User Manual

AS58 PB
AS58S PB
ASC58 PB
AM58 PB
AM58S PB
AMC58 PB

Introduction

Serial field bus technology is increasingly meeting with international acceptance in all areas of industrial applications and a wide spectrum of various fieldbus have appeared: Profibus is one of the most successful.

LIKA ELECTRONIC absolute encoders fulfill the requirements of a standard Profibus-DP node for a Profibus network. This User Guide is intended to help the user to install and use the absolute angular encoders with Profibus interface.

The GSD-File allows the direct input of device parameters in the menu fields of Step7 and other tools used to project Profibus networks.

We always appreciate feedback regarding improvements and suggestions.

Summary

1. Safety standards
2. Description and general information
3. Encoder Profile Classification
4. Class 1 and Class 2 Profile
5. Alarm messages using the LEDs in the connection cap
6. Installation

1 – Safety standards

For electrical connection follow strictly the notes on general catalogue. With reference to the directive 89/336/CEE about electromagnetic compatibility you must respect the following precaution:

2 – Description and general information

2.1 – Description of an absolute encoder

We usually make use of absolute encoder when we have to convert the angular position of a shaft into a number. This number is then transferred onwards in a digital form.

The basic principle is that light from a LED is transmitted through a transparent coded disc, and the bright-dark pattern is converted into digital signals.
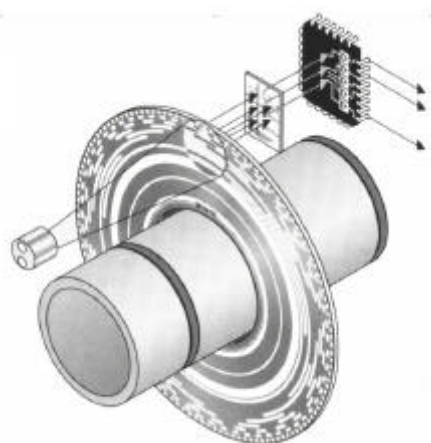
In this manner each angular position corresponds univocally to a sequence of zeros and ones This is the decisive difference to incremental encoders, which only sense the change in the angular position, but not assign a number to every position.

If an incremental encoder is rotated when it's in power off condition, when the equipment is powered-on again, the angular position information is lost, and it is necessary to home the machine. An absolute encoder will always sense position changes, even without a power supply available, and, after the power is switched-on again, transfers the angular position information to the higher-level control system. The coded disk allows individual revolutions to be measured standard resolutions available now are 4096 steps (=$2^3 \spadesuit$) and 8192 steps (= $2^3 \leq$) per revolution.

For multi-turn versions, a special gearbox is integrated in the absolute encoder. This system can

sense up to 4096 revolutions. This is a configuration non available with an absolute assignment of the angular range of 4096 steps/revolution x 4096 revolutions: the total number of steps is 16.777.215. These values are absolute, i.e. there is an absolute zero point, and after 4096 revolutions, the same values are repeated.

The user can influence this angular range in various ways, and therefore adapt the output values to his requirements. The output values can be modified as follows:

1. **Direction of rotation (CMP):** This defines whether the angular encoder counts up when rotating clockwise, or when rotating counter-clockwise.

2. **Resolution per revolution (RPR) :** Number of steps by which the value increases per revolution.

3. **Total resolution (TR) :** This parameter specifies the highest number, which the output position values can assume.

4. **Preset value (PV) :** The user can assign a value to any position of the encoder shaft: the preset value. The preset value must lie within the total resolution.

5. **Prog factor:** A factor x1/x2 can be entered; this defines the ratio between the physical resolution (x1) and the required resolution (x2). The prog factor can be alternatively entered to the value "Resolution per revolution".

2.2 – General information about Profibus

Profibus is available in the market with three different versions: Profibus-FMS, Profibus-PA and Profibus-DP. The LIKA ELECTRONIC absolute encoders, are designed for use with the DP version.

