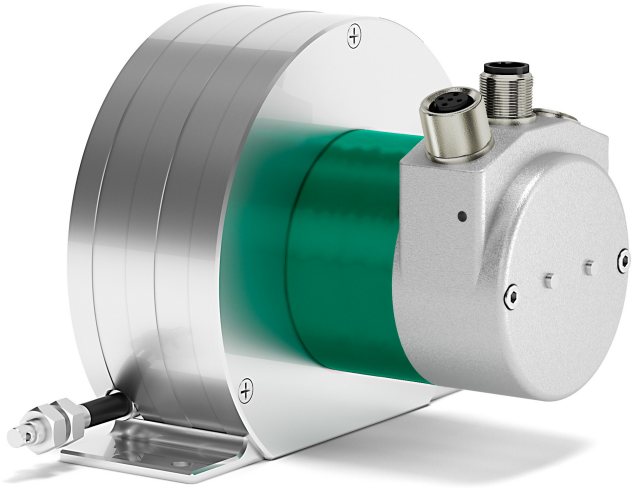
Smart encoders & actuators

User's guide

SFA-5000-CB
SFA-10000-CB



CANopen®

in compliance with DS301 & DS406 profiles

- 5000 mm & 10000 mm draw-wire encoder
- Integrated 25 bit multiturn absolute encoder
- Programmable resolution down to 24 µm
- Cable and M12 connectors options
- CANopen complying with DS 301 and DS 406 profiles

Suitable for the following models:

- SFA-5000-CB
- SFA-10000-CB

Table of Contents

1 - Safety summary	19
2 - Identification	21
3 - Mounting instructions	22
4 - Electrical connections	26
5 - Quick reference	35
6 - CANopen® interface	37
7 - Setting-up	79
8 - Default parameters list	83

General contents

User's guide 1
General contents 3
Subject index 6
Typographic and iconographic conventions 7
Preliminary information 8
Glossary of CANopen terms 9
1 - Safety summary 19
1.1 Safety 19
1.2 Electrical safety 19
1.3 Mechanical safety 20
2 - Identification 21
3 - Mounting instructions 22
3.1 Overall dimensions 22
3.2 Mounting instructions 23
3.3 Useful information 24
3.4 Maintenance 25
4 - Electrical connections 26
4.1 Connection cap 26
4.2 Connection cap with PG gland (cable output) 28
4.3 Connection cap with M12 connectors 29
4.4 Ground connection 30
4.5 Connection of the shield 30
4.6 Setting the baud rate: DIP A 31
4.7 Setting the node address: DIP B 32
4.8 Setting the RT bus termination 33
4.7 Diagnostic LEDs 34
5 - Quick reference 35
6 - CANopen® interface 37
6.1 EDS file 37
6.2 State machine 37
6.2.1 Initialization state 38
6.2.2 Pre-operational state 38
6.2.3 Operational state 38
6.2.4 Stopped state 38
6.3 Communication objects 39
6.3.1 Pre-defined connection set 40
6.4 NMT objects 40
6.5 Boot-up objects 41
6.6 PDO objects 41
PDO1 Cyclic mode: cyclic transmission of position value 41
PDO2 and PDO3 SYNC mode: synchronous transmission of position value 41
PDO4 Cyclic mode: cyclic transmission of velocity value 42
6.7 SDO objects 42
6.7.1 Command 43
6.8 Object dictionary 43
6.8.1 Communication Profile Area objects (DS 301) 45

1000-00 Device type ... 45
1001-00 Error register ... 45
1003 Predefined error field ... 45
1005-00 COB-ID SYNC message ... 45
1008-00 Manufacturer device name ... 45
1009-00 Manufacturer hardware version ... 45
100A-00 Manufacturer software version ... 45
100C-00 Guard time ... 46
100D-00 Life time factor ... 46
1010-01 Store parameters ... 46
1011-01 Restore default parameters ... 46
1014-00 COB-ID EMCY ... 47
1015-00 Inhibit time EMCY ... 47
1018 Identity object ... 47
1800 TPDO communication parameter 1 ... 48
1801 TPDO communication parameter 2 ... 49
1802 TPDO communication parameter 3 ... 51
1803 TPDO communication parameter 4 ... 52
1A00-01 TPDO mapping parameter 1 ... 54
1A01-01 TPDO mapping parameter 2 ... 54
1A02-01 TPDO mapping parameter 3 ... 54
1A03-01 TPDO mapping parameter 4 ... 55
6.8.2 Manufacturer Specific Profile Area objects ... 56
2104-00 Limit switch min. ... 56
2105-00 Limit switch max. ... 56
3000-00 Baud rate ... 56
3001-00 Node-ID ... 57
3005-00 Velocity format ... 58
3006-00 Velocity value ... 58
6.8.3 Standardised Device Profile Area objects (DS 406) ... 59
6000-00 Operating parameters ... 59
Code sequence ... 59
Scaling function ... 59
Limit switch min. ... 60
Limit switch max. ... 60
6001-00 Measuring units per revolution ... 60
6002-00 Total measuring range ... 62
6003-00 Preset value ... 66
6004-00 Position value ... 67
6200-00 Cyclic time ... 69
6500-00 Operating status ... 70
Code sequence ... 70
Scaling function ... 70
Limit switch min. ... 70
Limit switch max. ... 71
Current operating state ... 71
6501-00 Physical singleturn resolution ... 71
6502-00 Number of hardware distinguishable revolutions ... 72
6504-00 Supported alarms ... 72

6506-00 Supported warnings....72
6507-00 Profile and software version....72
6508-00 Operating time....73
6509-00 Offset value....73
650A-01 Manufacturer offset value....73
650B-00 Serial number....73
6.9 SDO abort codes....74
6.10 Emergency (EMCY) messages....75
6.11 Node guarding protocol....76
7 - Setting-up....79
7.1 Setting the Operational, Pre-operational state....79
7.2 Setting the resolution per revolution....79
7.3 Setting the total resolution....79
7.4 Setting the Operating parameters....79
7.5 Setting the Preset value....80
7.6 Setting the SYNC counter....80
7.7 Disabling the SYNC mode....80
7.8 Enabling the Cyclic mode....81
8 - Default parameters list....83
8.1 Communication Profile Area objects....83
8.2 Manufacturer Specific Profile Area objects....84
8.3 Standardized Device Profile Area objects....84

Subject index

1
1000-00 Device type....45
1001-00 Error register....45
1003 Predefined error field....45
1005-00 COB-ID SYNC message....45
1008-00 Manufacturer device name....45
1009-00 Manufacturer hardware version....45
100A-00 Manufacturer software version....45
100C-00 Guard time....46
100D-00 Life time factor....46
1010-01 Store parameters....46
1011-01 Restore default parameters....46
1014-00 COB-ID EMCY....47
1015-00 Inhibit time EMCY....47
1018 Identity object....47
1800 TPDO communication parameter 1....48
1801 TPDO communication parameter 2....49
1802 TPDO communication parameter 3....51
1803 TPDO communication parameter 4....52
1A00-01 TPDO mapping parameter 1....54
1A01-01 TPDO mapping parameter 2....54
1A02-01 TPDO mapping parameter 3....54
1A03-01 TPDO mapping parameter 4....55
2
2104-00 Limit switch min....56
2105-00 Limit switch max....56
3
3000-00 Baud rate....56
3001-00 Node-ID....57
3005-00 Velocity format....58
3006-00 Velocity value....58
6
6000-00 Operating parameters....59
6001-00 Measuring units per revolution....60
6002-00 Total measuring range....62
6003-00 Preset value....66
6004-00 Position value....67
6200-00 Cyclic time....69
6500-00 Operating status....70
6501-00 Physical singleturn resolution....71
6502-00 Number of hardware distinguishable revolutions....72
6504-00 Supported alarms....72
6506-00 Supported warnings....72
6507-00 Profile and software version....72
6508-00 Operating time....73
6509-00 Offset value....73
650A-01 Manufacturer offset value....73
650B-00 Serial number....73
C
COB-ID of TPDO1....48
COB-ID of TPDO2....49
COB-ID of TPDO3....51
COB-ID of TPDO4....52
Code sequence....59, 70
Current operating state....71
F
Flash memory error....75
I
Initialization....38
L
Last error occurred....45
Limit switch max....60, 71
Limit switch min....60, 70
N
Node guarding error....75
Number of occurred errors....45
O
Operational....38
P
Pre-operational....38
Previous errors occurred....45
Product code....47
R
Revision number....47
S
Scaling function....59, 70
Stopped....38
T
TPDO1 transmission type....48
TPDO2 transmission type....50
TPDO3 transmission type....51
TPDO4 transmission type....53
V
Vendor-ID....47

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 the device and the interface are coloured in **GREEN**;
- 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 and exhaustive information the operator needs to correctly and safely install and operate the **SFA-5000 and SFA-10000 absolute draw-wire encoders with CANopen interface**.
The cable pulling mechanism integrates a 13 x 12 bit absolute multiturn encoder (13 bits = singleturn resolution = 8,192 cpr; 12 bits = 4,096 revolutions).

SFA-5000 / SFA-10000 cable-pulling encoder is aimed at speed and position measurements and controls in a variety of industrial applications through the movement of a **5,000 mm (196.85") or 10,000 mm (393.7")** stainless steel wire. The typical back and forth travel of the moving equipment causes the wire to reel and unreel and thus the linear movement to be converted into a rotary motion detected by the encoder which is coupled to the drum.
The stroke per turn is always 200 mm (7.874"), the maximum number of turns is 25 for SFA-5000 and 50 for SFA-10000.

To make it easier to read and understand the text, this guide is divided into two main sections.
In the first section some 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 SFA-5000 / SFA-10000 cable-actuated encoder are provided.
In the second section, entitled **CANopen Interface**, you can find detailed information on the CANopen interface. In this section the interface features and the objects implemented in the unit are fully described.

Glossary of CANopen terms

CANopen, like many other networking systems, has a set of unique terminology. Table below contains a few of the technical terms used in this guide to describe the CANopen interface. They are listed in alphabetical order. The Glossary is owned and copyrighted by the CAN in Automation international users' and manufacturers' group.

Application layer	The application layer is the communication entity of the OSI (Open System Interface) reference model. It provides communication services to the application program.
Application objects	Application objects are signals and parameters of the application program visible at the application layer API (application programming interface).
Application profile	Application profiles define all communication objects and application objects in all devices that the network consists of.
Asynchronous PDO	An asynchronous PDO is transmitted whenever a defined internal event occurs. This event may also be the elapsing of the PDO's event timer. If an asynchronous PDO is received the protocol software immediately updates the mapped objects in the Object Dictionary.
Boot-up message	CANopen communication service transmitted whenever a node enters the **Pre-operational** state after initialization.
Bus	Topology of a communication network, where all nodes are reached by passive links, which allows transmission in both directions.
Bus analyser	Tool, which monitors the bus and displays the transmitted bits. There are bus analysers available on the physical layer, the data link layer, and different application layers (e.g. CANopen or DeviceNet).
Bus arbitration	If at the very same moment several nodes try to access the bus, an arbitration process is necessary. At the end of this process, only one node has bus access. The bus arbitration process used in CAN protocol is CMSA/CD (Carrier Sense Multiple Access/Collision Detection) with AMP (Arbitration on Message Priority). This allows bus arbitration without destruction of messages.
Bus length	The network cable length between the both termination resistors. The bus length of CANopen networks is limited by the used transmission rate. At 1 Mbps the maximum length is 25 m. When using lower transmission rates, longer bus lines may be used: at 50 kbps a length of 1 km is possible.
Bus off state	The CAN controllers switch to bus off state when the TEC (transmit error counter) has reached 255. During bus off state, the CAN controller transmits recessive bits. When a CANopen

	device recovers from bus off state, it has to transmit the boot-up message and it is recommended to send an Emergency message with the appropriate error code.
CAN	Controller Area Network (CAN) is a serial bus system originally developed by the Robert Bosch GmbH. It is internationally standardized by ISO 11898-1. CAN has been implemented by many semiconductor manufacturers.
CAN protocol controller	The CAN protocol controller is part of a CAN module performing data en-/de-capsulation, bit-timing, CRC, bit-stuffing, error handling, failure confinement, etc.
CAN transceiver	The CAN transceiver is connected to the CAN controller and to the bus lines. It provides the line transmitter and the receiver. There are high-speed, fault-tolerant, and single-wire transceivers available as well as transceivers for power-line or fiber optic transmissions.
CANopen	Family of profiles for embedded networking in industrial machinery, medical equipment, building automation (e.g. lift control systems, electronically controlled doors, integrated room control systems), railways, maritime electronics, truck-based superstructures, off-highway and off-road vehicles, etc.
CANopen application layer	The CANopen application layer and communication profile is standardized by EN 50325-4. It defines communication services and objects. In addition, it specifies the Object Dictionary and the network management (NMT).
CANopen Manager	The CANopen manager is responsible for the management of the network. The CANopen manager device shall include the NMT (network management) Master, the SDO (service data object) manager, and the Configuration manager.
CANopen Safety	Communication protocol allowing transmission of safety-relevant data. The protocol requires just one physical CAN network. Redundancy is achieved by sending each message twice with bit-wise inverted content using two identifiers differing at least in two bits.
Certification	Official compliance test of components or devices to a specific standard. CiA officially certifies CANopen devices.
CiA DR 303	Draft recommendation for CANopen cabling and connector pin assignments, coding of prefixes and SI unit as well as LED usage.
CiA DS 102	Draft standard for high-speed transmission according to ISO 11898-2 using 9-pin D-sub connectors.
CiA DS 301	The CANopen application layer and communication profile specification covers the functionality of CANopen NMT (network management) Slave devices.
CiA DS 401	The CANopen device profile for generic I/O modules covers the definition of digital and analogue input and output devices.
CiA DS 404	The CANopen device profile for measuring devices and closed-

	loop controllers supports also multi-channel devices.
CiA DS 406	The CANopen device profile for encoders defines the communication of rotating as well as linear sensors.
CiA DSP 302	The draft standard proposal for programmable CANopen devices includes CANopen manager functions, dynamic SDO connections, standardized boot-up procedure for NMT Slaves as well as program download.
CiA DSP 304	The CANopen safety protocol specification is approved by German authorities and is compliant to SIL class 3 applications.
CiA DSP 305	The Layer Setting Services (LSS) specify how to set node-ID and transmission rate via the CANopen network.
CiA DSP 306	This draft standard proposal defines format and content of Electronic Data Sheets (EDS) to be used in configuration tools.
CiA DSP 308	The CANopen framework for maritime applications defines redundancy of networks including swapping mechanism for SDOs and PDOs.
CiA DSP 309	Set of gateway specifications for CANopen to Ethernet-based networks (e.g. Modbus TCP(IP)).
CiA DSP 402	The CANopen device profile for drives and motion controllers defines the interface to frequency inverters, servo controllers as well as stepper motors.
CiA DSP 405	The CANopen device and interface profile for IEC 61131-3 compatible controllers is based on the CiA DSP 302 specification using network variables to be mapped into PDOs, and function blocks for SDO services, etc.
CiA DSP 407	The CANopen application profile for passenger information systems developed in cooperation with the German VDV specifies interfaces for a range of devices including displays, ticket printers, passenger counting units, main onboard computer, etc.
CiA DSP 408	The CANopen device profile for hydraulic controllers and proportional valves is compliant to the bus-independent VDMA device profile.
CiA DSP 410	The CANopen device profile for inclinometer supports 16-bit as well as 32-bit sensors.
CiA DSP 412	The CANopen device profiles for medical equipment specify the interfaces for x-ray collimators, x-ray generators, stands and tables.
CiA DSP 413	The CANopen interface profiles for in-vehicle truck gateways specify gateways to ISO 11992, J1939, and other in-vehicle networks. The CANopen network is mainly used for truck- or trailer-based superstructures, e.g. as in garbage trucks, truck-mounted cranes, and concrete mixers.
CiA DSP 414	The CANopen device profile for weaving machines specifies

