EAM 110M

USER MANUAL

Modbus

A Broadcom Company

Eltra®

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1. PRODUCT DESCRIPTION

The EAM 110M encoder sensor is a magnetic multiturn absolute encoder with Modbus-RTU communication.
Inside the product, the single-turn part and the number of revolutions are counted by magnetic detection of the displacement of the magnet placed in the magnet holder which turns with the customer's shaft.
In case of a power failure, a backup battery is available to count the number of revolutions, however, the backup battery is not replaceable by the end-user.
This manual pertains to the mechanical and electrical installation and configuration of the Modbus-RTU device, for other data please refer to the product datasheet.

2. INSTALLATION

Please follow the installation instructions carefully to ensure the correct commissioning of the product.

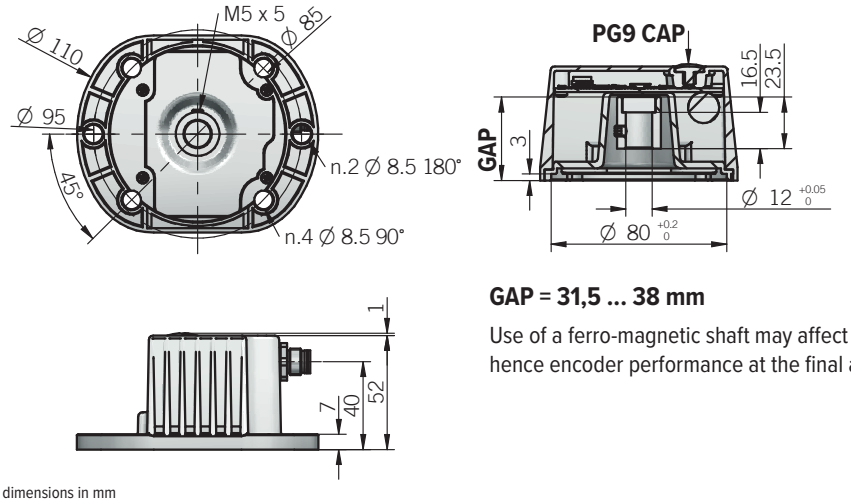
1. Ensure that the encoder is not powered and the dip-switch is in the OFF position.
2. Install the magnet holder by tightening the M5 grub screw with a recommended tightening torque of 0.4 Nm / 57 Ozin (threadlocker recommended, e.g., Loctite 425), making sure to comply with the installation tolerances of the magnet holder.
3. Fix the encoder to the motor or gearmotor using at least 2 screws through the fixing holes (8.5 mm diameter).
4. Connect the cable or the M12 connector with the power supply turned off.
5. Ensure that the dip-switch is still in the OFF position, the shaft is in a stable, stationary position, and no accidental movements are possible. Otherwise, move the dip-switch to the OFF position and ensure that the shaft is in a stable position.
6. Activate the dip-switch by moving it to the ON position and close the PG9 cap, recommended tightening torque 0.5 Nm / 70 Ozin.



7. Power the device.
8. Activate the product via the activation command.

Only after activating the product via the activation command is it possible to power it down. If the power is removed after powering the encoder (step 7) without sending the activation command, the activation procedure must be repeated starting from step 4.

Ensure that the shaft and the product remain in a stable, stationary position until the end of the installation procedure.



GAP = 31,5 ... 38 mm

Use of a ferro-magnetic shaft may affect the magnetic system and hence encoder performance at the final applications.

dimensions in mm

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ELECTRICAL CONNECTIONS

The EAM 110M product features an M12 connector (5 pin A coded) installed in the encoder cover. This connector provides both power supply and communication connections, as shown in the figure below.

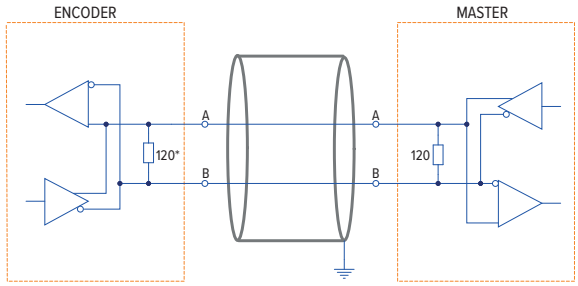
CONNECTIONS	
Function	**M12 5 pin**
+V DC	1
0 V	3
A	2
B	4
NC	5

M12 connector (5 pin)
M12 A coded
front view



LINE TERMINATION

Depending on the ordering code, the EAM 110M may or may not have the termination resistor on board.
Please provide an external line termination (120 Ohm) if the product is without termination and is used as the last station in the network.



* with line termination (T ordering code)

DEFAULT SETTINGS

The default settings are as per the table below.

SETTINGS	
Description	**Value**
Baud rate	19200
Parity	N
Stop bit	1
Data bits	8
Slave ID	22h (34d)
Counting direction	decreasing clockwise (shaft view)
Singleturn resolution	9 bit (512 positions/turn)
Multiturn resolution	16 bit (65536 turns)
Activation status	non active
Serial number	0
Scaling	not active
Comparator	low limit = 0 high limit = 511

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3. MODBUS DESCRIPTION

MODBUS is an application layer messaging protocol, positioned at layer 7 of the OSI model. Provides client/server communication between connected devices on different types of buses or networks.
The de facto industry serial standard since 1979, MODBUS continues to enable millions of automation devices to communicate.

MODBUS is a request/response protocol and offers services specified by function codes.
MODBUS function codes are elements of Request/Response PDUs.