The competent contact partner for the Profibus system in general, with a broad spectrum of information about the technology, manufacturer, and suppliers is:

PROFIBUS – Nutzerorganization e.V.(PNO)
Haid-Und-Neu-Stra?e 7
D-76131 Karlsruhe
Germany

The LIKA ELECTRONIC absolute encoders comply with Profibus-DP requirements according with DIN19245 Parts 1 and 3. The integrated Profibus-DP interface of the absolute encoder is designed for a maximum data transfer rate of 12 Mbaud. The integrated software supports the functions of the official encoder profile for Profibus-DP. Data is always output in binary code.
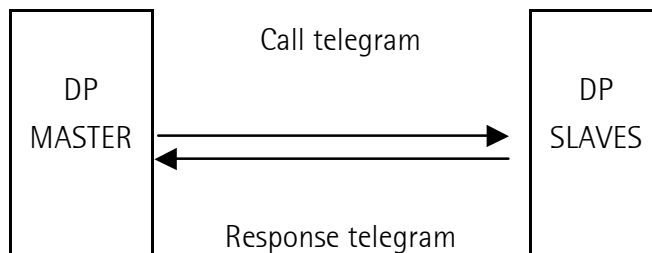
A basic differentiation is made between the following states when exchanging data:

1. Configuring- and parameterizing phase (DDLM_.Set_Prm). This is active when the system starts-up.

2. DDLM_Data_Exchange mode: "Standard operation". the masters sends an inquiry, which the angular encoder responds with the actual position (process actual value) .
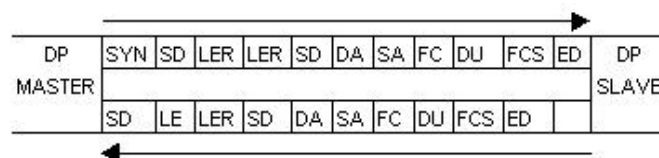
SRD   Send and request data with acknowledge (Data are sent and received in a message cycle)
Syn   Synchronization Time
SA   Source Address
SD   Start Delimiter
FC   Function Code
LE   Length
DU   Data Unit
Ler   Repeated Length
FCS   Frame Check Sequence
DA   Destination Address
ED   End Delimiter (always 16 hex)

For PROFIBUS-DP, a differentiation is made between four various telegram types. A differentiation is made by the value of the Start Delimiter (SD):

1. Request_FDL_Status (FDL= Fieldbus Data Link, also known as Layer 2). The Start Delimiter has the value 10 hex. This telegram is also sent from an active station, always after the GAP time has expired in order to search for new active nodes on the bus.

2. Data telegram with variable data length. This used in the SRD utility (send and request data with acknowledge). SD = 68 hex.

3. Telegram with a fixed data length. SD = A2 hex.

4. Token telegram (only between masters). SD = DC hex

2.3 – Configurating a Profibus–DP network

The interface of the absolute angular encoder is based on the PROFIBUS-DP Standard (EN 50170). In order to be able to use an absolute angular encoder as a SLAVE with the Profibus-DP interface, an interface board is required in the control system which acts as PROFIBUS master.
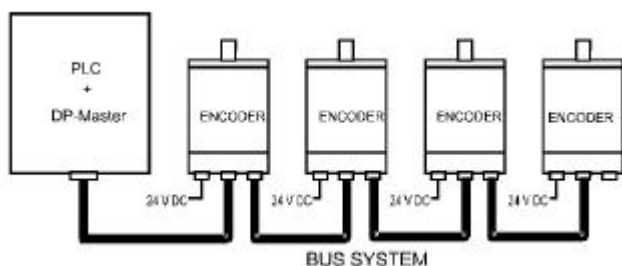
3 – Encoder profile classification

The absolute encoder with Profibus-DP interface transfers the process actual value in binary code. In addition a preset value can be transferred, by setting special bits, in the DDLM_Data_Exchange mode.

The Profibus Trade Organization (PTO) has defined encoder profiles, named Class 1 and Class 2. A differentiation is made between non-parameterizable (Class 1) and parameterizable (Class 2) absolute encoders. When configuring the LIKA ELECTRONIC absolute encoder the user specifies if the encoder should operate as Class 1 or Class 2.

