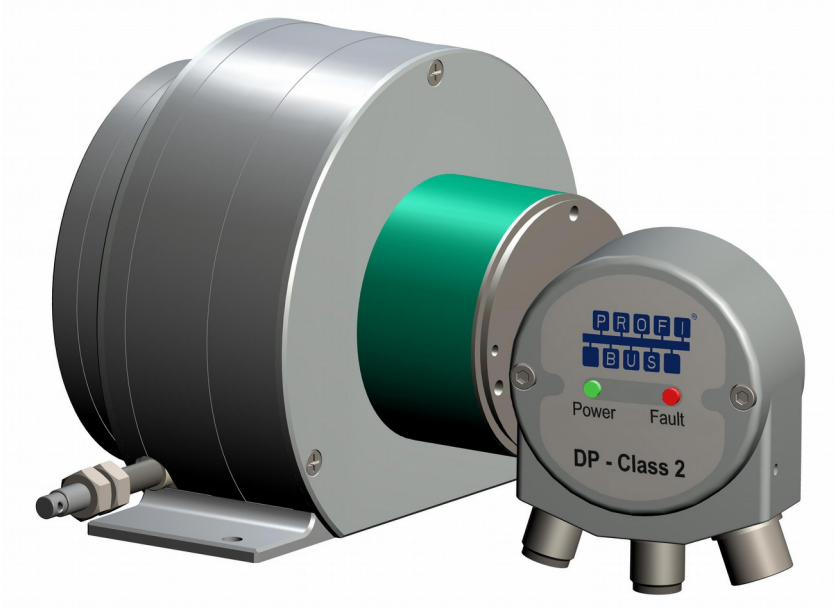
User's guide

SFA-5000

SFA-10000

Absolute draw-wire encoder

Profibus-DP Profile for Encoders



Smart encoders & actuators

General contents

Subject index

Typographic and iconographic conventions

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

- parameters are coloured in **GREEN**;
- alarms are coloured in **RED**;
- states are coloured in **FUCSIA**.

Some icons in the pages 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 Profibus-DP 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 rotative 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 **Profibus Interface**, you can find detailed information on the Profibus interface. In this section the interface features and the parameters implemented in the unit are fully described.

Glossary of Profibus terms

PROFIBUS, 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 PROFIBUS interface. They are listed in alphabetical order.

Address (Station)	IEC 61158-2: Medium attachment unit identification - unique number of a station connected to a segment (participant).
Address Space	Within PROFIBUS DP the maximum possible number of addressable network nodes per segment, e.g. 127.
Alarm	Notification of an abnormal or unexpected event within a system. Alarms in PROFIBUS DP require in addition to the standard diagnosis event mechanism within the cyclic data exchange a separate acyclic acknowledgement procedure between a host and a Slave application. Since DP-V1, "Device related diagnosis" is the basis for the "Alarm" and "Status" types of diagnosis events (GSD: "DPV1"=1). PROFIBUS DP defines the following alarm types: Diagnosis, Status, Process, Update, Pull and Plug Alarm. See "Device Related Diagnosis". The PNO maintains a Profile Guideline, Part3: Diagnosis, Alarms and Time Stamping, order no. 3.522.
Alert	Alert is a generic term for two different types of notifications within a PROFIBUS DP/PA network especially arranged but not exclusively for the process automation: • alarm; • event. Both alert types may be used with or without a user acknowledgement mechanism. The PNO maintains a PROFIBUS guideline "Time Stamp", order no. 2.192.
Application Profile	Within PROFIBUS a specified agreement within families of field devices on how to use the general PROFIBUS communication platform and its subsystems (e.g. device integration via GSD, EDD, FDT/DTM and Communication Function Blocks). Communication profiles are not a part of the PROFIBUS DP application profiles. See "Profile".
Baud rate (Data Rate)	Other common terms are "data transfer rate" and "transmission rate". Within PROFIBUS DP this is the amount of data transferred across a fieldbus segment per second. A data rate is measured in units of bits per second ("b/s" or "bps"), or baud.
Bus Cycle	The period of time the bus Master needs to poll every participant (Slave) once. More bus Masters can be activated by using the token principle which consequently prolong the bus cycle.
Class	See “DP Master”, “DP Master Class 1 (DPM1)” and “DP Master

	Class 2 (DPM2)".
Class 1 encoder	Encoder class must be set when you configure the device. Mandatory **Class 1** provides the basic functions of the device and can be used for: • sending the position value (see **Position value** parameter); • changing the counting direction (see **Code sequence** parameter); • setting the preset value (see **Preset value** parameter); • acquiring reduced diagnostic information (see **Diagnostic type** parameter = "16 bytes fixed (6+10)").
Class 2 (+VEL) encoder	Encoder class must be set when you configure the device. **Class 2 (+VEL)** provides all the Class 1 and Class 2 functions and additional velocity-related functions: • transmission of the velocity value (see **Position and velocity values** parameter); • setting of the velocity measuring unit (see **Velocity measure unit** parameter).
Class 2 encoder	Encoder class must be set when you configure the device. **Class 2** provides all the Class 1 functions and additional advanced functions such as: • scaling function (see **Scaling function control**, **Counts per revolution** and **Total resolution** parameters); • extended diagnostic information (see **Diagnostic type** parameter = "16 bytes (6+10)" or "63 bytes (6+57)").
Communication Function Block (Comm FB)	A basic function block defined for PROFIBUS DP and supplied by the PLC manufacturer for the standardized access of user programs to field devices. The standardization is based on IEC 61131-3. The PNO maintains a guideline "PROFIBUS Communication and Proxy Function Blocks acc. to IEC 61131-3", order no. 2.182.
Communication Parameter	Communication parameters are parameters, which adjust the communication protocol function to the current net configuration. Communication parameters exist for all phases of the communication protocols. Examples are bus address, token rotation time, idle time. See "Slave parametrization" and "Device parametrization".
Communication Profile	IEC 61158 comprises a summary of layer stacks of several different fieldbusses. IEC 61784 defines the useful combinations of these stacks via communication profiles CPF3/1 up to CPF3/3 (PROFINET). One of these is PROFIBUS DP. Within this communication profile three different physical profiles are defined: • RS 485 (RS 485-IS); • MBP-IS (MBP-LP, MBP); • Fibre Optics.

Cyclic Data Exchange	IEC 61158-3: Term used to describe events which repeat in a regular and repetitive manner. The MS0 services of PROFIBUS DP are based on cyclic data exchange. See "State machine".
Cyclic Redundancy Check (CRC)	Error-checking technique in which the frame recipient calculates a remainder by dividing frame contents by a prime binary divisor and compares the calculated remainder to a value stored in the frame by the sending node.
Data Rate (Baud rate)	Other common terms are "data transfer rate" and "transmission rate". Within PROFIBUS DP this is the amount of data transferred across a fieldbus segment per second. A data rate is measured in units of bits per second ("b/s" or "bps"), or baud.
Decentralized Peripherals (DP)	The term "Decentralized Peripherals" and the acronym "DP" stand for the simple, fast, cyclic and deterministic I/O data exchange between a bus Master and its assigned Slave devices. The corresponding PROFIBUS communication protocol is called PROFIBUS DP.
Device Identifier	Ident number: The primary device identification is an ident number of data type Unsigned16. This number is unique and assigned by the PNO business office upon application. It is stored within the device and defined in the corresponding GSD file via keyword. In addition it is part of the GSD file name. At runtime the ident number is used within: • the set Slave address procedure; • the parametrization telegram (octet 5 + 6); • the standard part of a diagnosis message (octet 5 + 6). The ident number explicitly cannot be retrieved from a device. Its main purpose is to make sure that a GSD file and configuration/parametrization data between Master Class 1 and its Slave are matching. The PNO maintains a technical guideline "Specification for PROFIBUS device description and device integration, Volume 1: GSD", Version 5.0, order no. 2.122. For a secondary identification possibility see the identification & maintenance functions (I&M). See "Ident Number".
Device Parametrization	The device parametrization within PROFIBUS DP consists of three phases. The first phase takes place during start-up of the communication system and provides basic communication parametrization and simple additional device parameters. Both are defined within the GSD file of a device, stored within a Master Class 1 after configuration in an engineering tool, and transmitted to the Slave at start-up time. Most of the automation cases in factory automation are covered by this method. More complex devices such as drives, laser scanners, scales, robots, transmitters, etc. require further individual parametrization before final production start. This is done in a second phase. In process automation certain device parameters such as value limits, value range, gain, etc. need to be adjusted even at run-time. For this second and third phase

	PROFIBUS DP provides two ways to accomplish the task: DTM/FDT and EDD. See "Slave parametrization" and "Communication parameter".
Device Profile	See "Profile".
DP Master	IEC 61158-5: Within PROFIBUS DP a fieldbus node that can be either Master Class 1 or Master Class 2. A Master Class 1 is a controlling device which controls several DP Slaves (field devices). NOTE: This is usually hosted by a programmable controller or a process controller. A Master Class 2 is a controlling device which manages configuration data (parameter sets) and diagnosis data of a DP Master Class 1, and that additionally can perform all communication capabilities of a DP Master Class 1.
DP Master Class1 (DPM1)	IEC 61158-5: A controlling device which controls several DP-Slaves (field devices). Usually programmable (logic) controllers or process control systems are hosts for Master Class 1.
DP Master Class2 (DPM2)	IEC 61158-5: A controlling device which manages configuration data (parameter sets) and diagnosis data of a DP-Master (Class 1). Additionally the DP-Master (Class 2) can perform all communication capabilities of a DP-Master (Class 1). Usually personal computers are hosts for DP Master Class 2 for programming, parametrizing, diagnosing and monitoring purposes.
DP Slave	IEC 61158-5: A field device that is assigned to one DP Master Class 1 as a provider for cyclic I/O data exchange. In addition acyclic functions and alarms could be supported.
Event	Within PROFIBUS DP/PA this is a signal or I/O data or process value within a certain field device at that point in time where a trigger condition arises. The values are associated with a time stamp and stored in a buffer. The time-stamped sample values are used to archive and visualize significant changes over the course of the production process. Such an event mechanism does not prevent from the cyclic transmission of these signals. A separate event alarm is requesting the transfer of the events to the main system.
Frame	A single set of data transmission from a device.
General Station Description (GSD)	A GSD is an electronically readable ASCII text file and contains both general and device-specific parameters for communication and network configuration. By means of keywords, a configuration tool allows to: • read device information (manufacturer, type, versions, bitmaps, etc.); • read texts for comfortable and easy to use configuration; • select transmission rates; • select modules and their I/O data length (configuration identifier);

	• read texts to assign diagnosis IDs to HMI displays; • select supported services (freeze, sync, etc.); from the GSD for the configuration of the device. A GSD replaces the previously conventional manuals or data sheets and thus already supports plausibility checks during the configuration phase. Distinction is made between a device GSD (for an individual device only) and a profile GSD, which may be used for devices that comply exactly with a profile such as a "PA device". GSDs for different languages may be provided in separate files with corresponding file extensions (*.gse for English, *.gsg for German, etc.) or altogether in one file (*.gsd). The device manufacturers are responsible for the scope and quality of the GSD of their devices.
Ident Number	See "Device Identifier". Notes: • the ident number is necessary for all DP devices except for Master Class 2; • the same ident number may be used for modular devices as long as the device can be described in the GSD file as a modular device.
Identifier	In general: a symbol that establishes the identity of the one bearing it. Within this context here it represents an absolute value of a parameter such as a physical address. It is intended for systematic and performance handling capabilities within computer systems, e.g. sorting, consistency checking, physical localization and alike. Usually an absolute value is associated with a logical value to represent the particular deployment of the identifier. Typical abbreviation for identifier is ID. IEC 61131-3: A combination of letters, numbers and underline characters, which begins with a letter or underline and which names a language element. Some of the major identifiers within PROFIBUS DP are: - Data type numeric identifier; - Configuration identifier (Cfg); - Device identifier (ident number); - Manufacturer identifier (MANUFACTURER ID); - Profile ident number (PROFILE ID).
Index	IEC 61158-5: Address of an object within an application process. The permitted range in PROFIBUS DP is 0 - 255. Indexes are used to address records of data (parameters, variables, state information, commands, etc.) within modules of a field device.
PDU (Protocol Data Unit)	A packet of data passed across a network via telegrams. The term implies a specific layer of the OSI seven layer model and a specific protocol. Each layer has its own PDU that is extended subsequently from the physical layer up to the application layer: • Physical layer protocol data unit (PhPDU); • Data link protocol data unit (DLPDU);

