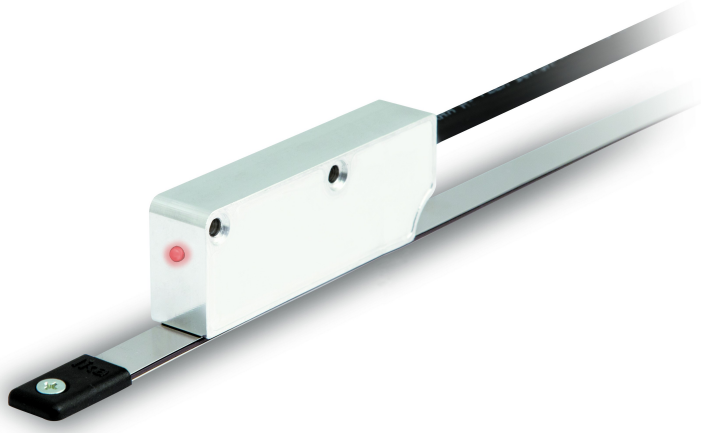
Smart encoders & actuators

User's guide

SMA21 + MTA-A154



- SMA21 absolute linear encoder
- MTA-A154 tape, 2 mm pitch, unaffected by dust and liquids
- Max. measuring length 32,749 mm / 107.444 ft
- Resolution range from 50 µm down to 1 µm
- SSI, BiSS & Panasonic® RS-485 interfaces, AB /AB incremental signals

Suitable for the following models:

- SMA21-BGx-...
- SMA21-G1x-...
- SMA21-GGx-...
- SMA21-JP1-...
- SMA21-SCx-...

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

When scrolling through the text some icons can be found on the side of the page: they are expressly designed to highlight the parts of the text which are of great interest and significance for the user. Sometimes they are used to warn against dangers or potential sources of danger arising from the use of the device. You are advised to follow strictly the instructions given in this guide in order to guarantee the safety of the user and ensure the performance of the device. In this guide the following symbols are used:

	This icon, followed by the word **WARNING**, is meant to highlight the parts of the text where information of great significance for the user can be found: user must pay the greatest attention to them! Instructions must be followed strictly in order to guarantee the safety of the user and a correct use of the device. Failure to heed a warning or comply with instructions could lead to personal injury and/or damage to the unit or other equipment.
	This icon, followed by the word **NOTE**, is meant to highlight the parts of the text where important notes needful for a correct and reliable use of the device can be found. User must pay attention to them! Failure to comply with instructions could cause the equipment to be set wrongly: hence a faulty and improper working of the device could be the consequence.
	This icon is meant to highlight the parts of the text where suggestions useful for making it easier to set the device and optimize performance and reliability can be found. Sometimes this symbol is followed by the word **EXAMPLE** when instructions for setting parameters are accompanied by examples to clarify the explanation.

Preliminary information

This guide is designed to provide the most complete and exhaustive information the operator needs to correctly and safely install and operate the **SMA21 series absolute linear encoder**.

The SMA21 linear encoder is designed to measure long displacements up to 32,749 mm (107.4 ft) 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 a track for incremental signals on the other side (on specific models only, see Figure 1). 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 SMA21-GGx-..., SMA21-G1x-..., and SMA21-BGx-...), the BiSS C-mode interface (order code SMA21-SCx-...), or the Panasonic® RS-485 serial interface (order code SMA21-JP1-...).
In specific version the encoder can further provide additional AB /AB incremental signals for speed feedback through the Line Driver RS-422 level output circuit.
It is mandatory to pair the sensor with the **MTA-A154 type magnetic tape**.
The max. measuring length is 16,339 mm (53.6 ft) for 1 µm resolution Panasonic® RS-485 interface version; it is 32,749 mm (107.4 ft) for all other versions.

