are not valid, set proper values to restore normal work condition. |
| bit 1: 0002h | **Flash memory error** | Internal error, it cannot be restored. |
| bit 2 | Not used | |
| bit 3: 0004h | **Following error** | The difference between the real position and the theoretical position is greater than the value set in parameter 310C-00 Max following error; we suggest reducing the work speed. |
| bit 4: 0008h | **Axis not synchronized** | Internal error, it cannot be restored. |
| bit 5: 0010h | **Target not valid** | Target position is over maximum travel limits. |
| bit 6: 0020h | **Emergency** | Bit 7 Emergency in the Control Word has been forced to low value (0); or alarms are active in the unit. |
| bit 7: 0040h | **Overcurrent** | The power supply current is exceeding maximum ratings. |

| | | |
|---|---|---|
| bit 8: 0080h | **Overtemperature** | The internal temperature of the device as sensed by a probe is exceeding maximum ratings (see **3006-00 Temperature value**). |
| bit 9 | Not used | |
| bit 10: 0400h | **Undervoltage** | The power supply voltage is under minimum ratings. |
| bit 11: 0800h | **CAN Life guard error** | Error in the "Node guarding protocol". For further information see section "8.4 Node guarding protocol" on page 68. |
| bit 12...15 | Not used | |

To reset a faulty condition use **Alarm reset** bit. Setting this bit to "1" causes the normal work status of the device to be restored. This command is used to reset an alarm condition of the Slave but only if the faulty condition has ceased. Using SDO messages you can read further information about the alarm in the index **1003 Pre-defined Error Field**.

Please note that should the alarm be caused by wrong object values (see **Machine data not valid**), normal work status can be restored only after having set proper values. **Flash memory error** alarm cannot be reset.

**NOTE**

Save default values using **1010-01 Save Parameters** function.

Should the power be turned off or **Reset node** or **Reset communication** commands be sent all data not saved will be lost!

### 8.2 Warning messages

For the complete list and the meaning of the warning messages please refer to "SDO abort codes" section in "CiA Draft Standard 301" document available at www.can-cia.org.

### 8.3 Emergency messages

Emergency (EMCY) objects are issued by the device when an internal error occurs.

Structure of EMCY object:

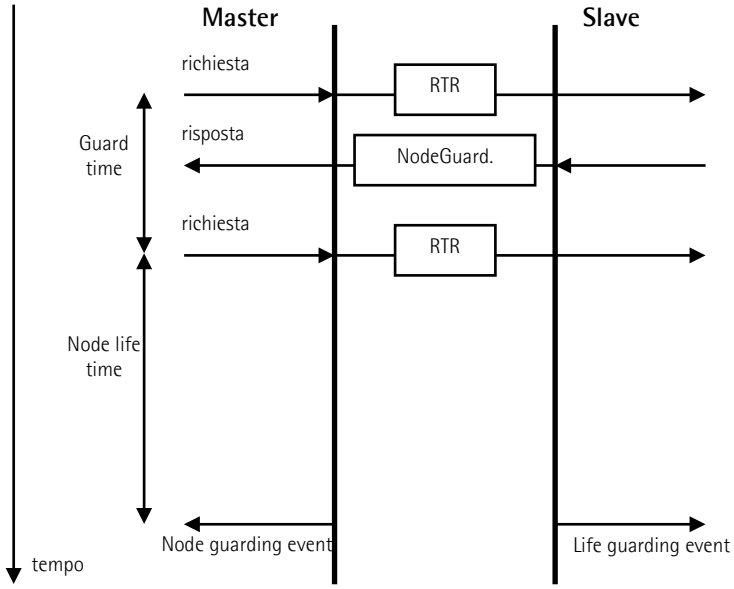
| IDENTIFIER | CAN Data Byte | | | |
|---|---|---|---|---|
| COB-ID(hex) | 0 | 1 | 2 | 3...7 |
| See object 1014h | Error code | | Errors sub-register | Specific codes |
| | LSB | MSB | 01 | 00...00 |

Emergency codes available:

| | |
|---|---|
| 0000h | No active errors |
| 1000h | Generic error |
| 2220h | Power surge |
| 3110h | Overvoltage |
| 3120h | Undervoltage |
| 4310h | Overtemperature |
| 5530h | Flash memory |
| 8130h | Life Guard |
| 8611h | Following error |

### 8.4 Node guarding protocol

At system boot the "Node guarding protocol" is not active; this protocol is activated automatically as soon as Master device sends a RTR (Remote Transmit Request) message the first time.