	• Application protocol data unit (APDU).
PI	The *PROFIBUS Nutzerorganisation e.V.* (PROFIBUS User Organisation, or PNO) was created in 1989. This group was composed mainly of manufacturers and users from Europe. In 1992, the first regional PROFIBUS organization was founded (PROFIBUS Schweiz in Switzerland). In the following years, additional Regional PROFIBUS & PROFINET Associations (RPAs) were added. In 1995, all the RPAs joined together under the international umbrella association PROFIBUS & PROFINET International (PI). Today, PROFIBUS is represented by 25 RPAs around the world (including PNO) with over 1400 members, including most if not all major automation vendors and service suppliers, along with many end users.
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PROFIBUS	PROcess FIeldBUS. PROFIBUS is a manufacturer independent fieldbus standard for applications in manufacturing, process and building automation. The PROFIBUS family is composed of three types of protocol, each of which is used for different tasks. The three types of protocols are: PROFIBUS FMS, DP and PA. IEC 61784-1: Communication network according to communication profile family 3 (CPF3); incorporating application profiles and system integration aspects like interfaces and languages for engineering tools and HMI. PROFIBUS is an open, digital communication system with a wide range of applications, particularly in the fields of factory and process automation. PROFIBUS is suitable for both fast, time-critical applications and complex communication tasks. The PROFIBUS logo is a registered trademark.
PROFIBUS DP	Acronym for "PROFIBUS for Decentralized Peripherals". Specification of an open fieldbus system with the following characteristics: • polling Master-Slave-system (cyclic communications, MS0); • flying Masters with robin round token passing coordination (MM); • connection based (MS1) and connectionless (MS2, MS3) acyclic communication between Masters and

	Slaves. Options (e.g.): • Data exchange broadcast (DXB), i.e. Slave to Slaves communication; • isochronous mode of Slaves; • clock synchronization; • redundancy. PROFIBUS DP is standardized within IEC 61158 and IEC 61784, communication profile families 3/1 and 3/2. The term "PROFIBUS DP" is also a synonym for the RS-485 based deployments within factory automation.
PROFIdrive	Communication technology especially adopted to the requirements of position and speed controlled drive applications (e.g. speed synchronized axis). Within the scope of PROFIBUS, "PROFIdrive" is used for the application of the PROFIBUS DP protocol (DP-V2) in motion control automation together with the corresponding application profiles ("PROFIdrive - Profile for variable speed drives" and "PROFIdrive - Profile drive technology") for the transmission technology RS-485.
Profile	Besides other things profiles in common define agreements on how to use communication means in a standardized manner. Within the context of fieldbusses several types of profiles are known: • communication profiles (e.g. IEC 61784); • physical profiles (MBP-IS, RS-485); • application profiles (see PROFIBUS TC3); • device profiles (e.g. robots); • branch profiles (e.g. extruder).
Profile Ident Number	Identifier of a particular profile definition. The profile ident number is taken from the pool of ident numbers handled by the PNO. It plays a role within the following scenarios. (1) In cases where the device of a manufacturer A should be replaceable by an equivalent device, the PNO is assigning number ranges to dedicated device types (Profile specific IDs) in combination with certain "Profile GSDs". Profiles using this methodology are e.g. "PA Devices" and "PROFIdrive". (2) Usually these Slave devices are designed to communicate with a Master Class 2 application (e.g. profile application or profile DTM). In order to ensure a Master application is communicating with an appropriate Slave, it is sending a profile specific ID during the establishment of the connection (MS2 Initiate Service). The Slave may answer with the same profile specific ID (if it is supporting this profile), with another ID (if it is supporting another profile) or with "0000h" if it is not supporting any profile. (3) I&M functions: Besides its basic I&M information devices - following a certain profile - are enabled to provide more detailed profile specific information.

Protocol Data Unit (PDU)	A packet of data passed across a network via telegrams. The term implies a specific layer of the OSI seven layer model and a specific protocol. Each layer has its own PDU that is extended subsequently from the physical layer up to the application layer: • Physical layer protocol data unit (PhPDU); • Data link protocol data unit (DLPDU); • Application protocol data unit (APDU).
Slave Parametrization	For a DP Slave several levels of parametrization exist. (1) The parameters on the DP communication level can be defined via a GSD file and comprise features such as baud rates, timing constraints, identification, options, transferable data structures, publisher subscriber links, etc. This level supports parametrization of simple modular Slaves and also special common additional communication layers such as PROFIsafe. This parametrization is fixed for a given operational life cycle after start-up. (2) More complex devices may be parametrized via EDD and/or FDT/DTM technology via an acyclic communication service (MS2). (3) For parameter changes at run-time such as batch operation (recipes) or motion control, special "parameter channels" associated with the cyclic data structures may be added or the MS1 services together with proxy function blocks may be used.
State Machine (DP)	An abstract machine consisting of a set of states (including the initial state), a set of input events, a set of output events, and a state transition function. A state machine describes the behaviour of a field device how to react in different situations. The state machine for DP Slaves comprises the following states/actions: - Power_On_Reset --> Set Slave address --> if successful, a transition follows to: - Wait_Prm --> Parametrization, diagnosis (optional) --> if successful, a transition follows to: - Wait_Cfg --> Configuration, diagnosis (optional) --> if successful, a transition follows to: - Data_Exch --> Normal operation: cyclic data exchange. On top of this basic communication layer state machine application profiles are defining their own additional state machines, e.g. PA devices, PROFIdrive, PROFIsafe, Ident Systems, Weighing and Dosage Systems. State machines are best modelled and documented with the help of the "Unified Modelling Language (UML)".
Station Address	Within PROFIBUS DP the address of a communication participant (Master or Slave). The permitted range is 0 to 127, with: - 126 intended to be used for the "soft" addressing of Slave devices; - 127 intended to be used for broadcast messages to all the

	Slaves.
Topology	In a communication network, the pattern of interconnection between network nodes; e.g. bus, ring, star configuration.
Transmission Rate (Baud rate)	The signalling rate of a digital communication line. It is the switching speed, or number of transitions (voltage or frequency changes) that are made per second. Within PROFIBUS DP the possible transmission rates depend on the MAU (Medium Attachment Unit) in use.
Watchdog Control	IEC 61158-6: This timer is part of the DP layer within a Slave. It is restarted by received requests from the bus Master and will set the outputs of a Slave to a fail-safe state after the expiration of the timer.
Watchdog Time (Twd)	IEC 61158-5: The watchdog timer is part of the DP layer within a Slave. The watchdog time is set by parametrization at run-up and consists of a watchdog time base (1 or 10 ms) and 2 factors. A selection can be made during configuration via the GSD file of a Slave. This is a Slave parameter. See "Watchdog control".

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 "Electrical connection" section;
- in compliance with 2014/30/UE norm on electromagnetic compatibility, following precautions must be taken:
  - before handling and installing the equipment, discharge electrical charge from your body and tools which may come in touch with the device;
  - power supply must be stabilized without noise; install EMC filters on device power supply if needed;
  - always use shielded cables (twisted pair cables whenever possible);
  - avoid cables runs longer than necessary;
  - avoid running the signal cable near high voltage power cables;
  - mount the device as far as possible from any capacitive or inductive noise source; shield the device from noise source if needed;
  - to guarantee a correct working of the device, avoid using strong magnets on or near by the unit;
  - minimize noise by connecting the shield and/or the connector housing and/or the frame to ground. Make sure that ground is not affected by

noise. The connection point to ground can be situated both on the device side and on user's side. The best solution to minimize the interference must be carried out by the user. 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 "Mechanical installation" section;
- 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

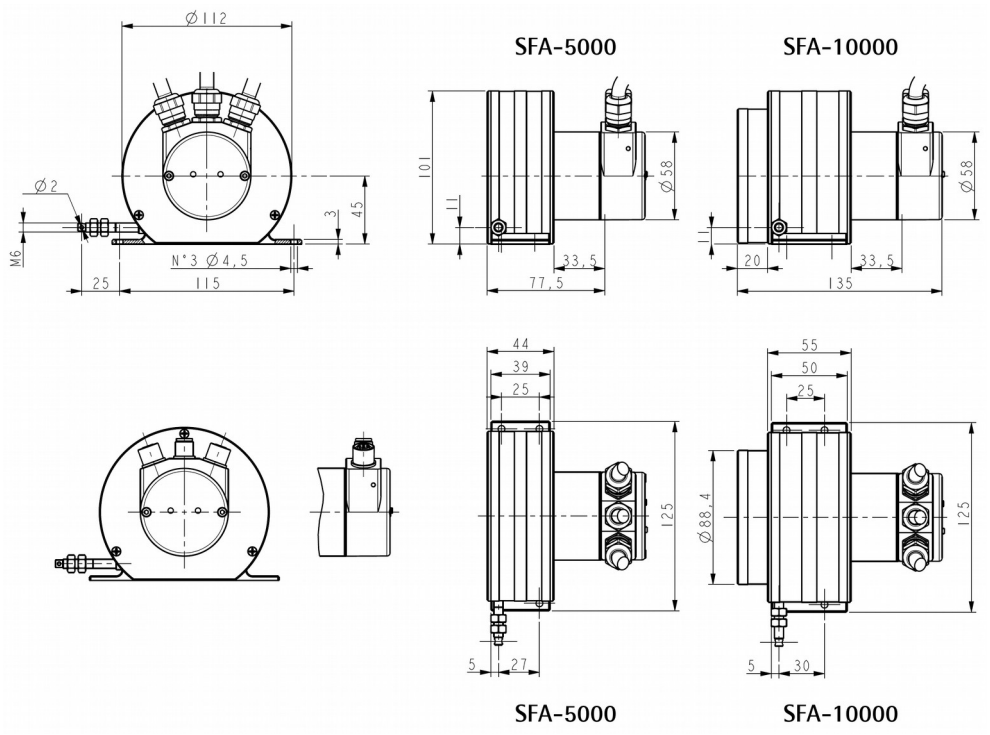
Device can be identified through the **order code** and the **serial number** printed on the label applied to its body. Information is listed in the delivery document too. Please always quote the order code and the serial number when reaching Lika Electronic. For any information on the technical characteristics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

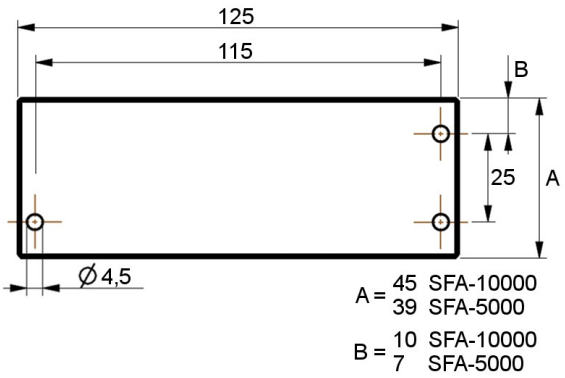
Warning: encoders having order code ending with "/Sxxx" may have mechanical and electrical characteristics different from standard and be supplied with additional documentation for special connections (Technical Info).

3 Mechanical installation

WARNING
Installation has to be carried out by qualified personnel only, with power supply disconnected and mechanical parts compulsorily in stop.