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 /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 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 the unit according to the explanation in the "4 - Electrical connections" section on page 15;
- the wires of unused signals must be cut at different lengths and insulated singularly;
- in compliance with 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 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 cable shield (or the connector housing) and the sensor 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.
- do not stretch the cable; do not pull or carry by cable; do not use the cable as a handle.

1.3 Mechanical safety

- Install the device following strictly the information in the "3 - Mounting instructions" section on page 11;
- 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 (as for instance brushes, scrapers, jets of compressed air, etc.) are in place in order to prevent the sensor and the magnetic scale from jamming.

2 - Identification

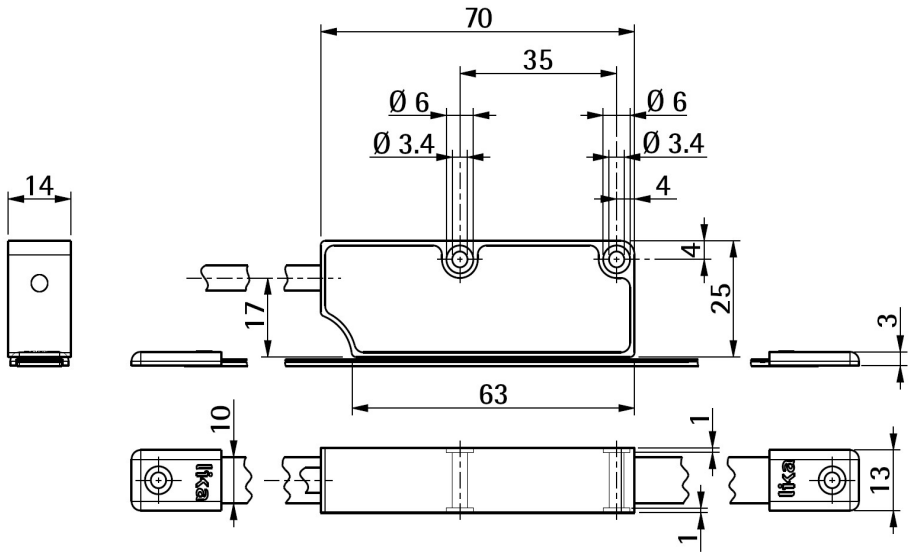
Device can be identified through the **order code** and the **serial number** printed on the label applied to its body. Information is listed in the delivery document too. Please always quote the order code and the serial number when reaching Lika Electronic for purchasing spare parts or needing assistance.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

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

3 - Mounting instructions

WARNING
Installation 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 **MTA-A154 type magnetic scale** only. For detailed information on the MTA-A154 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 (as for instance brushes, scrapers, jets of compressed air, etc.) are in place in order 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.
The Figure 1 shows how the sensor and the scale must be installed; please note that the MTA-A154 magnetic scale can be fitted with two tracks: an absolute track on one side and a track for incremental signals on the other side (see Figure 1). You must always comply strictly with the mounting direction!
MTA-A154 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 sensor moving as indicated by the arrow in the Figure; for the BiSS version see the **Counting direction** parameter on page 31; the counting direction function is not available for the SSI and the Panasonic® RS-485 interfaces).

