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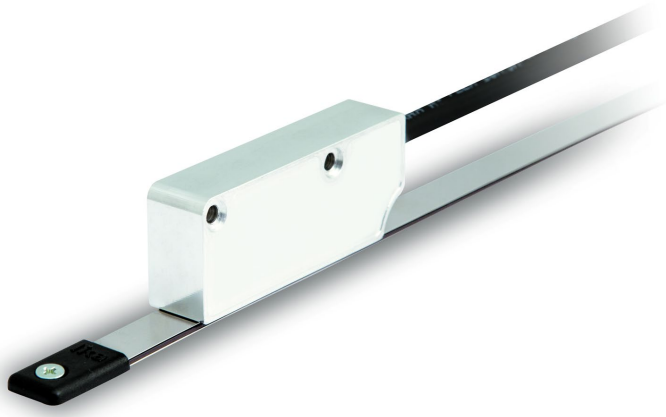
Magnetics that count

# User's guide

# ALS21 + LMS2-A153



- ALS21 absolute linear encoder
- LMS2-A153 tape, 2 mm pitch, unaffected by dust and liquids
- Max. measuring length 8,157 mm / 321.14”
- Resolution ranges from 50 µm down to 1 µm
- SSI, BiSS & Panasonic® RS-485 interfaces, AB incremental signals

Suitable for the following models:

- ALS21-A3+A9-...
- ALS21-A2+A8-...
- ALS21-A1+A7-...
- ALS21-A6-...
- ALS21-A5+A11-...

Table of Contents

# General contents

# Subject index

# Typographic and iconographic conventions

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

- parameters and objects both of the device and the interface are colored in GREEN;
- alarms are colored in RED;
- states are colored in FUCSIA.

When scrolling through the text some icons can be found on the side of the page: they are expressly designed to highlight the parts of the text which are of great interest and significance for the user. Sometimes they are used to warn against dangers or potential sources of danger arising from the use of the device. You are advised to follow strictly the instructions given in this guide 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 to guarantee the safety of the user and the 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 the 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 ALS21 series absolute linear encoder.
ALS21 is designed to measure displacements in industrial machines and automation systems. The measurement system includes a magnetic tape and a magnetic sensor with conversion electronics. The scale is magnetized with a coded sequence of North-South poles and can be fitted with two tracks: an absolute track on one side and an incremental track on the other side (on specific models only). As the encoder moves along the magnetic scale, the sensor detects the displacement and yields the absolute position information through the SSI interface (order code ALS21-A1-..., to ALS21-A4-... and ALS21-A7-... to ALS21-A10) or the BiSS C-mode interface (order code ALS21-A5-... and ALS21-A11-…) or the Panasonic® RS-485 serial interface (order code ALS21-A6-...).
In a specific version, the encoder can further provide additional AB incremental signals for speed feedback through the NPN o.c. output circuit.
It is mandatory to pair the sensor with the LMS2-A153 type magnetic tape. The measuring length is from 940 mm (37.008”) to 8,157 mm (321.26”).

To make it easier to read and understand the text, this guide can be divided into four 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 unit are provided.
In the second section, entitled SSI interface, both general and specific information is given on the SSI interface.
In the third section, entitled BiSS C-mode interface, both general and specific information is given on the BiSS C-mode interface. In this section, the parameters implemented in the unit are fully described.
In the fourth section, entitled Panasonic® RS-485 serial interface, both general and specific information is given on the Panasonic® RS-485 serial interface.
Finally, in the fifth section, entitled AB incremental output signals, some information is given on the additional incremental signals.

# 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 the power supply disconnected and stationary mechanical parts;
- The 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 environmental 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;
- Bogen Magnetics 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 the unit according to the explanation in the ”4 - Electrical connections” section on page 17;
- the wires of unused signals must be cut at different lengths and insulated singularly;
- in compliance with the 2014/30/UE norm on electromagnetic compatibility, the following precautions must be taken:

  - before handling and installing the equipment, discharge electrical charge from your body and tools that 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 running 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 the correct working of the device, avoid using strong magnets on or near the unit;
  - minimize noise by connecting the cable shield (or the connector housing) and the sensor to the ground. Make sure that the ground is not affected by noise. The connection point to the ground can be situated both on the device side and on the user’s side. The best solution to minimize the interference must be carried out by the user.

- do not stretch the cable; do not pull or carry by cable; do not use the cable as a handle.

- Install the device following strictly the information in the “3 - Mounting instructions” section on page 12;
- 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;
- protect the unit against acid solutions or chemicals that may damage it;
- 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 (such as brushes, scrapers, jets of compressed air, etc.) are in place to prevent the sensor and the magnetic scale from jamming.

## 2 - Identification

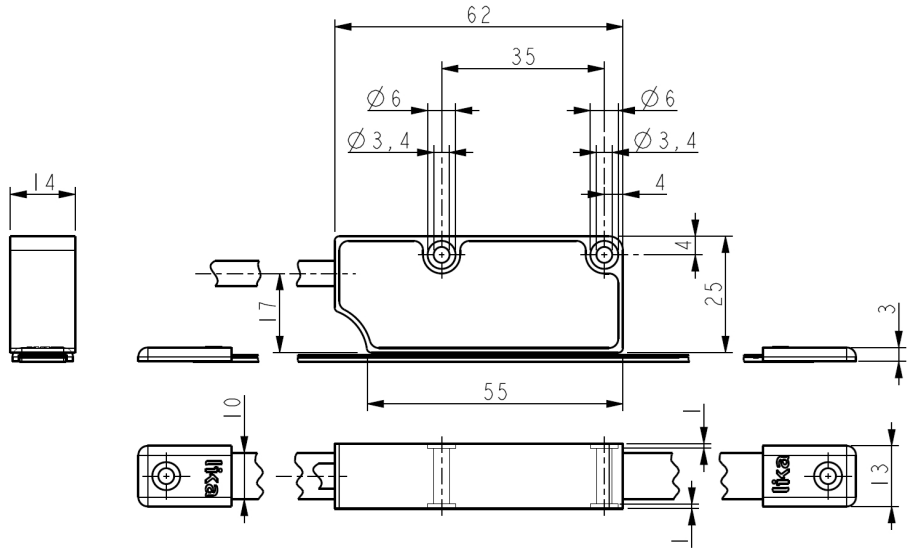
The device can be identified through the order code and the serial number printed on the label applied to its body. Information is listed in the delivery document too. Please always quote the order code and the serial number when reaching Bogen Magnetics for purchasing spare parts or needing assistance. For any information on the technical characteristics of the product refer to the technical datasheet.

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

# 3 - Mounting instructions

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

## 3.1 Overall dimensions




## 3.2 Magnetic scale

The sensor has to be paired with the LMS2-A153 type magnetic scale only. For detailed information on the LMS2-A153 type scale and how to mount it refer to the specific technical documentation.
Install 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 (for instance brushes, scrapers, jets of compressed air, etc.) are in place to prevent the sensor and the magnetic scale from jamming.
Make sure the mechanical installation meets the system's requirements of distance, planarity, and parallelism between the sensor and the scale indicated in Figure 2 all along the whole measuring length.
Figure 1 shows how the sensor and the scale must be installed; please note that the LMS2-A153 magnetic scale can be fitted with two tracks: an absolute track on one side and an incremental track on the other side. Thus, you must strictly comply with the mounting direction!
LMS2-A153 magnetic scale can be provided with a cover strip to protect its magnetic surface (see the order code).
The arrow indicates the standard counting direction (increasing count with the sensor moving as indicated by the arrow in the Figure; for the BiSS version see the Counting direction parameter on page 34; the counting

direction function is not available for the SSI and Panasonic® RS-485 interfaces).

WARNING
The system cannot work if mounted otherwise than illustrated in Figure 1.

3.3 Mounting the sensor

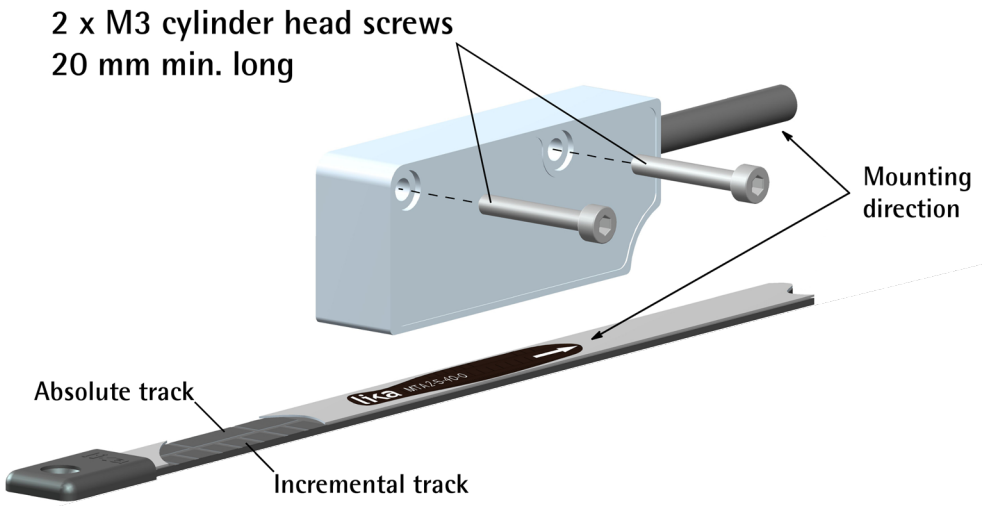



Figure 1

Make sure the mechanical installation complies with the system requirements concerning distance, planarity, and parallelism between the sensor and the scale as shown in Figure 2. Avoid contact between the parts.