Note: Class 1 and Class 2 encoders have nothing to do with Class 1 and Class 2 Masters. It is quite possible to use a Class 2 encoder with a Class 1 Master.

To choose between the different profile versions a GSD-File is used. The user can select the version that fits his hard and software. The GSD file is available from LIKA ELECTRONIC on a floppy disk or in the Internet (www.lika.it). The hardware of the absolute encoder, apart from the difference between multi and single turn encoders, is always the same. This allows the same encoder to be used in a wide field of applications.

3.1 – Class to use

If the user needs to know the actual position value and to change the direction of rotation, an absolute encoder Class 1 is enough.

If the user needs also to change resolution of the encoder or to enable a preset value then he have to use a Class 2 encoder.

4 – Class 1 and Class 2 profile

c **UL** us   File E211871

The device is to be supplied by a Class 2 Circuit or Low-Voltage Limited Energy or Energy Source not exceeding 30 Vdc

4.1 – Structure of the data when starting up the bus DDLM_Set_Prm mode

A differentiation must be made between two statuses when if comes to data transfer. On one hand, the phase when the system starts-up, when he angular encoder is parameterized (DDLM_Set_Prm mode), and on the other hand, standard operation (DDLMData Exchange mode). Some information is transferred at starts-up, however the preset value is only transferred during normal operation.

The control system configures the angular encoder when the system starts-up, i.e. the encoder profile, selected by the user, is transferred to the angular

encoder (also refer to Section 2 Encoder profile classification). Depending on the version which was selected, the parameter data, defined by the user, is transferred to the angular encoder (parameterization). Generally, this is realized automatically and the parameters are entered into a mask in the operator control software (e.g. Step 7). However, in some cases it is necessary to individually process the bits and bytes. Data is transferred according to the Profibus profile as shown in the schematic in the following Table Overview of the significance of the various bits and bytes when the bus starts-up.

OCTET (byte) No.	PARAMETER	BIT No.	CLASS
1..8	Reserved for PROFIBUS – specific data		X
9	Code sequence	0	C1
	Class2 functionality	1	C2
	Commissioning, diagnostics	2	OPTIONAL
	Scaling function control	3	C2
	Reserved	4	C2
	Reserved	5	C2
	Reserved	6	C2
	Reserved	7	C2
10 ... 13	Measuring units per revolution		C2
14 ... 17	Total measuring range in measuring units		C2
18 ... 25	Reserved for future use		C2
26 ...	Manufacturer specific functions		OPTIONAL

4.1.1 – Code sequence

The Code sequence defines the counting direction when the process actual value is output as the shaft rotates clockwise CW or counter-clockwise CCW when viewing the shaft. The count direction is defined by bit 0 in octet 9:

Octet 9 bit 0	Direction of rotation (viewing the shaft)	Output code
0	Clockwise CW	Increasing
1	Counter-clockwise CCW	Increasing

For Class 1, this is the only parameter, which can be set.

4.1.2 – Activating/de-activating Class 2 functionality

Using this switch, Class 2 angular encoders can be restricted to the functionality of Class 1, i.e. the parameterizing capability is disabled. Bit 1 in octet 9 is set in order to use the functions of a Class 2 encoder.

Octet 9 Bit 1	Class 2 functionality
0	Switched-out
1	Switched-in

4.1.3 – Activating/ de-activating Commissioning diagnostics

This function has no significance for the LIKA ELECTRONIC absolute encoder.

4.1.4 – Activating/ de-activating the Scaling function

The scaling function enables the resolution per revolution (RPR) and the selected total resolution (STR) to be parameterized. This switch should always be switched to one if the functions of Class 2 are to be used.

Octet 9 Bit 3	Scaling function
0	Switched-out
1	Switched-in

4.1.5 – Measuring units per revolution

The Measuring units per revolution' parameter is used to program the angular encoder so that a required number of steps can be realized, referred to one revolution.

If a value greater than the basic resolution of the absolute value encoder is selected as resolution per revolution, the output code is no longer in single steps. Thus, it should be observed, that the required resolution does not exceed the resolution of the absolute value encoder defined by the hardware.