100C-00 Guard Time: interval between two RTR messages (see on page 47).

**Node life time**: maximum time by which the Slave device must receive the following RTR message issued by the Master device.

"**Node life time**" = "100C-00 Guard Time" * "100D-00 Life Time Factor".

"Node guarding" is enabled only if "Node life time" ≠ 0.

If the Slave device does not receive a RTR message before the "Node life time" has expired, it warns activating a "Life Guarding Event". Furthermore the red LED on the back of the device starts flashing so indicating the "Node guarding error" (see on page 20), objects 1001-00 Error register and 1003 Pre-defined Error Field are updated and an error message is sent.
To reset the error send a Reset node command.

# 9 Programming examples

Hereafter are some examples of transmission between Master and Slave devices.
A generic "ID" value is used to indicate the encoder address; Master address is always 0.
All values are expressed in hexadecimal notation.

### Setting the Operational / Pre-operational state

NMT message — Master → Slave

| | COB-ID | Cmd | Nodo |
|---|---|---|---|
| Operational: | 000 | 01 | ID |
| Pre-operational: | 000 | 80 | ID |

### Setting object 3300-00 Preset (preset = 1000 = 3E8h)

Master → Encoder (Set request)

| COB-ID | Cmd | Index | | Sub | Process data | | | |
|---|---|---|---|---|---|---|---|---|
| 600+ID | 23 | 00 | 33 | 00 | E8 | 03 | 00 | 00 |

Encoder → Master (Set confirmation)

| COB-ID | Cmd | Index | | Sub | Process data | | | |
|---|---|---|---|---|---|---|---|---|
| 580+ID | 60 | 00 | 33 | 00 | 00 | 00 | 00 | 00 |

**NOTE**
Save default values using 1010-01 Save Parameters function.
Should the power be turned off or Reset node or Reset communication commands be sent all data not saved will be lost!

# 10 Default parameters list

| Parameters list | Default value | | |
|---|---|---|---|
| 3120-00 Distance per revolution PPR | 1024 | | |
| 310D-00 Position window P | 0 | | |
| 310E-00 Position window time ms | 100 | | |
| 310C-00 Max following error P | 1024 | | |
| 3111-00 Kp position loop | 500 | | |
| 3112-00 Ki position loop | 60 | | |
| 3108-00 Acceleration $PPS^2$ | 1000 | | |
| 3109-00 Deceleration $PPS^2$ | 1000 | | |
| 310F Delta space Positive delta P | 523263 | | |
| 310F Delta space Negative delta P | 523263 | | |
| 3114-00 Jog speed PPS | 1066 (RD4-...T48-...)<br>1600 (RD4-...T32-...) | | |
| 3115-00 Work speed PPS | 1066 (RD4-...T48-...)<br>1600 (RD4-...T32-...) | | |
| 3118-00 Start Torque current time ms | 2000 | | |
| 3302-00 Code sequence | 0 | | |
| 3330-00 Kp current loop | 200 | | |
| 3331-00 Ki current loop | 60 | | |
| 3340-00 Max current mA | 5000 | | |
| 3341-00 Starting Torque current mA | 7000 | | |
| 3300-00 Preset P | 0 | | |
| 3117-00 Jog step length P | 100 | | |

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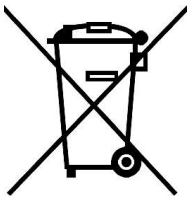
| HW-SW release | Document release | Description |
|---|---|---|
| 1-1 | 1.0 | First issue |
| 2-2<br>2-3 | 1.1 | General review, section "Preliminary information" added |
| 2-4 | 1.2 | Added Incremental jog function in Control Word and 3117-00 Jog step length parameter. Updated jog entries. Updated Axis enabled entry. Removed bits "Operational state", "Undervoltage" and "Following error". Changed position of bits Executing a command and Target position reached. Updated EDS file (V2). |
| 2-4 | 1.3 | Updated section "Electrical connections". |
| 2-4 | 1.4 | Updated information about objects 1400 Receive PDO Communication Parameter 1, 1800 Transmit PDO Communication Parameter 1, 3110-00 Cyclic Time |
| 2-4 | 1.5 | Warning against back EMF |

Dispose separately



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