STRUCTURE OF MODBUS RTU TELEGRAMS

In order to make settings in the device, the respective Modbus registers must be addressed via a telegram.
The basic structure of a Modbus telegram is shown below:

Start	Address	Function	Data	CRC	Stop
3,5 byte	1 byte	1 byte	N x 8 bits	2 bytes	3,5 bytes

The data area has a different structure depending on whether the telegram is a request or a reply and on the function code used.
In RTU mode, messages begin with a silent interval of at least 3.5 characters. Depending on the transmission speed set in the network, this interval is most easily implemented as a multiple of the duration of one character.
The first field subsequently transmitted is the device address in the range 01...F7h (247d), (248-255 are reserved for Modbus).
Allowed characters for all fields: hexadecimal 0-9, A-F.
Networked devices constantly monitor the network bus, even during 'silence' intervals.
When the first field (address field) is received, the device decodes it to determine whether the message is directed to it.
After the last character transmitted, an identical interval of at least 3.5 characters indicates the end of the message, a new message can begin after this interval.
The complete telegram must be transmitted as a continuous data stream. In the case of a silent interval of more than 1.5 characters before the end of the telegram, the receiving device deletes the message and assumes that the next byte is the address field of a new message.
Similarly, if a new message begins before the end of the 3.5 character silence interval, the receiving device will consider this new message as a continuation of the previous message. This will trigger an error, as the value in the final CRC field will not be valid for combined messages.

FUNCTION CODES

(3h) READ HOLDING REGISTERS

This function code is used to read the contents of a contiguous block of holding registers in a remote device. The request PDU specifies the address of the initial register and the number of registers. In the PDU, the registers are addressed starting from zero.
Therefore registers numbered 1-16 are addressed as 0-15.
The register data in the response message is packaged as two bytes per register, with the binary content right-justified within each byte. For each register, the first byte contains the higher order bits (MSB) and the second contains the lower order bits (LSB).

REQUEST		
Function code	1 byte	**3h**
Starting address	2 bytes	0h to FFFFh
Number of registers	2 bytes	from 1 to 125 (7Dh)

ANSWER		
Function code	1 byte	**3h**
Number of bytes	1 byte	2 x N*
Registers value	N* x 2 bytes	

*N = number of registers

ERROR		
Error code	1 byte	**83h**
Exception code	1 byte	01 or 02 or 03 or 04

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REQUEST		ANSWER	
Name	Hex	Name	Hex
Function	03	Function	03
Starting address Hi	00	Number of bytes	06
Starting address Lo	6B	Registry value Hi (108)	02
Number of registers Hi	00	Registry value Lo (108)	2B
Number of registers Lo	03	Registry value Hi (109)	00
		Registry value Lo (109)	00
		Registry value Hi (110)	00
		Registry value Lo (110)	64

The contents of register 108 contains the values of the two bytes (02 2B)h or 555d.
The contents of registers 109 – 110 are 00 00 e (00 64)h, or 0 and 100d,respectively.

(6h) WRITE SINGLE REGISTER

This function code is used to write a single holding register to a remote device.
The request PDU specifies the address of the register to be written. Registers are addressed starting from scratch. Therefore the register numbered 1 is addressed as 0. The normal response is an echo of the request, returned after the contents of the register have been read/written.

REQUEST		
Function code	1 byte	**6h**
Starting address	2 bytes	0h to FFFFh
Number of registers	2 bytes	0h to FFFFh

ANSWER		
Function code	1 byte	**6h**
Number of bytes	1 byte	0h to FFFFh
Register value	2 bytes	0h to FFFFh

ERROR		
Error code	1 byte	**86h**
Exception code	1 byte	01 o 02 o 03 o 04

Below is an example of a request to write register 2 with 3h:

REQUEST		ANSWER	
Name	Hex	Name	Hex
Function	06	Function	06
Starting address Hi	00	Starting address Hi	00
Starting address Lo	01	Starting address Lo	01
Number of registers Hi	00	Number of registers Hi	00
Number of registers Lo	03	Number of registers Lo	03

(10h) WRITE MULTIPLE REGISTERS

This function code is used to write a block of contiguous registers (1 to 123 registers) to a remote device. The required written values are specified in the request data field. The data is packed as two bytes per register.
The normal response returns the function code, starting address, and amount of registers written.

REQUEST		
Function code	1 byte	**10h**
Starting address	2 bytes	0h to FFFFh
Number of registers	2 bytes	1h to 7Bh
Byte	1 byte	2 x N*
Register value	N* x 2 bytes	value

*N = number of registers

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ANSWER		
Function code	1 byte	**10h**
Number of bytes	2 bytes	0h to FFFFh
Number of registers	2 bytes	da 1 a 123 (7Bh)

ERROR		
Error code	1 byte	**90h**
Exception code	1 byte	01 o 02 o 03 o 04

Below is an example request for writing two registers starting from 2 to 00 0A and 2h:

REQUEST		ANSWER	
Name	Hex	Nome	Hex
Function	10	Function	10
Starting address Hi	00	Starting address Hi	00
Starting address Lo	01	Starting address Lo	01
Number of registers Hi	00	Number of registers Hi	00
Number of registers Lo	02	Number of registers Lo	02
Number of bytes	04		
Registry value i Hi	00		
Registry value Lo	0A		
Registry value Hi	01		
Registry value Lo	02		

BROADCAST MESSAGES

BROADCAST messages are not supported.



Written data is validated according to the function, each unexpected value generates an error code.

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4. REGISTRY TABLE

(3h) READ HOLDING REGISTER

The registers in the following table (40002 ... 40021) are read-only.

Register	Internal register	Description	Type	Value	Default value (hex)
40002	1	Position value (MSB)	Unsigned16	Bit 17-32	-
40003	2	Position value (LSB)	Unsigned16	Bit 1-16	-
40004	3	Counting direction (shaft view)	Unsigned16	1 = CCW 2 = CW	2
40005	4	Reserved			
40006	5	Reserved			
40007	6	Comparator status	Unsigned16	0 = within set limits 1 = below limit 2 = above limit	-
40008	7	Battery level	Unsigned16	Battery voltage value (Volt) es. 3,69V (=369d)	-
40009	8	Reserved			
40010	9	Singleturn resolution (MSB)	Unsigned16	Positions/turn MSB	0
40011	10	Singleturn resolution (LSB)	Unsigned16	Positions/turn LSB	511d / 01FFh
40012	11	Total resolution (MSB)	Unsigned16	Total resolution	511d / 01FFh
40013	12	Total resolution (LSB)	Unsigned16	Total resolution	65535d / FFFFh
40014	13	Scaling status	Unsigned16	0 = scaling function not active 1 = scaling function active	0
40015	14	User serial number MSB	Unsigned16	User serial number MSB	0
40016	15	User serial number LSB	Unsigned16	User serial number LSB	0
40017	16	Firmware version	Unsigned16	Firmware version	-
40018	17	Battery percentage charge estimation	Unsigned16	Battery charge (%) es. 99% (=99d)	
40019	18	Product activation status	Unsigned16	0 = not active 1 = active	0
40020	19	Unique product identifier MSB	Unsigned16	UID MSB	-
40021	20	Unique product identifier LSB	Unsigned16	UID LSB	-