	the interface for feeder sub-systems.
CiA DSP 415	The CANopen application profile for asphalt pavers specifies interfaces to different devices used in road construction machinery.
CiA DSP 416	The CANopen application profile for building doors specifies interfaces for locks, sensors, and other devices used in electronically controlled building doors.
CiA DSP 417	The CANopen application profile for lift control specifies the interfaces for car controller, door controller, call controller and other controllers as well as for car units, door units, input panels, and display units, etc.
CiA DSP 418	The CANopen device profile for battery modules specifies the interface to communicate with battery chargers.
CiA DSP 419	The CANopen device profile for battery charger specifies the interface to communicate with the battery module.
CiA DSP 420	The CANopen device profile family for extruder downstream devices defines interfaces for puller, corrugator and saw devices.
CiA DSP 421	The CANopen device profile for railways specifies interfaces to sub-systems such as diesel engines, brake controllers, door controllers, etc.
CiA DSP 422	The CANopen application profile for municipal vehicles defines the communication of sub-systems used in garbage trucks.
CiA TR 308	This technical report specifies some timings for CANopen performance testing tools.
Client / Server communication	In a Client/Server communication the Client initiates the communication with the Server. It is always a point-to-point communication.
Client SDO	The Client SDO initiates the SDO communication by means of reading or writing to the Object Dictionary of the Server device.
COB ID	The COB ID is the object specifying the CAN message identifier and additional parameters such as valid/invalid and remote frame support.
Communication object (COB)	A communication object is one or more CAN messages with a specific functionality, e.g. PDO, SDO, Emergency, Time, or Error Control.
Communication profile	A communication profile defines the content of communication objects such as Emergency, Time, Sync, Heartbeat, NMT, etc. in CANopen.
Configuration Manager	The Configuration Manager (CMT) provides mechanisms for configuration of CANopen devices during boot-up.
Confirmed communication	Confirmed communication services require a bi-directional communication, meaning that the receiving node sends a confirmation that the message has been received successfully.

Conformance test plan	Definitions of test cases that have to be passed successfully in order to achieve conformance to a communication standard. The conformance test plan for CAN is standardized by ISO 16845.
Conformance test tool	A conformance test tool is the implementation of a conformance test plan.
Consumer	In CAN networks a receiver of messages is called a consumer meaning the acceptance filter is opened.
D-sub connector	Standardized connectors. Most common in use is the 9-pin D-sub connector (DIN 41652); its pin-assignment for CAN networks is specified in CiA DS 102.
Data link layer	Second layer in the OSI reference model providing basic communication services. The CAN data link layer defines data, remote, error, and overload frames.
Data type	Object attribute in CANopen defining the format, e.g. UNSIGNED8, INTEGER16, BOOLEAN, etc.
Default value	Object attribute in CANopen defining the pre-setting of not user-configured objects after power-on or application reset.
Device profile	A device profile defines the device-specific communication services including the configuration services in all details.
Draft Recommendation (DR)	This kind of recommendation is not fixed, but it is published. CiA's draft recommendations are not changed within one year.
Draft Standard (DS)	This kind of standard is not fixed, but it is published. CiA's draft standards are not changed within one year.
Draft Standard Proposal (DSP)	This kind of standard is a proposal, but it is published. CiA's draft standard proposals may be changed anytime without notification.
EDS checker	Software tool that checks the conformity of electronic data sheets. The CANopen EDS checker is available on CiA's web-site to be downloaded.
EDS generator	Software tool that generates CANopen electronic data sheets.
Electronic Data Sheet (EDS)	Electronic data sheets describe the functionality of a device in a standardized manner.
Emergency message	Pre-defined communication service in CANopen mapped into a single 8-byte data frame containing a 2-byte standardized error code, the 1-byte error register, and 5-byte manufacturer-specific information. It is used to communicate device and application failures.
EN 50325-4	CENELEC standard defining the CANopen application layer (version 4.0).
Entry category	Object attribute in CANopen defining whether this object is mandatory or optional.
Error code	CANopen specifies standardized error codes transmitted in emergency messages.

Error control message	The CANopen error control messages are mapped to a single 1-byte CAN data frame assigned with a fixed identifier that is derived from the device's Node ID. It is transmitted as boot-up message before entering **Pre-operational** state after initialization, and it is transmitted if remotely requested by the NMT Master (node guarding) or periodically by the device (heart-beat).
Event driven	Event driven messages are transmitted when a defined event occurs in the node. This may be a change of input states, elapsing of a local timer, or any other local event.
Event timer	The event timer is assigned in CANopen to one PDO. It defines the frequency of transmission.
Expedited SDO	This is a confirmed communication service of CANopen (peer-to-peer). It is made up by one SDO initiate message of the Client node and the corresponding confirmation message of the Server node. Expedited SDOs are used if not more than 4 byte of data has to be transmitted.
Flying Master	In safety-critical applications, it may be required that a missing NMT Master is substituted automatically by another stand-by NMT Master. This concept of redundancy is called Flying Master.
Form error	A corruption of one of the pre-defined recessive bits (CRC delimiter, ACK delimiter and EOF) is regarded as a form error condition that will cause the transmission of an error frame in the very next bit-time.
Function code	First four bits of the CAN identifier in the CANopen pre-defined identifier set indicating the function of the communication object (e.g. TPDO_1 or Error Control message).
Galvanic isolation	Galvanic isolation in CAN networks is performed by optocouplers or transformers placed between CAN controller and CAN transceiver chip.
Gateway	Device with at least two network interfaces transforming all seven OSI (open system interconnection) protocol layers, e.g. CANopen-to-Ethernet gateway.
Heartbeat	CANopen uses heartbeat message to indicate that a node is still alive. This message is transmitted periodically.
Heartbeat consumer time	The heartbeat consumer time defines the time when a node is regarded as no longer alive due to a missing heartbeat message.
Heartbeat producer time	The heartbeat producer time defines the transmission frequency of a heartbeat message.
Identifier	In general, the term identifier refers to a CAN message identifier. The CAN message identifier identifies the content of a data frame. The identifier of a remote frame corresponds to the identifier of the requested data frame. The identifier includes implicitly the priority for the bus arbitration.

Index	16-bit address to access the CANopen dictionary; for array and records the address is extended by an 8-bit Subindex.
Inhibit timer	Object in CANopen for PDOs and Emergency messages that forbids for the specified time (inhibit time) a transmission of this communication object.
Initialization state	NMT Slave state in CANopen that is reached automatically after power-on and communication or application reset.
Interface profile	CANopen profile that describes just the interface and not the application behaviour of device, e.g. gateway and bridge devices.
ISO 11898-1	International standard defining the CAN data link layer including LLC, MAC and PLS sub-layers.
ISO 11898-2	International standard defining the CAN high-speed MAU.
Life guarding	Method in CANopen to detect that the NMT Master does not guard the NMT Slave any more. This not recommended for new systems designs.
Line topology	Networks, where all nodes are connected directly to one bus line. CAN networks use theoretically just line topologies without any stub cable. However in practice you find tree and star topologies as well.
Master	Communication or application entity that is allowed to control a specific function. In networks this is for example the initialization of a communication service.
Multiplexed PDO (MPDO)	The MPDO is made of 8 byte including one control byte, three multiplexer bytes (containing the 24-bit Index and Subindex), and four bytes of object data.
Network length	Bus length. The network cable length between both termination resistors. The bus length of CANopen networks is limited by the used transmission rate. At 1 Mbps the maximum length is 25 m. When using lower transmission rates, longer bus lines may be used: at 50 kbps a length of 1 km is possible.
Network management	Entity responsible for the network boot-up procedure and the optional configuration of nodes. It also may include node-supervising functions such as node guarding.
Network variables	Network variables are used in programmable CANopen devices to be mapped into PDOs after programming the device.
NMT	Network management in CANopen.
NMT Master	The NMT Master device performs the network management by means of transmitting the NMT message. With this message, it controls the state machines of all connected NMT Slave devices.
NMT Slave	The NMT Slaves receive the NMT message, which contains commands for the NMT state machine implemented in CANopen devices.

NMT state machine	The NMT state machines support different states and the highest prior CAN message transmitted controls the transition to the states by the NMT Master.
Node guarding	Mechanism used in CANopen and CAL to detect bus off or disconnected devices. The NMT Master sends a remote frame to the NMT Slave that is answered by the corresponding error control message.
Node ID	Unique identifier for a device required by different CAN-based higher-layer protocols in order to assign CAN identifiers to this device, e.g. in CANopen and DeviceNet. In the pre-defined connection set of CANopen some of the CAN message identifiers are derived from the assigned Node ID.
Object Dictionary	Heart of each CANopen device containing all communication and application objects.
Operational state	In the NMT **Operational** state all CANopen communication services are available.
PDO mapping	In PDOs, there may be mapped up to 64 objects. The PDO mapping is described in the PDO mapping parameters.
Pin assignment	Definition of the use of connector pins.
Pre-defined connection set	The pre-defined connection set is a default assignment of CAN message identifiers to CANopen communication objects. Some CANopen communication objects are distributed in broadcast (NMT message, Sync message, Time message) and others are transmitted between NMT Master device and dedicated NMT Slave devices (PDO, SDO, Emergency, and Error Control). This default assignment guarantees that the CAN message identifiers are uniquely assigned in the network, if the node-ID has been assigned uniquely.
Pre-operational state	In the NMT **Pre-operational** state no CANopen PDO communication is allowed.
Process Data Object (PDO)	Communication object defined by the PDO communication parameter and PDO mapping parameter objects. It is an unconfirmed communication service without protocol overhead.
Producer	In CAN networks a transmitter of messages is called a producer.
Protocol	Formal set of conventions and rules for the exchange of information between nodes, including the specification of frame administration, frame transfer and physical layer.
Receiver	A CAN node is called receiver or consumer, if it is not transmitter and the bus is not idle.
Redundant networks	In some safety-critical applications (e.g. maritime systems), redundant networks may be required that provide swapping capability in case of detected communication failures.
Remote frame	With a remote frame another node is requested to transmit

	the corresponding data frame identified by the very same identifier. The remote frame's DLC has the value of the corresponding data frame DLC. The data field of the remote frame has a length of 0 byte.
Remote transmission request (RTR)	Bit in the arbitration field indicating if the frame is a remote frame (recessive value) or a data frame (dominant value).
Repeater	Passive component that refreshes CAN bus signals. It is used to increase the maximum number of nodes, or to achieve longer networks (>1 km), or to implement tree or meshed topologies.
Reset application	This NMT command resets all objects in CANopen devices to the default values or the permanently stored configured values.
Reset communication	This NMT command resets only the communication objects in CANopen devices to the default values or the permanently stored configured values.
RPDO	The Receive Process Data Object (RPDO) is a communication object that is received by a CANopen device.
SDO block transfer	SDO block transfer is a CANopen communication service for increasing downloading. In SDO block transfer, the confirmation is sent after the reception of a number of SDO segments.
SDO Manager	The SDO Manager handles the dynamic establishment of SDO connections. It resides on the very same node as the NMT Master.
Segmented SDO	If objects longer than 4 bytes are transmitted by means of SDO services, a segmented transfer is used. The number of segments is theoretically not limited.
Server SDO	The Server SDO receives the SDO messages from the corresponding SDO Client and responds to each SDO message or to a block of SDO messages (SDO block transfer).
Service Data Object (SDO)	SDOs provide the access to entries in the CANopen Object Dictionary. An SDO is made up of at least two CAN messages with different identifiers. SDOs are always confirmed point-to-point communication services.
SI unit	International system of units for physical values as specified in ISO 1000:1983.
Stopped state	NMT state in which only NMT messages are performed and under some conditions error control messages are transmitted.
Sub-index	8-bit sub-address to access the sub-objects of arrays and records.
Suspend transmission	CAN controllers in error passive mode have to wait additional 8 bit-times before the next data or remote frame may be transmitted.
SYNC message	Dedicated CANopen message forcing the receiving nodes to

	sample the inputs mapped into synchronous TPDOs. Receiving this message causes the node to set the outputs to values received in the previous synchronous RPDO.
Termination resistor	In CAN high-speed networks with bus topology, both ends are terminated with resistors in order to suppress reflections.
TIME message	Standardized message in CANopen containing the time as a 6-byte value given as ms after midnight and days after 1st January 1984.
TPDO	The Transmit Process Data Object (TPDO) is a communication object that is transmitted by a CANopen device.
Transmission type	CANopen object defining the scheduling of a PDO.
Value definition	Detailed description of the value range in CANopen profiles.
Value range	Object attribute in CANopen defining the allowed values that this object supports.

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 assumes no liability for the customer's failure to comply with these requirements.

1.2 Electrical safety

- Turn off the power supply before connecting the device;
- connect according to explanation in the "4 - Electrical connections" section on page 26;
- in compliance with the 2014/30/EU norm on electromagnetic compatibility, following precautions must be taken:
  - before handling and installing, 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. Provide the ground connection as close as possible to the encoder. We suggest using the ground point provided in the cap, use one TCEI M3 x 6 cylindrical head screw with two tooth lock washers.

1.3 Mechanical safety

- Install the device following strictly the information in the "3 - Mounting instructions" section on page 22;
- mechanical installation has to be carried out with stationary mechanical parts;
- do not disassemble the unit;
- do not tool the unit;
- delicate electronic equipment: handle with care; do not subject the device to knocks or shocks;
- respect the environmental characteristics of the product;
- we suggest installing the unit providing protection means against waste, especially swarf as turnings, chips, or filings; should this not be possible, please make sure that adequate cleaning measures are in place in order to prevent the wire from jamming;
- to avoid failures, never exceed the maximum measuring length and prevent the wire from tangling up;
- never release the wire freely, always help the wire wind properly: risk of personal injury and/or equipment damage;
- always keep the wire aligned not to damage the equipment;
- the stroke per turn of the draw-wire unit is 200 mm (7.874").