Fix the sensor using two M3 20 mm min. long cylinder head screws inserted in the provided holes. Recommended tightening torque: 1.1 Nm. Recommended minimum bend radius of the cable: R ≥ 42 mm.
Please note that the LMS2-A153 magnetic scale can be provided with a cover strip to protect its magnetic surface (see the order code). Therefore, the distance between the sensor and the magnetic scale is different whether the cover strip is applied.

The allowed gap D (see Figure 2) between the sensor and the scale must be in the range indicated in the following table:

| Gap sensor / LMS2-A153 magnetic scale (D) | |
|---|---|
| without cover strip | with cover strip |
| 0.1 – 0.6 mm / 0.004” - 0.024” | 0.1 – 0.4 mm / 0.004” - 0.016” |

WARNING

Make sure the mechanical installation complies with the system requirements concerning distance, planarity, and parallelism between the sensor and the scale as shown in Figure 2 all along the whole measuring length.

Please note that the LMS2-A153 magnetic scale can be fitted with two tracks: an absolute track on one side and an incremental track on the other side. You must strictly comply with the mounting direction!

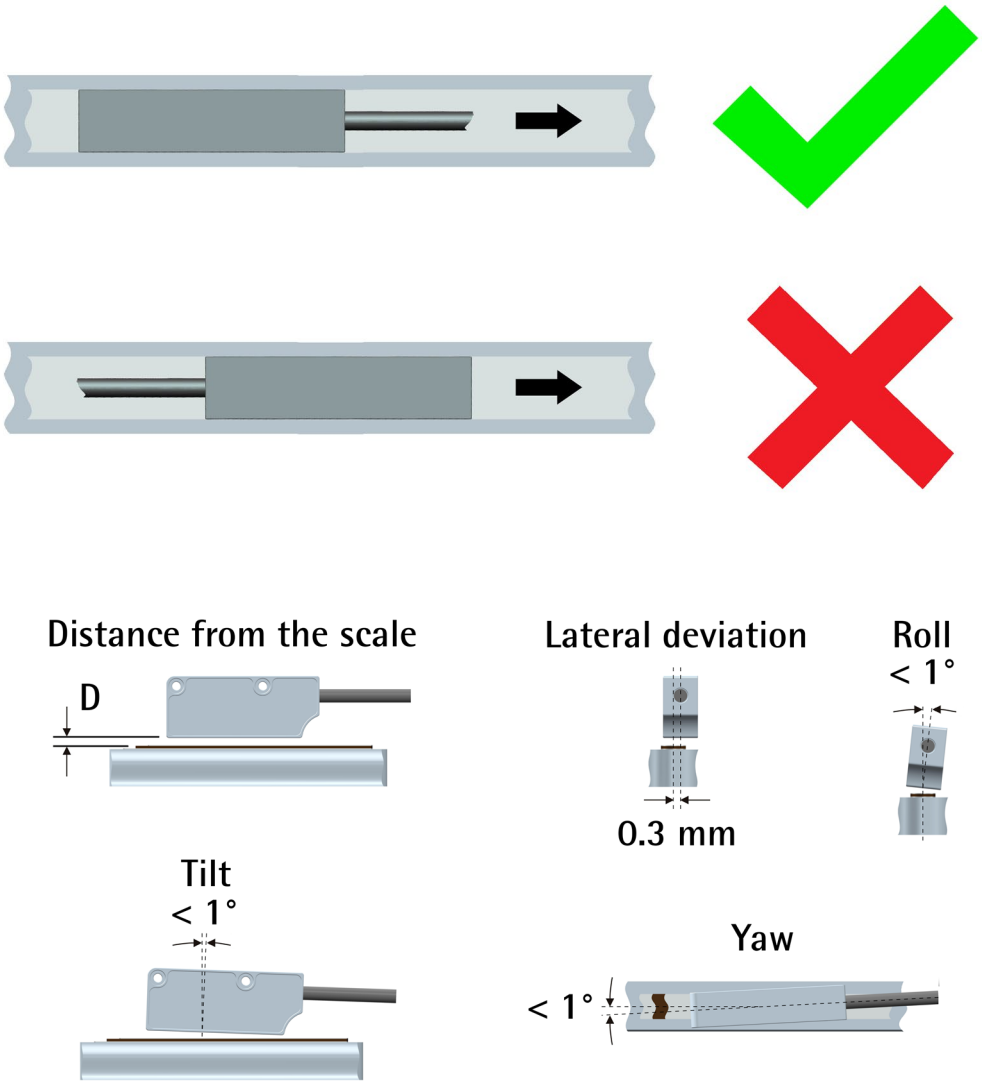



Figure 2

WARNING

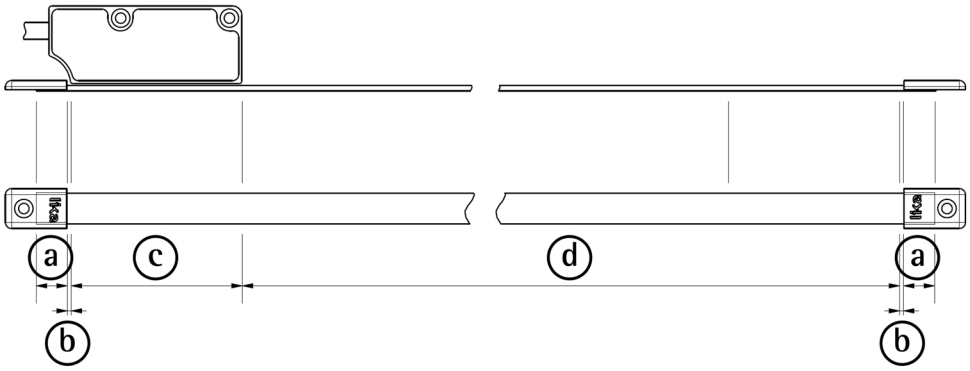
After having installed the sensor on the magnetic scale a zero setting / Preset operation is compulsorily required. The zero setting / Preset operation is further required every time either the sensor or the scale is replaced. The

zero setting / Preset function is available for the BiSS interface only, refer to page 34. It is not available for the SSI (ALS21-A3+A9-..., ALS21-A1+A7-..., ALS21-A2+A8-...) and the Panasonic® RS-485 interfaces (ALS21-A6-...).

3.4 Measuring length (Figure 1)

The maximum tape length L is between 1,000 mm / 39.37” and 8,220 mm / 323.622” (for further information refer to the order code of the tape in the product datasheet).

The sensor area must always be fully within the limits of the tape magnetic surface, then the maximum measuring length is the maximum length of the tape minus the length of the sensor head (and further two safety sections at both ends each one being min. 2-pole pitch long). For instance: if the travel in your application is 5,000 mm / 196.85”, then the length of the tape to be installed will be: 5,000 mm / 196.85” (measuring length d) + 55 mm / 2.165” (length of the bottom of the read-head c, see also the Figure 1) + 2 x 2 mm / 0.079” (the length of two pole pitches for safety reasons b). If you install the optional tape terminals add 1 cm (0.4”) a. The sum of a + b must be doubled as it is intended for each end of the tape. The minimum length of the tape will be 5,063 mm / 201.331”.



# 4 - Electrical connections

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

WARNING
If wires of unused signals come in contact, irreparable damage could be caused to the device. Please insulate them singularly.

## 4.1 SSI and BiSS connections

| Function | M12 8-pin | M8 cable |
|---|---|---|
| 0Vdc | 1 | Black |
| +Vdc [1] | 2 | Red |
| Clock IN + / MA + | 3 | Yellow |
| Clock IN - / MA - | 4 | Blue |
| Data OUT + / SLO + | 5 | Green |
| Data OUT - / SLO - | 6 | Orange |
| A [2] | 7 | White |
| B [2] | 8 | Grey |
| Shield | Case | Shield |

1 See the order code for the power supply voltage level
EXAMPLE
ALS21-A5-... +Vdc = +5Vdc ± 5%
ALS21-A11-... +Vdc = +5Vdc +30Vdc

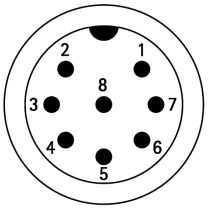
2 AB incremental output signals are provided in specific versions only, see the order code: ALS21-A2-... and ALS21-A8-… (= SSI interface, MSB Left Aligned protocol, Gray output code, + AB incremental signals); ALS21-A5-... and ALS21-A11-… (BiSS interface, C protocol + AB incremental signals). For any information, please refer to the “8 – AB incremental output signals” section on page 47.