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(6h / 10h) WRITE HOLDING REGISTER

Register	Internal register	Description	Value	Default value (hex)	Reboot required
40257	256	Baud rate	1 = 9600 2 = 19200 3 = 38400 4 = 57600 5 = 115200	2	Yes
40258	257	Data bit	2 = 8 bit	2	Yes
40259	258	Parity	1 = none 2 = even 3 = odd	1	Yes
40260	259	Stop bit	1 = 1 bit 3 = 2 bit	1	Yes
40261	260	Update Communication Parameters	1 = activate function	-	Yes
40262	261	Node address	1 ... 247d (1 ... F7h)	34d (22h)	Yes
40263	262	Update Node address	1 = activate function	-	Yes
40264	263	MSB preset value	Preset value MSB	-	
40265	264	LSB preset value	Preset value LSB	-	
40266	265	Update Preset	1 = activate function	-	
40267	266	Counting direction	1 = CCW 2 = CW	2	
40268	267	Update counting direction	1 = activate function	-	
40269	268	Reserved			
40270	269	Reserved			
40271	270	User serial number MSB	User serial number MSB	0	
40272	271	User serial number LSB	User serial number LSB	0	
40273	272	Update user serial number	1 = activate function	-	
40274	273	Reserved			
40275	274	Comparator lower limit	Comparator lower limit	0	
40276	275	Comparator upper limit	Comparator upper limit	511d / 01FFh	
40277	276	Update Comparator	1 = update comparator limits	-	
40278	277	Singleturn resolution (MSB)	Positions/turn MSB	0	
40279	278	Singleturn resolution (LSB)	Positions/turn LSB	511d / 01FFh	
40280	279	Total resolution (MSB)	Total resolution	511d / 01FFh	
40281	280	Total resolution (LSB)	Total resolution	65535d / FFFFh	
40282	281	Scaling function	1 = activate Scaling	-	
40283	282	Reserved			
40284	283	Activation	123d / 7Bh = active	0	
40285	284	Activation function	1 = enable activation	-	

RESERVED REGISTERS

Register	Internal register	Description	Value
40300 ... 40337	299 ... 336	Reserved	

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DESCRIPTION OF REGISTERS

The operation of the various registers available is explained below.

Position value - registers 40002/40003

The encoder position value is divided between high value (register 40002) and low value (register 40003).
The value in register 40002 represents the number of revolutions while the value in register 40003 represents the position within a single revolution. The data is considered valid if no error flags are present.

Number of revolutions value
bit 15 ... 0
MSB ... LSB

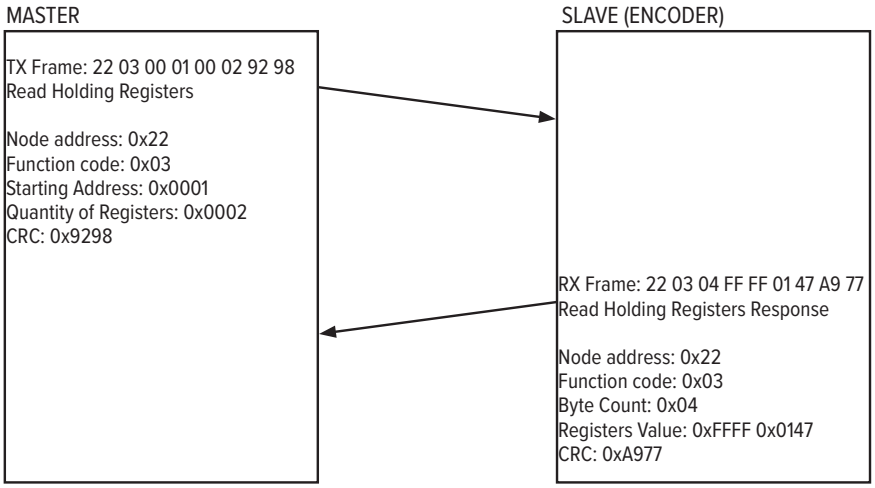
Representation register 40002

Register 40003 also contains the product status bits as shown in the table below:

Battery status	Activation status	General error	Reserved	Pos/turn value
bit 15	bit 14	bit 13	bit 12 ... 9	bit 8 ... 0
0 = charged 1 = discharged	0 = activated 1 = not activated	0 = not present 1 = present (contact factory)	0	MSB ... LSB

Representation register 40003

The default resolution is 65536 revolutions - 512 positions/revolution possibly modified by the Scaling function parameters.



Example of position reading with encoder activated, node address 22h and position FFFFh (revolutions) / 147h (pos/turn) and no active flags

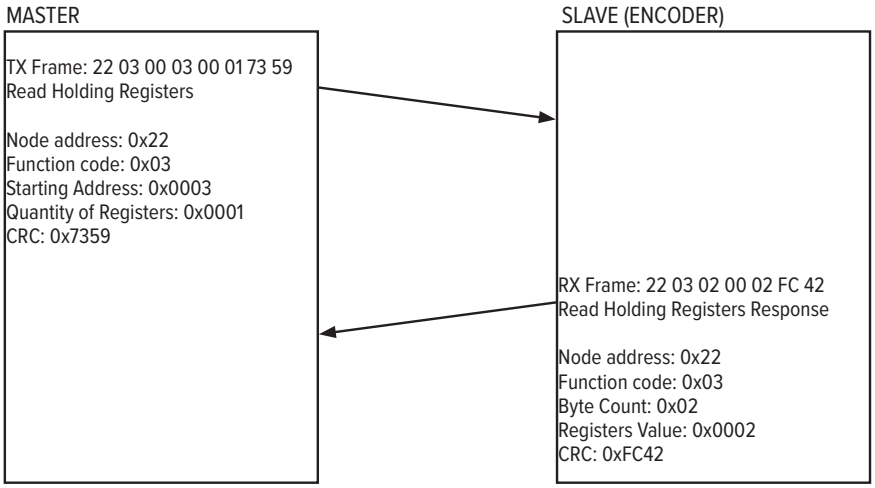
The position value remains at 0 (with activation status flag = 1) until the product is activated