2 - Identification

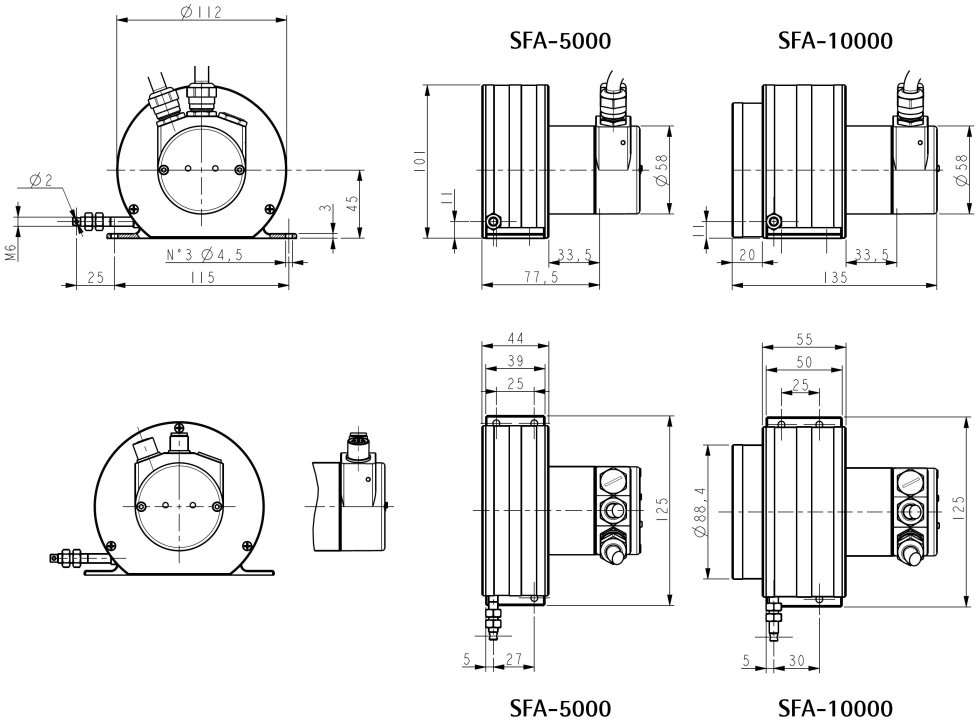
Device can be identified through the **order code** and the **serial number** printed on the label applied to its enclosure. Information is listed in the delivery document too. Please always quote the order code and the serial number when reaching Lika Electronic for purchasing spare parts or needing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

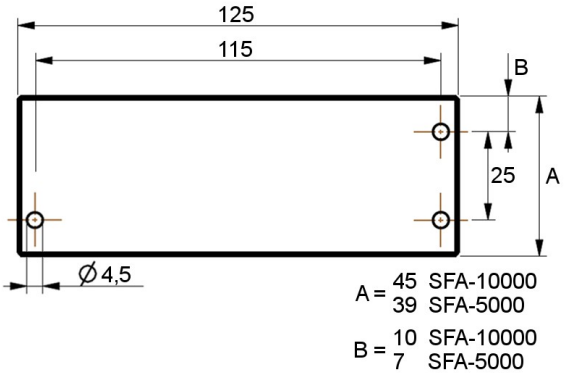
Warning: encoders having order code ending with "/Sxxx" may have mechanical and electrical characteristics different from standard and be supplied with additional documentation for special connections (Technical info).

3 - Mounting instructions

WARNING
Installation, electrical connection and maintenance operations must be carried out by qualified personnel only, with power supply disconnected. Mechanical components must be in stop.

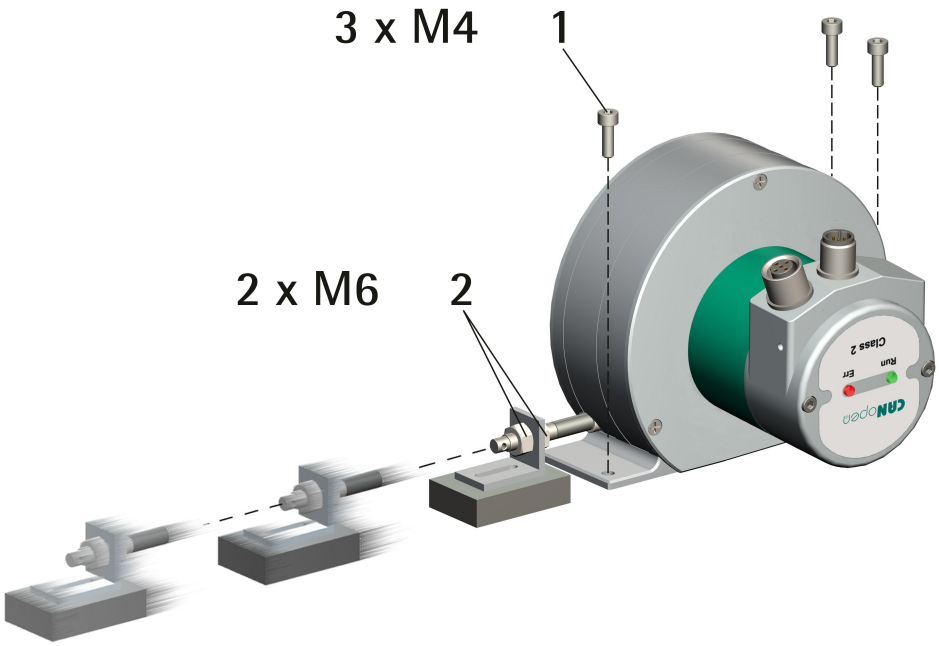
3.1 Overall dimensions





Values are expressed in mm

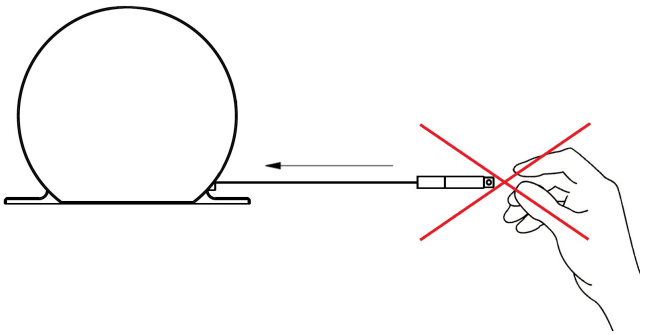
3.2 Mounting instructions



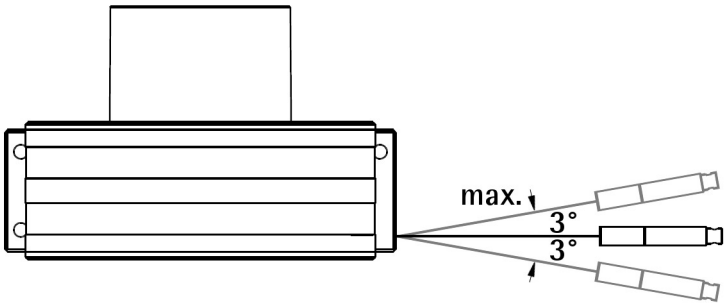
- Fasten the draw-wire unit onto a fixed support using three M4 screws **1**;
- remove the safety wire that pins the end of the measuring wire during transport;
- fix the end of the measuring wire to the moving unit using the provided M6 nuts **2**.

WARNING
We suggest installing the unit providing protection means against waste, especially swarf as turnings, chips, or filings; should this not be possible, please make sure that adequate cleaning measures are in place in order to prevent the wire from jamming.
To avoid irreparable failures, never exceed the maximum measuring length and prevent the wire from tangling up.

Never release the wire freely, always help the wire wind properly: risk of personal injury and/or equipment damage.



Always keep the wire aligned not to damage the equipment (maximum deviation: 3°).



3.3 Useful information

If you want to know the **maximum measuring length** and the **physical linear resolution** of the draw-wire encoder please refer to the order code. The stroke per turn is always 200 mm (7.874"), the maximum number of turns is 25 for SFA-5000 and 50 for SFA-10000.

EXAMPLE 1

SFA-**5000**-**CB**-**8192**-PG using the physical resolution (**Scaling function** in **6000-00 Operating parameters** = 0)
Stroke per turn of the drum = 200 mm (7.874")
6501-00 Physical singleturn resolution, physical resolution per turn = 13 bits = 8,192 cpr
6502-00 Number of hardware distinguishable revolutions, number of physical revolutions = 12 bits = 4,096 revolutions
Total physical resolution = 25 bits = 33,554,432 information
Physical linear resolution = 0.024 mm = 24 µm
Max. number of turns of the drum = 25
Max. measuring length = 5,000 mm (196.85")

Number of information = 204,800

EXAMPLE 2
SFA-**10000**-**CB**-**8192**-M12 using a custom resolution (**Scaling function** in **6000-00 Operating parameters** = 1)
Stroke per turn of the drum = 200 mm (7.874")
6501-00 Physical singleturn resolution, physical resolution per turn = 13 bits = 8,192 cpr
6502-00 Number of hardware distinguishable revolutions, number of physical revolutions = 12 bits = 4,096 revolutions
Custom resolution per turn = **6001-00 Measuring units per revolution** = 2,000 cpr (example)
6002-00 Total measuring range = 8,192,000 information (example)

$$\text{Custom number of encoder revolutions} = \frac{\text{6002-00 Total measuring range}}{\text{6001-00 Measuring units per revolution}} = 4{,}096$$

Linear resolution = 0.1 mm = 100 µm
Max. number of turns of the drum = 50
Max. measuring length = 10,000 mm (393.7")
Number of information = 100,000

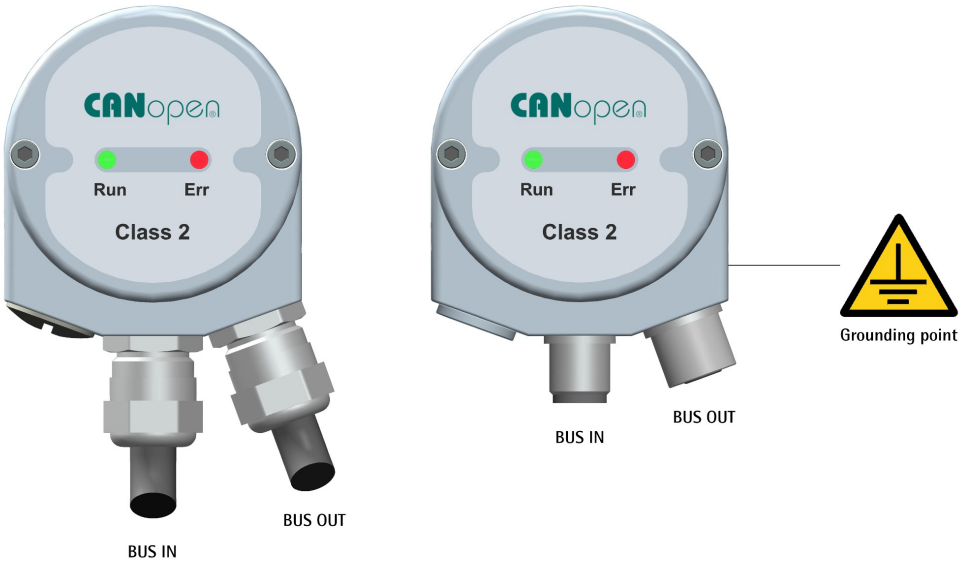
3.4 Maintenance

The measuring system does not need any particular maintenance; anyway it has to be handled with the utmost care as any delicate electronic equipment. From time to time we recommend the following operations:

- the unit and the wire have to be cleaned regularly using a soft and clean cloth to remove dust, chips, moisture etc.; do not use oil to clean the wire.

4 - Electrical connections

WARNING
Installation, electrical connection and maintenance operations must be carried out by qualified personnel only, with power supply disconnected. Mechanical components must be in stop.



SFA-...-PG SFA-...-M12

4.1 Connection cap

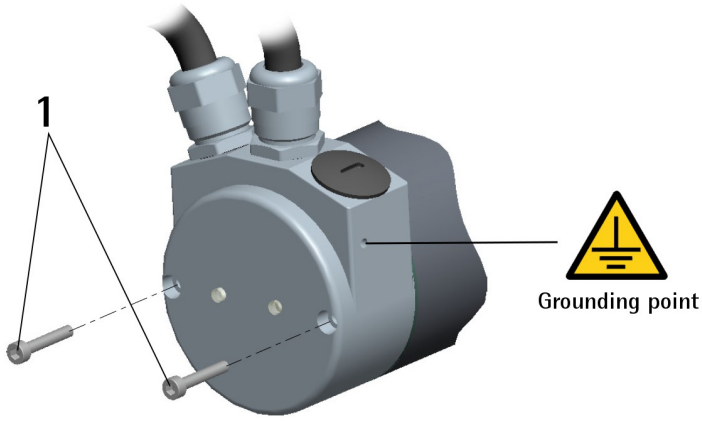
WARNING
Do not remove or mount the connection cap with power supply switched ON. Damage may be caused to internal components.

The terminal connectors for connecting the power supply and the BUS IN and BUS OUT cables (PG cable version) as well as the DIP switches meant to set the node ID and the baud rate and activate the termination resistance (PG cable version and M12 connector version) are located inside the encoder connection cap. Thus you must remove the connection cap to access any of them.

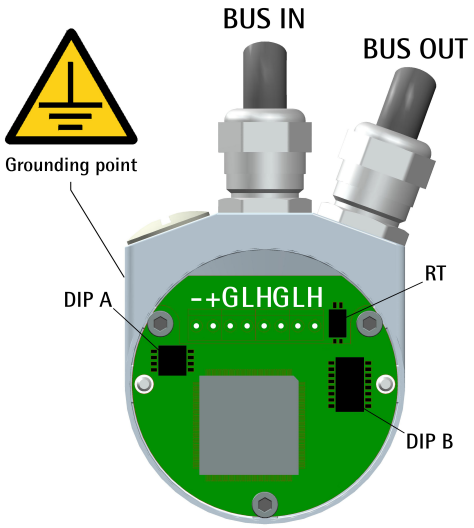
NOTE
Be careful not to damage the internal components when you perform this operation.

To remove the connection cap loosen the two screws **1**. Please be careful when you disconnect the internal connector.
Always replace the connection cap at the end of the operation. Take care in re-connecting the internal connector. Tighten the screws **1** using a tightening torque of approx. 2.5 Nm.

WARNING
You are required to check that the encoder body and the connection cap are at the same potential before replacing the connection cap!



4.2 Connection cap with PG gland (cable output)

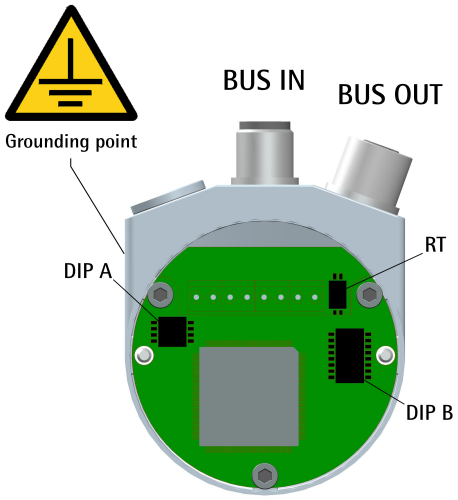


Cable output versions (...-PG order code) are fitted with two PG9 cable glands for BUS IN and BUS OUT connections as well as for power supply. The bus cables can be connected directly to the terminal connectors located by each cable gland. You can use either cable for power supply.
We recommend CANopen certificated cables to be used. Core diameter should not exceed Ø 1.5 mm (0.06 inches).

Terminal connector	Description
-	0Vdc power supply voltage
+	+10Vdc +30Vdc power supply voltage
G	CAN GND [1]
L	CAN Low
H	CAN High
PG	CAN Shield [2]

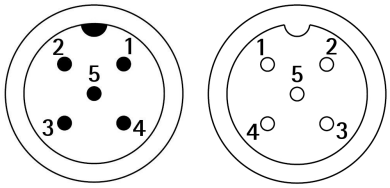
[1] CAN GND is the 0V reference of CANopen signals, it is not connected to 0Vdc supply voltage.
[2] Connect the cable shield to the cable gland.

4.3 Connection cap with M12 connectors



Connector output versions (...-M12 order code) are fitted with two M12 connectors with pin-out in compliance with the CANopen® standard. Therefore you can use standard CAN cordsets and patchcords commercially available. For a complete list of the available cordsets and patchcords please refer to the product datasheet ("Accessories" list).