## 4.2 Panasonic® RS-485 connections

| Function | M12 8-pin | M8 cable |
|---|---|---|
| 0Vdc | 1 | Black |
| +5Vdc ±5% | 2 | Red |
| reserved | 3, 4 | Yellow, Blue |
| A (REQ+ / SD+) | 5 | Green |
| B (REQ- / SD-) | 6 | Orange |
| not connected | 7, 8 | White, Grey |
| Shield | Case | Shield |

4.3 M12 8-pin connector specifications

M12 8-pin connector
male, frontal side
A coding



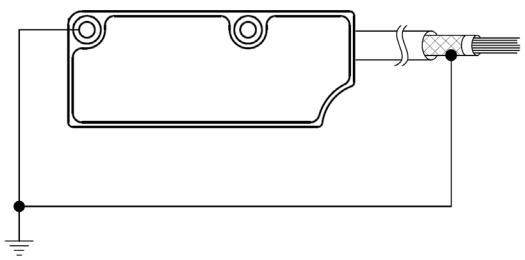

4.4 M8 cable specifications

| | |
|---|---|
| Model: | HI-FLEX sensor cable type M8 |
| Cross section: | 2 x 0.25 $mm^2$ + 6 x 0.14 $mm^2$ (24/26 AWG) |
| Jacket: | PUR, ether base, halogen-free, oil, hydraulic fluid, coolant emulsifier, alkali, and hydrolysis resistant |
| Shield: | Tinned copper braid, coverage > 85% |
| Outer diameter: | 5.5 mm / 0.216” |
| Min. bend radius: | Outer diameter x 7.5 |
| Work temperature: | -50°C +90°C / -58°F +194°F, fixed application<br>-40°C +90°C / -40°F +194°F, dynamic application, not for continuous use |
| Conductor resistance: | <84.7 Ω/Km (0.25 $mm^2$), <152 Ω/Km (0.14 $mm^2$) |

The total length of the cable that connects the sensor and the receiving device should not exceed the values stated in the “Cable lengths” section of the linear encoders' catalog or indicated in this manual; they are specific for each type of output circuit. If you need to reach greater distances, please contact Bogen Magnetics Technical Dept.

4.5 Ground connection

Minimize noise by connecting the cable shield (or the connector housing) and the sensor to the ground. Make sure that the ground is not affected by noise. The connection point to the ground can be situated both on the device side and on the user’s side. The best solution to minimize the interference must be carried out by the user.



4.6 Standard counting direction (Figure 1)

The positive counting direction (count-up information) is achieved when the sensor moves on the tape according to the white arrow shown in Figure 1. In the BiSS interface, the counting direction can be set so that the count-up information is provided when the sensor moves on the tape in the direction opposite to the one shown by the white arrow in Figure 1. For further information refer to the Counting direction parameter in the Configuration register on page 34. The counting direction cannot be changed in the SSI and Panasonic® RS-485 interfaces.

NOTE

The Counting direction parameter affects the absolute position information, not the AB incremental signals.

4.7 AB incremental output signals

For any information on the AB incremental output signals refer to the “8 – AB incremental output signals” section on page 47. AB incremental output signals are provided in specific versions only, see the: ALS21-G1x-... and ALS21-SCx-... order codes.

4.8 Features summary

| Order code | Resolution µm | Max. travel speed m/s | Recommended travel speed m/s (for best signal performance) |
|---|---|---|---|
| ALS21-xxx-R50-... | 50 | 10 | < 7 |
| ALS21-xxx-R10-... | 10 | 10 | < 7 |
| ALS21-xxx-R5-... | 5 | 10 | < 7 |
| ALS21-xxx-R2-... | 2 | 4.7 | < 2.8 |
| ALS21-xxx-R1-... | 1 | 2.4 | < 1.4 |

| | |
|---|---|
| Max. scale length (max. measuring length) | 8,220 mm (8,157 mm) |
| Pole pitch dimension | 2 mm |
| Max. information (max. value) | 23 bits (8,388,607) |

# 5 - SSI interface

Order codes: ALS21-A3+A9-…
ALS21-A1+A7-…
ALS21-A2+A8-…

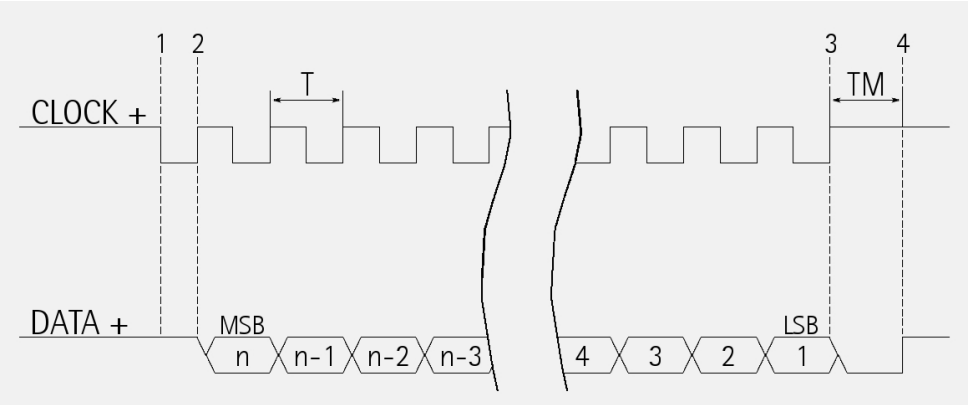
## 5.1 SSI (Synchronous Serial Interface)

SSI (the acronym for Synchronous Serial Interface) is a synchronous point-to-point serial interface engineered for unidirectional data transmission between one Master and one Slave. Developed in the first eighties, it is based on the RS-422 serial standard. Its most peculiar feature is that data transmission is achieved by synchronizing both the Master and the Slave devices to a common clock signal generated by the controller; in this way, the output information is clocked out at each controller's request. Furthermore, only two pairs of twisted wires are used for data and clock signals, thus a six-wire cable is required.
The main advantages in comparison with parallel or asynchronous data transmissions are:

- less conductors are required for transmission;
- less electronic components;
- possibility of insulting the circuits galvanically using optocouplers;
- high data transmission frequency;
- hardware interface independent from the resolution of the absolute encoder.

Furthermore, the differential transmission increases the noise immunity and decreases the noise emissions. It allows multiplexing from several encoders; thus, process controls are more reliable with simplified line design and easier data management.

Data transmission is carried out as follows.
At the first falling edge of the clock signal (1, the logic level changes from high to low) the absolute position value is stored while at the following rising edge (2) the transmission of data information begins starting from the MSB.




At each change of the clock signal and at each subsequent rising edge (2) one bit is clocked out at a time, up to LSB, so completing the data word transmission. The cycle ends at the last rising edge of the clock signal (3). This means that up to n + 1 rising edges of the clock signals are required for each data word transmission (where n is the bit resolution); for instance, a 13-bit encoder needs 14 clock edges. If the number of clocks is greater than the number of bits of the data word, then the system will send a zero (low logic level signal) at each additional clock, zeros will either lead (LSB ALIGNED protocol) or follow (MSB ALIGNED protocol) or lead and/or follow (TREE FORMAT protocol) the data word. After the period Tm mono flop time, having a typical duration of 12 µsec, calculated from the end of the clock signal transmission, the encoder is then ready for the next transmission and therefore the data signal is switched high.
The clock signal has a typical logic level of 5V, the same as the output signal which has customarily a logic level of 5V in compliance with RS-422 standard. The output code can be either Binary or Gray (see the order code).

5.2 “MSB left aligned” protocol

“MSB left aligned” protocol allows to left align the bits, beginning from MSB (most significant bit) to LSB (least significant bit); MSB is then sent at the first clock cycle. If the number of clock signals is higher than the data bits, then unused bits are forced to logic level low (0) and follow the data word. This protocol can be used in sensors having any resolution. The number of clocks to be sent to the sensor must equal the number of data bits at least, anyway, it can be higher, as stated previously. The great advantage of this protocol over the TREE format or the LSB RIGHT ALIGNED format is that data can be transmitted with a minimum time loss and Tm mono flop time can immediately follow the data bits without any additional clock signal.
The device uses a variable number of bits to provide the position information, according to the resolution, as shown in the following table.

ALS21

| Model | Resolution | Length of the word | Max. number of information |
|---|---|---|---|
| ALS21-A3+A9-R50-...<br>ALS21-A1+A7-R50-...<br>ALS21-A2+A8-R50-... | 50 µm | 19 bits | 18 bits (262143) |
| ALS21-A3+A9-R10-...<br>ALS21-A1+A7-R10-...<br>ALS21-A2+A8-R10-... | 10 µm | 21 bits | 20 bits (1048575) |
| ALS21-A3+A9-R5-...<br>ALS21-A1+A7-R5-...<br>ALS21-A2+A8-R5-... | 5 µm | 22 bits | 21 bits (2097151) |
| ALS21-A3+A9-R2-...<br>ALS21-A1+A7-R2-...<br>ALS21-A2+A8-R2-... | 2 µm | 23 bits | 22 bits (4194303) |
| ALS21-A3+A9-R1-...<br>ALS21-A1+A7-R1-...<br>ALS21-A2+A8-R1-... | 1 µm | 24 bits | 23 bits (8388607) |

The output code can be GRAY or BINARY (see the order code).
The length of each information is equal to the resolution.