If the product activation procedure has been completed and the flag is at 1 (Activation status = not activated) please contact the factory

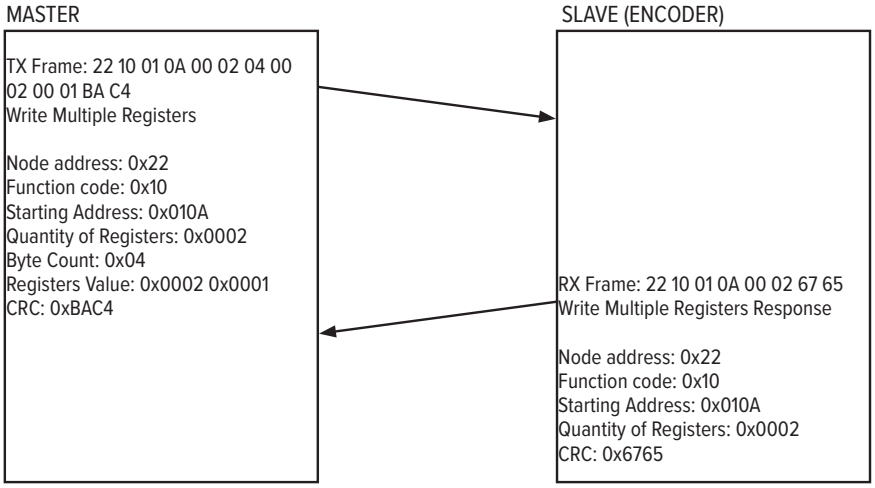
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Counting direction - register 40004

The counting direction (default clockwise / decrementing shaft side view) is indicated in register 40004 and can be changed by writing the appropriate value to registers 40267 (counting direction) and 40268 (function activation).



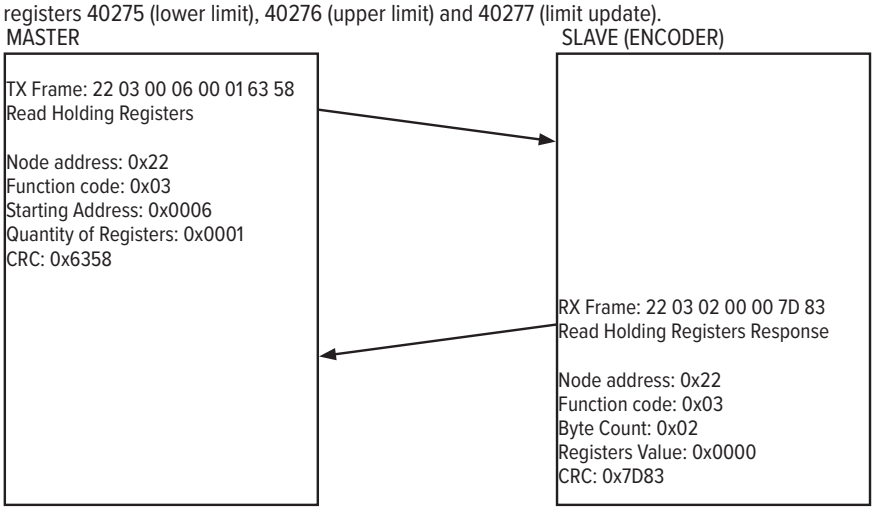
Example of count direction reading (value 2), node address 22h.



Example of multiple writing of count direction (value 2), node address 22h.

Comparator status - register 40007

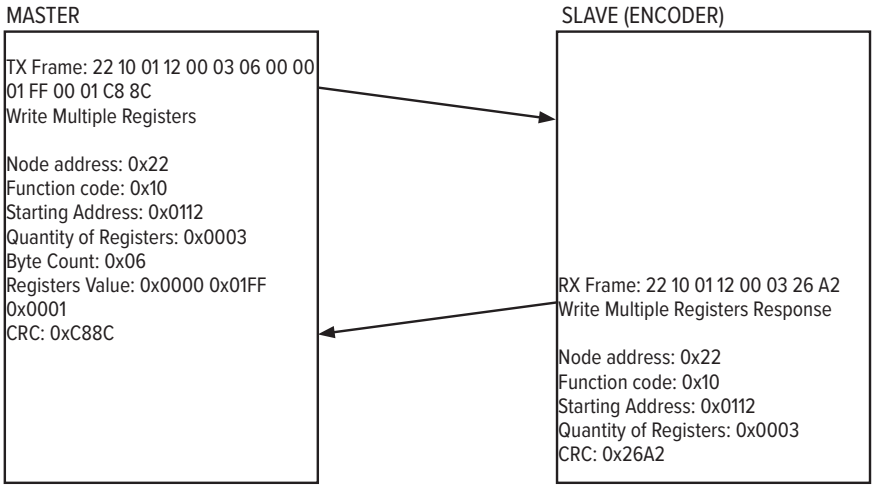
The status of the comparator is indicated in register 40007. The upper and lower limits can be changed by writing the appropriate values in registers 40275 (lower limit), 40276 (upper limit) and 40277 (limit update).



Example of comparator status reading (value 0), node address 22h.

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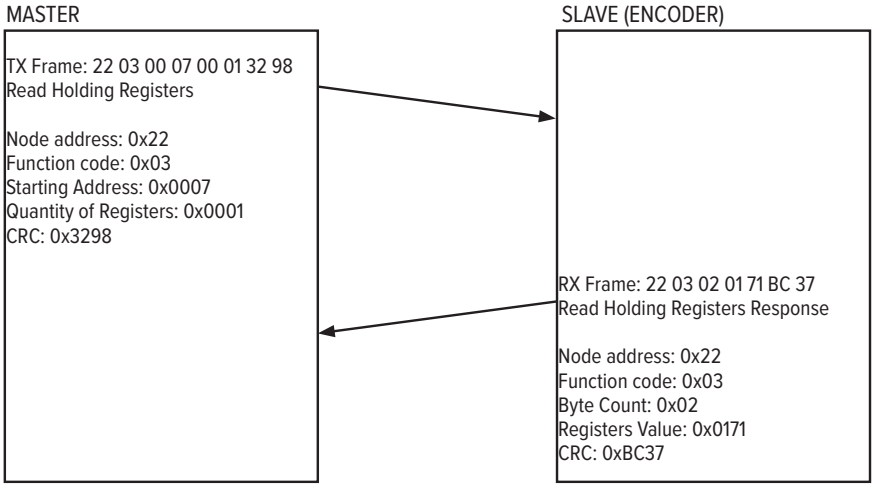


Example of multiple writing of comparator lower (0) and upper (511) limit values, node address 22h.