M12 5-pin connector
A coding
(frontal side)



male (BUS IN) female (BUS OUT)

M12	Description
Case	CAN Shield
1 [1]	
2	+10Vdc +30Vdc power supply voltage
3	0Vdc power supply voltage
4	CAN High
5	CAN Low

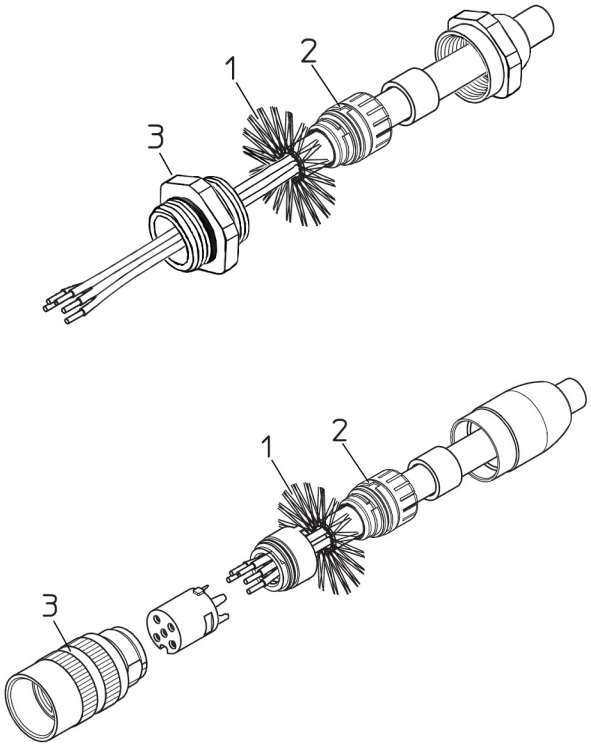
[1] CAN Shield is also connected to pin 1 to allow the connection of the shield even if the plug connector has a plastic case.

4.4 Ground connection

To minimize noise connect properly the shield and/or the connector housing and/or the frame to ground. 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. 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. We suggest using the ground point provided in the cap (see the Figures, use one TCEI M3 x 6 cylindrical head screw with two tooth lock washers).

4.5 Connection of the shield

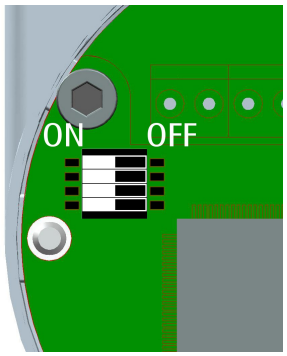
Disentangle and shorten the shielding **1** and then bend it over the part **2**; finally place the ring nut **3** of the connector. Be sure that the shielding **1** is in tight contact with the ring nut **3**.



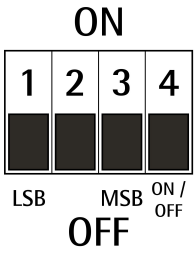
4.6 Setting the baud rate: DIP A

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

The transmission rate (baud rate) can be set both via hardware by using the DIP A dip switch and via software (see the **3000-00 Baud rate** object).
If the **DIP A** bit 4 = "OFF", the bit rate is set in the **3000-00 Baud rate** object of the "Object Dictionary" and can be modified using SDO messages.
If the **DIP A** bit 4 = "ON", the bit rate is set via DIP A.



DIP A:



Set the binary value of the transmission rate considering that: ON=1, OFF=0.

bit	**1** LSB	**2**	**3** MSB	**4**
	2^0	2^1	2^2	ON/OFF

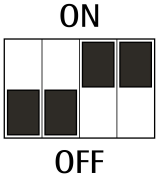
Available baud rate values are:

Decimal value	Binary value	Baud rate
0	000	20 Kbit/s
1	001	50 Kbit/s
2	010	100 Kbit/s
3	011	125 Kbit/s
4	100	250 Kbit/s
5	**101**	**500 Kbit/s (default)**
6	110	800 Kbit/s
7	111	1000 Kbit/s

EXAMPLE

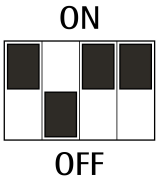
Set the baud rate to 250Kbit/s:
$\mathbf{4_{10} = 100_2}$ (binary value, see the table above)

bit	**1**	**2**	**3**	**4**
	2^0	2^1	2^2	2^3
	OFF	OFF	ON	ON



Set the baud rate to 500Kbit/s:
5_{10} = 101_2 (binary value, see the table above)

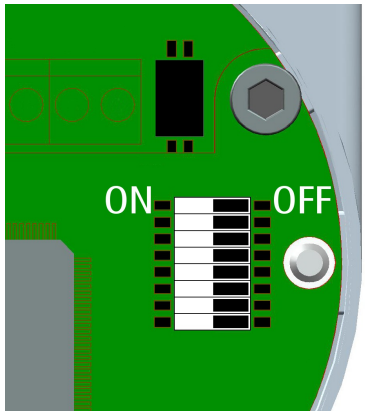
bit	1	2	3	4
	2^0	2^1	2^2	2^3
	ON	OFF	ON	ON



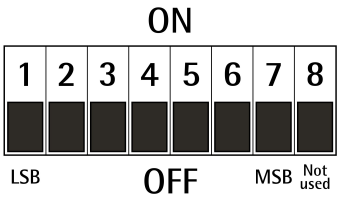
4.7 Setting the node address: DIP B

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

The node address can be set both via hardware by using the DIP B dip switch and via software (see the 3001-00 Node-ID object). If all bits of **DIP B** are "OFF" the node address is set in the 3001-00 Node-ID object of the "Object Dictionary" and can be modified using SDO messages.
If one bit at least of **DIP B** is set to "ON" the node address is set via DIP B.
Allowed node addresses are between 1 and 127. **The default address is 1.**



DIP B:

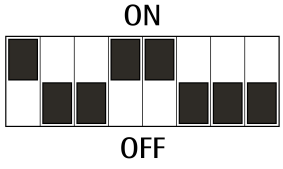


Set the node number in binary value considering that: ON=1, OFF=0

bit	1 LSB	2	3	4	5	6	7 MSB	8 not used
	2^0	2^1	2^2	2^3	2^4	2^5	2^6	

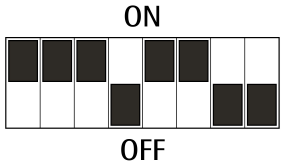
EXAMPLE
Set the node address = 25:
25_{10} = 0001 1001$_2$ (binary value)

bit	1	2	3	4	5	6	7	8
	2^0	2^1	2^2	2^3	2^4	2^5	2^6	
	ON	OFF	OFF	ON	ON	OFF	OFF	OFF



Set the node address = 55:
55_{10} = 0011 0111$_2$ (binary value)

bit	1	2	3	4	5	6	7	8
	2^0	2^1	2^2	2^3	2^4	2^5	2^6	
	ON	ON	ON	OFF	ON	ON	OFF	OFF



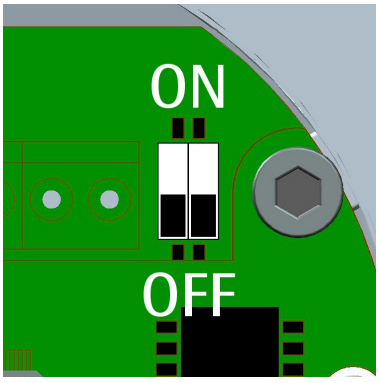
WARNING
If the baud rate and the node address are set via software, the Master device has to detect the baud rate of the Slave (scanning of baud rate) when the encoder is being installed. Once the communication has been activated the new baud rate and node address values can be set (**3000-00 Baud rate** and **3001-00 Node-ID** objects). After having set new values, transmit a **Reset node** command and then save the parameters (**1010-01 Store parameters** object). To avoid conflict between the Slaves, this operation must be carried out when only one device is connected to the network.

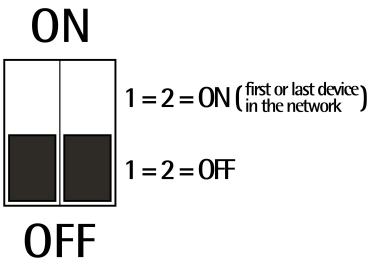
4.8 Setting the RT bus termination

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

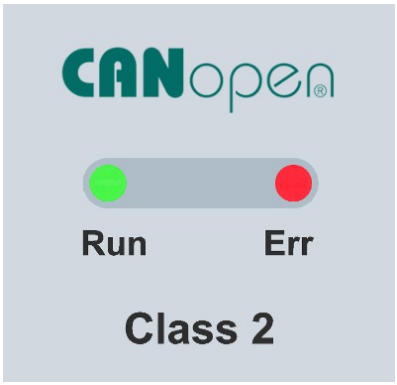
A bus termination resistance is provided inside the connection cap and must be activated as line termination if the encoder is at the ends of the transmission line (i.e. it is either the first or the last device in the transmission line).
Use RT Switch to activate or deactivate the bus termination.

RT	Description
1 = 2 = ON	Activated: if the encoder is the first or the last device in the transmission line
1 = 2 = OFF	Deactivated: if the encoder is not the first or the last device in the transmission line





4.7 Diagnostic LEDs



Two LEDs located in the connection cap are designed to show visually the operating or fault status of the CANopen® interface.

RUN LED (GREEN)	Description
ON	The encoder is in **Operational** state
Single flash	The encoder is in **Stopped** state
Blinking	The encoder is in **Pre-Operational** state

ERR LED (RED)	Description
ON	The CAN controller is switched off, the bus is off
Double flash	**Node Guarding error**, see on page 75 ff
Single flash	Max. number of warning errors has been reached
Blinking	Generic error or **Flash memory error**, see on page 75 ff
OFF	No error

During initialization, device carries out a hardware test to check LEDs operation. Both LEDs light up.

5 - Quick reference

Using the default settings provided by the manufacturer, you can switch on the device and read immediately its position.

Follow the instructions below to:

- read the physical resolution of the device: physical singleturn resolution (**6501-00 Physical singleturn resolution**) and number of physical revolutions (**6502-00 Number of hardware distinguishable revolutions**);
- set a custom cyclic time **6200-00 Cyclic time** ≠ 0;
- set the **Operational** mode;
- read the current position (in a cyclic mode and/or a synchronous mode).

Default Baud rate and Node ID are:
Baud rate = 500 Kbit/s
Node-ID = 1

Reading the physical resolution per revolution: 6501-00 Physical singleturn resolution

Master → Encoder

COB-ID	Cmd	Index		Sub	Process data			
601	40	01	65	00	-	-	-	-

Encoder → Master

COB-ID	Cmd	Index		Sub	Process data			
581	43	01	65	01	A0	A1	A2	A3

steps/rev. = ((A3<<24) | (A2<<16) | (A1<<8) | A0)

Reading the number of physical revolutions: 6502-00 Number of hardware distinguishable revolutions

Master → Encoder

COB-ID	Cmd	Index		Sub	Process data			
601	40	02	65	00	-	-	-	-

Encoder → Master

COB-ID	Cmd	Index		Sub	Process data			
581	43	02	65	01	B0	B1	B2	B3

N. rev. =((B3<<24) | (B2<<16) | (B1<<8) | B0)

Setting the cyclic time: 6200-00 Cyclic time (100 ms = 64h)

Master → Encoder

COB-ID	Cmd	Index		Sub	Process data			
600+ID	2B	00	62	00	64	00	-	-

Encoder → Master

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	00	62	00	00	00	-	-

Setting the Operational mode

Master → Encoder

COB-ID	Cmd	Node
000	01	01

Reading the position every 100 ms

Encoder → Master

COB-ID	Byte 0	Byte 1	Byte 2	Byte 3
181	Low	...	...	High

NOTE

For further examples please refer to the "7 - Setting-up" section on page 79.

6 - CANopen® interface

Lika draw-wire encoders are always Slave devices and comply with the "Device profile for encoders", Class 2.
For any omitted information concerning the CANopen® protocol, refer to the "CiA Draft Standard Proposal 301. Application Layer and Communication Profile" and "CiA Draft Standard Proposal 406. Device profile for encoders" documents available at the address **www.can-cia.org**.

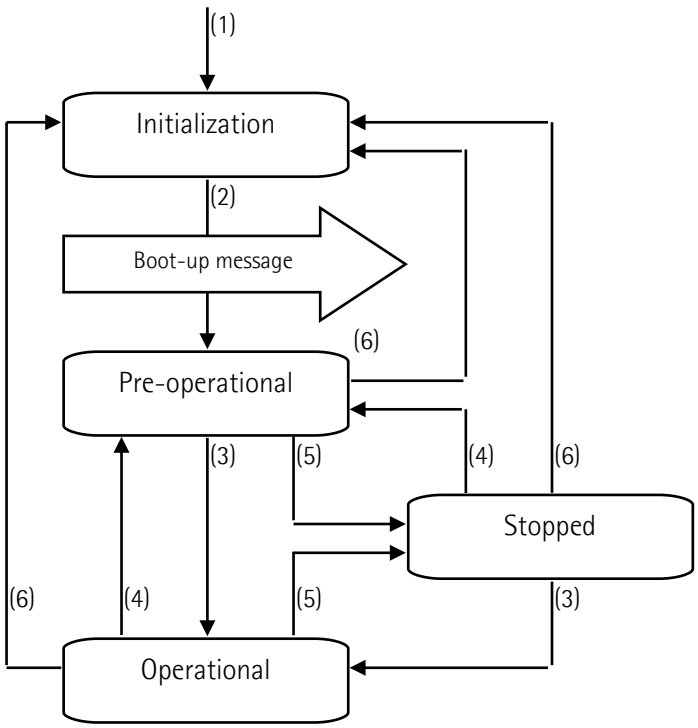
6.1 EDS file

CANopen® draw-wire encoders are equipped with their own EDS file **Lika_SFAxCB_DS406_Vx.eds** . When you need to download the file please refer to the address **www.lika.biz > ROTARY ENCODERS > DRAW-WIRE UNITS (DRAW-WIRE) > ABSOLUTE**).
EDS file must be installed in the CANopen® Master device.
Vx is intended to indicate the file version.

WARNING
Please always ascertain that the EDS file conforms to the encoder model.

6.2 State machine

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



(1)	Power 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**

6.2.1 Initialization state

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

6.2.2 Pre-operational state

In this state the communication between the Master and the Slave is possible using SDO messages. They allow the working parameters to be set. The Slave cannot send PDO messages. The state is signalled through the green LED (see on page 34).
To switch the Slave device to the **Operational** state the Master must send a **Start remote node** command using an NMT message (see on page 79).

6.2.3 Operational state

In this state the Slave device is operational and all communication objects are available. The Slave device can use the parameters available in the "Object dictionary" (see on page 43) and is allowed to send process data using PDO messages. The "Object dictionary" can be accessed by using SDO messages. The state is signalled through the green LED (see on page 34). To switch the Slave device back to the **Pre-operational** state the Master must send an **Enter pre-operational** command using an NMT message (see on page 79).

6.2.4 Stopped state

In this state the Slave device is forced to cut off the communication with the Master (except the Node Guarding, if active). The communication using PDO and SDO messages is not allowed. The state is signalled through the green LED (see on page 34).
To switch the Slave device to either the **Pre-operational** or **Operational** state the Master must send the specific commands **Enter pre-operational** or **Start remote node** using an NMT message (see on page 79).

NOTE
Please refer to the "7 - Setting-up" section on page 79 for an example of how the states are to be set.