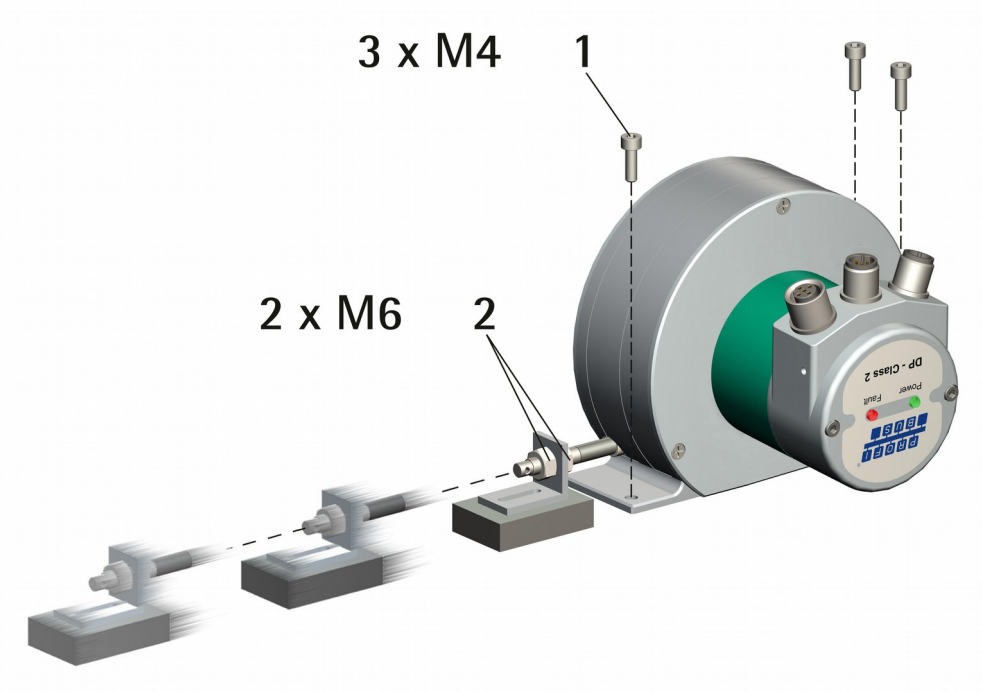
3.1 Overall dimensions





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 transport safety wire that pins the end of the measuring wire;
- 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**-**PB**-**8192**-PG using the physical resolution (**Scaling function control** = 0)
Stroke per turn of the drum = 200 mm (7.874")
Physical resolution per turn = 13 bits = 8,192 cpr
Max. number of physical revolutions = 4,096
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**-**PB**-**8192**-M12 using a custom resolution (**Scaling function control** = 1)
Stroke per turn of the drum = 200 mm (7.874")
Physical resolution per turn = 13 bits = 8,192 cpr
Max. number of physical revolutions = 4,096
Custom resolution per turn = **Counts per revolution** = 2,000 cpr (example)
Total resolution = 8,192,000 information (example)

$$\text{Custom number of encoder revolutions} = \frac{\text{Total resolution}}{\text{Counts per revolution}} = 4{,}096$$

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 connection

WARNING
Electrical connection has to be carried out by qualified personnel only, with power supply disconnected and mechanical parts compulsorily in stop.

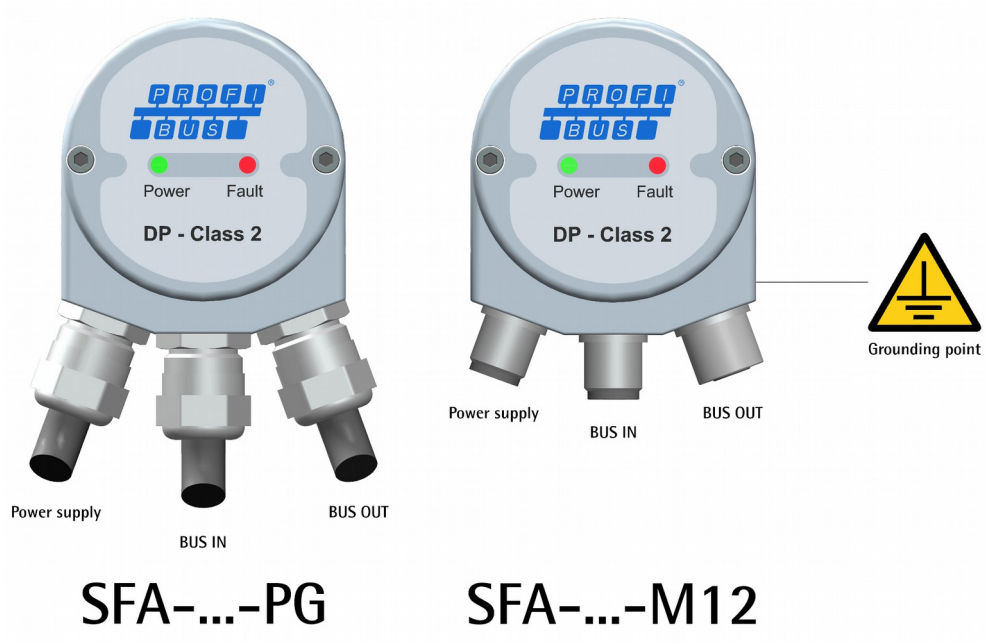


Figure 1

4.1 Encoder connection cap (Figure 1 and Figure 2)

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 connection cap version) as well as the dip-switches meant to set the node ID and activate the termination resistance (PG and M12 connection cap versions) 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** (Figure 2). Please be careful with 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 back flange and the connection cap are at the same potential before replacing the connection cap!

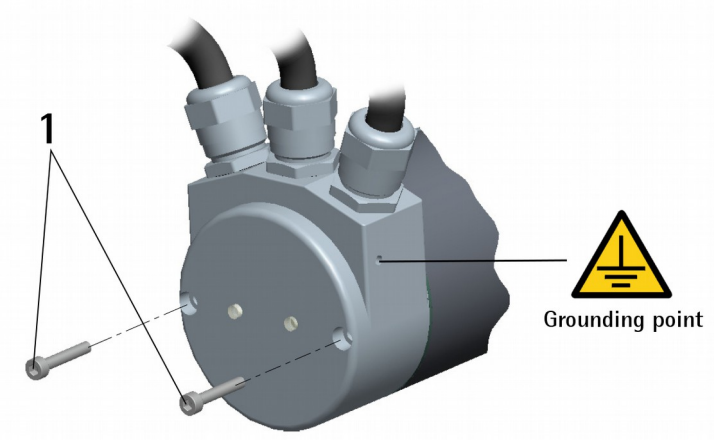


Figure 2

4.2 Profibus encoder with PGs: PG version (Figure 2 and Figure 3)

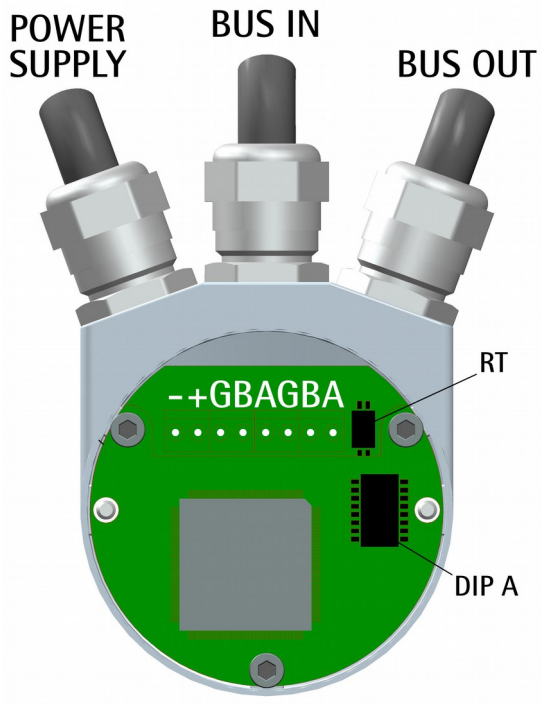


Figure 3

The draw-wire encoder is fitted with three PG9 cable glands for Power Supply, BUS IN and BUS OUT connections. The bus cables can be connected directly to the terminal connectors in front of each cable gland. We recommend Profibus certified 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	Profibus GND [1]
B	Profibus B (Red)
A	Profibus A (Green)
PG	Shield [2]

[1] Profibus GND is the 0V reference of Profibus signals, it is not connected to 0Vdc supply voltage.

[2] Connect the cable shield to cable gland.

4.3 Profibus encoder with M12 connectors: M12 version (Figure 2 and Figure 4)

The draw-wire encoder is fitted with three M12 connectors with pin-out in compliance with the Profibus standard. Therefore you can use standard Profibus cables commercially available.

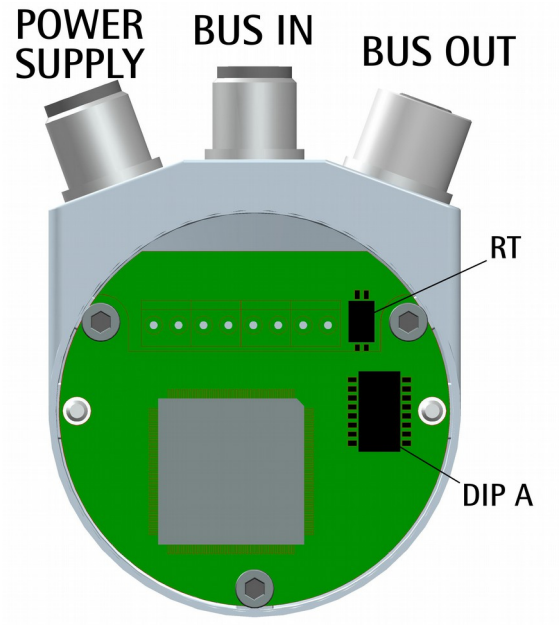


Figure 4

Power supply
M12 connector
A coding
(frontal side)

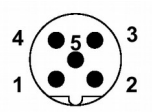
male

Pin	Function
1	+10Vdc +30Vdc power supply voltage
2	n.c.
3	0Vdc power supply voltage
4 [1]	Shield
Case	

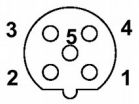
n.c. = not connected

[1] Shield is also connected to pin 4 to allow the connection of the shield even if the plug connector has a plastic case.

Profibus signals
M12 connector
B coding
(frontal side)



male
(BUS IN)



female
(BUS OUT)

Pin	Function
1	n.c.
2	Profibus A (Green)
3	n.c.
4	Profibus B (Red)
5	n.c.
Case	Shield

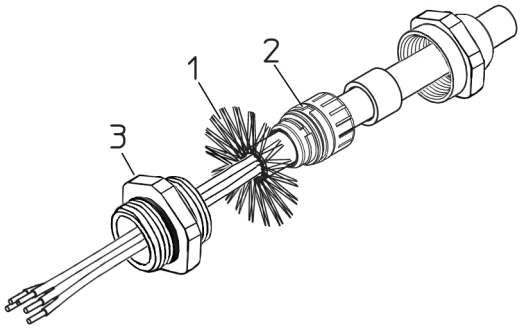
n.c. = not connected

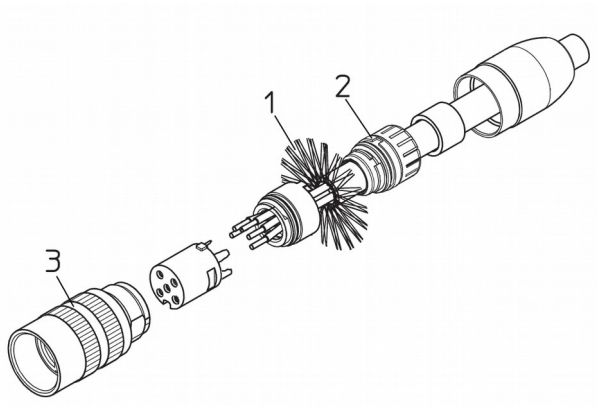
4.4 Ground connection (Figure 2)

Minimize noise by connecting the shield and/or the connector housing and/or the enclosure 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. You are advised to provide the ground connection as close as possible to the unit. We suggest using the ground point provided in the connection cap (see Figure 2, use one TCEI M3 x 6 cylindrical head screw with two tooth lock washers).

4.5 Shield connection

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 Diagnostic LEDs (Figure 1)

Two LEDs located in the outer side of the encoder are designed to show the operating or fault status of the Profibus-DP interface.

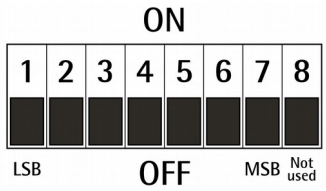
Fault (red)	Power (green)	Event
OFF	OFF	No power supply or hardware fault
OFF	ON	Correct operation (correct communication)
OFF	Flashing	Red Zone, see the "6.9 "Red Zone"" section on page 66
ON	Flashing	Configuration parameters not valid
ON	OFF	Transmission time-out error
Flashing	ON	Bus communication failure
Flashing	Flashing	Flash memory error

4.7 Node Address: DIP A (Figure 3 and Figure 4)

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

The node number must be set via hardware using the DIP A dip-switches. It can be set also via software by means of the SAP55 service (see here below).
Allowed addresses are from 0 to 125. The default value is 1. Value 126 is reserved to enable the use of the internal address and the SAP55 service.

DIP A:



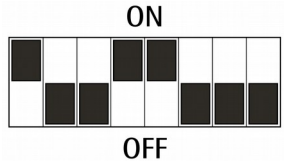
Turn the power supply off and set the node address in binary value; consider that: ON=1, OFF=0

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

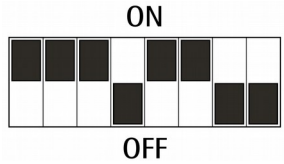
Set the node address = 25:
25_{10} = 0001 1001$_2$ (binary value)

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
This device is designed to allow the node address setting also via software by means of the Service Access Point SAP55 Set_Slave_Address. For any information please refer to the "5.4 Setting the node address via BUS (SAP55 service)" section on page 40 and to the "6.8 Set_Slave_Address command (SAP55 service)" section on page 64.