Structure of the position information

| | | | | | |
|---|---|---|---|---|---|
| ALS21-A3+A9-R50-...<br>ALS21-A1+A7-R50-...<br>ALS21-A2+A8-R50-... | bit | 18 | ... | 1 | 0 |
| ALS21-A3+A9-R10-...<br>ALS21-A1+A7-R10-...<br>ALS21-A2+A8-R10-... | bit | 20 | ... | 1 | 0 |
| ALS21-A3+A9-R5-...<br>ALS21-A1+A7-R5-...<br>ALS21-A2+A8-R5-... | bit | 21 | ... | 1 | 0 |
| ALS21-A3+A9-R2-...<br>ALS21-A1+A7-R2-...<br>ALS21-A2+A8-R2-... | bit | 22 | ... | 1 | 0 |
| ALS21-A3+A9-R1-...<br>ALS21-A1+A7-R1-...<br>ALS21-A2+A8-R1-... | bit | 23 | ... | 1 | 0 |
| | value | MSB | ... | LSB | Error bit |

WARNING
The position value issued by the sensor is expressed in counts; to convert the counts into a metric measuring unit you must multiply the number of detected counts by the resolution.

EXAMPLE 1
ALS21-A3+A9-R50-…
resolution = 50 µm
detected counts = 123
position value = 123 * 50 = 6,150 µm = 6.15 mm

EXAMPLE 2
ALS21-A3+A9-R1-…
resolution = 1 µm
detected counts = 1,569
position value = 1,569 * 1 = 1,569 µm = 1.569 mm

5.3 Recommended transmission rates

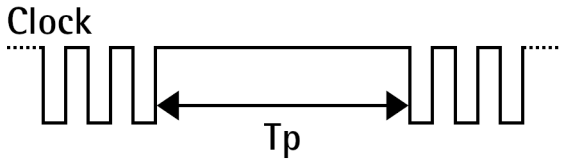
The SSI interface has a frequency of data transmission ranging between 100 kHz and 1 MHz.

The CLOCK signal and DATA signal comply with the “EIA standard RS-422”.

The SSI clock frequency (baud rate) depends on the length of the cable and must comply with the technical information reported in the following table:

| Cable length | Baud rate |
|---|---|
| < 50 m | < 400 kHz |
| < 100 m | < 300 kHz |
| < 200 m | < 200 kHz |
| < 400 m | < 100 kHz |

The time interval between two Clock sequence transmissions must be at least 16 µs ( Tp > 16 µs).




5.4 Error bit

The error bit is intended to communicate the normal or fault status of the Slave.

“1”: correct status (no active error)

“0”: an error is active:

- reading error: the sensor is not able to read the scale correctly; among the possible causes are: the scale is not installed properly (for instance: the scale is mounted contrariwise to the sensor; or it is mounted upside down; see the “3 - Mounting instructions” section on page 12); the scale magnetic surface is damaged somewhere; the sensor is not working properly;
- frequency error: the sensor is travelling too fast on the scale.

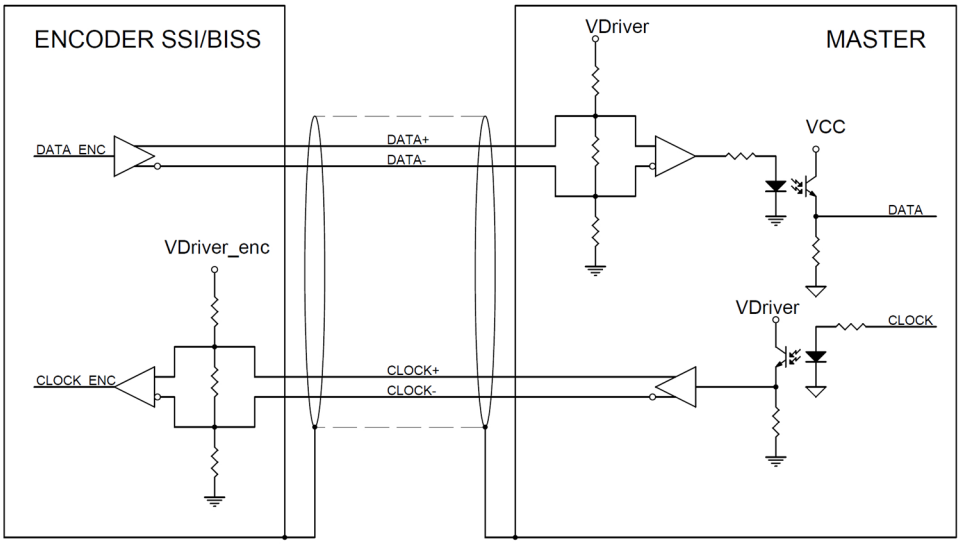
NOTE

For any information on the structure of the position information word, please refer to the “5.2 “MSB left aligned” protocol” section on page 21.

## 5.5 Helpful information

- The zero setting / Preset and Counting direction functions are not available.
- The position information increases when the sensor moves as indicated by the arrow in Figure 1, starting from a min. value up to a max. value; min. and max. values depend on the specific LMS2-A153 magnetic scale installed in your application.
- If required by your application, at installation execute a zero setting / Preset operation of the position read by the Master.

## 5.6 Recommended SSI input circuit



# 6 - BiSS C-mode interface

## Order code: standard ALS21-A5+A11-…

ALS21 is a Slave device and complies with the “BiSS C-mode interface” and the “Standard encoder profile”.
For detailed information not listed in this manual please refer to the official BiSS website (www.biss-interface.com).
The device is designed to operate in a point-to-point configuration and has to be installed in a “single Master - single Slave” network.

WARNING
Never connect the sensor in a “single Master - Multi Slave” network.

CLOCK MA and DATA SLO signal levels comply with the “RS-422 EIA standard”.

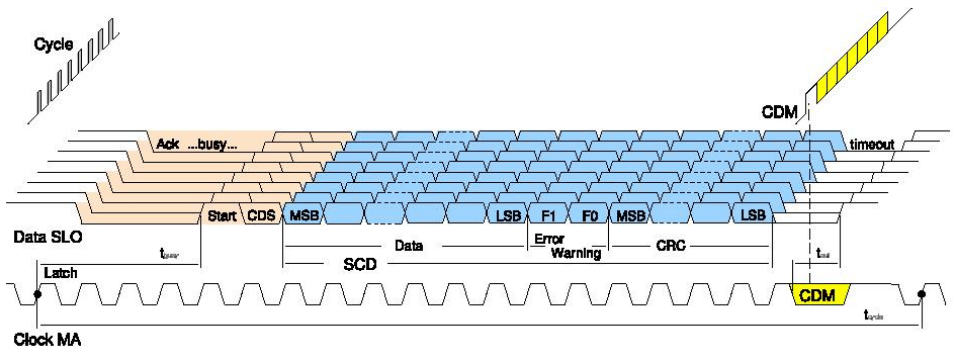
### 6.1 XML file

The product is supplied with an XML file idbiss4C69.xml (see at the address www.bogen-magnetics.com > PRODUCTS > MAGNETIC SENSORS > ALS21). Install the XML file in your BiSS Master device.

### 6.2 Communication

The BiSS C-mode protocol uses two types of data transmission protocols:

- Single Cycle Data (SCD): this is the primary data transmission protocol. It is used to transmit the process data from the Slave device to the Master device. See the “6.3 Single Cycle Data” section on page 27.
- Control Data (CD): transmission of a single bit following the SCD data. It is used to read data from or write data to the registers of the Slave. See the “6.4 Control Data CD” section on page 28.



6.3 Single Cycle Data

SCD (32 bits) consists of the following values: 24-bit position value (Position), 1 error bit (Error, nE), 1 warning bit (Warning, nW), and CRC checking (CRC, 6 bits).

SCD structure:

| bits | 31 … 8 | 7 | 6 | 5 … 0 |
|---|---|---|---|---|
| function | Position | Error | Warning | CRC |

**Position**

(24 bits)

Process data to be transmitted from the Slave to the Master.

The transmission starts with the msb (most significant bit) and ends with the lsb (least significant bit).

| | | | | | |
|---|---|---|---|---|---|
| ALS21-A5+A11-R50-... | 31 … 26 | 25 | … | 8 | bits |
| ALS21-A5+A11-R10-... | 31 … 28 | 27 | … | 8 | |
| ALS21-A5+A11-R5-... | 31 … 29 | 28 | … | 8 | |
| ALS21-A5+A11-R2-... | 31 & 30 | 29 | … | 8 | |
| ALS21-A5+A11-R1-... | 31 | 30 | … | 8 | |
| | 0 | MSB | … | LSB | value |

To convert the position value into microns or millimeters, multiply the received data value by the resolution (see 4Dhex Absolute resolution register).