6.3 Communication objects

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

- Network management NMT protocol: NMT protocols are used by the Master to manage the nodes and the network, issue the state machine change commands (i.e. to start and stop the devices), detect the remote device boot-ups and the error conditions.
- Process Data Objects PDO protocol: used to process real time data (transmission of process data in real time).
- Service Data Objects SDO protocol: used to set and read values from the "Object dictionary" of a remote device.
- Special Function Objects:
  - SYNC: synchronization message used by the Master to enable the Slaves devices to transmit process data (encoder position and velocity).
  - Emergency: the error messages are triggered by each error event.
  - Node Guarding: used to request the state of the Slave: the NMT Master polls each NMT Slave at regular time intervals.

Relation between the device states and the communication objects:

	Initial.	Pre-oper.	Operat.	Stopped
NMT		X	X	X
PDO			X	
SDO		X	X	
SYNC			X	
EMCY		X	X	
Boot-up	X			
Node Guarding		X	X	X

6.3.1 Pre-defined connection set

Master → Slave broadcast		
Type of COB (Object)	Function code (binary)	COB-ID (hex)
NMT	0000	000
SYNC	0001	080

Peer-to-peer transmission		
EMERGENCY	0001	081 - 0FF
PDO 1 (tx)	0011	181 - 1FF
PDO 2 (tx)	0101	281 - 2FF
PDO 3 (tx)	0111	381 - 3FF
PDO4 (tx)	1001	481 - 4FF
SDO (tx)	1011	581 - 5FF
SDO (rx)	1100	601 - 67F
Node guarding	1110	701 - 77F
Boot-up	1110	701 - 77F

The type of COB (tx or rx) is viewed from the Slave device.

6.4 NMT objects

NMT structure:

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

2 CAN Data Bytes	
Command	Slave ID
NMT Func.	Slave ID

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

NMT Function:

Command	NMT Function	State node
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

6.5 Boot-up objects

Boot-up message structure:

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

6.6 PDO objects

PDO (tx) messages are always made up of four CAN Data Bytes and are used by the encoder to transmit the position value and/or the velocity value.

PDO structure:

IDENTIFIER		4 CAN Data Bytes			
COB-ID (hex)		Byte 0	Byte 1	Byte 2	Byte 3
F.C.	Node-ID	Low	...	...	High
		position value (with PDO1, PDO2, PDO3)			
		velocity value (with PDO4)			

Four types of PDO messages are defined, they are:

PDO1 Cyclic mode: cyclic transmission of position value

The encoder uses the PDO1 message to transmit the position value **cyclically**, i.e. periodically and independently from the Master.
The interval between two issues is set in the **6200-00 Cyclic time** object.
To activate (or deactivate) the cyclic mode it is necessary to set to 0 (or 1) the most significant bit of COB-ID used by PDO1 (**1800 TPDO communication parameter 1**, sub 1 object).

PDO2 and PDO3 SYNC mode: synchronous transmission of position value

The transmission of the position value is managed by the Master **by sending a SYNC message**.
SYNC message is a high-priority COB transmitted by the Master to request the position value of the encoder through a PDO.
If several nodes (encoders) are connected to the network, the Master receives the position values from the Slaves according to the order of the Node addresses.

The encoder can be programmed to send a reply after a set number of SYNC messages by setting a counter.
The PDO message will be transmitted after having received the set number of SYNC messages.
For PDO2 the value of the counter must be set in the **1801 TPDO communication parameter 2**, sub 2 object.
For PDO3 refer to the **1802 TPDO communication parameter 3**, sub 2 object.

The SYNC transmission mode can be enabled (or disabled) by setting to 0 (or 1) the most significant bit (MSB) of COB-IB used by PDO (**1801 TPDO communication parameter 2** / **1802 TPDO communication parameter 3**, sub1 objects).

PDO4 Cyclic mode: cyclic transmission of velocity value

The encoder uses the PDO4 message to transmit the velocity value **cyclically**, i.e. periodically and independently from the Master.
The interval between two issues is set in the **6200-00 Cyclic time** object.
To activate (or deactivate) the cyclic mode it is necessary to set to 0 (or 1) the most significant bit of COB-ID used by PDO4 (**1803 TPDO communication parameter 4**, sub 1 object).

NOTE
More than one transmission mode can be active at the same time.

6.7 SDO objects

SDO messages are used to set and read values from the Object dictionary of the encoder. These parameters are described in the "Object dictionary" section, see on page 43.
Four bytes at the most are used for CAN data, other four bytes are used for Command, Index and Sub-index fields. SDO messages are always followed by confirmation. This means that when the Master sends an SDO message to the Slave, then the Slave always sends a reply through the suitable SDO message (and a warning, should an error occur).

Structure of SDO message:

IDENTIFIER		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			
		1byte	LSB	MSB	1byte	LSB	...	...	MSB

Com command
Index parameter index
Sub parameter sub-index, i.e. second index of the parameter
Data parameter value (either read or written into the parameter)

6.7.1 Command

The command byte contains the type of telegram transmitted to the CAN network.
The main types of COB telegram are as follows:

- Set: it is used to send the configuration parameters to a device;
- Req: it is used by the Master to read data from a Slave device;
- Warning: it is used by the Slave to send error messages to the Master (e.g. following a wrong SDO message: **Object does not exist in the object dictionary**, ...).

Command	COB	COB type	Data length
22h	Set	M → S request	not spec.
23h	Set	M → S request	4 bytes
2Bh	Set	M → S request	2 bytes
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	not spec.
43h	Req	S → M reply	4 bytes
4Bh	Req	S → M reply	2 bytes
4Fh	Req	S → M reply	1 byte
41h	Req	S → M reply segmented SDO	
80h	Warning	S → M reply	4 bytes

6.8 Object dictionary

The most important part of a device profile is the Object Dictionary. The Object Dictionary is essentially a grouping of objects accessible via the network in an ordered, pre-defined fashion.
The user-related objects are grouped in three main areas: the Communication Profile Area, the Manufacturer Specific Profile Area and the Standardised Device Profile Area. The objects are all described in the EDS file.

The **Communication Profile Area** at indexes from 1000h to 1FFFh contains the communication specific parameters for the CANopen network. These entries are common to all devices. NMT services, PDO objects and SDO objects are described in this section. The Communication Profile Area objects comply with the "CiA Draft Standard Proposal 301 CANopen Application layer and communication profile". Refer to the "6.8.1 Communication Profile Area objects (DS 301)" section on page 45.

The **Manufacturer Specific Profile Area** at indexes from 2000h to 5FFFh is free to add manufacturer-specific functionality. Refer to the "6.8.2 Manufacturer Specific Profile Area objects" section on page 56.

The **Standardised Device Profile Area** at indexes from 6000h to 9FFFh contains all data objects common to a class of devices that can be read or written via the network. The device profiles may use entries from 6000h to 9FFFh to describe the device parameters and the device functionality. The Standardised Device Profile Area objects comply with the "CiA Draft Standard 406 CANopen Device profile for encoders". Refer to the "6.8.3 Standardised Device Profile Area objects (DS 406)" section on page 59.

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

Unsigned/Signed8 data type:

Process data bytes							
byte 4							
7	6	5	4	3	2	1	0
MSbit			...			LSbit	

Unsigned/Signed16 data type:

Process data bytes	
byte 4	byte 5
LSByte	MSByte

Unsigned/Signed32 data type:

Process data bytes			
byte 4	byte 5	byte 6	byte 7
LSByte	...	...	MSByte

Unsigned/Signed64 data type:

Process data bytes							
byte 4	byte 5	byte 6	byte 7	byte 8	byte 9	byte 10	byte 11
LSByte	...	...	...	...	...	...	MSByte

6.8.1 Communication Profile Area objects (DS 301)

1000-00 Device type

[Unsigned32, ro]
It contains information about the device type. The object describes the type of device and its functionality.
Default = 0002 0196h = multiturn encoder, DS 406

1001-00 Error register

[Unsigned8, ro]
Should an error occur, the bit 0 of this object is set to "1".
Default = 00h

1003 Predefined error field

This object is intended to show the last four errors which caused an emergency message to be triggered. For any information refer to the "6.10 Emergency (EMCY) messages" section on page 75.

- **00 Number of occurred errors** [Unsigned8, rw]
  (write 00h to delete the error history)
- **01 Last error occurred** [Unsigned32, ro]
- **02 ... 04 Previous errors occurred** [Unsigned32, ro]

1005-00 COB-ID SYNC message

[Unsigned32, rw]
This object indicates the configured COB-ID of the synchronization object (SYNC). Further, it defines whether the CANopen device generates the SYNC.
Default = 0000 0080h (CANopen device generates SYNC message)

1008-00 Manufacturer device name

[String, ro]
It shows the name of the device (manufacturer).
Default = "LIKA srl"

1009-00 Manufacturer hardware version

[String, ro]
It shows the hardware version of the device.
Default = device dependent

100A-00 Manufacturer software version

[String, ro]
It shows the software version of the device.
Default = device dependent

100C-00 Guard time

[Unsigned16, rw]
It allows to set the Guard time expressed in milliseconds (msec).
The **100C-00 Guard time** object is used in the "Node guarding protocol" controlled by the Master. For more details see the "6.11 Node guarding protocol" section on page 76.
Default = 0000h

100D-00 Life time factor

[Unsigned8, rw]
The **100D-00 Life time factor** object is used in the "Node guarding protocol" controlled by the Master. For more details see the "6.11 Node guarding protocol" section on page 76.
Default = 00h

1010-01 Store parameters

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

Master → Encoder

COB-ID	Cmd	Index		Sub	Data bytes			
600+ID	23	10	10	01	73	61	76	65
					s	a	v	e

Encoder → Master (confirmation)

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

1011-01 Restore default parameters

[Unsig32, rw]
This object allows the operator to restore all parameters to default values (default values 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 format) in the data bytes and then issue a **Reset node** command:

Master → Encoder

COB-ID	Cmd	Index		Sub	Data bytes			
600+ID	23	11	10	01	6C	6F	61	64
					l	o	a	d

Encoder → Master (confirmation)

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

Master → Encoder (**Reset node**)

COB-ID	Cmd	Slave ID
000	81	ID

Encoder → Master (Boot-up)

COB-ID	Cmd
700+ID	00

NOTE
Save the default values after upload using the store parameters function (see the **1010-01 Store parameters** object).

1014-00 COB-ID EMCY

[Unsigned32, rw]
This object defines the COB-ID used to send emergency messages (EMCY).
If the node address is set using the internal dip-switches (i.e. at least one dip-switch for setting the node has HIGH logic level = 1), when the power is turned on, this object is always forced to the default value. Otherwise, if the node address is set via software (i.e. all dip-switches for setting the node have LOW logic level = 0) it retains the set value, unless a software procedure for setting a new address is forced at power on. For further information please refer to the "4.7 Setting the node address: DIP B" section on page 32.
Default = NodeID+0000 0080h

1015-00 Inhibit time EMCY

[Unsigned16, rw]
Inhibit time of the emergency messages (EMCY) expressed in multiples of 100 µs. When set to 0, this function is disabled.
Default = 0000h

1018 Identity object

- **01 Vendor-ID** provided by CIA organization [Unsigned32, ro]
  Default = 0000 012Eh
- **02 Product code** [Unsigned32, ro]
  Default = 0000 0000h
- **03 Revision number** [Unsigned32, ro]
  Default = 0000 0001h

1800 TPDO communication parameter 1

PDO1 message is used by default for cyclic transmission of the position value.
For more information refer to the "6.6 PDO objects" section on page 41.
See the **6200-00 Cyclic time** object to set the cyclic timer.

- **01 COB-ID of TPDO1** [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 = Node-ID+4000 0180h (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".
If the node address is set using the internal dip-switches (i.e. at least one dip-switch for setting the node has HIGH logic level = 1), when the power is turned on, this object is always forced to the default value. Otherwise, if the node address is set via software (i.e. all dip-switches for setting the node have LOW logic level = 0) it retains the set value, unless a software procedure for setting a new address is forced at power on.

- **02 TPDO1 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	**not implemented**

	profile specific	

Default = FEh (cyclic transmission, see hereafter and the **6200-00 Cyclic time** object)

WARNING
Following an attempt to set the **Transmission Type** to 0, the value is accepted but 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 **6200-00 Cyclic time** object ≠ 0, the PDO message is sent cyclically and the interval between two messages is the time set next to the **6200-00 Cyclic time** object; otherwise, if the value next to the **6200-00 Cyclic time** object = 0, the PDO message is not sent.

NOTE
Please refer to the "7 - Setting-up" section on page 79 for an example of how the **1800 TPDO communication parameter 1** object is to be set.

1801 TPDO communication parameter 2

PDO2 message is used by default for synchronous transmission of the position value. For more information refer to the "6.6 PDO objects" section on page 41.

- **01 COB-ID of TPDO2** [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 = Node-ID+4000 0280h (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".
If the node address is set using the internal dip-switches (i.e. at least one dip-switch for setting the node has HIGH logic level = 1), when the power is turned on, this object is always forced to the default value. Otherwise, if the node address is set via software (i.e. all dip-switches for setting the node have LOW logic level = 0) it retains the set value, unless a software procedure for setting a new address is forced at power on.

- **02 TPDO2 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 = 01h (synchronous transmission at each SYNC command)
The position value is transmitted after the set number of SYNC commands.
The interval between the SYNC commands must be set next to this **1801 TPDO communication parameter 2**, sub 2 object.

WARNING
Following an attempt to set the **Transmission Type** to 0, the value is accepted but 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 **6200-00 Cyclic time** object ≠ 0, the PDO message is sent cyclically and the interval between two messages is the time set next to the **6200-00 Cyclic time** object; otherwise, if the value next to the **6200-00 Cyclic time** object = 0, the PDO message is not sent.

NOTE
Please refer to the "7 - Setting-up" section on page 79 for an example of how the **1801 TPDO communication parameter 2** object is to be set.

1802 TPDO communication parameter 3

PDO3 message is used by default for synchronous transmission of the position value. For more information refer to the "6.6 PDO objects" section on page 41.

- **01 COB-ID of TPDO3** [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 = Node-ID+C000 0380h (disabled, no RTR)

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".
If the node address is set using the internal dip-switches (i.e. at least one dip-switch for setting the node has HIGH logic level = 1), when the power is turned on, this object is always forced to the default value. Otherwise, if the node address is set via software (i.e. all dip-switches for setting the node have LOW logic level = 0) it retains the set value, unless a software procedure for setting a new address is forced at power on.

- **02 TPDO3 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 = 01h (synchronous transmission at each SYNC command)

The position value is transmitted after the set number of SYNC commands.
The interval between the SYNC commands must be set next to this **1802 TPDO communication parameter 3**, sub 2 object.

WARNING
Following an attempt to set the **Transmission Type** to 0, the value is accepted but 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 **6200-00 Cyclic time** object ≠ 0, the PDO message is sent cyclically and the interval between two messages is the time set next to the **6200-00 Cyclic time** object; otherwise, if the value next to the **6200-00 Cyclic time** object = 0, the PDO message is not sent.

NOTE
Please refer to the "7 - Setting-up" section on page 79 for an example of how the **1802 TPDO communication parameter 3** object is to be set.

1803 TPDO communication parameter 4

PDO4 is used by default for cyclic transmission of the velocity value.
For more information refer to the "6.6 PDO objects" section on page 41.
See the **6200-00 Cyclic time** object to set the cyclic timer.