The following registers are updated when the scaling function is changed:
Lower limit (40275) = 0
Upper limit (40276) = 2^m-1

Battery voltage level - register 40008

The internal battery voltage level (if dip-switch in ON position when the product is powered) is indicated in register 40008 and is expressed in hundredths of a volt (e.g. 3.69V = 369d). The value is updated when the product is switched on.



Example of battery voltage reading (value 171h = 369d), node address 22h.

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Scaling - registers 40010 ... 40014

The scaling function allows the maximum resolution of the encoder to be reduced and is indicated in registers 40010 (MSB single-turn) / 40011 (LSB single-turn) / 40012 (MSB total resolution) / 40013 (LSB total resolution). The scaling state (active/disactive) is indicated in register 40014.

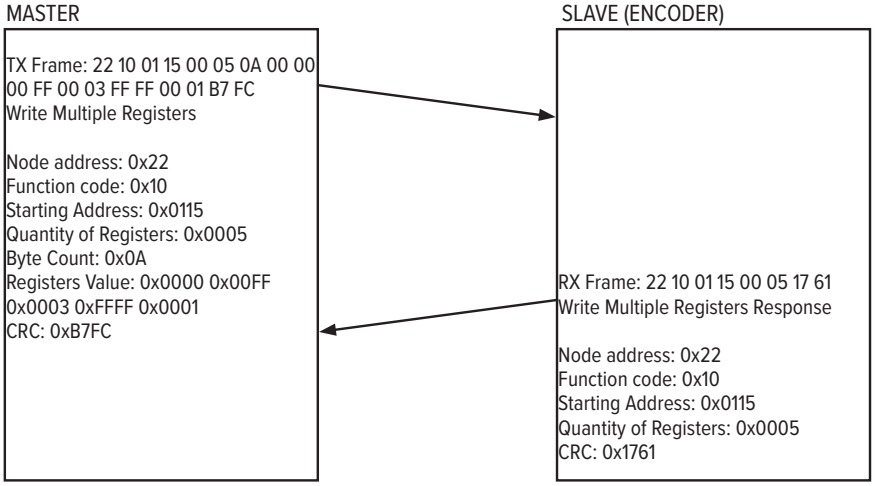
The singleturn resolution (m) can be changed between 1 and 511 by writing the appropriate values to registers 40278 (MSB) and 40279 (LSB). The value in register 40278 is always 0.

bit 15 ... 9	bit 8 ... 0
0	2^m-1

Register representation 40279, m expressed in bits 1 to 9

The multi-turn resolution (M) can be changed between 1 and 65535 by setting the total resolution (t=m+M) by writing the appropriate values to registers 40280 (MSB) and 40281 (LSB). The total resolution is then calculated as 2^t-1 and must not exceed 25 bits (33,554,431 total positions). The result is then divided into MSB and LSB and written to registers 40280 / 40281. Activation / deactivation is done by writing to register 40282.

The following registers are updated when the Scaling function is changed:
Lower limit (40275) = 0
Upper limit (40276) = 2^m-1
Preset (40264/40265) = 0



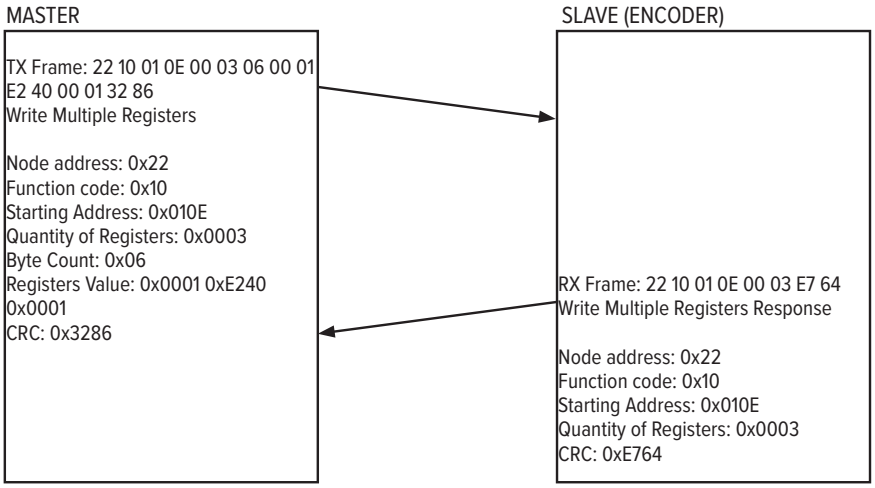
Example of single-turn resolution setting m=8, M=10 (t=8+10=18) and Scaling activation, node address 22h.