EXAMPLE 1

ALS21-A5+A11-R50-..., Absolute resolution = 32 hex, 50 µm

detected counts = 123

position value = 123 * 50 = 6,150 µm = 6.15 mm

EXAMPLE 2

ALS21-A5+A11-R1-..., Absolute resolution = 01 hex, 1 µm

detected counts = 1,569

position value = 1,569 * 1 = 1,569 µm = 1.569 mm

**Error**
(1 bit)
This is intended to communicate the normal or fault status of the Slave.

nE = “1”: correct status (no active error)
= “0”: error status: an error is active:

- reading error: the sensor is not able to read the scale correctly; among the possible causes is: the scale is not installed properly (for instance: the scale is mounted contrariwise to the sensor, or it is mounted upside down; see the “3 - Mounting instructions” section on page 12); the scale magnetic surface is damaged somewhere; the sensor is not working properly;
- frequency error: the sensor is traveling too fast on the scale.

**Warning**
(1 bit)
This is used along with the Position control register (see on page 36) to perform an automatic position control.

WARNING
The use of both the Position control register and this Warning bit is strictly reserved for Bogen Magnetics technicians.

**CRC**
(6 bits)
CRC, namely Cyclic Redundancy Check, is the error checking field resulting from a “Redundancy Check” calculation performed on the message contents. This is intended to check whether transmission has been performed properly (inverted output).
Polynomial: $X^6+X^1+1$ (binary: 1000011)

Logic circuit:

6.4 Control Data CD
For complete CD structure information please refer to the official BiSS documents: “Protocol description C-mode”.
The main control data is described in this section.

**Register address**
(7 bits)

This is the address of the register; it specifies the register you need to read from or write to.

**RW**

(2 bits)

It sets whether you need to write to the register (RW = “01”) or to read from the register (RW = “10”).

RW = “01”: when you need to write to the register

RW = “10”: when you need to read from the register

**DATA**

(8 bit)

When writing to the register (RW = “01”): this is the value to be set in the register (i.e. transmitted from the Master to the Slave).

When reading from the register (RW = “10”): this is the value that is read in the register (i.e. transmitted from the Slave to the Master).

Data bit structure:

| bit | 7 | … | … | 0 |
|---|---|---|---|---|
| | MSB | … | … | LSB |

**CRC**

(4 bits)

CRC, namely Cyclic Redundancy Check, is the error checking field resulting from a “Redundancy Check” calculation performed on the message contents. This is intended to check whether transmission has been performed properly (inverted output).

Polynomial: $X^4+X^1+1$ (binary: 10011)

Logic circuit:

6.5 Used registers

| Register (hex) | Function |
|---|---|
| 42 - 43 | Profile ID |
| 44 … 47 | Serial number |
| 48 | Command |
| 49 | Configuration |
| 4D | Absolute resolution |
| 51 … 53 | Preset / Offset |
| 55 | Device type |
| 58 | SINE / COSINE resolution |
| 59 | Position control |
| 78 … 7D | Device ID |
| 7E - 7F | Manufacturer ID |

All registers in this section are listed according to the following scheme:

Function name
[Address, access]
Description of the function and default value.

- Address: register address expressed in hexadecimal notation.
- Access: ro = read-only
  rw = read and write
  wo = write-only
- Default parameter values are written in bold.

## Profile ID

[42 - 43, ro]
These registers contain the identification code of the used profile.

| Register | 42 | 43 | |
|---|---|---|---|
| Hex | 28 | 12 | ALS21-A5+A11-R50-... |
| | | 14 | ALS21- A5+A11-R10-... |
| | | 15 | ALS21- A5+A11-R5-... |
| | | 16 | ALS21- A5+A11-R2-... |
| | | 17 | ALS21- A5+A11-R1-... |

See “Standard encoder profile”, “data format”, and “Variant 0-24”.

## Serial number

[44 … 47, ro]

These registers show the serial number of the device expressed in hexadecimal notation.

Register 44 : year of production
Register 45 : week of production
Registers 46 and 47 : serial number in ascending order

## Command

[48, wo]

| Value | Function |
|---|---|
| 00 | **Normal operation** |
| 01 | **Save parameters on EEPROM** |
| 02 | **Save and activate Preset / Offset** |
| 04 | **Load and save default parameters** |

After having set a new value in some register, use the Save parameters on EEPROM function in this register to store it. Set “01” in the register.
After having set a Preset / Offset value, use the Save and activate Preset / Offset function in this register to both store and activate the preset / offset at the same time. Set “02” in the register.
Load and save default parameters: default parameters are set at the factory by Bogen Magnetics engineers to allow the operator to run the device for standard operation in a safe mode. As soon as the command is sent the default parameters are uploaded and activated. All parameters that have been set previously are overwritten, thus previously set values are lost. The complete list of machine data and the relevant default parameters preset by Bogen Magnetics engineers are available on the page 55. Set “04” in the register.

WARNING
As soon as the Load and save default parameters command is sent, all parameters which have been set previously are overwritten, thus previously set values are lost!

As soon as the command is sent, the register is set back to "00" (Normal operation) automatically.
Wait for min. 30 ms (EPROM writing time) before using a new function.

Default = 00 (Normal operation)

## Configuration

[49, rw]

| Bit | Function | bit=0 | bit=1 |
|---|---|---|---|
| 0 | Not used | | |
| 1 | Set preset / offset | Preset | Offset |
| 2 | Enable preset / offset | Enable | Disable |
| 3 | Not used | | |
| 4 | Not used | | |
| 5 | Output code | Gray | Binary |
| 6 | Counting direction * | Standard | Inverted |
| 7 | Not used | | |

*: it affects the absolute position information, not the AB incremental signals

**Set preset / offset**

This parameter is available only if the Enable preset / offset parameter is set to ENABLE. It allows to activate either the preset function (Set preset / offset = PRESET) or the offset function (Set preset / offset = OFFSET); the Preset or Offset value has to be set in the Preset / Offset register. After having enabled the preset / offset functions (Enable preset / offset = ENABLE), this item allows to activation of either the preset function or the offset function. The value set in the Preset / Offset register will have a different meaning depending on the value of this parameter whether it is set to PRESET (0) or OFFSET (1). In the first case (Set preset / offset = PRESET) the Preset / Offset register is used to set the preset value; while in the second case (Set preset / offset = OFFSET) the Preset / Offset register is used to set the offset value. To activate the preset / offset value use the Save and activate Preset / Offset function in the Command register (set “02” in the register 48).

For any information on the preset and offset functions refer to the Preset / Offset register on page 34.

Default = 0 (Preset)

**Enable preset / offset**

It enables / disables the preset / offset functions. After having enabled the use of the functions you have to choose whether to activate the preset or the offset in the Set preset / offset parameter. Then to activate a new value, set it next to the Preset / Offset register and send the Save and activate Preset / Offset command (set “02” in the register 48).

Default = 0 (enable)

**Output code**

The sensor provides the absolute position information in the desired code format: GRAY (0) or BINARY (1).

Default = 1 (Binary)

**Counting direction**
The standard counting direction is to be intended with the sensor moving as indicated by the arrow in Figure 1. This parameter allows to reverse of the counting direction. In other words, it allows the count up when the sensor moves in the reverse of the standard direction, i.e. in the opposite direction to the one shown by the arrow in Figure 1. It is possible to choose the following options: STANDARD (0) and INVERTED (1). When the counting direction is set to STANDARD -Counting direction = STANDARD-, the position information increases when the sensor moves according to the arrow in Figure 1. When the option INVERTED is set -Counting direction = INVERTED-, the position information increases when the sensor moves in reverse of the standard direction, i.e. in the opposite direction to the one shown by the arrow in Figure 1.
Default = 0 (Standard)

NOTE
The Counting direction parameter affects the absolute position information, not the AB incremental signals.

The new setting will be active immediately after transmission. Use the Save parameters on EEPROM function (set “01” in the register 48) to store the new value.

Configuration register default value = 20h

## Absolute resolution

[4D, ro]
It allows one to read the resolution of the absolute sensor.

| | | |
|---|---|---|
| 32hex : | Resolution = 50 µm | (max position = 03 FF FFh, 18 bits) |
| 0Ahex : | Resolution = 10 µm | (max position = 0F FF FFh, 20 bits) |
| 05hex : | Resolution = 5 µm | (max position = 1F FF FFh, 21 bits) |
| 02hex : | Resolution = 2 µm | (max position = 3F FF FFh, 22 bits) |
| 01hex : | Resolution = 1 µm | (max position = 7F FF FFh, 23 bits) |

## Preset / Offset

[51 … 53, rw]
This function is available only if the Enable preset / offset parameter in the Configuration register is set to ENABLE. Furthermore, it has a double function depending on whether the Set preset / offset parameter in the Configuration register is set to PRESET or OFFSET. In the first case (Set preset / offset = PRESET) the Preset / Offset register is used to set the preset value; while in

the second case (Set preset / offset = OFFSET) the Preset / Offset register is used to set the offset value.

WARNING
Activate the preset / offset value only when the device is not moving.

Preset
The Preset function is meant to assign a value to a desired physical position of the sensor. The chosen physical position will get the value set next to this item and all the previous ad following positions will get a value according to it. This function is useful, for example, when the zero position of the sensor and the zero position of the axis need to match. The preset value will be set for the position of the sensor at the moment when the preset value is activated. To activate the preset, stop the sensor in the desired position, enter the desired value next to this Preset / Offset register and then send the Save and activate Preset / Offset command in the Command register (set "02" in the register 48).