NOTE
After having set the device address, please check the bus termination switch position (see the "4.9 RT Bus termination (Figure 3 and Figure 4)" section on page 32).

4.8 Baud rate

The baud rate is set by the Master via software at configuration of the node (Slave).
This device supports the following baud rates (they are listed in the .GSD file too):
9.6 kbit/s, 19.2 kbit/s, 93.75 kbit/s, 187.5 kbit/s, 500 kbit/s, 1.5 Mbit/s, 3 Mbit/s, 6 Mbit/s, 12 Mbit/s.

The following table shows the maximum transmission rates in relation to permissible line length:

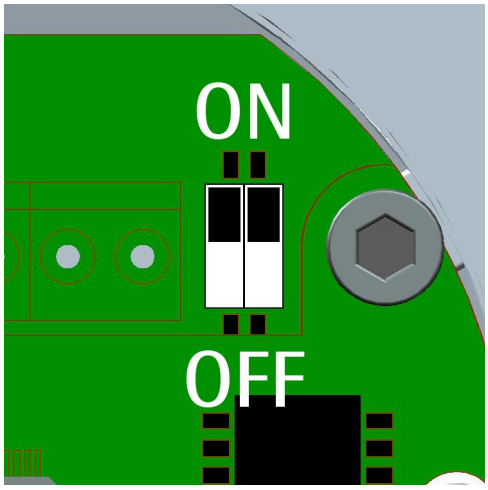
Baud rate [Kbit/s]	9.6	19.2	93.75	187.5	500	1500	12000
Max. cable length	1200 m 4000 ft	1200 m 4000 ft	1200 m 4000 ft	1000 m 3300 ft	400 m 1300 ft	200 m 660 ft	100 m 330 ft

4.9 RT Bus termination (Figure 3 and Figure 4)

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

A bus termination resistance is provided inside the encoder enclosure and has to 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



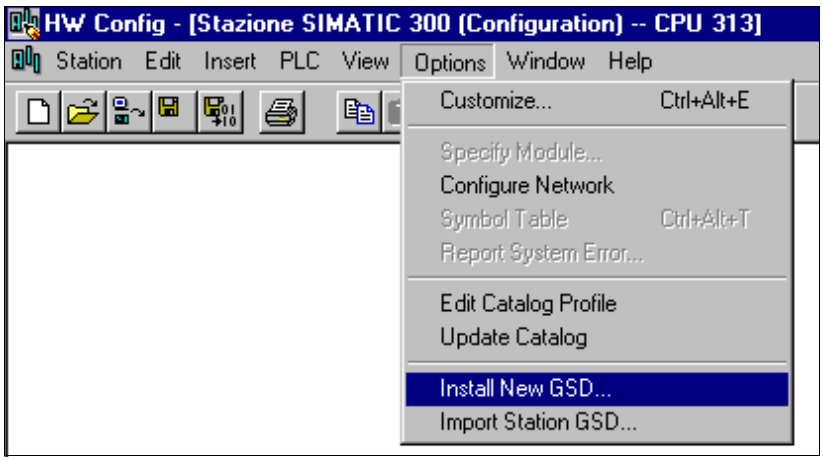
5 Quick reference

5.1 STEP7 configuration

5.1.1 Importing the GSD file

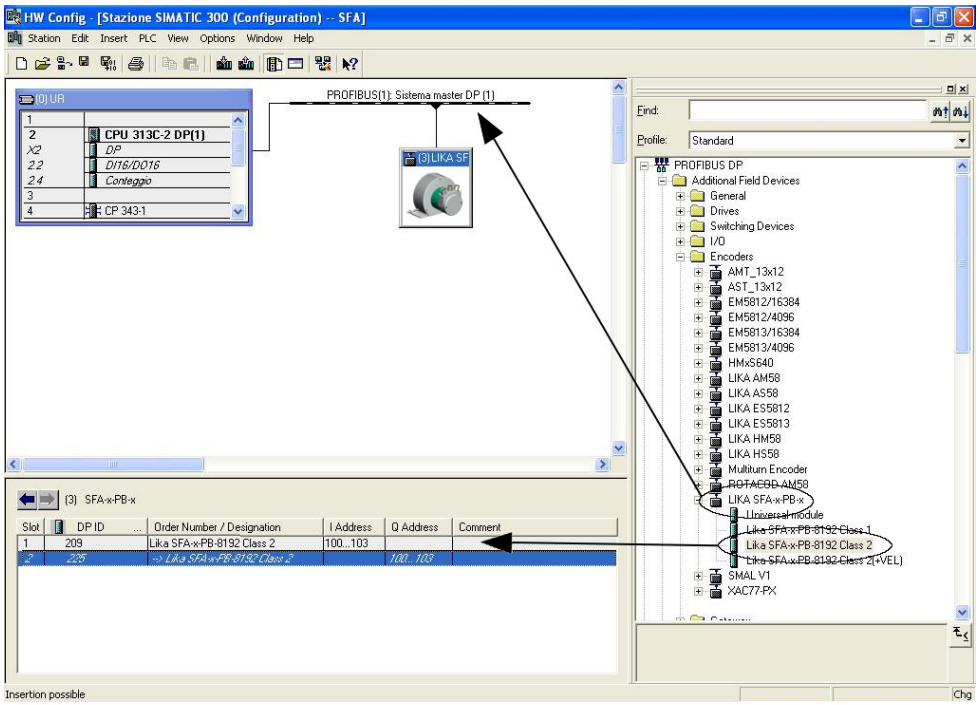
Profibus draw-wire encoders are supplied with their own GSD file **SFA25_Vx.GSD**, Vx is intended to indicate the file version. To download the file enter **www.lika.biz > ROTARY ENCODERS > DRAW-WIRE UNITS > ABSOLUTE**.
The GSD file is available in both English version (**SFA25_Vx.GSE**) and Italian version (**SFA25_Vx.GSI**).
The GSD file has to be installed in the Profibus Master device.

In the menu bar of the **HW Config** window, press **Options** and then the **Install New GSD...** command.
Select the correct GSD file in the installation window and install it.



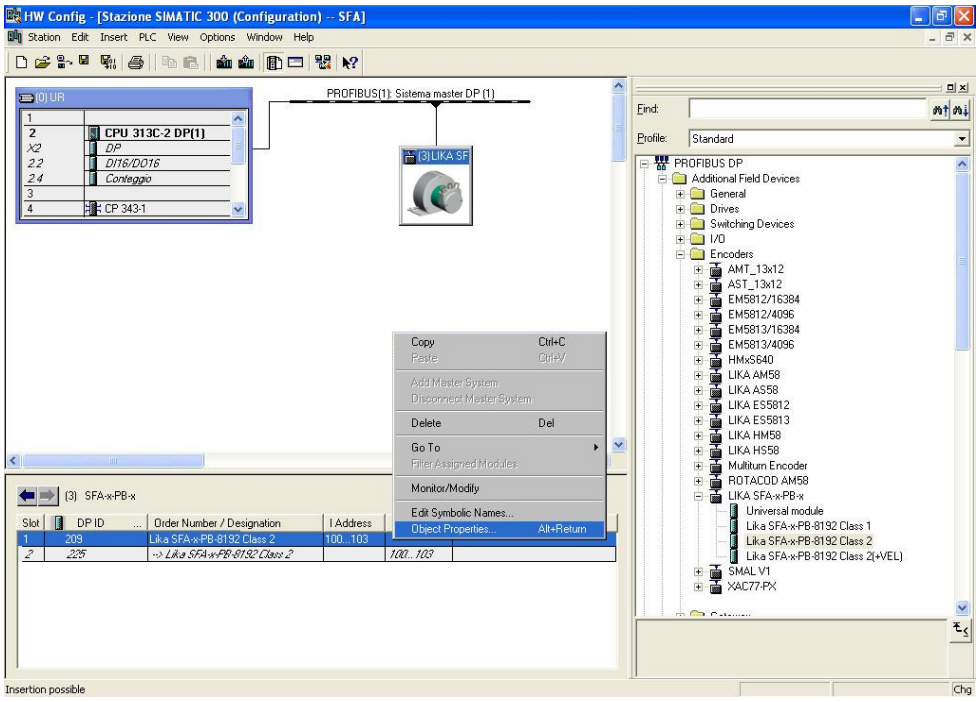
5.1.2 Adding a node to the project

In the side pane of the **HW Config** window, open the directory tree and select **Catalog\PROFIBUS_DP\Additional Field Devices\Encoders**; drag the "LIKA SFA-x-PB-x" module to the main window and drop it on "PROFIBUS(1): DP master system (1)".
Then drag the desired submodule (Lika SFA-x-PB-8192 Class 1, Lika SFA-x-PB-8192 Class 2 or Lika SFA-x-PB-8192 Class 2(+VEL)) to the variables table in the bottom; in this way you set the class of the device (for further details on the available classes see the "6.2 Classes of the Device profile" section on page 43).

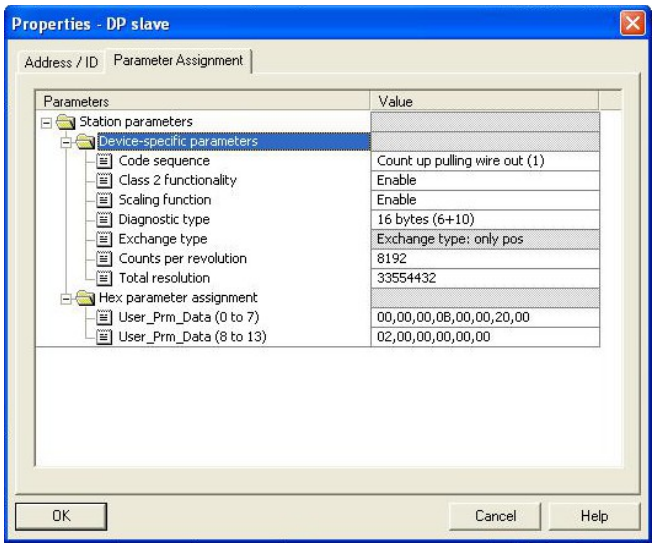


5.1.3 Encoder configuration parameters

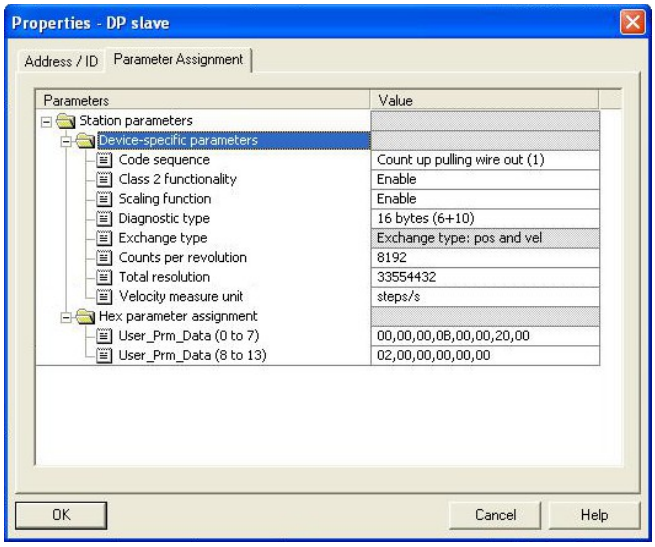
To enter the Encoder configuration parameters window, select the device in the submodule page in the bottom of the **HW Config** window and right-click to open the menu; then choose the **Object Properties...** command.



The **Properties – DP slave** window will appear; in the **Parameter Assignment** page the list of all encoder parameters is available.
For any information on using and setting each parameter refer to the "6.4 DDLM_Set_Prm" section on page 46.



Class 2 example



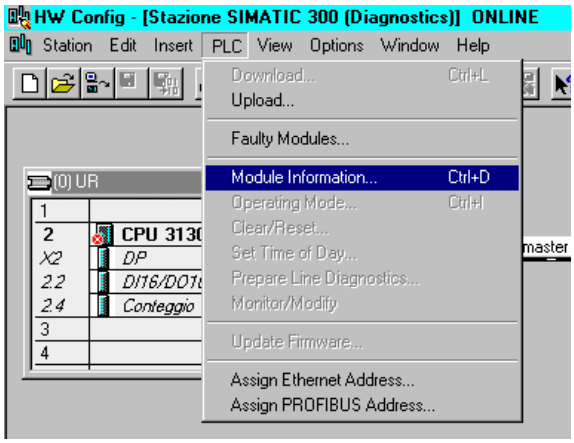
Class 2(+VEL) example

After having set new parameter values, press the **OK** button to close the **Properties – DP slave** window and then press the **Download** button (see the icon on the left) in the toolbar of the **HW Config** window to download the set parameters.