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

3.3 Mounting the sensor

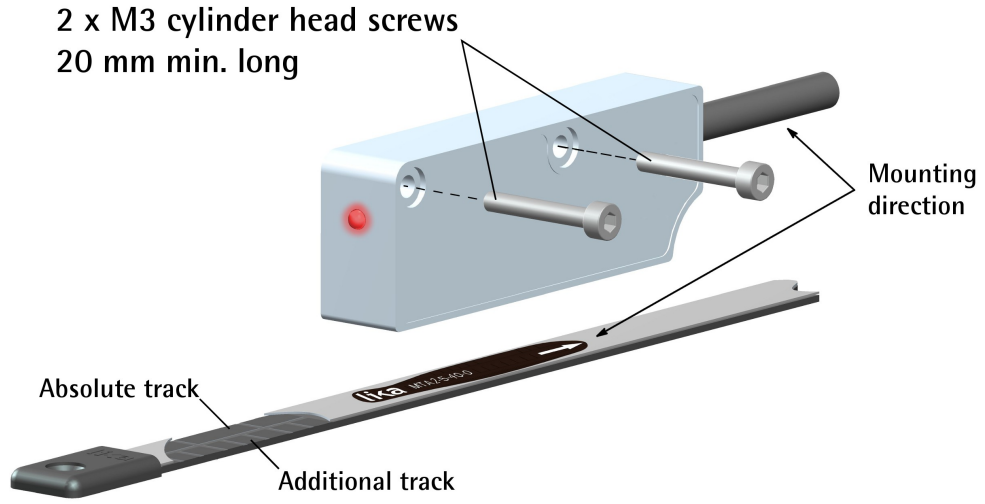


Figure 1

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 by means of **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 ≥ 45 mm**.
Please note that the MTA-A154 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 / MTA-A154 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 MTA-A154 magnetic scale can be fitted with two tracks: an absolute track on one side and a track for incremental signals on the other side (see Figure 1). You must always comply strictly with the mounting direction!