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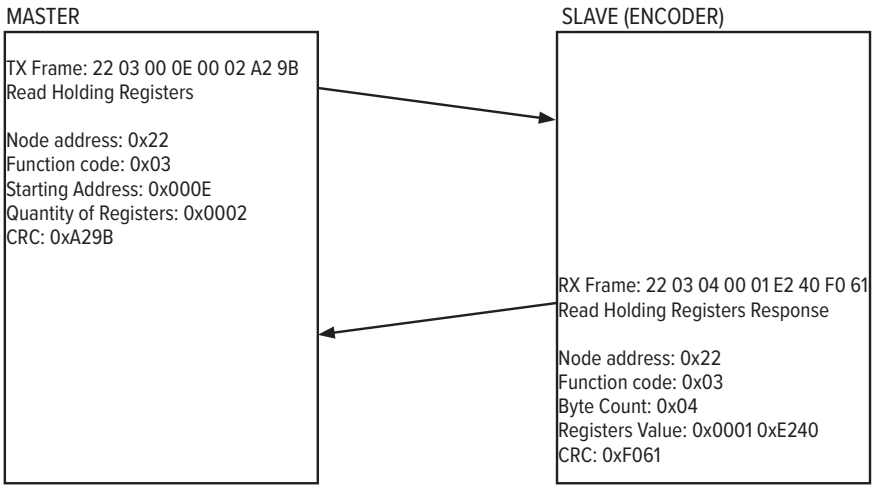
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User serial number - registers 40015/40016

32bit are made available in the device for writing user data (e.g. electronic label).
The indication is divided between registers 40015 (MSB) and 40016 (LSB), while values can be entered by writing the appropriate values into registers 40271 (MSB) and 40272 (LSB) and activating the update via register 40273.



Example of writing user serial number (value 0001 E240 h = 123456d) with enable, node address 22h.

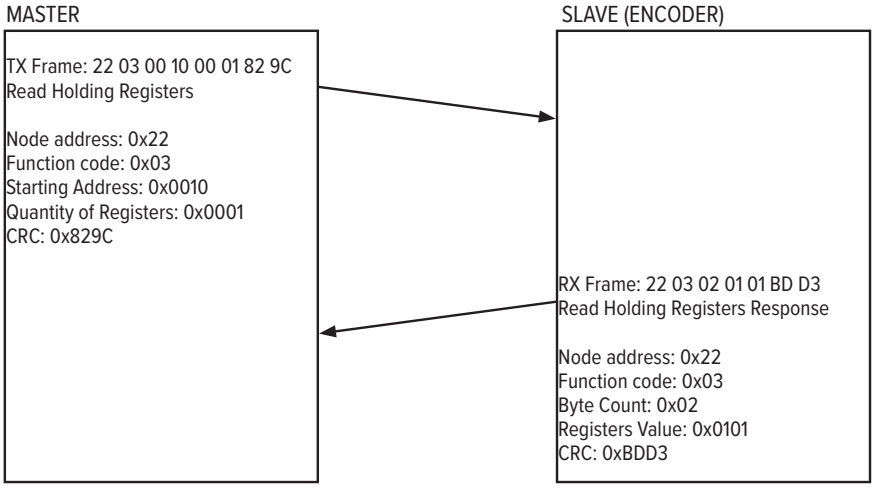


Reading example User serial number (value 0001 E240 h = 123456d), node address 22h.

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Firmware version - register 40017

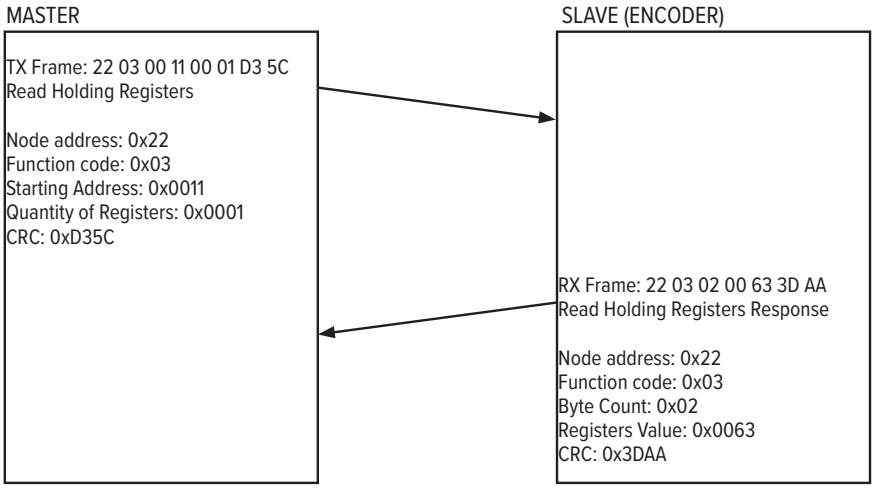
The firmware version installed in the device is indicated in register 40017.



Example of reading firmware version (value 101h = version 1.1), node address 22h.

Battery percentage charge estimation - register 40018

The estimated battery charge (if dip-switch in ON position when the product is powered) is indicated in register 40018 and is expressed as a percentage (e.g. 63h = 99d). The value is updated when the product is switched on.



Example of battery charge percentage reading (value 63h = 99d), node address 22h.

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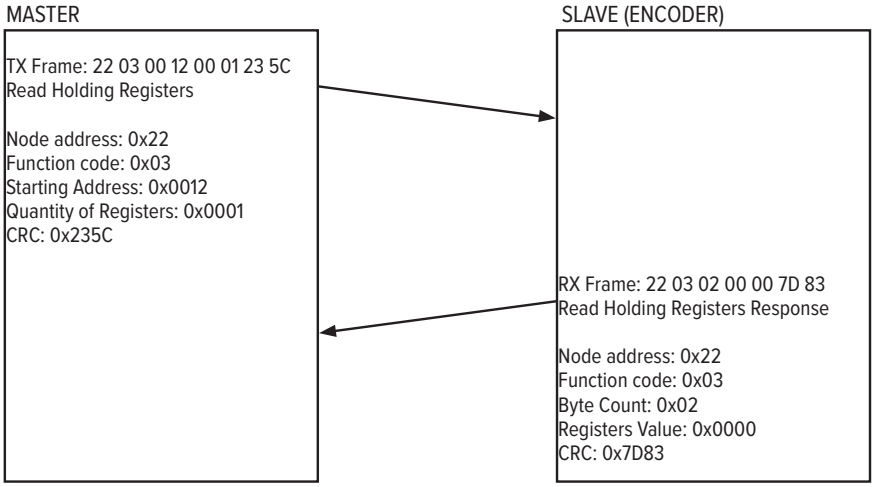
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Product activation status - register 40019