- **01 COB-ID of TPDO4** [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 = Node-ID+C000 0480h (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".
If the node address is set using the internal dip-switches (i.e. at least one dip-switch for setting the node has HIGH logic level = 1), when the power is turned on, this object is always forced to the default value. Otherwise, if the node address is set via software (i.e. all dip-switches for setting the node have LOW logic level = 0) it retains the set value, unless a software procedure for setting a new address is forced at power on.

- **02 TPDO4 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 (cyclic transmission, see hereafter and the **6200-00 Cyclic time** object)

WARNING
Following an attempt to set the **Transmission Type** to 0, the value is accepted but 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 **6200-00 Cyclic time** object ≠ 0, the PDO message is sent cyclically and the interval between two messages is the time set next to the **6200-00 Cyclic time** object; otherwise, if the value next to the **6200-00 Cyclic time** object = 0, the PDO message is not sent.

NOTE
Please refer to the "7 - Setting-up" section on page 79 for an example of how the **1803 TPDO communication parameter 4** object is to be set.

NOTE

- The transmission of PDO1, PDO2, PDO3 and PDO4 messages can be enabled (or disabled) by setting to "0" (or "1") the most significant bit (msb) used by the PDO (**180xh**, sub1 object).
- The cyclic transmission or synchronous transmission can be modified by setting the **180xh** sub 2 object. If you need the position value (or the velocity value) to be transmitted every "n" SYNC commands, you must set the "n" value next to the **180xh** sub 2 object:
  01h: synchronous transmission at each SYNC command;
  02h: synchronous transmission every two SYNC commands;
  ...
  FEh: cyclic transmission:
  if **6200-00 Cyclic time** ≠ 0 → "cyclic transmission": the cycle time is set next to the **6200-00 Cyclic time** object;
  if **6200-00 Cyclic time** = 0 → the PDO message is not sent.

1A00-01 TPDO mapping parameter 1

[Unsig32, rw]
This object contains the mapping of the PDO the encoder uses to transmit the position value, according to the DS 406 device profile specifications.
This object describes the content of the PDO by its index, sub-index and length.
The length contains the length of the application object expressed in bits.

31 24	23 16	15 8	7 0
Index		Sub-Index	Length
MSB			LSB

Default = 6004 0020h = **6004-00 Position value** object, the length is 32 bits

1A01-01 TPDO mapping parameter 2

[Unsig32, rw]
See the **1A00-01 TPDO mapping parameter 1**, sub 1 object.
Default = 6004 0020h

1A02-01 TPDO mapping parameter 3

[Unsig32, rw]
See the **1A00-01 TPDO mapping parameter 1**, sub 1 object.
Default = 6004 0020h

1A03-01 TPDO mapping parameter 4

[Unsig32, rw]

This object contains the mapping of the PDO the encoder uses to transmit the velocity value , according to the manufacturer profile.

This object describes the content of the PDO by its index, sub-index and length.

The length contains the length of the application object expressed in bits.

31 24	23 16	15 8	7 0
Index		Sub-Index	Length
MSB			LSB

Default = 3006 0020h = **3006-00 Velocity value** object, the length is 32 bits

6.8.2 Manufacturer Specific Profile Area objects

2104-00 Limit switch min.

[Unsigned32, rw]
This object is used to set the lowest software limit switch (-).
If the encoder position is greater than the value set in this object, then the bit 12 of the **6500-00 Operating status** object will be set to "0".
If the encoder position is less than the value set in this object, then the bit 12 of the **6500-00 Operating status** object will be set to "1".
To enable this function set the bit 12 **Limit switch min.** of the **6000-00 Operating parameters** object to "1".
Default = 0000 0010h

2105-00 Limit switch max.

[Unsigned32, rw]
This object is used to set the highest software limit switch (+).
If the encoder position is less than the value set in this object, then the bit 13 of the **6500-00 Operating status** object will be set to "0".
If the encoder position is greater than the value set in this object, then the bit 13 of the **6500-00 Operating status** object will be set to "1".
To enable this function set the bit 13 **Limit switch max.** of the **6000-00 Operating parameters** object to "1".
Default = 003F FFF0h

3000-00 Baud rate

[Unsigned8, rw]
This object is meant to set the baud rate (transmission rate) according to the following table:

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	**500 Kbit/s (default)**
06h	800 Kbit/s
07h	1000 Kbit/s

The bit rate is set through the **3000-00 Baud rate** object only if the bit 4 in the DIP A dip switch is set to "OFF". If the bit 4 in the DIP A dip switch is set to "ON", the bit rate is set by DIP A. For any further information refer to the "4.6 Setting the baud rate: DIP A" section on page 31.

To change the baud rate value you have to:
- set the 3000-00 Baud rate object;
- send a **Reset node** command (or **Reset communication** command);
- save the parameter;
- set the Master to the new baud rate.

Default = 05h

Master → Encoder

COB-ID	Cmd	Index		Sub	Data byte
600+ID	2F	00	30	00	see table

Encoder → Master (confirmation)

COB-ID	Cmd	Index		Sub	Data byte
580+ID	60	00	30	00	00

Master → Encoder (**Reset node**)

COB-ID	Cmd	Slave ID
000	81	ID

Set the Master device to the new baud rate:

Encoder → Master (Boot-up with new baud rate setting)

COB-ID	Cmd
700+ID	00

NOTE
To save the new Baud rate value execute the store parameters function (see the 1010-01 Store parameters object).
When the power is turned off, the parameters not saved are lost.

3001-00 Node-ID

[Unsigned8, rw]
This object defines the node identifier (node ID) of the device. The node addresses are allowed in the range 1 to 127. The default value is 1.

The node number is set through the 3001-00 Node-ID object only if all bits in the DIP B dip switch are set to "OFF". If one bit at least of the DIP B dip switch is set to "ON" the node number is set by DIP B. For any further information refer to the "4.7 Setting the node address: DIP B" section on page 32.

To change the Node-ID value you have to:
- set the 3001-00 Node-ID object;
- send a **Reset node** command;
- save the parameter.

Default = 01h

Master → Encoder

COB-ID	Cmd	Index		Sub	Data byte
600+ID	2F	01	30	00	new Node-ID

Encoder → Master (confirmation)

COB-ID	Cmd	Index		Sub	Data byte
580+ID	60	01	30	00	00

Master → Encoder (**Reset node**)

COB-ID	Cmd	Slave ID
000	81	old ID

Encoder → Master (Boot-up with new Node-ID)

COB-ID	Cmd
700+ID	00

NOTE
To save the new Node-ID value execute the store parameters function (see the **1010-01 Store parameters** object).
When the power is turned off, the parameters not saved are lost.

3005-00 Velocity format

[Unsigned8, rw]
This attribute defines the engineering units for the velocity value.
00h = steps/s: number of steps per second (default);
01h = rpm: number of revolutions per minute.
Default = 00h

3006-00 Velocity value

[Unsigned32, ro]
This attribute shows the current output speed value detected by the position sensor and calculated every 100 ms.
The value can be expressed in either steps per second or revolutions per minute according to the setting in the previous **3005-00 Velocity format** object.
The value is transmitted according to the settings in the **1803 TPDO communication parameter 4** object.

6.8.3 Standardised Device Profile Area objects (DS 406)

6000-00 Operating parameters

[Unsigned16, rw]

Bit	Function	bit = 0	bit = 1
0	**Code sequence**	Count up information rewinding the wire	**Count up information pulling the wire out**
1	not used		
2	**Scaling function**	**disabled**	enabled
3 ... 11	not used		
12	**Limit switch min.**	**disabled**	enabled
13	**Limit switch max.**	**disabled**	enabled
14 and 15	not used		

Default values are highlighted in bold
Default = 0001h

Code sequence
This is intended to set whether the count increases (count up information) when you rewind the wire or when you pull the wire out.
Setting 0 (bit 0 **Code sequence** = 0) causes the position value to increase when you rewind the wire; on the contrary, setting 1 (bit 0 **Code sequence** = 1) causes the position value to increase when you pull the wire out.
Default = 1

To know whether the **Code sequence** is currently set to to "Count up information rewinding the wire" or "Count up information pulling the wire out", you can read the bit 0 **Code sequence** of the **6500-00 Operating status** object, see on page 70.

Scaling function
When this option is disabled, the device uses the physical resolution values (see the **6501-00 Physical singleturn resolution** and **6502-00 Number of hardware distinguishable revolutions** objects); if it is enabled, it uses the custom resolution set in the **6001-00 Measuring units per revolution** and **6002-00 Total measuring range** objects with the following relation:

$$\text{Transmitted position} = \frac{\text{6001-00 Measuring units per revolution}}{\text{6501-00 Physical singleturn resolution}} * \text{real position} \leq \text{6002-00 Total measuring range}$$

The value in the **6001-00 Measuring units per revolution** object must be equal to or less than the value in the **6501-00 Physical singleturn resolution**

object. The total custom resolution in the **6002-00 Total measuring range** object must be equal to or less than the maximum physical value (**6501-00 Physical singleturn resolution** * **6502-00 Number of hardware distinguishable revolutions**).
Default = 0

To know whether the **Scaling function** is currently enabled, you can read the bit 2 **Scaling function** of the **6500-00 Operating status** object, see on page 70.

WARNING
When you enable the scaling function (bit 2 **Scaling function** = 1), please enter scaled values next to the **6001-00 Measuring units per revolution** and **6002-00 Total measuring range** objects that are consistent with the physical values.

WARNING
Every time you enable the scaling function and/or change the scaling values (see the **6001-00 Measuring units per revolution** and **6002-00 Total measuring range** objects) then you are required to set a new preset value (see the **6003-00 Preset value** object) and finally save the new parameters (see the **1010-01 Store parameters** object).

Limit switch min.
Limit switch max.
They allow to enable (1) / disable (0) the operation of the **2104-00 Limit switch min.** and **2105-00 Limit switch max.** objects. For further information see on page 56.
Default = 0

To know whether the **Limit switch min.** / **Limit switch max.** functions are currently enabled, you can read the bit 12 **Limit switch min.** and bit 13 **Limit switch max.** of the **6500-00 Operating status** object, see on page 70.

6001-00 Measuring units per revolution

[Unsig32, rw]

WARNING
This object is active only if the bit 2 **Scaling function** in the **6000-00 Operating parameters** object is set to "=1"; otherwise it is ignored and the system uses the physical values (**6501-00 Physical singleturn resolution** and **6502-00 Number of hardware distinguishable revolutions**) to calculate the position information.

This object sets a custom number of distinguishable steps per revolution (custom singleturn resolution).
To avoid counting errors, check that

$$\frac{\text{6501-00 Physical singleturn resolution}}{\text{6001-00 Measuring units per revolution}} = \text{integer value.}$$

You are allowed to set whatever integer value less than or equal to the **maximum number of physical steps per revolution** (see the hardware counts per revolution in the encoder identification label and the **6501-00 Physical singleturn resolution**).

Default = 0000 2000h (8,192 cpr)

Setting the resolution per revolution 6001-00 Measuring units per revolution (2^{13}=0000 2000h)

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	23	01	60	00	00	20	0	00

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	01	60	00	00	00	00	00

WARNING
When you set a new value next to the **6001-00 Measuring units per revolution** object, please always check also the **6002-00 Total measuring range** object value and be sure that the resulting number of revolutions complies with the physical number of revolutions of the device (see the **6502-00 Number of hardware distinguishable revolutions** object, 4,096 revolutions).

Let's suppose that the draw-wire encoder is programmed as follows:
6001-00 Measuring units per revolution: 8,192 cpr
6002-00 Total measuring range = 33,554,432 = 8,192 (cpr) * 4,096 (rev.)
Let's set a new singleturn resolution, for instance: **6001-00 Measuring units per revolution** = 360 cpr.

If we do not change the **6002-00 Total measuring range** value at the same time, we will get the following result:

$$\text{Number of revolutions} = \frac{33{,}554{,}432\ (\text{6002-00 Total measuring range})}{360\ (\text{6001-00 Measuring units per revolution})} = 93{,}206.755...$$

As you can see, the encoder is required to carry out more than 93,000 revolutions, this cannot be as the hardware number of revolutions is, as stated, 4,096 (see the **6502-00 Number of hardware distinguishable revolutions** object). When this happens, the encoder falls into an error signalling the faulty condition through the diagnostic LEDs (see on page 34).

WARNING
Every time you enable the scaling function (bit 2 **Scaling function** in the **6000-00 Operating parameters** object) and/or change the value in the scaled values (**6001-00 Measuring units per revolution** and **6002-00 Total measuring range** objects), then you are required to set a new preset value (see the **6003-00 Preset value** object) and finally save the new parameters (see the **1010-01 Store parameters** object).

NOTE
Please refer to the "7 - Setting-up" section on page 79 for an example of how the **6001-00 Measuring units per revolution** object is to be set.

6002-00 Total measuring range

[Unsigned32, rw]

WARNING
This object is active only if the bit 2 **Scaling function** in the **6000-00 Operating parameters** object is set to "=1"; otherwise it is ignored and the system uses the physical values (**6501-00 Physical singleturn resolution** and **6502-00 Number of hardware distinguishable revolutions**) to calculate the position information.

This object sets a custom number of distinguishable steps over the total measuring range. The total resolution of the encoder results from the product of **6001-00 Measuring units per revolution** by the required **Number of revolutions**.
Allowed values are equal to or less than the **Total hardware resolution** (**6501-00 Physical singleturn resolution** * **6502-00 Number of hardware distinguishable revolutions**, see the encoder label).
Default = 0200 0000h (33,554,432 information)

Setting the total resolution 6002-00 Total measuring range (2^{25}=0200 0000h)

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	23	02	60	00	00	00	00	02

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	02	60	00	00	00	00	00

WARNING

When you set a new value next to the 6002-00 Total measuring range object, please always check also the 6001-00 Measuring units per revolution object value and be sure that the resulting number of revolutions complies with the **Hardware number of revolutions** of the device.
Let's suppose that the draw-wire encoder is programmed as follows:
6001-00 Measuring units per revolution: 8,192 cpr
6002-00 Total measuring range = 33,554,432 = 8,192 (cpr) * 4,096 (rev.)
Let's set a new total resolution, for instance: 6002-00 Total measuring range = 360.
As the 6002-00 Total measuring range must be greater than or equal to the 6001-00 Measuring units per revolution, the above setting is not allowed. When this happens, the encoder falls into an error signalling the faulty condition through the diagnostic LEDs (see on page 34).

WARNING

Every time you enable the scaling function (bit 2 **Scaling function** in the 6000-00 Operating parameters object) and/or change the value in the scaled values (6001-00 Measuring units per revolution and 6002-00 Total measuring range objects), then you are required to set a new preset value (see the 6003-00 Preset value object) and finally save the new parameters (see the 1010-01 Store parameters object).

EXAMPLE

Draw-wire encoder **SFA-5000-CB-8192-M12**

The physical values are as follows:
Stroke per turn of the drum = 200 mm (7.874")
6501-00 Physical singleturn resolution, physical resolution per turn = 13 bits = 8,192 cpr
6502-00 Number of hardware distinguishable revolutions, number of physical revolutions = 12 bits = 4,096 revolutions
Total physical resolution = 25 bits = 33,554,432 information

Physical linear resolution = 0.024 mm = 24 µm
Max. number of turns of the drum = 25
Max. measuring length = 5,000 mm (196.85")
Number of information = 204,800

The specific installation requires 2,048 counts/rev. * 1,024 turns:

- Enable scaling function: **6000-00 Operating parameters**, bit 2 **Scaling function** = "1"
- Counts per revolution: **6001-00 Measuring units per revolution** = 2,048 (0000 0800h)
- Total resolution: **6002-00 Total measuring range** = 2,048 * 1,024 = 2,097,152 (0020 0000h)

Let's suppose that we need a tenth of a millimetre linear resolution in the specific installation.