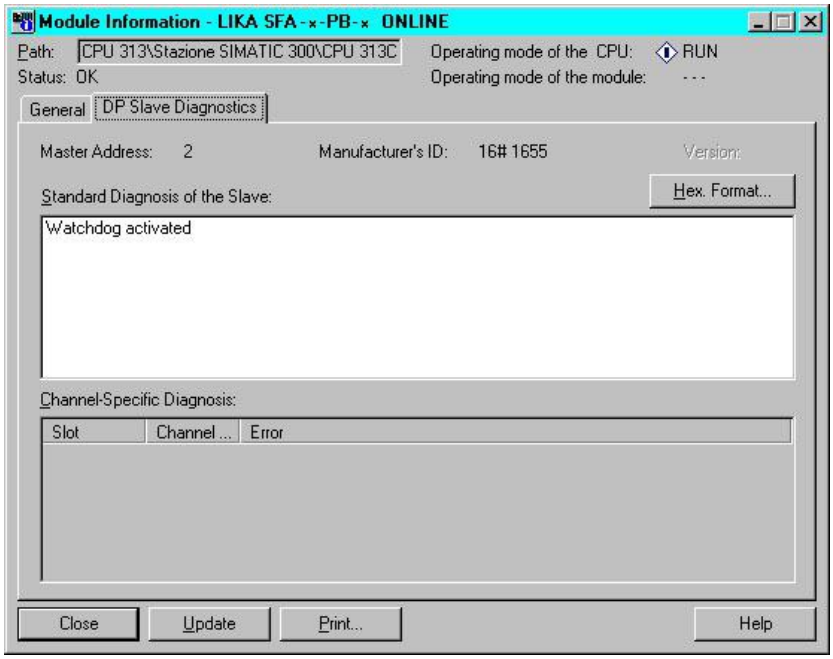
5.2 Reading diagnostic information

The diagnostic information message can be set to either 16 or 63 bytes, see the **Diagnostic type** parameter.

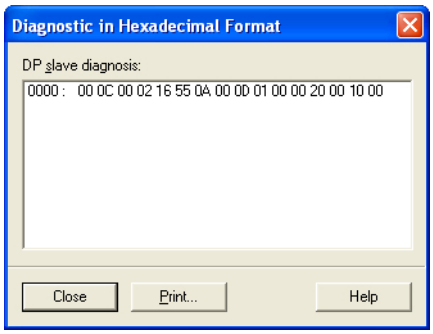
Before entering the diagnostic page, it is necessary to connect to the unit (enter online status). To do this, select **Station\Open online** in the **HW Config** window or press the **Online<->Offline** button (see the icon on the left). Then select **PLC\Module information...** to enter the **Module information** window. Finally open the **DP Slave Diagnostics** page.



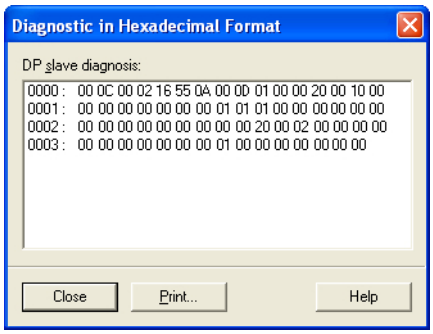
Press the **Hex. Format...** button to display the diagnostic information:



16-byte Diagnostics:



63-byte Diagnostics:



NOTE

Should the 63-byte diagnostics not work properly using STEP7 software we suggest setting the 16-byte diagnostics.

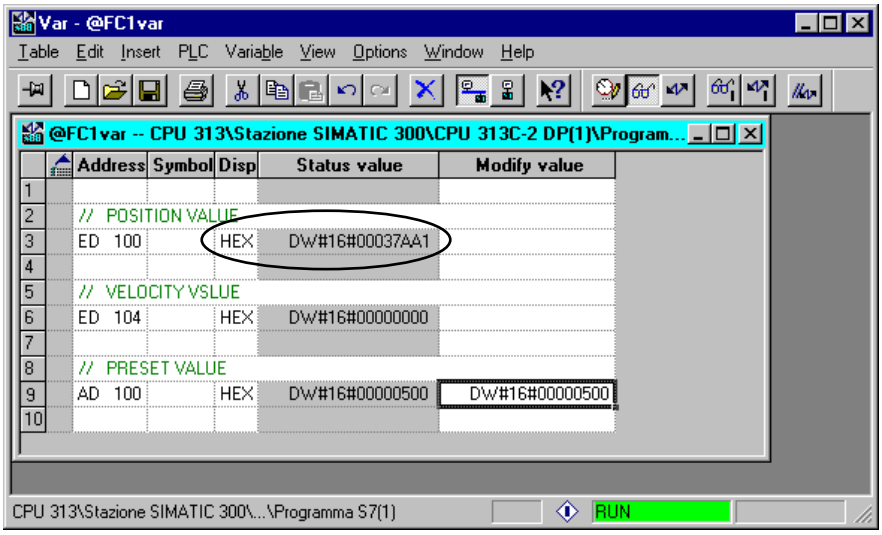
If the diagnostic information is not used, we recommend the 16-byte diagnostics to be set (see the "5.1.3 Encoder configuration parameters" section on page 35).

See the "6.7 DDLM_Slave_Diag" section on page 62 for a complete list and meaning of each diagnostic byte.

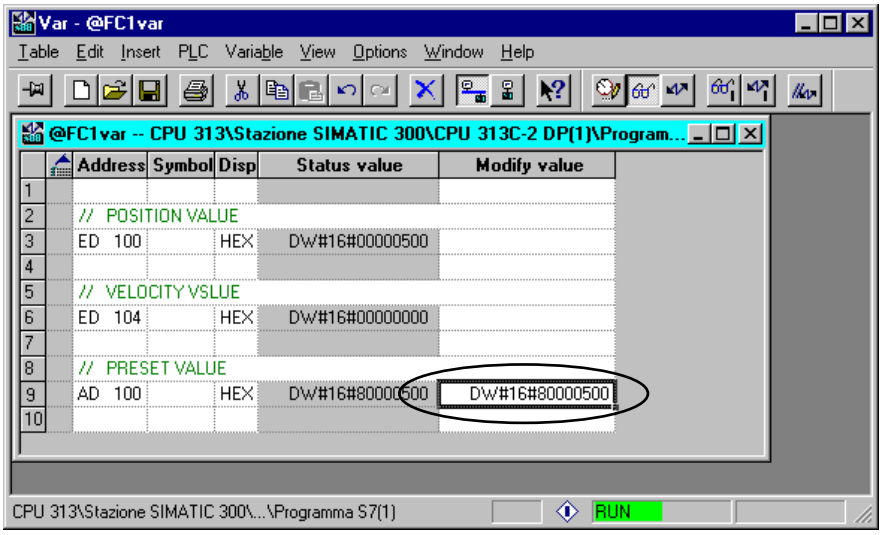
5.3 Setting the Preset value

EXAMPLE

The encoder having device address 1 transmits the **Position value** to the Master.
The **Position value** is loaded into variables ED 100...103 (4 bytes).
The **Speed value** is loaded into variables ED 104...107 (4 bytes).
The **Preset value** is sent to the encoder using the variables AD 100...103 (4 bytes).



The current position of the encoder is 0003 7AA1hex.
To set the **Preset value** = 0000 0500hex, set the bit 31 of the variable AD 100 = "1" (8000 0500hex).



Finally press the **Command variables** button in the Toolbar (see the icon here on the right).

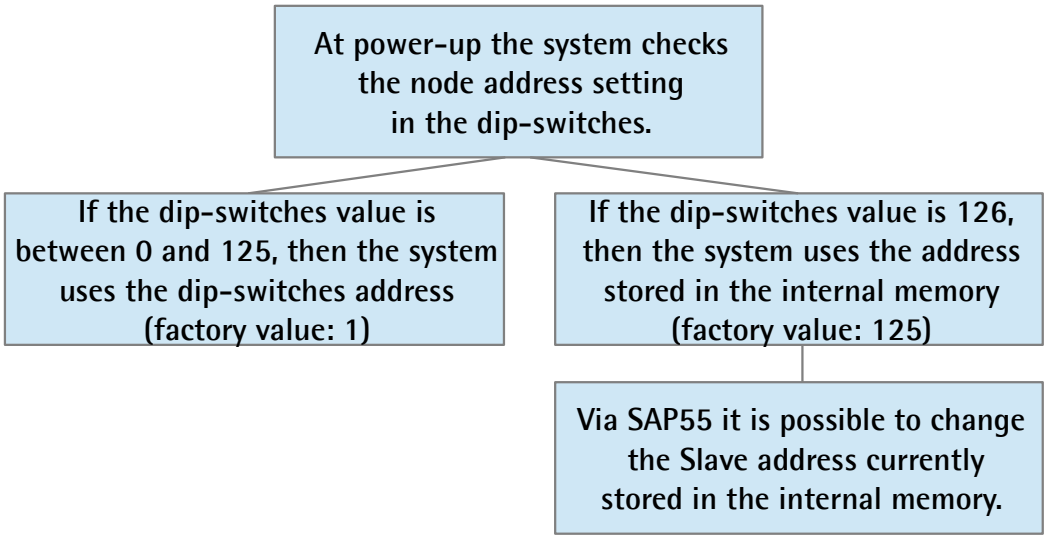
Now the position of the encoder is 0000 0500hex.
To close the "Preset" procedure set the bit 31 of the variable 100 back to "0" and then press the **Command variables** button again.

NOTE
It may occur that data variables having index higher than 127 or data greater than 4 bytes are not treated properly in STEP7 software. Should this happen, we recommend "MD" reference operators (pointers) for encoder position, speed and Preset to be used.

5.4 Setting the node address via BUS (SAP55 service)

WARNING
SAP55 service can only be accomplished by a **Class 2 DP Master (DPM2)**. Class 1 Masters (DPM1) cannot accomplish the SAP55 service.

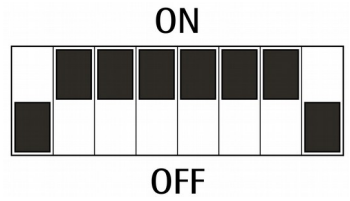
Lika SFA PB draw-wire encoders are designed to allow the Slave address setting either via hardware switches (see the "4.7 Node Address: DIP A (Figure 3 and Figure 4)" section on page 30) or via a bus command by means of the SAP55 service.
The Service Access Point SAP55 Set_Slave_Address allows to change the address stored in the internal memory of a Slave device. SAP55 service is part of the Profibus specifications and allows to change the internal memory address in the event that the device does not provide switches for setting its address or they are not usable. The address stored in the internal memory of the Slave is used only if the hardware switches are set to "126". The internal memory address stored at factory by Lika Electronic is "125". On the contrary, if the hardware switches are set to any value between 0 and 125, then the external switches will determine the Slave address.



WARNING

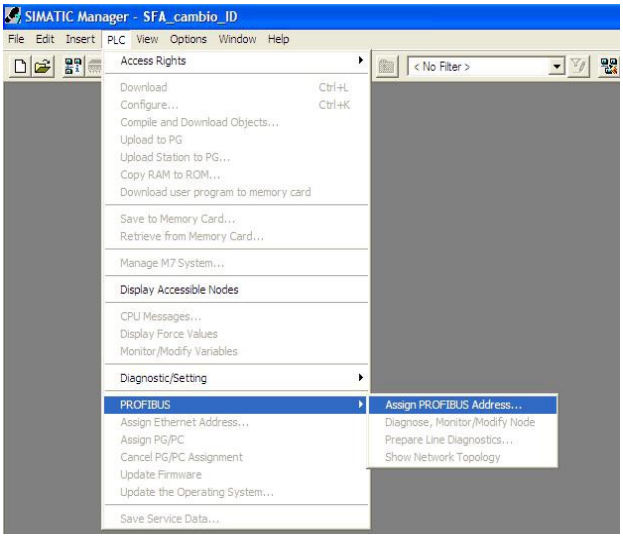
Please note that the node address set via hardware switches and the node address stored in the internal memory are independent from each other! The node address stored in the internal memory can be changed only by means of the SAP55 service and the Set_Slave_Address command.