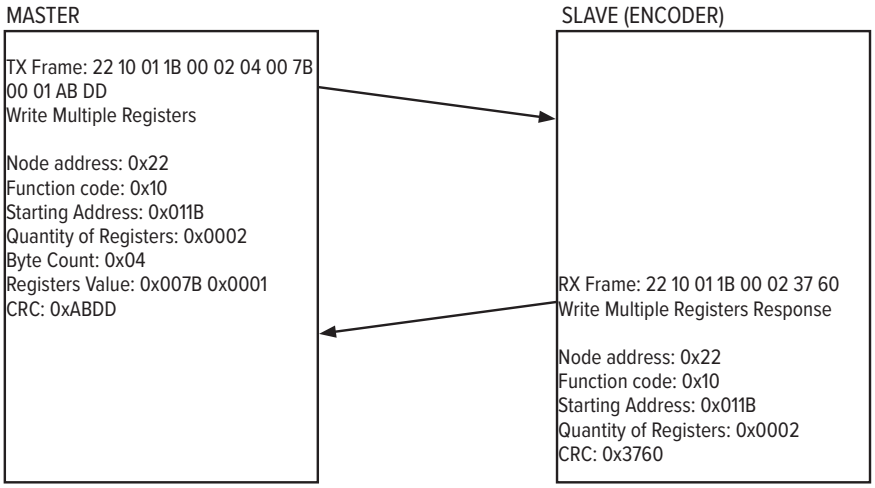
The product activation status is indicated in register 40019 and can be activated by writing the appropriate value (123d) to register 40284 (activation) and enabling it in register 40285. Once activated, the Activation Status flag in register 40003 is set to 0.

The SW activation procedure must be performed at the end of the installation procedure as stated in the INSTALLATION section

The SW activation function does not allow deactivation; to deactivate the product, power must be switched off and the dip-switch must be set to the OFF position



Example of activation status reading (value 0, not active), node address 22h.

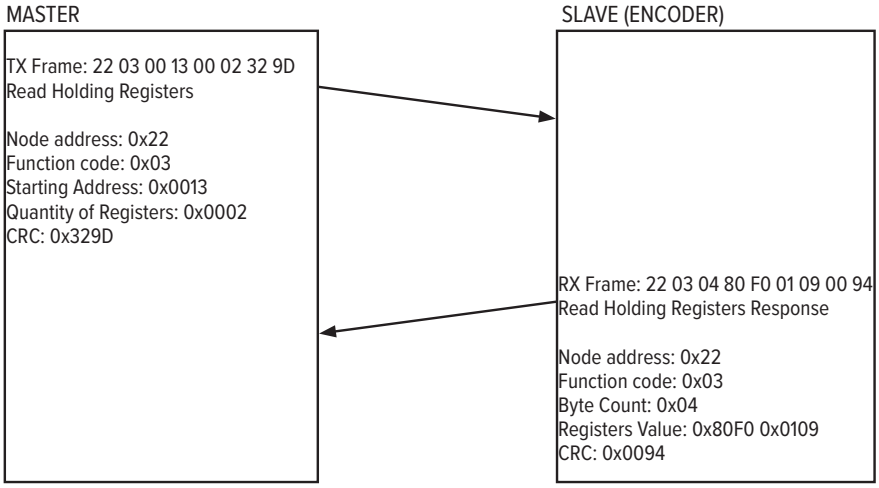


Example of multiple writing of activation status (value 1, active), node address 22h.

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Unique product identifier (UID) - registers 40020/40021

Each product has a unique identifier, the number in 32-bit format is indicated in registers 40020 (MSB) and 40021 (LSB).



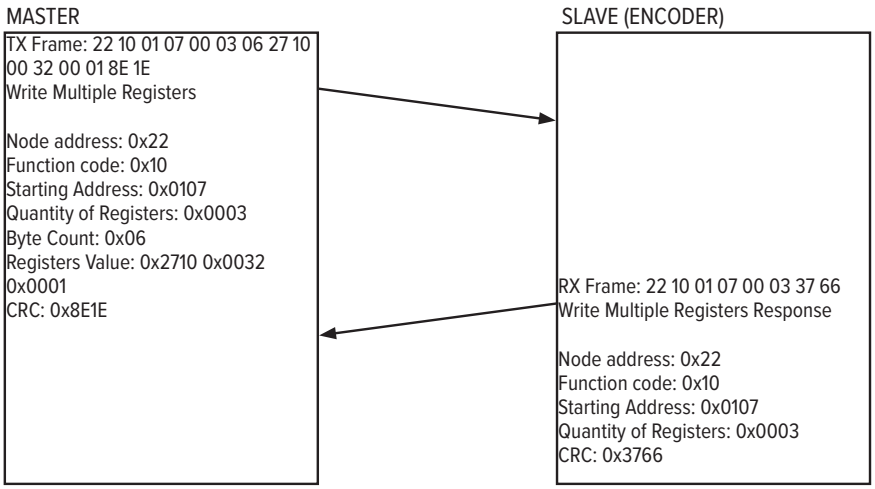
Example of reading UID (value 80F0 0109h), node address 22h.

Preset - registers 40264 ... 40266

A preset value can be written to registers 40264 (MSB) and 40265 (LSB). The function is activated by writing to register 40266.
The subsequent position reading (with the shaft at standstill) corresponds to the set value.
The set value must be within the total resolution.

Preset operation must be performed with the encoder shaft standstill

The following registers are updated when the Scaling function is changed:
Preset (40264/40265) = 0



Example of preset setting with enable (value 2710 0032 h = 10000 rpm and position 50 single-turn), node address 22h.

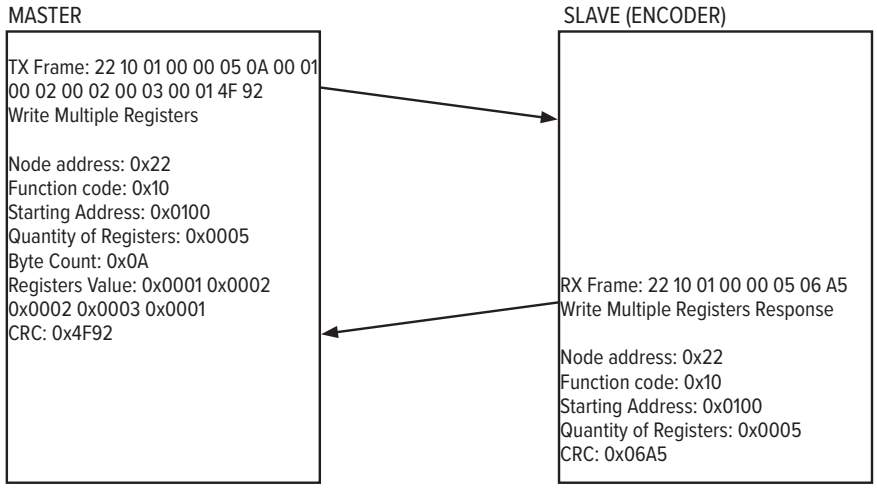
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Communication parameters - registers 40257 ... 40261

The communication parameters can be changed by writing to registers 40257 (Baud rate), 40258 (Data bits), 40259 (Parity), 40260 (Stop bits) and activating the update via register 40261.