Octet	10	11	12	13
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
	Measuring per revolution			

4.1.6 – Total measuring range

Using the 'Total measuring range' parameter, the user can program the angular encoder, so that after a specific number of revolutions, it starts to count again at zero. Normally, this would be 4096 revolutions, however using the 'Total measuring range' parameter, even shorter periods can be selected. The procedure is described below. When selecting the total resolution, certain rules must be observed. These are obtained from the physical principle of the absolute angular encoder (also refer to 1.2). The total resolution entered here is the highest output value, after which the output values start again at zero.

Example: 100 steps are selected for each revolution, total resolution 12 800, and then the angular encoder starts again at zero after 128 revolutions and then counts up to 11 799). For example, if 3 700 had been selected, then the period after which the output value would repeat itself, would be 37 revolutions. However, this period of 37 revolutions does not "fit" into the 4096 revolutions, which is specified from the hardware, and at some point, a step occurs. This is always the case for all pure absolute angular encoders.

Then if the period length is 4096 revolutions a sequence can repeat itself after a defined number of revolutions, and the angular encoder should start again after this number of revolutions (= periods). If

another period length is required (e.g. the process always repeats itself after 8 revolutions), the following rules should be observed:

1.   If n steps per revolution were selected, then the selected total resolution STR cannot cause the periods to be longer than the maximum 4096 revolutions. This means that the selected total resolution must be less than 4096 times the number of steps per revolution:

STR < 4096 x n

If this is not observed, then the LEDs in the connecting cover display parameterizing error (refer to chap. 4)

2.   The periods. i.e. STR/ n must be an integer number. This must fit an integer number of times (integer multiple) in 4096. Thus, the following equation must apply:

4096 / (STR / n) = 4096 x n / STR = integer number

This function is not monitored. No error message is output.

The value for the selected total measuring range is saved in octets 14 to 17:

Octet	14	15	16	17
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
	Selected total measuring range in measuring steps			

Note: In order that the resolution can be parameterized to be effective per revolution, Class 2 functionality and the scaling function must be included.

NOTE: If the parameterizing is changed, then it maybe necessary to default the earlier set preset. in standard operation, as they now refer to the modified scaling.

4.2 – Normal operation– DDLM_Data_Exchange mode

This is the normal status when the system is operational. When requested to do so, the angular encoder sends the actual values to the control system. It can then also receive data. This is the preset value for Class 2 angular encoders. The versions below, refer to multi-turn versions, but can also be considered exactly like single-turn encoders.

4.2.1 – Transferring the process actual value

In the standard operating mode, MSB = 0 (bit 31, bit 15 for single-turn versions) The angular encoder does not change the preset value.

4.2.2 – Preset value

The preset value is the process actual value, which should then be output when the axis is in a certain physical position. Using the preset value parameter, the value output from the angular encoder, is defined at a specific angular position. The preset value may not exceed the total resolution parameter. The preset value is set after the scaling parameter 'Resolution per revolution' is transferred, and 'Total resolution' is set and refers to these scaled quantities. The preset value is transferred in the Data_Exchange mode by setting bit 31.
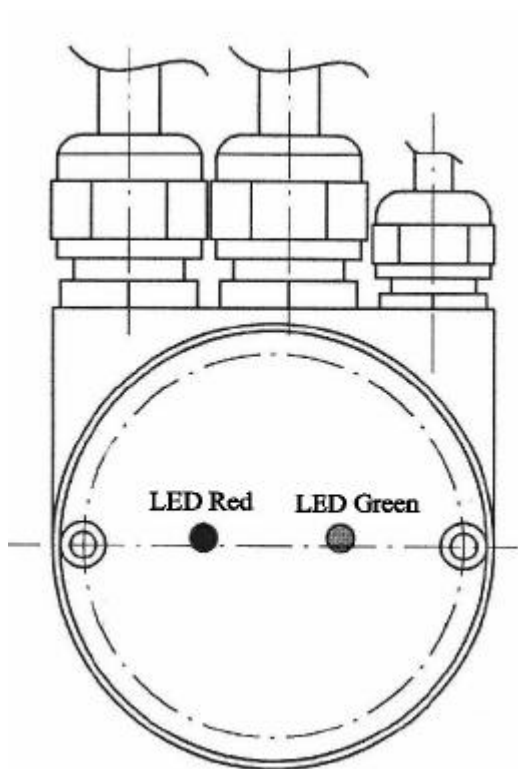
It takes less than 40 ms to save the preset so that it is not lost when the power fails. After the preset value has been received, bit 31 is set as acknowledgment, and the actual process actual value is immediately returned. The procedure is shown below as table.