Offset
The offset function is meant to assign a value to a desired physical position of the sensor so that the output position information is shifted according to the value next to this Preset / Offset register. The number of transmitted values will match the maximum number of position information as per the set resolution, but the output information will range between the Preset / Offset value (minimum value) and the sum of the max. position information as per the set resolution (see the Absolute resolution register) + the Preset / Offset value (maximum value). The offset value will be set for the position of the sensor at the moment when the offset value is activated. To activate the offset, stop the sensor to the desired position, enter the desired value next to this Preset / Offset register and then send the Save and activate Preset / Offset command in the Command register (set "02" in the register 48).

Preset / Offset structure:

| Reg. | 51 | 52 | 53 |
|---|---|---|---|
| | MSB | … | LSB |
| | $2^{23}$ - $2^{16}$ | $2^{15}$ - $2^{8}$ | $2^{7}$ - $2^{0}$ |

Use the Save and activate Preset / Offset function (set "02" in register 48) to store and activate the new value.
The max. allowed Preset value depends on the set resolution:
resolution = 50 µm → max preset = 03 FF FFh (18 bits)
resolution = 10 µm → max preset = 0F FF FFh (20 bits)
resolution = 5 µm → max preset = 1F FF FFh (21 bits)
resolution = 2 µm → max preset = 3F FF FFh (22 bits)

resolution = 1 µm → max preset = 7F FF FFh (23 bits)

The Offset value must be less than or equal to the difference between the overall position information (24 bits, see Position) and the max. position information allowed by the set resolution (see the Absolute resolution register).

Default = 00h.

### Device type

[55, ro]

This register describes the type of device.

Default = 07h: BiSS linear encoder + AB incremental signal

### SINE / COSINE resolution

[58, ro]

This register describes the period of the sine/cosine signal.

Default = 00h: the register is not used

### Position control

[59, rw]

This is used along with the Warning bit (see on page 28) to perform an automatic position control.

Default = 00h

WARNING

Do not change the value in this register, its use is strictly reserved for Bogen Magnetics technicians.

### Device ID

[78 … 7D, ro]

These registers show the Device ID, hexadecimal values are according to ASCII code.

| Reg. | 78 | 79 | 7A | 7B | 7C | 7D |
|---|---|---|---|---|---|---|
| Hex | 53 | 4D | 41 | 32 | xx | xx |
| ASCII | S | M | A | 2 | - | - |

xx: software version

### Manufacturer ID

[7E – 7F, ro]

These registers show the Manufacturer ID, hexadecimal values are according to ASCII code.

| Reg. | 7E | 7F |
|---|---|---|
| Hex | 4C | 69 |
| ASCII | L | i |

Li = Lika Electronic.

6.6 Application note

Device communication specifications:

| Parameter | Value |
|---|---|
| Clock Frequency | min 200 kHz, max 10 MHz |
| BiSS Timeout | auto adaptation to clock, max 16 µs |
| Internal position update frequency | 30 kHz |

6.7 Examples

All values are expressed in hexadecimal notation unless otherwise indicated.

6.7.1 Setting the Configuration register (49)

| | | |
|---|---|---|
| Bit 0 | = not used | = 0 |
| Bit 1 Set preset / offset | = PRESET | = 0 |
| Bit 2 Enable preset / offset | = ENABLE | = 0 |
| Bit 3 | = not used | = 0 |
| Bit 4 | = not used | = 0 |
| Bit 5 Output code | = BINARY | = 1 |
| Bit 8 Counting direction | = INVERTED | = 1 |
| Bit 7 | = not used | = 0 |

$01100000_2$ = 60 hex

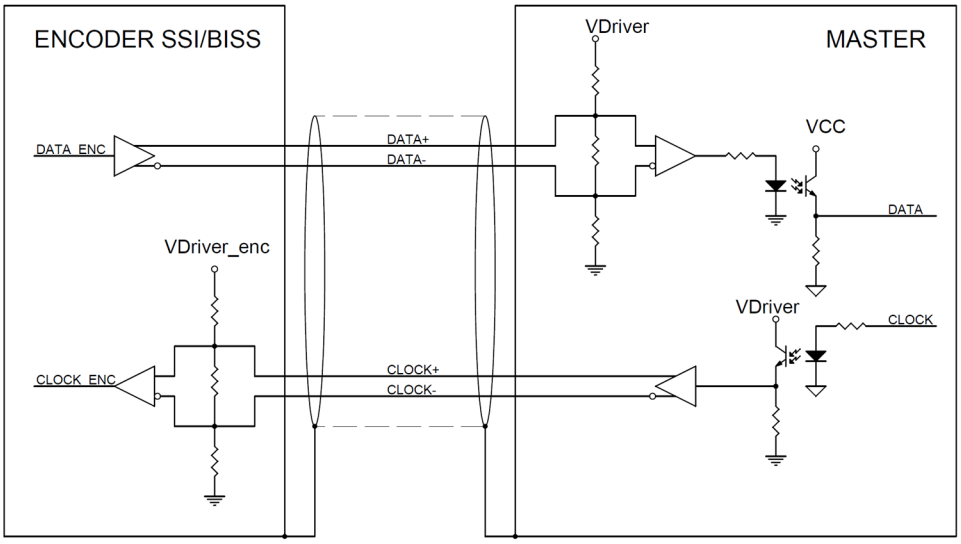
| Function | ADR | DATA Tx |
|---|---|---|
| writing the Configuration register | 49 | 60 |
| Save parameters on EEPROM | 48 | 01 |

### 6.7.2 Setting the Preset / Offset registers (51-53)

After having enabled and chosen the PRESET function (Enable preset / offset = ENABLE; Set preset / offset = PRESET in the Configuration register, see the previous “6.7.1 Setting the Configuration register (49)“) section, you want to set and activate the new Preset value = $100000_{10}$ = 01 86 A0h

| Function | ADR | DATA Tx |
|---|---|---|
| writing the Preset / Offset registers | 51 | 01 |
| | 52 | 86 |
| | 53 | A0 |
| Save and activate Preset / Offset | 48 | 02 |

## 6.8 Recommended BiSS input circuit



# 7 - Panasonic® RS-485 serial interface

## Order code: ALS21-A6-…

### 7.1 RS-485 port settings

Serial port settings are as follows:

| Serial port settings | Value |
|---|---|
| Baud rate (Mbit/s) | 2.5 |
| Byte size | 8 |
| Parity | None |
| Stop bits | 1 |
| Flow control | None |

### 7.2 Frame format

Master → Encoder

| CF |
|---|

Encoder → Master

| CF | SF | DF0 | DF1 | ... | DF7 | CRC |
|---|---|---|---|---|---|---|

The following abbreviations are used in the text:
CF: Control Field, see the “7.3.1 Control Field” section on page 41
SF: Status Field, see the “7.3.2 Status Field” section on page 41
DF: Data Field, see the “7.3.3 Data Field” section on page 42
CRC: CRC Field, see the “7.3.4 CRC Field” section on page 45
SB: Start bit
SC: Sync code
D: Delimiter

#### 7.2.1 Positional data obtaining and reset

Two types of requests (REQ) can be issued from a servo driver, according to the Data ID (see CF):

- request for positional data;
- request for resetting positional data or errors.

#### 7.2.2 Invalid conditions for request

A request is not valid in the following cases:

- logic of Sync code is not valid;
- Data ID code is not valid;
- logic of parity is not valid;
- logic of Delimiter is not valid;
- data length is not valid.

## 7.3 Description of the fields

### 7.3.1 Control Field

Control Field CF is related to Data Field DF, for a correct Data ID setting see the “7.3.3 Data Field” section on page 42.

| SB | SC | | | ID code | | | | | D |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | cc0 | cc1 | cc2 | cc3 | cc4 | 1 |

| Frame type | Data ID (ID code) | CF value |
|---|---|---|
| Obtaining data | Data ID 4: 24-bit absolute positional data + error code | A2h |
| | Data ID 5: 48-bit absolute positional data | 2Ah |
| | Data ID A: 24-bit absolute positional data + encoder IDs + error code | 52h |
| Resetting data / errors | Data ID B: 24-bit absolute positional data + error code (error reset) | DAh |
| | Data ID F: 24-bit absolute positional data + error code (positional data reset) | 7Ah |

### 7.3.2 Status Field

Status Field SF is configured as follows:

| SB | Information | | | | Error | | | | D |
|---|---|---|---|---|---|---|---|---|---|
| 0 | dd0 | dd1 | dd2 | dd3 | ea0 | ea1 | 0 | 0 | 1 |

The dd0-dd3 information bits are not used in this encoder and have a fixed value = “0”.

ea0-ea1: encoder error status bits: they are set when an error or an alarm has occurred in the encoder. The detail of the alarm/error is transmitted separately via ALMC byte (see the next “7.3.3 Data Field” section).