For the new settings to take effect, the product must be restarted

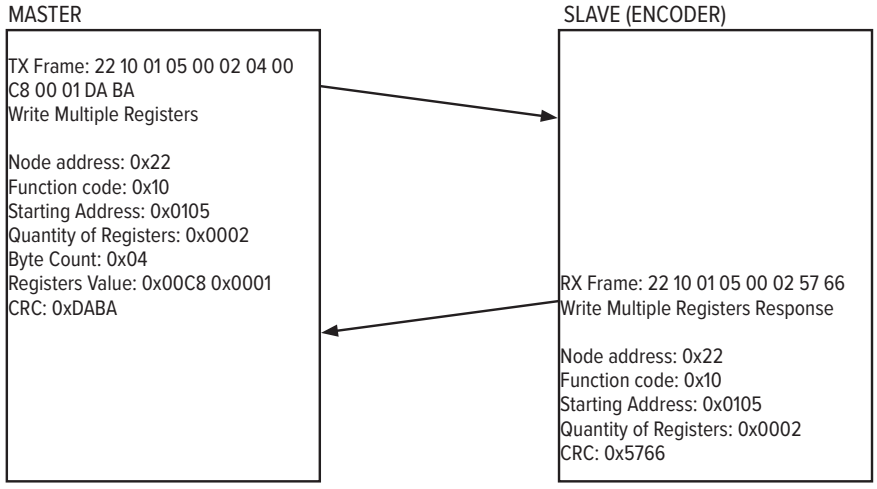


Example of setting communication parameters Baud rate 9600 (1h), Data bits 8 (2h), Even parity (2h), Stop bits 2 (3h) and enable, node address 22h.

Node address 40262/40263

The device address can be changed by writing to register 40262 and activating the update via register 40263.

For the new settings to take effect, the product must be restarted



Example of node address change (from 22h to C8h) and enabling.

BIBLIOGRAPHY

· Modbus Application Protocol Specification V1.1b3

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INSTALLATION AND PRECAUTIONS



The transducer must be used in accordance with its specifications. It is a precision measuring instrument and not a safety device.



Personnel responsible for mounting and commissioning the device must be qualified and carefully follow installation instructions. For safety reasons, it is strongly recommended to avoid any mechanical or electrical modifications.
Please note that any modifications made to the product will invalidate the warranty.



To ensure proper functioning, avoid subjecting the device to stress or impact.



Please ensure that the mechanical coupling of the transducer is designed as specified in the technical datasheet and that the product is installed according to the instructions provided.



Additionally, ensure that the operating environment is free from corrosive substances, such as acids, and materials that are incompatible with the device and its IP rating.



It is also recommended that the device is properly grounded. If necessary, please make an additional external connection.



Products with variant codes (a number or combination of numbers after the full stop) may have different mechanical, electrical, or connection requirements than standard products. Please refer to the additional documentation for further information.



Installation and wiring should only be carried out by trained personnel in a POWER-OFF condition.



In order to prevent short circuits, it is essential to insulate any unused wires at varying lengths.
Please note that it is not recommended to connect unused pins on the connector.



Prior to switching on, please verify the voltage range applicable to the device.



Please ensure that power and signal cables are positioned in a way that avoids capacitive or inductive interferences, which may otherwise cause device malfunction. Furthermore, please ensure that the transducer cable is kept at a safe distance from power lines and any other cables with high noise levels.



Users who integrate the transducer into their appliances must comply with CE/UKCA regulations and are responsible for marking the end machine/device.



Failure to observe these usage and installation precautions may invalidate the warranty.



Eltra disclaims any liability for damages or injuries resulting from non-compliance with these directives.



The products should be stored in their original packaging in a dust-free, dry and temperature-regulated location that is free from chemical influences or mechanical shock/vibrations.



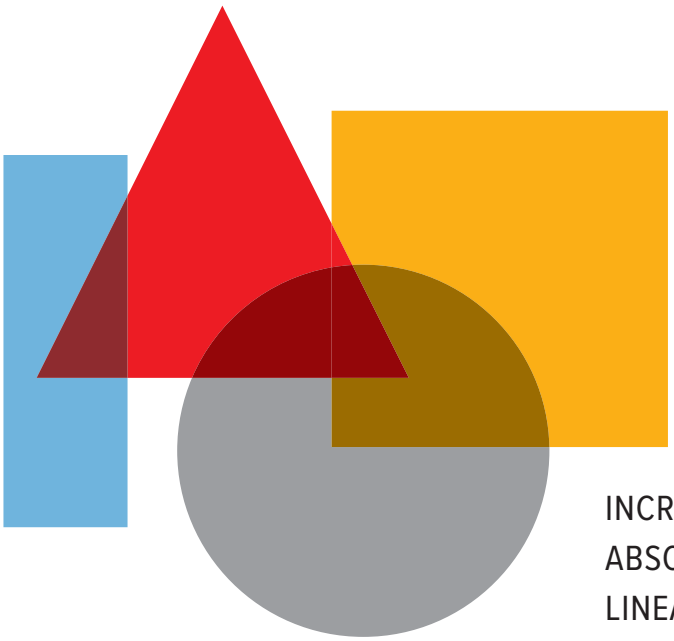
For storage periods exceeding 12 months, rotate the encoder shaft every 12 months at low speed (e.g. by hand) to allow the bearing lubricant to distribute.

Please refer to www.eltra.it for sales conditions.

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