As previously stated, SAP55 service and the use of the node address stored in the internal memory are allowed only if the DIP A hardware switches are set to the value **126** ($0111\ 1110_2$):

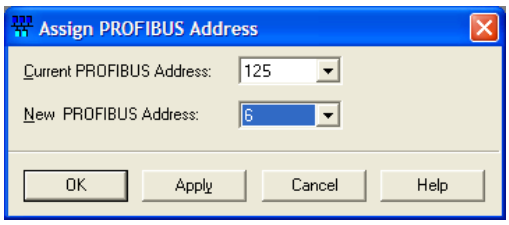


In this way you set that the Slave address will be read from the internal memory. As stated, the value stored at factory by Lika Electronic is "125".

To change the node address stored in the internal memory, open the **SIMATIC Manager** window and press the **Assign PROFIBUS Address...** command in the **PLC\PROFIBUS** menu. The **Assign PROFIBUS Address** window will appear on the screen.



In the **Assign PROFIBUS Address** window select the node address currently stored in the internal memory (factory setting = 125) in the **Current PROFIBUS Address** combo box and then select the new address you want to set in the **New PROFIBUS Address** combo box (for instance: "6"). Press the **Apply** button and then the **OK** button to confirm.



Please refer also to the "6.8 Set_Slave_Address command (SAP55 service)" section on page 64.

6 Profibus® interface

Lika SFA draw-wire encoders are Slave devices and comply with the "Profibus-DP Profile for Encoders"; they can be set as Class 1, Class 2 or Class 2 (+VEL) devices (see the "6.2 Classes of the Device profile" section on page 43).
For any omitted information refer to the official Profibus website **www.profibus.com**.

6.1 GSD file

Profibus draw-wire encoders are supplied with their own GSD file **SFA25_Vx.GSD**, Vx is intended to indicate the file version. To download the file enter **www.lika.biz > ROTARY ENCODERS > DRAW-WIRE UNITS > ABSOLUTE**.
The GSD file is available in both English version (**SFA25_Vx.GSE**) and Italian version (**SFA25_Vx.GSI**).
The GSD file has to be installed in the Profibus Master device.

6.2 Classes of the Device profile

Encoder class must be set when you configure the device.

Mandatory **Class 1** provides the basic functions of the device and can be used for:

- sending the position value (see **Position value** parameter);
- changing the counting direction (see **Code sequence** parameter);
- setting the preset value (see **Preset value** parameter);
- acquiring reduced diagnostic information (see **Diagnostic type** parameter = "16 bytes fixed (6+10)").

Class 2 provides all the Class 1 functions and additional advanced functions such as:

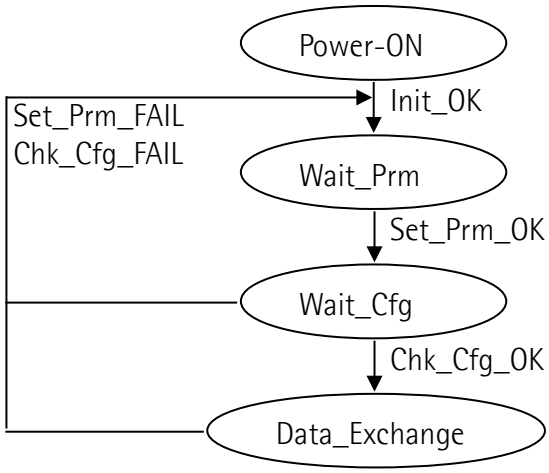
- scaling function (see **Scaling function control**, **Counts per revolution** and **Total resolution** parameters);
- extended diagnostic information (see **Diagnostic type** parameter = "16 bytes (6+10)" or "63 bytes (6+57)").

Class 2 (+VEL) provides all the Class 1 and Class 2 functions and additional velocity-related functions:

- transmission of the velocity value (see **Position and velocity values** parameter);
- setting of the velocity measuring unit (see **Velocity measure unit** parameter).

6.3 Modes of operation

Profibus-DP devices allow operation using different communication modes (see the Figure below):



NOTE
All the parameters -except for the **Preset value**- are transmitted in **Set_Prm** mode.
Preset value is transmitted only in **Data_Exchange** mode.

Types of communication

Transmission of data between the Master and the Slave is carried out using the following types of messages:

- **DDLM_Set_Prm:**
  it is used for configuring the Slave. This communication mode is active immediately after the power is turned ON and used to send parameters from the Master to the Slave (see the "6.4 DDLM_Set_Prm" section).

- **DDLM_Chk_Cfg:**
  it sets the number of bytes used for data transmission in **Data_Exchange** mode (see the "6.5 DDLM_Chk_Cfg" section).

- **DDLM_Data_Exchange:**
  it is used as "standard operation mode".
  Used by the Master to send the **Preset value**; used by the Slave to transmit the position and velocity values (see the "6.6 DDLM_Data_Exchange" section).

- **DDLM_Slave_Diag:**
  it is used when the power is turned ON and whenever the Master needs diagnostic information from the Slave device (see the "6.7 DDLM_Slave_Diag" section).

- **Set_Slave_Address:**
  It is used to set a new node number via BUS (service SAP55, see the "6.8 Set_Slave_Address command (SAP55 service)" section).

6.4 DDLM_Set_Prm

When the system is turned ON, configuration data set by the operator is sent to the absolute encoder by the controller. Parameters transmission depends on the configuration chosen by the operator. Customarily data is sent automatically while data setting is carried out through a user's interface available in the controller's software (for instance, STEP7, see the "5.1 STEP7 configuration" section on page 33).
However sometimes it is necessary to set some bits and bytes according to the working specifications you want to set.
Data transmission is carried out in compliance with the values set for the encoder profile and shown in the following tables.

DDLM_Set_Prm with Class 1:

Byte	Parameter	
0 ... 9	Reserved for PROFIBUS network	
10	Operating parameters	
	bit 0	Code sequence
	bit 1	Class 2 functionality
	bits 2 ... 5	Reserved
	bit 6	Diagnostic type
	bit 7	Exchange type
11 ... 20	Reserved	

DDLM_Set_Prm with Class 2:

Byte	Parameter	
0 ... 9	Reserved for PROFIBUS network	
10	Operating parameters	
	bit 0	Code sequence
	bit 1	Class 2 functionality
	bit 2	Reserved
	bit 3	Scaling function control
	bits 4 and 5	Reserved
	bit 6	Diagnostic type
	bit 7	Exchange type
11 ... 14	Counts per revolution	
15 ... 18	Total resolution	
19 and 20	Reserved	

DDLM_Set_Prm with Class 2 (+VEL):

Byte	Parameter	
0 ... 9	Reserved for PROFIBUS network	
10	Operating parameters	
	bit 0	Code sequence
	bit 1	Class 2 functionality
	bit 2	Reserved
	bit 3	Scaling function control
	bits 4 and 5	Reserved
	bit 6	Diagnostic type
	bit 7	Exchange type
11 ... 14	Counts per revolution	
15 ... 18	Total resolution	
19	Velocity measure unit	
20	Reserved	

6.4.1 Byte 10 - Operating parameters

Bit	Function	bit = 0	bit = 1
0	Code sequence	Count up rewinding the wire	**Count up pulling wire out**
1	Class 2 functionality	disabled	**enabled**
2	Reserved		
3	Scaling function control	disabled	**enabled**
4, 5	Reserved		
6	Diagnostic type	**reduced 16 bytes (6+10)**	extended 63 bytes (6+57)
7	Exchange type	only pos	pos + vel

Default values are highlighted in bold.

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 (min. = 0, max. = 1)

WARNING
Every time you change the Code sequence, then you are required to set a new preset value (see the Preset value parameter).

Class 2 functionality

This is only available when the encoder Class 2 or the encoder Class 2 (+VEL) are installed (see the SFA-x-PB-8192 Class 2 or SFA-x-PB-8192 Class 2 (+VEL) submodules).
Two device classes are defined in the encoder profile, one mandatory class (Class 1) and one class with optional functions (Class 2). This encoder implements functions of both Class 1 and Class 2 for encoders. For any information on the available encoder classes see the "6.2 Classes of the Device profile" section on page 43.
0 = Disabled = Encoder Class 1 is set.
1 = Enabled = Encoder Class 2 or Encoder Class 2 (+VEL) is set.
Default = 1 (min. = 0, max. = 1)

Scaling function control

This is only available when the encoder Class 2 or the encoder Class 2 (+VEL) are installed (see the SFA-x-PB-8192 Class 2 or SFA-x-PB-8192 Class 2 (+VEL) submodules).
When this option is disabled (bit 3 **Scaling function control** = 0 = DISABLED), the device uses the hardware resolution, i.e. the hardware counts per revolution and the hardware number of revolutions to arrange the absolute position information, see the encoder data on the label applied to the device (see also on page 22).
On the contrary, when it is enabled (bit 3 **Scaling function control** = 1 = ENABLED), the device uses the custom resolution transmitted through the bytes from 11 to 18 to calculate the position information (see the **Counts per revolution** and the **Total resolution** parameters).
For a correct use of this function see the "6.4.2 Bytes 11 ... 14" and "6.4.3 Bytes 15 ... 18" sections.
Default = 1 (min. = 0, max. = 1)

WARNING
When you enable the scaling function (**Scaling function control** = 1), please enter scaled values next to the **Counts per revolution** and **Total resolution** parameters that are consistent with the physical values. In the case of inconsistent values, the system does not go online and visually warns about the wrong parametrization and fault condition by means of the diagnostic LEDs.

WARNING
Every time you enable the scaling function and / or change the scaled values (see the **Counts per revolution** and **Total resolution** parameters), then you are required to set a new preset value (see the **Preset value** parameter).

WARNING
You can activate the custom values set next to the **Counts per revolution** and **Total resolution** parameters only if **Class 2 functionality** = ENABLED.
If **Scaling function control** = ENABLED the set custom resolution values are enabled and used by the encoder; on the contrary, if **Scaling function control** = DISABLED you are allowed to set new resolution values, however they are not enabled even if sent to the encoder: the encoder still goes on using the physical values, NOT the new entered values, until you enable the **Scaling function control**.

Diagnostic type

0 = Reduced = 16-byte diagnostic information
1 = Extended = 63-byte diagnostic information
Encoder Class 1 only provides 16-byte reduced diagnostics.
Encoder Class 2 and Encoder Class 2 (+VEL) can provide either 16-byte reduced diagnostics or 63-byte extended diagnostics, according to this setting.
The meaning of each diagnostic byte is detailed in the "6.7 DDLM_Slave_Diag" section on page 62.
Default = 0 (min. = 0, max. = 0) for Class 1
Default = 0 (min. = 0, max. = 1) for Class 2 and Class 2 (+VEL)

Exchange type

0 = Pos = the device only transmits the position value (Class 1 and Class 2).
1 = Pos + vel = the device transmits both position and velocity values (Class 2 (+VEL)).
Default = 0 (min. = 0, max. = 0) for Class 1 and Class 2
Default = 1 (min. = 1, max. = 1) for Class 2 (+VEL)

6.4.2 Bytes 11 ... 14

Counts per revolution

Byte	11	12	13	14
Bit	31-24	23-16	15-8	7-0
Data	2^{31} to 2^{24}	2^{23} to 2^{16}	2^{15} to 2^{8}	2^{7} to 2^{0}
	MSbyte	...	...	LSbyte

WARNING
This is only available when the encoder Class 2 or the encoder Class 2 (+VEL) are installed (see the SFA-x-PB-8192 Class 2 or SFA-x-PB-8192 Class 2 (+VEL) submodules).
You can activate a new value next to the **Counts per revolution** parameter only if **Class 2 functionality** = ENABLED. If **Scaling function control** = ENABLED the set resolution values are enabled and used by the encoder; on the contrary, if **Scaling function control** = DISABLED you are allowed to set new resolution values, however they are not enabled even if sent to the encoder: the encoder still goes on using the physical values, NOT the new entered values, until you enable the **Scaling function control**. See the "6.4.1 Byte 10 - Operating parameters" section on page 48.

If **Class 2 functionality** = DISABLED or **Scaling function control** = DISABLED, then the system uses the physical values to arrange the position information.

The **Counts per revolution** parameter allows to program a custom number of distinguishable steps per revolution (singleturn resolution).
The custom singleturn resolution value must be less than or equal to the physical singleturn resolution -hardware counts per revolution value- (≤ 8,192).
Setting a value greater than allowed causes the encoder to fall into error signalling the fault condition through the diagnostic LEDs (see on page 30).

You are allowed to set any integer value less than or equal to the Hardware counts per revolution. However we suggest setting a value that is a power of 2 (1, 2, 4, ... 2048, 4096, ...). This is meant to avoid counting errors (refer also to the "6.9 "Red Zone"" section on page 66).

Default = 8192 (min. = 1, max. = 8192)

NOTE
See some examples on setting a custom resolution on page 52.