| ea0 | ea1 | Contents |
|---|---|---|
| 1 | * | Encoder alarm (warning). Although there is no error in the position information transmitted by the encoder, it is set when there is a danger of failure. |

| | | |
|---|---|---|
| | | It contains the logic sum of bit 6 and bit 7 of ALMC. This bit is not latched inside the encoder, it is cleared as soon as the cause of the alarm is resolved.<br>See Signal on the strength alarm and Temperature alarm in the "7.3.3.1 Encoder errors" section on page 43. |
| * | 1 | Encoder error. It is set because of an encoder failure or an error in the position information; or when a stop of the motor is required. It contains the logic sum of bits from 0 to 5 of ALMC. This bit is latched inside the encoder. A reset is requested, an error reset ID must be transmitted 10 times continuously, see the "7.3.3.2 Resetting an error" section on page 44. See Overspeed, Initialization error, Hardware error, Encoder inharmonious error, Higher track error, and Low amplitude error in the "7.3.3.1 Encoder errors" section on page 43. |

* Option

### 7.3.3 Data Field

Data Field DF is related to Control Field CF, it depends on the Data ID transmitted by the servo driver. For a correct Data ID setting see the "7.3.1 Control Field" section on page 41.

| SB | Data Field (LSB first) | | | | | | | | D |
|---|---|---|---|---|---|---|---|---|---|
| 0 | df0 | df1 | df2 | df3 | df4 | df5 | df6 | df7 | 1 |

| Data ID | DF0 | DF1 | DF2 | DF3 | DF4 | DF5 |
|---|---|---|---|---|---|---|
| Data ID 4 | ABS0 | ABS1 | ABS2 | ALMC | | |
| Data ID 5 | ABS0 | ABS1 | ABS2 | ABS3 | ABS4 | ABS5 |
| Data ID A | ABS0 | ABS1 | ABS2 | ENID1 | ENID2 | ALMC |
| Data ID B | ABS0 | ABS1 | ABS2 | ALMC | | |
| Data ID F | ABS0 | ABS1 | ABS2 | ALMC | | |

A blank field means that no byte is transmitted.
High bits that are not used have a fixed value = "0".
ABS0-ABS5: 48-bit absolute positional data, ABS0 is the low byte, ABS5 is the high byte. The position is transmitted from LS byte to MS byte in Binary output code. Minus values are described as complements of two. Data range: 800000000000h – 7FFFFFFFFFFh.

| ABS5 | | | ABS4 | | | ABS3 | | | ABS2 | | | ABS1 | | | ABS0 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 47 | ... | 40 | 39 | ... | 32 | 31 | ... | 24 | 23 | ... | 16 | 15 | ... | 8 | 7 | ... | 0 |

MSB LSB

48-bit data transmission order →

ALS21

ABS0-ABS2: 24-bit absolute positional data, ABS0 is the low byte, ABS2 is the high byte. Position is transmitted from LS byte to MS byte in Binary output code. Data range: 000000h – FFFFFFh.

| ABS2 | | | ABS1 | | | ABS0 | | |
|---|---|---|---|---|---|---|---|---|
| 23 | ... | 16 | 15 | ... | 8 | 7 | ... | 0 |

MSB LSB

24-bit data transmission order →

ENID1: encoder ID1, the absolute linear encoder type has a fixed value: 51h.
ENID2: encoder ID2, has a fixed value: 0h.
ALMC: encoder error codes, the value of the relevant bit is "1" when an error occurs, see the ALMC table below. It is latched until the reset operation is carried out by the servo driver.
The ALMC byte (the bit is high = "1" upon error occurrence) is as follows:

| | |
|---|---|
| Bit 7 | Temperature alarm Not implemented |
| Bit 6 | Signal on the strength alarm Not implemented |
| Bit 5 | Low amplitude error |
| Bit 4 | Higher track error Not implemented |
| Bit 3 | Encoder inharmonious error Not implemented |
| Bit 2 | Hardware error |
| Bit 1 | Initialization error |
| Bit 0 | Overspeed |

See the next "7.3.3.1 Encoder errors" section.

### 7.3.3.1 Encoder errors

See the ALMC byte in the previous "7.3.3 Data Field" section.

| Flag | Explanation | Bit |
|---|---|---|
| **Temperature alarm** | This alarm is not implemented. | 7 |
| **Signal on the strength alarm** | This alarm is not implemented. | 6 |
| Low amplitude error | It is set when a signal low amplitude error occurs. Check is accomplished during operation. | 5 |
| **Higher track error** | This alarm is not implemented. | 4 |
| **Encoder inharmonious error** | This alarm is not implemented. | 3 |

| | | |
|---|---|---|
| **Hardware error** | It is set if an error is detected in the $E^2$PROM. Check is accomplished at power on. | 2 |
| **Initialization error** | The setting is performed in the case the above-mentioned errors occurred during initialization right after turning on the power supply or after a reset ID; or in the case the absolute position cannot be detected. | 1 |
| **Overspeed** | The error occurs while the encoder is running because the speed is not proper (overspeed). Check is accomplished during operation. | 0 |

7.3.3.2 Resetting an error

| Function | Data ID | Description |
|---|---|---|
| All errors resetting | Data ID B | Data ID must be transmitted to the encoder 10 times in succession at transmission intervals of 40 µs or more.<br>The encoder carries out an initialization when the reset is performed as well as when the power is turned on. Do not transmit a request ID until an initialization is completed. The Initialization error must be cleared after the initialization is completed and a normal operation starts. |
| Positional data resetting | Data ID F | Data ID must be transmitted to the encoder 10 times in succession at transmission intervals of 40 µs or more while the shaft is in stop.<br>Positional data is reset to “0”.<br>No request ID is accepted while a position data reset operation is in progress because it needs both the process of composing the absolute positions and the process of writing data to $E^2$PROM. |

EXAMPLE
Transmission of encoder position value: Data ID 4 (24-bit positional data)

Master → Encoder

| A2h |
|---|

Encoder → Master

| A2h | SF | DF0 | DF1 | DF2 | DF3 | CRC |
|---|---|---|---|---|---|---|

Encoder positional data:
DF0: LS byte
DF2: MS byte
position = (DF2 << 16) + (DF1 << 8) + DF0;

with 23-bit long position value:

| 23 | Bit 22 ... | 0 |
|---|---|---|
| 0 | encoder positional data | |

with 21-bit long position value:

| 23 | 22 | 21 | Bit 20 ... | 0 |
|---|---|---|---|---|
| 0 | 0 | 0 | encoder positional data | |

with 17-bit long position value:

| 23 | 22 | 21 | 20 | 19 | 18 | 17 | Bit 16 ... | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | encoder positional data | |

### 7.3.4 CRC Field

| SB | CRC code | | | | | | | | D |
|---|---|---|---|---|---|---|---|---|---|
| 0 | rc0 | rc1 | rc2 | rc3 | rc4 | rc5 | rc6 | rc7 | 1 |

The generation algorithm is according to $G(X) = X^8 + 1$.
Data is configured in accordance with LSB first.
The calculation is executed by processing all bits except for the Start bit and Delimiter of fields rather than CRC.

EXAMPLE
Example with Data ID 4

Master → Encoder

| CF |
|---|
| A2h |

Encoder → Master

| CF | SF | DF0 | DF1 | DF2 | DF3 | CRC |
|---|---|---|---|---|---|---|
| A2h | 00h | 10h | 32h | 54h | 00h | D4h |

EXAMPLE
Example with Data ID 5

Master → Encoder

| CF |
|---|
| 2Ah |

Encoder → Master

| CF | SF | DF0 | DF1 | DF2 | DF3 | DF4 | DF5 | CRC |
|---|---|---|---|---|---|---|---|---|
| 2Ah | 02h | DAh | 04h | 00h | 43h | 25h | 00h | 90h |

## 8 – AB incremental output signals

WARNING
AB incremental output signals are provided in specific versions only, see the order code: ALS21-A2+A8-... (= SSI interface, MSB Left Aligned protocol, Gray output code, + AB incremental signals); ALS21-SCx-... (BiSS interface, C protocol + AB incremental signals).

In addition to the absolute position information, the ALS21 sensor can provide two AB incremental signals through the NPN open collector output circuit.
$I_{out}$ = 20 mA max.
Thermal and short-circuit protections are not provided.

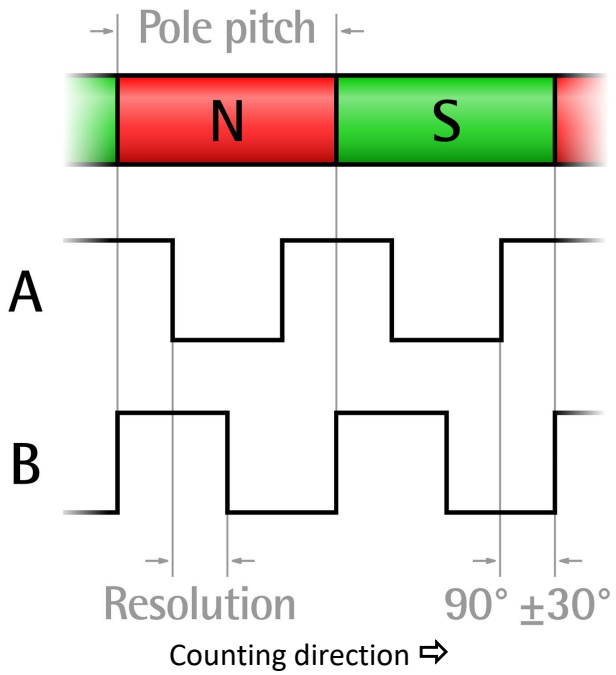
Please note that in this case the LMS2-A153 magnetic scale is fitted with two tracks: an absolute track on one side and an incremental track on the other side. You must strictly comply with the mounting direction! For complete information refer to the "3 - Mounting instructions" section on page 12 and to the "4 - Electrical connections" section on page 17.