- Enable the scaling function: bit 2 **Scaling function** in the **6000-00 Operating parameters** object = 1
- Custom resolution per turn = **6001-00 Measuring units per revolution** = 2,000 cpr
- Linear resolution = 0.1 mm = 100 µm

$$\text{Linear resolution} = \frac{\text{Stroke per turn}}{\text{6001-00 Measuring units per revolution}} = \frac{200\text{ mm}}{2{,}000} = 0.1\text{ mm}$$

The custom number of revolutions can be as the physical number of revolutions:

$$\text{Custom number of encoder revolutions} = \frac{\text{6002-00 Total measuring range}}{\text{6001-00 Measuring units per revolution}} = 4{,}096$$

- **6002-00 Total measuring range** = 8,192,000 information

NOTE
Please note that if you set a preset along the path, when the encoder moves back and cross the zero, the value immediately after 0 will be 8,192,000 - 1, i.e. 8,191,999.

...	8,191,997	8,191,998	8,191,999	0	1	2	...

EXAMPLE

Using the values in the previous example let's suppose that the travel in the application is 2 m long. As the stroke per turn is 200 mm you need 10 revolutions to cover the travel length.

- **6002-00 Total measuring range** = **6001-00 Measuring units per revolution** * custom number of revolutions = 2,000 * 10 = 20,000

In fact:

$$\text{Custom number of encoder revolutions} = \frac{\text{6002-00 Total measuring range}}{\text{6001-00 Measuring units per revolution}} = 10$$

In this case you will obtain several 20,000 information sections following each other all along the whole measuring length. The position information will be from 0 to 19,999; then again from 0 to 19,999 and so on.

...	19,997	19,998	19,999	0	1	2	...	19,997	19,998	19,999	0	1	2	...

← max. measuring length →

NOTE

To avoid counting errors we suggest setting values which are power of 2 (2^n: 2, 4, ..., 2048, 4096, 8192,...) in the **6001-00 Measuring units per revolution** and **6002-00 Total measuring range** objects.

WARNING

Every time you enable the scaling function (bit 2 **Scaling function** in the **6000-00 Operating parameters** object) and/or change the value in the scaled values (**6001-00 Measuring units per revolution** and **6002-00 Total measuring range** objects), then you are required to set a new preset value (see the **6003-00 Preset value** object) and finally save the new parameters (see the **1010-01 Store parameters** object).

NOTE

Please refer to the "7 - Setting-up" section on page 79 for an example of how the **6002-00 Total measuring range** object is to be set.

6003-00 Preset value

[Unsigned32, rw]

This object allows to set the encoder position to a Preset value. The Preset function is meant to assign a desired value to a physical position of the encoder shaft (i.e. to a position of the wire in the stroke). The chosen position will get the value set next to this object and all the previous and the following positions will get a value according to it. This function is useful, for example, when the zero position of the encoder and the zero position of the axis need to match. The preset value will be set for the position of the encoder (i.e. the position of the wire) in the moment when the preset value is transmitted. We suggest setting the preset value when the encoder is in stop.

Default = 0000 0000h

EXAMPLE

Let's take a look at the following example to better understand the preset function and the meaning and use of the related objects: **6003-00 Preset value** and **6509-00 Offset value**.

The encoder position which is transmitted results from the following calculation:

Transmitted value = **read position** (it does not matter whether the position is physical or scaled) + **6003-00 Preset value** - **6509-00 Offset value**.

If you never set the **6003-00 Preset value** and you never performed the preset setting, then the transmitted value and the read position are necessarily the same as **6003-00 Preset value** = 0 and **6509-00 Offset value** = 0.

When you set the **6003-00 Preset value** and then execute the preset setting, the system saves the current encoder position in the **6509-00 Offset value** object. It follows that the transmitted value and the **6003-00 Preset value** are the same as **read position** - **6509-00 Offset value** = 0; in other words, the value set next to the **6003-00 Preset value** object is paired with the current position of the encoder as you wish.

For example, let's assume that the value "50" is set next to the **6003-00 Preset value** object and you execute the preset setting when the encoder position is "1000". In other words, you want to receive the value "50" when the encoder reaches the position "1000".

We will obtain the following information sequence:

Transmitted value = **read position** (="1000") + **6003-00 Preset value** (="50") - **6509-00 Offset value** (="1000") = 50.

The following transmitted value will be:

Transmitted value = **read position** (="1001") + **6003-00 Preset value** (="50") - **6509-00 Offset value** (="1000") = 51.

And so on.

To set the preset value you must send the following command:
Set the Preset value **6003-00 Preset value** (preset = 1000 = 03E8h)

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	23	03	60	00	E8	03	00	00

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	03	60	00	00	00	00	00

NOTE

- If the scaling function is disabled (see the bit 2 **Scaling function** in the **6000-00 Operating parameters** object), the **6003-00 Preset value** must be less than or equal to the **Total hardware resolution** - 1 (**6501-00 Physical singleturn resolution** * **6502-00 Number of hardware distinguishable revolutions** - 1).
- If the scaling function is enabled (see the bit 2 **Scaling function** in the **6000-00 Operating parameters** object), the **6003-00 Preset value** must be less than or equal to the **6002-00 Total measuring range** - 1.

WARNING

Check the value in the **6003-00 Preset value** object and perform the preset operation every time you set a new **Code sequence** and/or change the scaled values (**6001-00 Measuring units per revolution** and/or **6002-00 Total measuring range**).

6004-00 Position value

[Unsigned32, ro]
This object contains the current position value of the encoder.
The output value is scaled according to the scaling parameters (if the scaling function is enabled), see the bit 2 **Scaling function** of the **6000-00 Operating parameters** object.
The position value is transmitted cyclically or synchronously according to the settings in the **1800 TPDO communication parameter 1**, **1801 TPDO communication parameter 2** and **1802 TPDO communication parameter 3** objects (see on page 48 ff).

WARNING

Please note that the position value issued by the encoder is expressed in pulses; thus you have then to convert the number of pulses into a linear measuring unit.

To convert the position value into millimetres (mm) or micrometres (µm) you have to multiply the number of information by the linear resolution of the encoder expressed in millimetres or micrometres.
To know the linear resolution of the encoder please consider that **the stroke per turn of the drum is 200 mm**.

The linear resolution results from the following calculation:

$$\textbf{Linear resolution} = \frac{\text{Stroke per turn of the drum}}{\text{Singleturn resolution cpr}}$$

If you want to know the linear position value you will need to multiply the transmitted position value by the linear resolution.

Linear position value = transmitted position * linear resolution

NOTE
Please note that the encoder's linear resolution can be read also in the order code next to the rotary resolution. Refer to the product datasheet.

EXAMPLE 1
Let's suppose that we are using the physical resolution of the SFA-5000-CB-8192-PG draw-wire encoder (the bit 2 **Scaling function** in the **6000-00 Operating parameters** object = 0).
The physical singleturn resolution of the measuring device is 8,192 cpr (= 0.024 mm, see the order code in the product datasheet).
As stated, the linear resolution results from the following calculation:

$$\textbf{Linear resolution} = \frac{\text{Stroke per turn of the drum}}{\text{Singleturn resolution cpr}}$$

$$\textbf{Linear resolution} = \frac{200}{8{,}192} = 0.024 \text{ mm} = 24 \text{ µm}$$

Let's say that the transmitted position value is 123.

Thus the linear position value will be as follows:
Linear position value = transmitted position * linear resolution

Linear position value = 123 * 0.024 = 2.952 mm = 2,952 µm

EXAMPLE 2
Let's suppose that we are using the SFA-5000-CB-8192-PG draw-wire encoder. The singleturn resolution is set to the custom value of 4,000 cpr (**6001-00 Measuring units per revolution** = 4000). The transmitted position value is 1,569.
The linear resolution can be easily calculated as follows:

$$\textbf{Linear resolution} = \frac{200}{4{,}000} = 0.05 \text{ mm} = 50 \text{ µm}$$

Thus the linear position value will be as follows:

Linear position value = 1,569 * 0.05 = 78.45 mm = 78,450 µm

6200-00 Cyclic time

[Unsigned16, rw]
The cyclic timer value is used in the asynchronous transmission mode (**Transmission Type** = FEh) to set the interval between two following PDO transmissions during a cyclic communication.
If the value next to this **6200-00 Cyclic time** object ≠ 0, the PDO message is sent cyclically and the interval between two messages is the time set in this object; otherwise, if the value next to this **6200-00 Cyclic time** object = 0, the PDO message is not sent.
The value is expressed in milliseconds. See on pages 41 and 48 ff.
Default = 0000h

Enabling the Cyclic mode
Set the cyclic time **6200-00 Cyclic time** (100 ms = 64h)

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	2B	00	62	00	64	00	-	-

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	00	62	00	00	00	-	-

NOTE
Please refer to the "7 - Setting-up" section on page 79 for an example of how the **6200-00 Cyclic time** object is to be set.

6500-00 Operating status

[Unsigned16, ro]

Bit	Function	bit = 0	bit = 1
0	**Code sequence**	Count up information rewinding the wire	Count up information pulling the wire out
1	not used		
2	**Scaling function**	Disabled	Enabled
3 ... 11	not used		
12	**Limit switch min.**	Position > **2104-00 Limit switch min.**	Position < **2104-00 Limit switch min.**
13	**Limit switch max.**	Position < **2105-00 Limit switch max.**	Position > **2105-00 Limit switch max.**
14	not used		
15	**Current operating state**	**Stopped** / **Pre-operational**	**Operational**

Code sequence

It shows the value that is currently set through the bit 0 **Code sequence** in the **6000-00 Operating parameters** object. If the bit is "=0" the output encoder position value has been set to increase when you rewind the wire; if the bit is "=1" instead the output encoder position value has been set to increase when you pull the wire out. To set the code sequence you must set the bit 0 **Code sequence** of the **6000-00 Operating parameters** object. For any further information on setting and using the counting direction function refer to the **6000-00 Operating parameters** object on page 59.

Scaling function

It shows the value that is currently set through the bit 2 **Scaling function** in the **6000-00 Operating parameters** object. In other words, it is intended to show whether the scaling function is enabled or disabled. If the value is "=0" the scaling function is disabled; if the value is "=1" instead the scaling function is enabled. To disable / enable the scaling function you must set the bit 2 **Scaling function** of the **6000-00 Operating parameters** object to 0 / 1. For any further information on setting and using the scaling function refer to the **6000-00 Operating parameters** object on page 59.

Limit switch min.

If the encoder position is greater than the value set in the **2104-00 Limit switch min.** object, the bit 12 of this object is set to "0".

If the encoder position is less than the value set in the **2104-00 Limit switch min.** object, the bit 12 of this object is set to "1".
To enable this function set the bit 12 **Limit switch min.** of the **6000-00 Operating parameters** object to "1". See on page 60.

Limit switch max.
If the encoder position is less than the value set in the **2105-00 Limit switch max.** object, the bit 13 of this object is set to "0".
If the encoder position is greater than the value set in the **2105-00 Limit switch max.** object, the bit 13 of this object is set to "1".
To enable this function set the bit 13 **Limit switch max.** of the **6000-00 Operating parameters** object to "1". See on page 60.

Current operating state
It shows the current operating state of the unit. For further information on the available states see the "6.2 State machine" section on page 37.
bit 15 = 0: **Stopped** or **Pre-operational** state;
bit 15 = 1: **Operational** state.

6501-00 Physical singleturn resolution

[Unsigned32, ro]

WARNING
This object is active only if the bit 2 **Scaling function** in the **6000-00 Operating parameters** object is set to "=0"; otherwise it is ignored and the system uses the custom values (**6001-00 Measuring units per revolution** and **6002-00 Total measuring range**) to calculate the position information.

This object is intended to show the number of physical distinguishable steps per each revolution provided by the hardware (physical singleturn resolution, 8,192 cpr). If the bit 2 **Scaling function** in the **6000-00 Operating parameters** object is set to "=0" the system uses this value (and the **6502-00 Number of hardware distinguishable revolutions** object value) to calculate the position information.
If you want to set a custom singleturn resolution see the **6001-00 Measuring units per revolution** object.
Default = 0000 2000h

NOTE
Please refer to the "5 - Quick reference" section on page 35 for an example of how the **6501-00 Physical singleturn resolution** object can be read.

6502-00 Number of hardware distinguishable revolutions

[Unsigned16, ro]

WARNING

This object is active only if the bit 2 **Scaling function** in the **6000-00 Operating parameters** object is set to "=0"; otherwise it is ignored and the system uses the custom values (**6001-00 Measuring units per revolution** and **6002-00 Total measuring range**) to calculate the position information.

This object is intended to show the number of physical revolutions provided by the hardware (number of physical revolutions, 4,096 revolutions).
The **Total hardware resolution** results from **6501-00 Physical singleturn resolution** * **6502-00 Number of hardware distinguishable revolutions**.
If the bit 2 **Scaling function** in the **6000-00 Operating parameters** object is set to "=0" the system uses this value (and the **6501-00 Physical singleturn resolution** object value) to calculate the position information.
If you want to set a custom number of revolutions see the **6001-00 Measuring units per revolution** and **6002-00 Total measuring range** objects.
Default = 1000h

NOTE

Please refer to the "5 - Quick reference" section on page 35 for an example of how the **6502-00 Number of hardware distinguishable revolutions** object can be read.

6504-00 Supported alarms

[Unsigned16, ro]
This object contains the information on the alarms supported by the encoder.
No alarms are supported in this encoder.
Default = 0000h (alarms not supported)

6506-00 Supported warnings

[Unsigned16, ro]
This object contains the information on the warnings supported by the encoder.
No warnings are supported in this encoder.
Default = 0000h (warnings not supported)

6507-00 Profile and software version

[Unsig32, ro]
It shows the version of both the profile and the software.
Version of the profile for encoders = 3.1
Version of the software = 1.1

Default = 0301 0101h

6508-00 Operating time

[Unsigned32, ro]
This object contains the information on the operating time. The operating time monitor stores the operating time for the encoder expressed in operating hours. The operating time is stored in the encoder non-volatile memory as long as the encoder is power supplied.
This object is currently not used in this encoder.
Default = FFFF FFFFh (not used)

6509-00 Offset value

[Integer32, ro]

As soon as you activate the preset, the current position value of the encoder is saved in this object. The offset value is then used in the preset function in order to calculate the encoder position value to be transmitted. To zero set the value in this object you must upload the factory default values (see the **1011-01 Restore default parameters** object on page 46).

For any further information on the preset function and the meaning and use of the related objects and commands **6003-00 Preset value** and **6509-00 Offset value** refer to page 66.
Default = 0000 0000h

650A-01 Manufacturer offset value

[Integer32, ro]
This object contains the manufacturer offset value. This is the difference between the physical zero position of the encoder (zero set mechanically) and the zero position set by the manufacturer (zero set via software).
Default = 0000 0000h

650B-00 Serial number

[Unsigned32, ro]
This object contains the serial number of the encoder.
This object is currently not used in this encoder.
Default = FFFF FFFFh (not used)

NOTE
To save the new parameters execute the store parameters function (see the **1010-01 Store parameters** object).
When the power is turned off or in case of **Reset node** and **Restore node** commands, the parameters not saved are lost.