M = Master		Status bits						
S = Slave	Bit	31	30	29	28	27	26	25
M ® S		1	0	0	0	0	0	0
S ® M		1	0	0	0	0	0	0
M ® S		0	0	0	0	0	0	0
S ® M		0	0	0	0	0	0	0
	Data bits							
	24...0							
	Required process actual value=preset value is transferred here							
	New= required process actual value is transferred here							
	Reset to normal mode							
	New= required process actual value is transferred here							

Note: If high precision is required, the preset mode should only be executed when the encoder shaft is at a standstill. If the shaft moves quickly during this time, offsets can occur, as even when the preset value is set, bus propagation times occur (bus delay times).

5 – Alarm messages using the LEDs in the connection cap

The connection cap has two LEDs, which optically represent the status of the bus at the angular encoder. This red LED is used to display errors and the green LED is used to display the status of the angular encoder. Each LED can have one of three conditions: OFF, ON, flashing. From the nine combination possibilities, six are used to display a special condition.
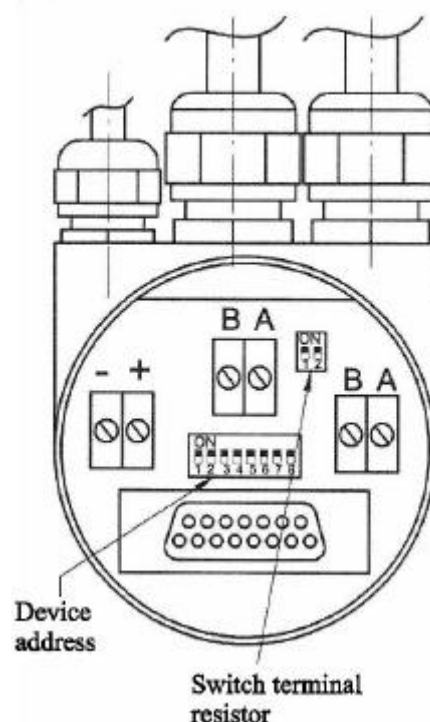
No	Red LED	Green LED	Status signal/ possible cause
1	OFF	OFF	Power supply missing
2	ON	Flashing	Parameterizing- or configuring error, i.e. the encoder receives configuring- or parameterizing data with the incorrect length or inconsistent data (for example, the total resolution has been set too high)
3	Flashing	ON	Encoder ready, but is not addressed from the master (for example an incorrect address was sent)
4	ON	OFF	Encoder doesn't receive data for a long period of time (for example, the data line has been interrupted).
5	OFF	ON	Standard operation in the Data Exchange mode
6	ON	ON	System blocked
7	Flashing	Flashing	Eeprom error

6 – Installation

6.1 – Settings in the Connecting Cover
With the DIP-switches on connecting side (under the connecting cover), is possible to set the encoder address and, if necessary, to activate the terminating resistor (see chap. 5.1.2).

6.1.1 – Node address
The node (station) address is simple to set using the rotary switch under the connecting cover. Permissible addresses lie between 0 and 127, whereby each one must be unique in the complete system. The user can simply remove the connecting cover for installation purposes by releasing two screws on the encoder.
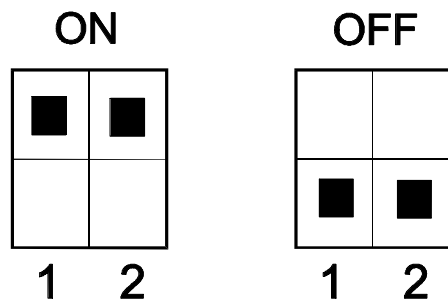

6.1.2 – Terminating resistor
The terminating resistors must be switched-in, if the encoder is used as the end device. The terminating resistors are set using the double dip switches in the connecting cover.