WARNING
When you set a new value next to the **Counts per revolution** parameter, please always check also the **Total resolution** parameter value and be sure that the resulting number of revolutions complies with the **Hardware number of revolutions** of the device (4,096 revolutions).
Let's suppose that our encoder is programmed as follows:
Counts per revolution: 8192 cpr
Total resolution = 33554432_{10} = 8192 (cpr) * 4096 (rev.)
Let's set a new singleturn resolution, for instance: **Counts per revolution** = 360.
If we do not change the **Total resolution** value at the same time, we will get the following result:

$$\textbf{Number of revolutions} = \frac{33554432\ (\textbf{Total resolution})}{360\ (\textbf{Counts per revolution})} = 93{,}206.755...$$

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. When this happens, the encoder falls into an error signalling the faulty condition through the diagnostic LEDs (see on page 30).

WARNING

When you enable the scaling function (**Scaling function control** = 1), please enter scaled values next to the **Counts per revolution** and **Total resolution** parameters that are consistent with the physical values. In the case of inconsistent values, the system does not go online and visually warns about the wrong parametrization and fault condition by means of the diagnostic LEDs.

WARNING

Every time you change the value in this parameter, then you are required to set a new preset value (see the **Preset value** parameter).

6.4.3 Bytes 15 ... 18

Total resolution

Byte	15	16	17	18
Bit	31-24	23-16	15-8	7-0
Data	2^{31} to 2^{24}	2^{23} to 2^{16}	2^{15} to 2^{8}	2^{7} to 2^{0}
	MSbyte	...	...	LSbyte

WARNING

This is only available when the encoder Class 2 or the encoder Class 2 (+VEL) are installed (see the SFA-x-PB-8192 Class 2 or SFA-x-PB-8192 Class 2 (+VEL) submodules).
You can activate a new value next to the **Total resolution** item only if **Class 2 functionality** = ENABLED. If **Scaling function control** = ENABLED the set resolution values are enabled and used by the encoder; on the contrary, if **Scaling function control** = DISABLED you are allowed to set new resolution values, however they are not enabled even if sent to the encoder: the encoder still goes on using the physical values, NOT the new entered values, until you enable the **Scaling function control**. See the "6.4.1 Byte 10 - Operating parameters" section on page 48.

If **Class 2 functionality** = DISABLED or **Scaling function control** = DISABLED, then the system uses the physical values to arrange the position information.

This parameter is intended to set a custom number of distinguishable steps over the total measuring range. The **Total resolution** of the encoder results from the product of **Counts per revolution** by the required **Number of revolutions**.

In other words, this parameter allows to set the length of the travel the encoder has to measure expressed in number of distinguishable steps (number of information).

Allowed values are less than or equal to the **Total hardware resolution** value (≤ 33,554,432).
Setting a value greater than allowed causes the encoder to fall into an error signalling the faulty condition through the diagnostic LEDs (see on page 30).

We recommend the **Total resolution** to be set to a power of 2. This is meant to avoid problems when using the device in endless operation (when crossing the physical zero) and entering the "Red Zone" (see the "6.9 "Red Zone"" section).

Default = 33554432 (min. = 1, max. = 33554432)

WARNING
When you set a new value next to the **Total resolution** parameter, please always check also the **Counts per revolution** parameter value and be sure that the resulting number of revolutions complies with the **Hardware number of revolutions** of the device (4,096 revolutions).
Let's suppose that our encoder is programmed as follows:
Counts per revolution: 8192 cpr
Total resolution = 33554432_{10} = 8192 (cpr) * 4096 (rev.)
Let's set a new total resolution, for instance: **Total resolution** = 360.
As the **Total resolution** must be greater than or equal to the **Counts 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 30).

WARNING
When you enable the scaling function (**Scaling function control** = 1), please enter scaled values next to the **Counts per revolution** and **Total resolution** parameters that are consistent with the physical values. In the case of inconsistent values, the system does not go online and visually warns about the wrong parametrization and fault condition by means of the diagnostic LEDs.

WARNING
Every time you change the value in this parameter, then you are required to set a new preset value (see the **Preset value** parameter).

EXAMPLE

We install the following draw-wire encoder: SFA-**5000**-**PB**-**8192**-PG.

The physical values are:
Stroke per turn of the drum = 200 mm (7.874")
Physical resolution per turn = 13 bits = 8,192 cpr
Max. number of physical revolutions = 4,096
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

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

- Enable the scaling function (**Scaling function control** = 1); byte 10 = 0A hex (bit 1 = bit 3 = "1")
- Custom resolution per turn = **Counts per revolution** = 2,000 cpr; bytes 11 ... 14 = 0000 07D0 hex
- Linear resolution = 0.1 mm = 100 µm

$$\text{Linear resolution} = \frac{\text{Stroke per turn}}{\text{Counts per revolution}} = \frac{200\text{ mm}}{2{,}000} = 0.1\text{ mm}$$

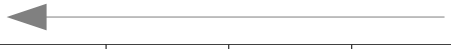
The custom number of revolutions can be as the physical number of revolutions:

$$\text{Custom number of encoder revolutions} = \frac{\text{Total resolution}}{\text{Counts per revolution}} = 4{,}096$$

- **Total resolution** = 8,192,000; bytes 15 ... 18 = 007D 0000 hex

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.

- **Total resolution** = **Counts per revolution** * custom number of revolutions = 2,000 * 10 = 20,000; bytes 15 ... 18 = 0000 4E20 hex

In fact:

$$\text{Custom number of encoder revolutions} = \frac{\textbf{Total resolution}}{\textbf{Counts per revolution}} = 10$$

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

When new values are set next to the **Counts per revolution** and/or **Total resolution** parameters, a new **Preset value** setting is required according to the new resolution.

6.4.4 Byte 19

Velocity measure unit

This byte is available only when Class 2 (+VEL) is set (see also **Class 2 functionality** and **Exchange type** items).
It defines the unit of measurement for the speed value transmitted by the device.
00 = step/s (steps per second);
01 = rpm (revolutions per minute).
Default = 0 (min. = 0, max. = 1)

6.5 DDLM_Chk_Cfg

The Configuration function allows the Master to send configuration data to the Slave for any check operation. The main purpose of this function is to set the number of bytes used for the Data_Exchange as viewed from the Master side.

Chk_Cfg message structure (1 byte):

bit 7 = Consistency (="1")
bit 6 = Word format ("0"=byte,"1"=word=4 bytes)
bits 5 and 4 = In/out data ("01"=Input, "10"=output)
bits 3 ... 0 = Length code

EXAMPLE

bit	7	6	5	4	3	2	1	0	
Data	1	1	0	1	0	0	0	1	D1h
	1	1	0	1	0	0	1	1	D3h
	1	1	1	0	0	0	0	1	E1h

Class 1 and Class 2:
D1hex = 4 byte input
E1hex = 4 byte output

Class 2 (+VEL):
D3hex = 8 byte input
E1hex = 4 byte output

6.6 DDLM_Data_Exchange

This is the normal operation status of the system. The Slave (for both Class 1 and Class 2) can transmit the **Position value** (and speed value -**Position and velocity values**- if Class 2 (+VEL) is set) and receive the **Preset value** from the Master. See also the **Exchange type** parameter.

Position value

when either Class 1 or Class 2 is set (Encoder → Master)

Byte	1	2	3	4
Bit	31-24	23-16	15-8	7-0
Data	2^{31} to 2^{24}	2^{23} to 2^{16}	2^{15} to 2^{8}	2^{7} to 2^{0}
	MSbyte	...	...	LSbyte

See also the **Exchange type** parameter.
It has a mandatory length of 32 bits and is right aligned in the data field.
This parameter contains the current position value of the encoder.

If the scaling function is enabled, the output value is scaled according to the scaling parameters (see Scaling function control on page 49).

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:

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

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-PB-8192-PG draw-wire encoder (Scaling function control = 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:

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

$$\text{Linear resolution} = \frac{200}{8192} = 0.024 \text{ mm} = 24 \text{ µm}$$

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 = 2952 µm

EXAMPLE 2
Let's suppose that we are using the SFA-5000-PB-8192-PG draw-wire encoder. The singleturn resolution is set to the 4000 cpr custom value (**Counts per revolution** = 4000). The transmitted position value is 1569.
The linear resolution can be easily calculated as follows:

$$\text{Linear resolution} = \frac{200}{4000} = 0.05 \text{ mm} = 50 \text{ µm}$$

Thus the linear position value will be as follows:

Linear position value = 1569 * 0.05 = 78.45 mm = 78450 µm

Position and velocity values

when Class 2 (+VEL) is set (Encoder → Master)

Byte	1	...	4	5	...	8
Bit	31-24	...	7-0	31-24	...	7-0
	Position			**Velocity**		

For more information on the position value refer to the previous **Position value** parameter on page 56.
See also the **Exchange type** parameter.
The velocity value is expressed according to the setting in the **Velocity measure unit** parameter.

Max. speed and counting frequency

To convert the speed value from m/s into rpm (revolutions per minute), then you must use the following formula:

$$\textbf{Speed in rpm} = \frac{60 * \text{speed m/s}}{0.2}$$

If you need to convert the speed value from rpm into m/s, use the following formula instead:

$$\textbf{Speed in m/s} = \left(\frac{\text{rpm} * 200}{60}\right) / 1000$$

EXAMPLE
Let's assume that we are using the SFA-5000-PB-8192-PG draw-wire encoder and the maximum speed of the application is 1 m/s. To calculate the counting frequency we must convert the speed expressed in m/s into rpm first.
Using the above formula you will get:

$$\textbf{Speed in rpm} = \frac{60 * 1}{0.2} = 300 \text{ rpm}$$

Please note that the maximum counting frequency of an encoder, expressed in kHz, results from the number of revolutions per minute (rpm) -i.e. its rotational speed- and the number of pulses per revolution (cpr) -i.e. its resolution. It can be calculated by using the following formula:

$$\textbf{Maximum counting frequency (kHz)} = \frac{\text{rpm} * \text{cpr}}{60 * 1000}$$

In the example:

$$\textbf{Maximum counting frequency (kHz)} = \frac{\text{rpm} * \text{cpr}}{60 * 1000} = \frac{300 * 8192}{60 * 1000} = 45 \text{ kHz}$$

It follows that the higher the maximum rotational speed of the encoder and its resolution, the higher the counting frequency. This has to be considered carefully when you program the encoder, in particular referring to the maximum counting frequency of the encoder as stated in the technical specifications, to the following electronic equipment and to the length of the cables.

If you reverse the formula you can easily calculate the maximum number of revolutions starting from the value of the counting frequency (as allowed by the encoder, permitted by the subsequent electronics and accepted by the cable run) and the desired number of pulses per revolution:

$$\textbf{rpm} = \frac{\text{Maximum counting frequency (kHz)} * 60 * 1000}{\text{cpr}}$$

The reversed formula can be very useful -for instance- when you know the maximum counting frequency that is applicable to the system (because of the encoder, the following electronics and the cable length) and you need to calculate the maximum rotational speed the encoder is allowed to reach at the desired resolution.

Preset value

when any Class is set (Master → Slave)

Byte	1	2	3	4
Bit	31-24	23-16	15-8	7-0
Data	2^{31} to 2^{24}	2^{23} to 2^{16}	2^{15} to 2^{8}	2^{7} to 2^{0}

This parameter 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 (i.e. a position in the travel of the wire). The chosen physical position will get the value set next to this item and all the previous and following positions will get a value according to it. 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 sent. The **Preset value** value is sent by the Master to the Slave in **Data_Exchange** mode by setting the bit 31 = "1" for 3 cycles.

The MSB of the preset value controls the preset function in the following way:
Normal operating mode: MSB = 0 (bit 31): the encoder will make no change in the preset value.
Preset mode: MSB = 1 (bit 31): with the MSB = 1 the encoder accepts the transferred value (bits 0 ... 30) as a preset value in binary code.

- If **Scaling function control** = DISABLED, then
  the **Preset value** must be less than or equal to the **Total hardware resolution**.
- If **Scaling function control** = ENABLED, then
  the **Preset value** must be less than or equal to the **Total resolution**.

EXAMPLE

Preset value to be set = 0000 1000hex
Current **Position value** = 0005 5000hex

	Byte	1	2	3	4
Cycle	Bit	31-24	23-16	15-8	7-0
1°	M→S	80	00	10	00
	S→M	00	05	50	00
2°	M→S	80	00	10	00
	S→M	00	05	50	00
3°	M→S	80	00	10	00
	S→M	00	00	10	00

NOTE

We suggest setting the **Preset value** when the axis is in stop.
The new **Preset value** is saved immediately after receipt.