In the following table, the main features of the incremental measuring system are listed for each order code. They concern the resolution (i.e. the distance between two following edges of A and B channels); the minimum edge distance (i.e. the minimum spacing between two following signal edges at output, the maximum counting frequency, and the maximum travel speed.

| Order code | Resolution µm | Minimum edge distance µs [1] | Max. AB frequency kHz [2] | Max. AB frequency kHz [3] | Max. travel speed m/s | Recommended travel speed m/s (for best signal performance) |
|---|---|---|---|---|---|---|
| ALS21-A2+A8-R50-...<br>ALS21-A5+A11-R50-... | 50 | 0.25 | 50 | 200 | 10 | < 7 |
| ALS21-A2+A8-R10-...<br>ALS21-A5+A11-R10-... | 10 | 0.25 | 250 | 1000 | 10 | < 7 |
| ALS21-A2+A8-R5-...<br>ALS21-A5+A11-R5-... | 5 | 0.25 | 500 | 2000 | 10 | < 7 |
| ALS21-A2+A8-R2-...<br>ALS21-A5+A11-R2-... | 2 | 0.25 | 580 | 2320 | 4.7 | < 2.8 |

| | ALS21 | | | | | |
|---|---|---|---|---|---|---|
| ALS21-A2+A8-R1-...<br>ALS21-A5+A11-R1-... | 1 | 0.25 | 580 | 2320 | 2.4 | < 1.4 |

1 Max. counting frequency = 4 MHz
2 Calculated at max. speed, per period, with min. edge distance
3 Calculated at max. speed, between edges, with min. edge distance




Please note that the incremental signals and their relationship with the pole pitch are represented schematically in the Figure above; in the example, the interpolation factor 4x is used. The real interpolation factor results from the size (expressed in µm) of the pole pitch divided by the resolution of the specific sensor.

EXAMPLE
Let's suppose we have an ALS21-A2+A8-R50-... sensor
Resolution = 50 µm
Pole pitch size in µm = 2,000 µm (for all ALS21 devices)

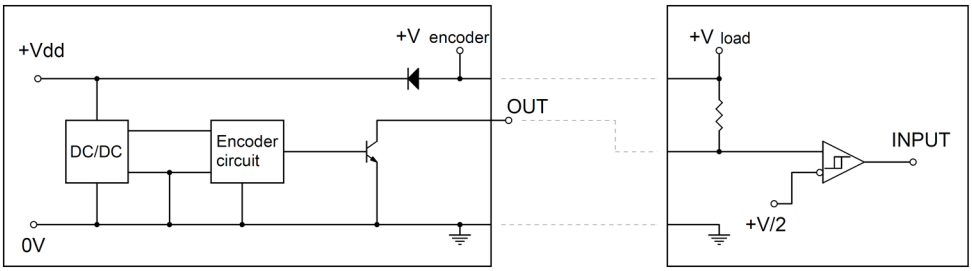
$$\text{Interpolation factor} = \frac{2{,}000}{50} = 40$$

Thus, in the case of the ALS21-A2+A8-0050-... sensor, the system will provide 40 AB edges per pole.

NOTE

Please note that the Counting direction parameter available in the BiSS-C interface (see on page 34) affects the absolute position information, not the AB incremental signals.

8.1 Recommended input circuit




+V load = +5Vdc typically, it can be higher provided that $I_{out}$ < 20 mA.

Max. cable length = 10 m, 33 ft
The max. frequency allowed for the AB signals depends on the cable length and the applied load.

Thermal and short-circuit protections are not provided.

# 9 - Error and fault diagnostics

In case of wrong alignment between the sensor and the magnetic scale, at power on or during operation the following errors may occur:

- when switching on the system an alarm is triggered through the dedicated bit: the scale is not read correctly; it may be due to one of the following reasons: the scale is not mounted properly (for instance: the scale is mounted contrariwise to the sensor, or it is mounted upside down; see the “3 - Mounting instructions” section on page 12); the scale magnetic surface is damaged somewhere; the sensor is not working properly; this may cause invalid data to be transmitted; as soon as the sensor is aligned correctly the error bit switches to a high logic level;
- during operation an alarm is triggered through the dedicated bit: as previously stated, the scale is not read correctly; it may be due to one of the following reasons: the scale is not mounted properly (for instance: the scale is mounted contrariwise to the sensor, or it is mounted upside down; see the “3 - Mounting instructions” section on page 12); the scale's magnetic surface is damaged somewhere; the sensor is not working properly; furthermore, the alarm may be caused by a frequency error: the sensor is traveling too fast on the scale. The last valid position is “frozen” (kept in memory) until the next valid position is detected on the scale.

In the SSI interface, the device status is transmitted via the error bit, see the “5.4 Error bit” section on page 24.
In the BiSS interface, the device status is transmitted via the nE bit, see the Error bit on page 28.
In the Panasonic® RS-485 interface, the device status is transmitted via the Status Field SF, see the “7.3.2 Status Field” section on page 41.

NOTE
When the error bit has a high logic level (SSI / BiSS interfaces: normal status, no alarm active) or the error / warning bits in the Status Field SF have a low logic level (Panasonic® RS-485 serial interface: normal status, no alarm/warning active), this means that the sensor is working properly and both the absolute position information and the incremental signals are output correctly. Please note that the error bit is intended to communicate the status of both the absolute interface and the AB incremental signals.

For further information refer also to the “11 - Troubleshooting” section on page 53.

# 10 - Maintenance

The magnetic measurement 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:

- periodically check the soundness of the structure and make sure that there are no loose screws; tighten them if necessary;
- check the mounting tolerances between the sensor and the magnetic scale are met all along the whole measuring length. Mechanical plays compromise the correct operation. Wear of the machine may increase the tolerances;
- the surface of the magnetic scale has to be regularly cleaned using a soft and clean cloth to remove dust, chips, moisture, etc.

# 11 - Troubleshooting

The following list shows some typical faults that may occur during the installation and operation of the magnetic measurement system.

Fault
The system does not work (no count/pulse output).

Possible cause

- The scale and/or the sensor are not installed properly. The active surface of the scale does not match the sensitive part of the sensor, or the sensor installation does not comply with the mounting direction. For correct installation please refer to the “3 - Mounting instructions” section on page 12.
- A magnetic part or a protection surface is interposed between the sensor and the scale. Only non-magnetic materials are allowed between the sensor and the scale.
- Installation does not meet the mounting tolerances between the sensor and the scale indicated in this guide. During operation, the sensor hits the surface of the scale (check whether the sensor-sensitive part is damaged). Or the sensor is mounted too far from the scale.
- The sensor has been damaged by a short circuit or wrong connection.

Fault
The measured values are either inaccurate or not provided in the whole length.

Possible cause

- The mounting tolerances between the sensor and the scale are not met all along the whole measuring length. For correct installation see the “3 - Mounting instructions” section.
- The sensor is not installed properly on the scale (see the “3 - Mounting instructions” section).
- The connection cable runs near high voltage cables or the shield is not connected properly.
- Frequency error: the sensor is traveling too fast on the scale.
- The frequency of the Master clock is set too high or too low and the transmission cannot be synchronized correctly (see the “5 - SSI interface” and “6 - BiSS C-mode interface” sections).
- A section of the magnetic scale has been damaged mechanically or magnetically along the measuring length.
- The measuring error is caused by a torsion in the machine structure. Check parallelism and symmetry in the movement of the machine.

For further information refer also to the “9 - Error and fault diagnostics” section on page 51.

# 12 - Default parameters list

## BiSS-C interface

| Parameters list | Default value * | | |
|---|---|---|---|
| Command | 00 | | |
| Configuration | 20 | | |
| Bit 0 not used | 0 | | |
| Bit 1 Set preset / offset | 0 = Preset | | |
| Bit 2 Enable preset / offset | 0 = Enable | | |
| Bit 3 not used | 0 | | |
| Bit 4 not used | 0 | | |
| Bit 5 Output code | 1 = Binary | | |
| Bit 6 Counting direction | 0 = Standard | | |
| Bit 7 not used | 0 | | |
| Preset / Offset | 00 00 00 | | |

* All values are expressed in hexadecimal notation.

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| Document release | Release date | Description | HW | SW | Interface |
|---|---|---|---|---|---|
| 1.0 | 22.09.2014 | First issue | | | |
| 1.1 | 21.04.2016 | General review, new BiSS order codes | | | |
| 1.2 | 31.01.2019 | General review | | | |
| 1.3 | 14.07.2023 | New order codes, new Universal power supply, new Panasonic® RS-485 serial interface, minor amendments | | | |
| 1.4 | 10.11.2023 | Encoder inharmonious error alarm removed | | | |
| 1.5 | 10.05.2024 | Panasonic® information added to RS-485 serial interface | | | |


Dispose separately

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