6.9 SDO abort codes

Here follows the list and meaning of the SDO abort codes indicated by CANopen but not necessarily supported by the manufacturer. For complete information please refer to the "SDO abort transfer protocol" section in the "CiA Draft Standard 301" document available at the address www.can-cia.org.

Abort code	Description
0503 0000h	Toggle bit not alternated.
0504 0000h	SDO protocol timed out.
0504 0001h	Client/server command specifier not valid or unknown.
0504 0002h	Invalid block size (block mode only).
0504 0003h	Invalid sequence number (block mode only).
0504 0004h	CRC error (block mode only).
0504 0005h	Out of memory.
0601 0000h	Unsupported access to an object.
0601 0001h	Attempt to read a write only object.
0601 0002h	Attempt to write a read only object.
0602 0000h	Object does not exist in the object dictionary.
0604 0041h	Object cannot be mapped to the PDO.
0604 0042h	The number and length of the objects to be mapped would exceed PDO length.
0604 0043h	General parameter incompatibility reason.
0604 0047h	General internal incompatibility in the device.
0606 0000h	Access failed due to an hardware error.
0607 0010h	Data type does not match, length of service parameter does not match
0607 0012h	Data type does not match, length of service parameter too high
0607 0013h	Data type does not match, length of service parameter too low
0609 0011h	Sub-index does not exist.
0609 0030h	Invalid value for parameter (download only).
0609 0031h	Value of parameter written too high (download only).
0609 0032h	Value of parameter written too low (download only).
0609 0036h	Maximum value is less than minimum value.
060A 0023h	Resource not available: SDO connection
0800 0000h	General error
0800 0020h	Data cannot be transferred or stored to the application.
0800 0021h	Data cannot be transferred or stored to the application because of local control.
0800 0022h	Data cannot be transferred or stored to the application because of the present device state.
0800 0023h	Object dictionary dynamic generation fails or no object dictionary is present (e.g. object dictionary is generated from file and generation fails

	because of an file error).
0800 0024h	No data available

6.10 Emergency (EMCY) messages

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

EMCY message structure:

IDENTIFIER	CAN Data Byte			
COB-ID(hex)	0	1	2	3...7
see the 1014-00 COB-ID EMCY object	Error code		Error Sub-register	Specific code
	LSB	MSB	01	00 ... 00

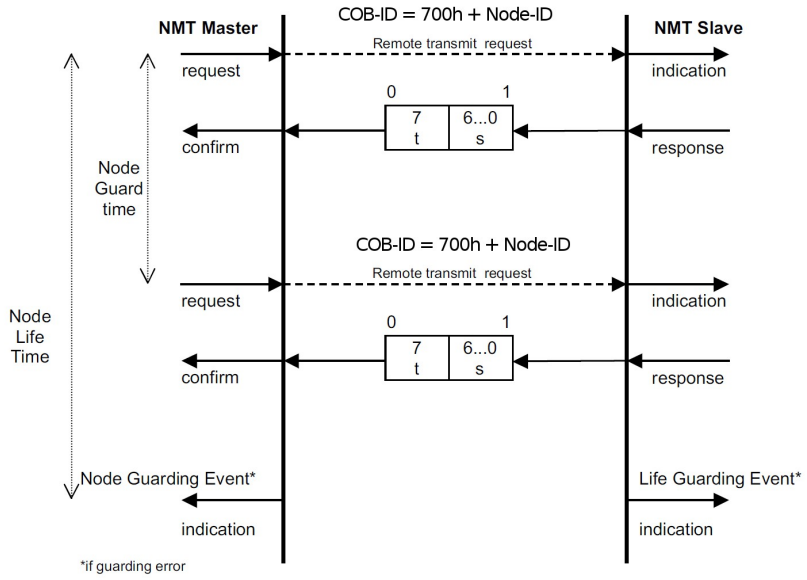
Available error codes indicated by CANopen but not necessarily supported by the manufacturer:

Error code	Description
0000h	Error reset or no error
1000h	Generic error, **Node guarding error**
2000h	Current – generic error
2100h	Current, CANopen device input side – generic
2200h	Current inside the CANopen device – generic
2300h	Current, CANopen device output side – generic
3000h	Voltage – generic error
3100h	Mains voltage – generic
3200h	Voltage inside the CANopen device – generic
3300h	Output voltage – generic
4000h	Temperature – generic error
4100h	Ambient temperature – generic
4200h	Device temperature – generic
5000h	CANopen device hardware – generic error
5530h	**Flash memory error**
6000h	CANopen device software – generic error
6100h	Internal software – generic
6200h	User software – generic
6300h	Data set – generic

7000h	Additional modules – generic error
8000h	Monitoring – generic error
8100h	Communication – generic
8110h	CAN overrun (objects lost)
8120h	CAN in error passive mode
8130h	Life guard error or heartbeat error
8140h	Recovered from bus off
8150h	CAN-ID collision
8200h	Protocol error - generic
8210h	PDO not processed due to length error
8220h	PDO length exceeded
8230h	DAM MPDO not processed, destination object not available
8240h	Unexpected SYNC data length
8250h	RPDO timeout
9000h	External error – generic error
F000h	Additional functions – generic error
FF00h	Device specific – generic error

6.11 Node guarding protocol

This protocol is used to detect remote error in the network. Each NMT Slave uses one remote COB for the Node Guarding protocol. This protocol implements the provided initiated Error Control services.



S: the state of the NMT Slave

4: STOPPED

5: OPERATIONAL

127: PRE-OPERATIONAL

t: Toggle bit. The value of this bit must alternate between two consecutive responses from the NMT Slave. The value of the Toggle bit of the first response after the Node Guarding protocol becomes active is 0. The Toggle bit in the Node Guarding protocol is only reset to 0 when reset_communication is passed (no other change of the state resets the Toggle bit). If a response is received with the same value of the Toggle bit as in the preceding response then the new response is handled as if it was not received.

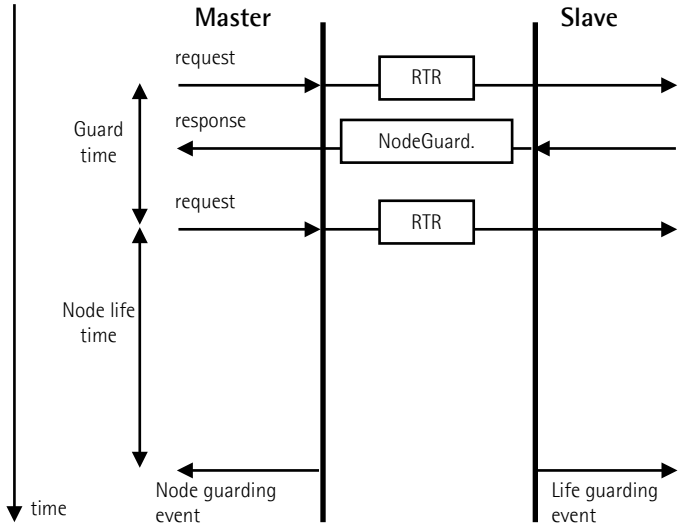
The NMT Master polls each NMT Slave at regular time intervals. This time-interval is called the guard time (see the **100C-00 Guard time** object) and may be different for each NMT Slave. The response of the NMT Slave contains the state of that NMT Slave. The **node life time** is given by the **100C-00 Guard time** object value multiplied by the **100D-00 Life time factor** object value. The node life time can be different for each NMT Slave. If the NMT Slave has not been polled during its life time, a remote node error is indicated through the 'Life Guarding Event' service.

A remote node error is indicated through the 'Node guarding event' service if:

- the remote transmit request is not confirmed within the node life time;
- the reported NMT Slave state does not match the expected state.

If it has been indicated that a remote error has occurred and the errors in the guarding protocol have disappeared, it will be indicated that the remote error has been resolved through the 'Node Guarding Event' and 'Life Guarding Event' services.

At system boot the "Node guarding protocol" is disabled; this protocol is enabled automatically as soon as the Master device sends an RTR message (Remote Transmission Request) the first time.



100C-00 Guard time: interval between two RTR messages.
Node life time: maximum time available for the encoder to receive an RTR message.

Node life time = **100C-00 Guard time** * **100D-00 Life time factor**.

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

If the Slave does not receive an RTR message before the **Node life time** has expired, it warns activating a "Life Guarding Event". Furthermore the red LED starts flashing so indicating the Node guarding error (see on page 34), **1001-00 Error register** and **1003 Predefined error field** objects are updated and an error message is sent.
To reset the error send a **Reset node** command.

7 - Setting-up

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

7.1 Setting the Operational, Pre-operational state

NMT message — Master → Slave

	COB-ID	Cmd	Node
Operational:	000	01	ID
Pre-operational:	000	80	ID

7.2 Setting the resolution per revolution

6001-00 Measuring units per revolution (2^{13}=0000 2000h)

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	23	01	60	00	00	20	0	00

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	01	60	00	00	00	00	00

7.3 Setting the total resolution

6002-00 Total measuring range (2^{25}=0200 0000h)

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	23	02	60	00	00	00	00	02

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	02	60	00	00	00	00	00

7.4 Setting the Operating parameters

6000-00 Operating parameters

(**Code sequence**: 1 = count up information pulling the wire out, **Scaling function**: 1 = enabled, **Limit switch min. / Limit switch max.**: 0 = disabled)

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	2B	00	60	00	05	00	-	-

Encoder → Master (Set confirmation)

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

7.5 Setting the Preset value

6003-00 Preset value (preset = 1000 = 03E8h)

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	23	03	60	00	E8	03	00	00

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	03	60	00	00	00	00	00

7.6 Setting the SYNC counter

1801 TPDO communication parameter 2 sub 2 (n = 5 = 05h)

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	2F	01	18	02	05	-	-	-

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	01	18	02	00	-	-	-

7.7 Disabling the SYNC mode

1801 TPDO communication parameter 2 sub 1

Read COB-ID used by PDO2:

Master → Encoder (Req request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	40	01	18	01	-	-	-	-

Encoder → Master (Req reply)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	43	01	18	01	B0	B1	B2	B3

COB-ID used by PDO2 = ((B3<<24) | (B2<<16) | (B1<<8) | B0)
set the most significant bit to 1:

```
B3 |= 0x80;
```

Set the new COB-ID used by PDO2 (**1801 TPDO communication parameter 2** sub 1):

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	23	01	18	01	B0	B1	B2	B3

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	01	18	01	00	00	00	00

7.8 Enabling the Cyclic mode

Set the cyclic time **6200-00 Cyclic time** (100 ms = 64h)

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	2B	00	62	00	64	00	-	-

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	00	62	00	00	00	-	-

Read the COB-ID used by PDO1 (**1800 TPDO communication parameter 1**, sub 1):

Master → Encoder (Req request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	40	00	18	01	-	-	-	-

Encoder → Master (Req reply)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	43	00	18	01	B0	B1	B2	B3

COB-ID used by PDO1 = ((B3<<24) | (B2<<16) | (B1<<8) | B0)
set the most significant bit to 0:

```
B3 &= 0x7F;
```

Set the new COB-ID used by PDO1 (**1800 TPDO communication parameter 1**, sub 1):

Master → Encoder (Set request)

COB-ID	Cmd	Index		Sub	Process data			
600+ID	23	00	18	01	B0	B1	B2	B3

Encoder → Master (Set confirmation)

COB-ID	Cmd	Index		Sub	Process data			
580+ID	60	00	18	01	00	00	00	00

NOTE

To save the new parameters execute the store parameters function (see the **1010-01 Store parameters** object).

When the power is turned off or in case of **Reset node** and **Restore node** commands, the parameters not saved are lost.

8 - Default parameters list

Default values are expressed in hexadecimal notation, unless otherwise indicated.

8.1 Communication Profile Area objects

Parameters list	Default values		
1000-00 Device type	0002 0196h		
1001-00 Error register	00h		
1003 Predefined error field	-		
1005-00 COB-ID SYNC message	0000 0080h		
1008-00 Manufacturer device name	LIKA srl*		
1009-00 Manufacturer hardware version	Device dependent		
100A-00 Manufacturer software version	Device dependent		
100C-00 Guard time	0000h		
100D-00 Life time factor	00h		
1014-00 COB-ID EMCY	NODE-ID+0000 0080h		
1015-00 Inhibit time EMCY	0000h		
1018 Identity object 01 Vendor number 02 Product number 03 Revision number	 0000 012Eh 0000 0000h 0000 0001h		
1800 TPDO communication parameter 1 01 COB-ID of TPDO1 02 TPDO1 transmission type	 NODE-ID+4000 0180h FEh		
1801 TPDO communication parameter 2 01 COB-ID of TPDO2 02 TPDO2 transmission type	 NODE-ID+4000 0280h 01h		
1802 TPDO communication parameter 3 01 COB-ID of TPDO3 02 TPDO3 transmission type	 NODE-ID+C000 0380h 01h		
1803 TPDO communication parameter 4 01 COB-ID of TPDO4 02 TPDO4 transmission type	 NODE-ID+C000 0480h FEh		
1A00-01 TPDO mapping parameter 1	6004 0020h		
1A01-01 TPDO mapping parameter 2	6004 0020h		
1A02-01 TPDO mapping parameter 3	6004 0020h		
1A03-01 TPDO mapping parameter 4	3006 0020h		

* Text string

8.2 Manufacturer Specific Profile Area objects

Parameters list	Default values		
2104-00 Limit switch min.	0000 0010h		
2105-00 Limit switch max.	003F FFF0h		
3000-00 Baud rate	05h		
3001-00 Node-ID	01h		
3005-00 Velocity format	00h		

8.3 Standardized Device Profile Area objects

Parameters list	Default values		
6000-00 Operating parameters 0 Code sequence 2 Scaling function 12 Limit switch min. 13 Limit switch max.	0001h 1 = count up pulling the wire out 0 = disabled 0 = disabled 0 = disabled		
6001-00 Measuring units per revolution	0000 2000h		
6002-00 Total measuring range	0200 0000h		
6003-00 Preset value	0000 0000h		
6200-00 Cyclic time	0000h		
6500-00 Operating status	-		
6501-00 Physical singleturn resolution	0000 2000h		
6502-00 Number of hardware distinguishable revolutions	1000h		
6504-00 Supported alarms	0000h		
6506-00 Supported warnings	0000h		
6507-00 Profile and software version	0301 0101h		
6508-00 Operating time	FFFF FFFFh		
6509-00 Offset value	0000 0000h		
650A-01 Manufacturer offset value	0000 0000h		
650B-00 Serial number	FFFF FFFFh		

This page intentionally left blank

This page intentionally left blank

This page intentionally left blank

Document release	Release date	Description	HW	SW	EDS file version
1.0	01.02.2018	First issue	R1	2.0	V1

This device is to be supplied by a Class 2 Circuit or Low-Voltage Limited Energy or Energy Source not exceeding 30 Vdc. Refer to the order code for supply voltage rate.
Ce dispositif doit être alimenté par un circuit de Classe 2 ou à très basse tension ou bien en appliquant une tension maxi de 30Vcc. Voir le code de commande pour la tension d'alimentation.

Dispose separately

Lika Electronic
Via S. Lorenzo, 25 • 36010 Carrè (VI) • Italy

Tel. +39 0445 806600
Fax +39 0445 806699

info@lika.biz • www.lika.biz