WARNING

Check the value in the **Preset value** parameter and perform the preset operation every time you change the value next to the **Code sequence**, **Counts per revolution** and **Total resolution** parameters.

6.7 DDLM_Slave_Diag

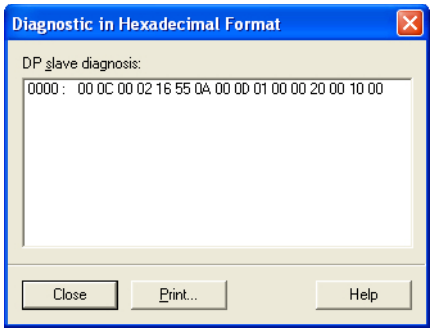
The Master device can send a request for diagnostic information at any time to the Slave device.
Lika devices provide two types of diagnostics (see the **Diagnostic type** parameter on page 50):

- reduced diagnostics (16-byte diagnostics)
- extended diagnostics (63-byte diagnostics).

Class 1 devices only provide 16-byte reduced diagnostics. Class 2 and Class 2 (+VEL) devices can provide either 16-byte reduced diagnostics or 63-byte extended diagnostics.

Set the diagnostic type during DDLM_Set_Prm, operating parameters (byte 10), see the "6.4.1 Byte 10 - Operating parameters" section on page 48.

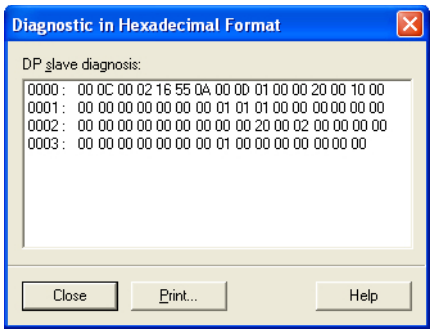
16-byte reduced diagnostics:



Byte	Description
0	Status 1
1	Status 2
2	Status 3
3	Master ID
4	Manufacturer ID
5	
6	Extended diagnostic header
7	Alarms

Byte	Description
8	Operating status
9	Encoder type
10	Physical singleturn resolution
11	
12	
13	
14	Number of physical distinguishable revolutions
15	

63-byte extended diagnostics:



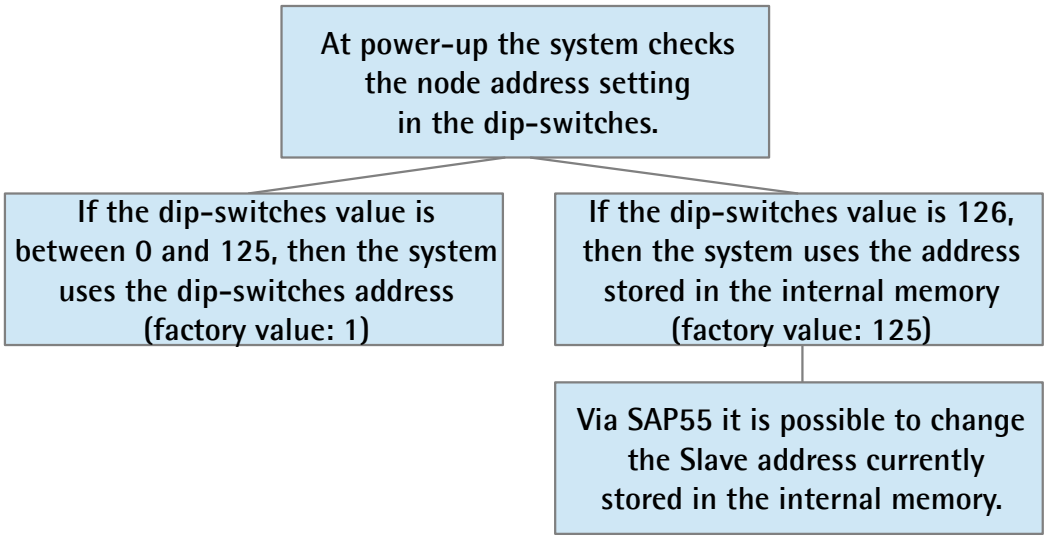
Byte	Description
0	Status 1
1	Status 2
2	Status 3
3	Master ID
4	Manufacturer ID
5	
6	Extended diagnostic header
7	Alarms
8	Operating status
9	Encoder type
10	Physical singleturn resolution
11	
12	
13	
14	Number of physical distinguishable revolutions
15	
16	Additional alarms
17	Supported alarms
18	
19	Warnings
20	
21	Supported warnings
22	
23	Profile version
24	
25	Software version
26	
27	Operating time
28	
29	
30	

Byte	Description
31	Offset value
32	
33	
34	
35	Manufacturer offset value
36	
37	
38	
39	Programmed measuring units per revolution
40	
41	
42	
43	Programmed Total Measuring Range in measuring units
44	
45	
46	
47	Serial number
48	
49	
50	
51	
52	
53	
54	
55	
56	
57	Reserved
58	Reserved
59	Reserved
60	Reserved
61	Reserved
62	Reserved

6.8 Set_Slave_Address command (SAP55 service)

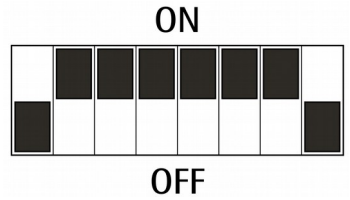
WARNING
SAP55 service can only be accomplished by a **Class 2 DP Master (DPM2)**. Class 1 Masters (DPM1) cannot accomplish the SAP55 service.

Lika SFA draw-wire encoders are designed to allow the Slave address setting either via hardware switches (see the "4.7 Node Address: DIP A (Figure 3 and Figure 4)" section on page 30) or via a bus command by means of the SAP55 service.
The Service Access Point SAP55 Set_Slave_Address allows to change the address stored in the internal memory of a Slave device. SAP55 service is part of the Profibus specifications and allows to change the internal memory address in the event that the device does not provide switches for setting its address or they are not usable. The address stored in the internal memory of the Slave is used only if the hardware switches are set to "126". The address stored at factory by Lika Electronic is "125". On the contrary, if the hardware switches are set to any value between 0 and 125, then the external switches will determine the Slave address.



WARNING
Please note that the node address set via hardware switches and the node address stored in the internal memory are independent from each other! The node address stored in the internal memory can be changed only by means of the SAP55 service and the Set_Slave_Address command.

As previously stated, SAP55 service and the use of the node address stored in the internal memory are allowed only if the DIP A hardware switches are set to the value **126** ($0111\ 1110_2$):



In this way you set that the Slave address will be read from the internal memory. As stated, the value stored at factory by Lika Electronic is "125".

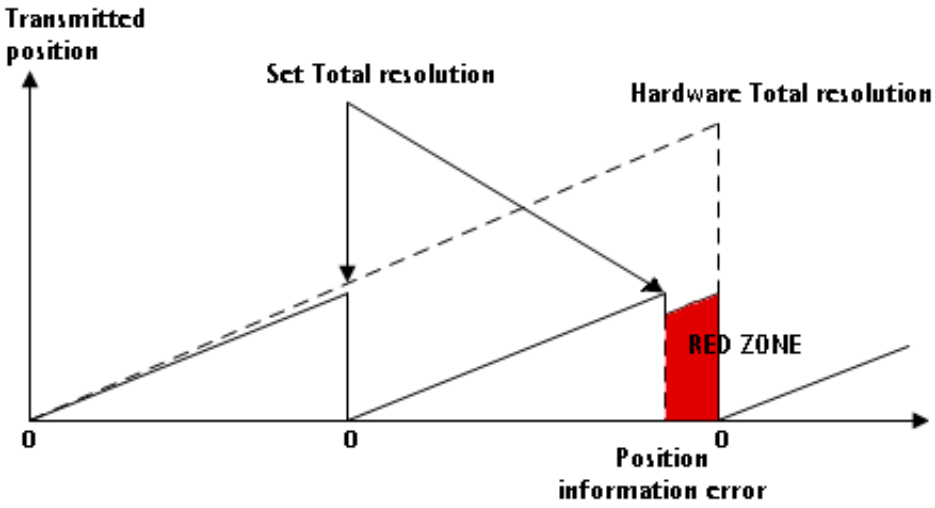
The message has the following DATA bytes:

Byte	Description
0	New node number
1	Manufacturer ID
2	
3	Lock node number (= 0: not supported)

6.9 "Red Zone"

The so-called "Red Zone" occurs when **Total resolution** or **Counts per revolution** are not a power of 2.

When this problem arises, the device must operate within the "red zone" for a certain number of positions. The size of the "red zone" is variable. To calculate it we must subtract the **Total resolution** value from the **Hardware total resolution** of the device as many times as until the difference is less than the the set **Total resolution** value. When the encoder crosses the limit of the last **Total resolution** section thus entering the "red zone", a counting error occurs, i.e. a jump in the position count. The problem can be represented graphically in the Figure below.



EXAMPLE

SFA-xxxxxx-8192-xxx draw-wire encoder

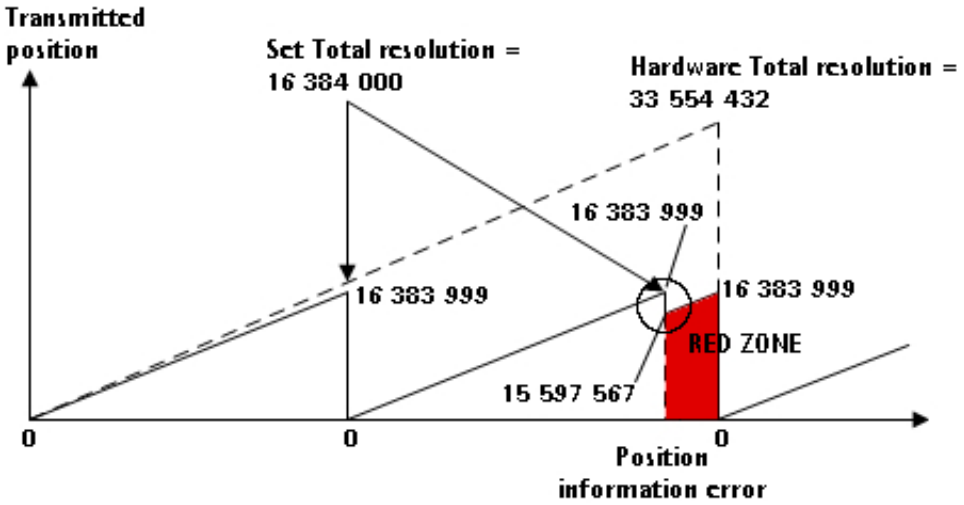
- **Hardware counts per revolution** = 8,192 (2^{13})
- **Hardware number of turns** = 4,096 (2^{12})
- **Total hardware resolution** = 33,554,432 (2^{25})

Set parameters values:

- **Counts per revolution** = 8,192
- **Number of revolutions** = 2,000
- **Total resolution** = 16,384,000

$$\frac{\text{Hardware number of turns}}{\text{Number of revolutions}} = \frac{4{,}096}{2{,}000} = 2.048$$

It follows that, for 96 revolutions (4,096 - 2 * 2,000 = 96), the encoder will work within the "Red Zone" limits.



NOTE

- The "Red Zone" status is indicated by the green LED flashing while the red LED is OFF (see the "4.6 Diagnostic LEDs (Figure 1)" section on page 30).
- When the encoder is operating within the limits of the "red zone" (i.e. for 8,192 cpr * 96 revolutions = 786,432 counts: 15,597,567 ... 16,383,999), the transmitted position is consistent with the set resolution: it is calculated so that the last position within the "red zone" before crossing the zero position is **Total resolution** -1".
- Please be careful using the position information sent by the encoder when it is operating within the limits of the "red zone". When the encoder crosses from the normal status to the "red zone" status (and vice versa), a position information error occurs. See the Figure above: when entering the "red zone" the position information jumps from 16,383,999 to 15,597,567!

7 Default parameters list

Parameters list	Default values		
Code sequence	1 = Count up pulling the wire out		
Class 2 functionality	1 = Enabled		
Scaling function control	1 = Enabled		
Diagnostic type	0 = 16 bytes (6+10)		
Exchange type	Class 1 and Class 2 = 0 = only pos Class 2 (+VEL) = 1 = pos and vel		
Counts per revolution	8,192		
Total resolution	33,554,432		
Velocity measure unit	0 = steps/s		
Preset value	0		

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Document release	Release date	Description	HW	SW	Interface
1.0	14.06.2016	First issue			

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