Terminating resistor

ON   OFF

1   2   1   2

The bus has only been correctly terminated, if the encoder is mounted to the connecting cover.

The angular encoder can be commissioned after the address has been set by hardware and the cable terminating resistor has been switched-in if required.

6.2. – To prepare the cable and to connect the screen

To connect the cable to the terminal board in the cap the user has to do the following things: approximately 55 mm of the bus cable sheath must be removed and approximately 50 mm of the braided screen. Approximately 5 mm insulation must be removed from the individual conductors.

To achieve the highest possible noise immunity the data transmission between different components goes over screened cable. The screen should be connected to ground on both ends of the cable. In certain cases a compensation current might flow over the screen. Therefore a potential compensation wire is recommended.

6.3 – Installation procedure

For a correct installation of the Profibus-DP encoder referred to the following instructions.

Two cables passing through PG7 carry the power supply. Peel the insulated cables, then insert the cable with positive voltage on the «+»marked terminal and the ground on the «–» marked terminal. BUS lines are brought to the encoder by a couple of PG09 (with braiding collection), from each one of them esc a BUS SINET LC2 cable to connect the encoder with the preceding and the following device.

Insert the green and red cables on the terminals marked with A and B, then fix firmly the cables with the terminals. The encoder settings are effectuated by the eight DIP-switch (switch). Only the first 7 DIP-switch are used, because only a setting between 0 and 124 (decimals) is allowed. Each setting can be used by one and only device.

To activate the terminating line for the last device move to "ON" the contacts of the two DIP-switches (see pictures on chap. 6.1.1 and 6.1.2).

6.4 – Assembling instructions

Is recommended to do the coupling between the encoder shaft and the exterior shaft of movement transmission with an elastic joint, to guarantee the maximum life to the mechanical members of the encoder itself.

ATTENTION: Is keenly recommended to do any machining (drilling, milling, etc.) on encoder shaft. This may cause sever damages of the interior members, with immediate expiration of the warranty. Our technical-commercial personnel is disposable to any request about "custom made" shaft.

6.5 – Warnings

The following points should be observed:

- Do not drop the angular encoder or subject it to excessive vibration. The encoder is a precision device.
- Do not open the angular encoder housing (this does not mean that you cannot remove the connection cap). If the device is opened and closed again, then it can be damaged and dirt may enter the unit.
- The angular encoder shaft must be connected to the shaft to be measured through a suitable coupling. This coupling is used to dampen vibrations and imbalance on the encoder shaft and also avoid inadmissible high forces. Suitable couplings are available from LIKA ELECTRONIC.
- If the encoder is used in particularly hard environment, it is forbidden to use appropriated protective measures.
- Only qualified personnel may commission and operate these devices.
- Qualified personnel have to work according to the safety standard.
- It's forbidden to make any electrical and/ or mechanical changes to the encoder.
- Route the connecting cable to the angular encoder at a considerable distance away or completely separated from power cables with their associated

noise. Completely screen cables must be used for reliable data transfer and good grounding must be provided. For fieldBUS interface encoder use only the cables requested for the BUS you are using.

- It is important to use the screen braiding collection devices on connectors which expected it (see fieldBUS connectors).

- Cabling, establishing and interrupting electrical connections may only be carried-out when the equipment is in a no-voltage condition. Short-circuits, voltage spikes etc. can result in erroneous functions and uncontrolled statuses which can even include severe personnel injury and material damage.

- Before powering-up the system, check all of the electrical connections. Connections, which are not correct, can cause the system to function incorrectly and fault connections can result in severe personnel injury and material damage.
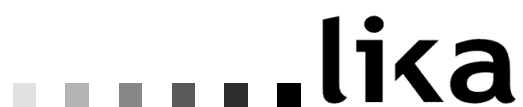
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