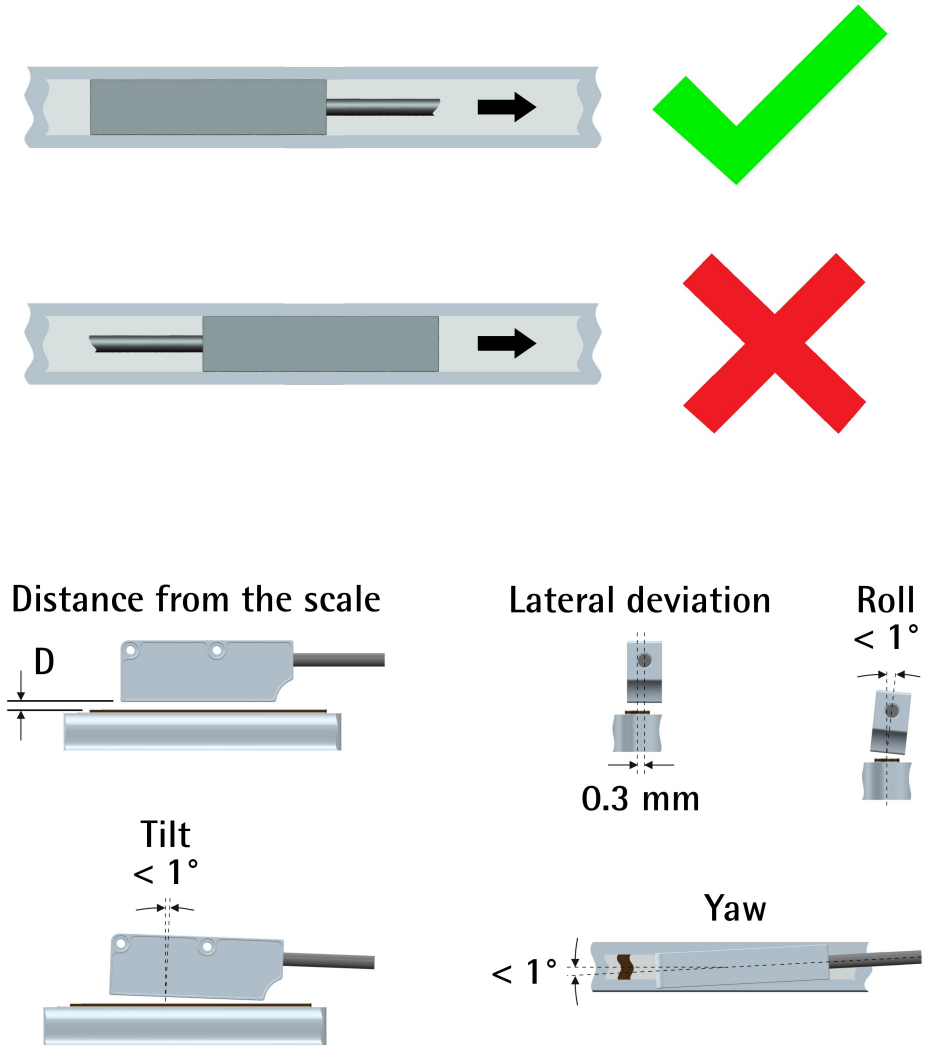


Figure 2

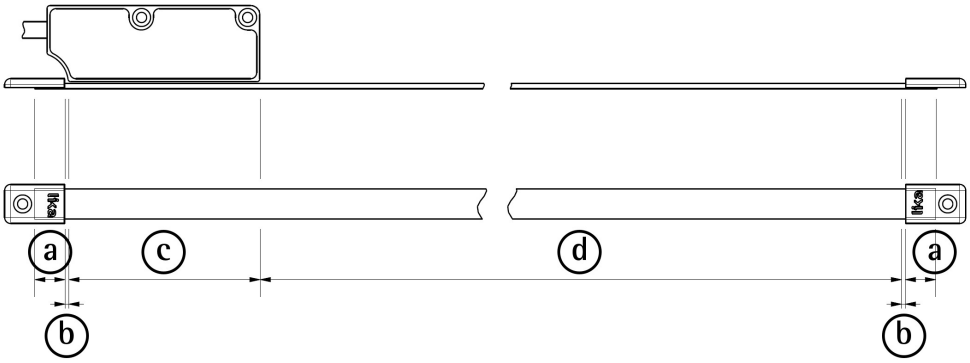
WARNING

After having installed the sensor on the magnetic scale, then a zero setting / Preset operation is 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 32. It is not available for the SSI and the Panasonic® RS-485 interfaces (SMA21-BGx-..., SMA21-GGx-..., SMA21-G1x-..., SMA21-JP1-...).

3.4 Measuring length (Figure 1)

The **maximum tape length** is 16,339 mm (643.268") for 1 µm resolution Panasonic® RS-485 interface version; it is 32,749 mm / 1289.33" for all other versions. 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 minimum length of the tape to be installed will be: 5,000 mm / 196.85" (measuring length ⓓ) + 63 mm / 2.48" (length of the bottom of the readhead ⓒ, see also the Figure 1) + 2 x 2 mm / 0.079" (the length of two pole pitches for safety reasons ⓑ). If you install the optional tape terminals add 1 cm (0.4") ⓐ. The sum of ⓐ + ⓑ values must be doubled as it is intended for each end of the tape. The minimum length of the tape will be 5,071 mm / 199.646".



4 - Electrical connections

WARNING
Electrical connection must be carried out by qualified personnel only, with 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 & BiSS connections

Function	M12 8-pin	M12 12-pin	T12 cable
0Vdc	1	1	White_Green
+Vdc [1]	2	2	Brown_Green
Clock IN + / MA +	3	3	Violet
Clock IN - / MA -	4	4	Yellow
Data OUT + / SLO +	5	5	Grey
Data OUT - / SLO -	6	6	Pink
A [2]	-	9	Green
/A [2]	-	10	Brown
B [2]	-	11	Red
/B [2]	-	12	Black
not connected	7, 8	7, 8	White, Blue
Shield	Case	Case	Shield

1 See the order code for power supply voltage level
EXAMPLE
SMA21-SC**1**-... +Vdc = +5Vdc ± 5%
SMA21-SC**4**-... +Vdc = +5Vdc +30Vdc

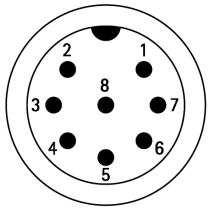
2 AB /AB incremental output signals are provided in specific versions only, see the order code: for example, SMA21-G1x-... (= SSI interface, MSB Left Aligned protocol, Gray output code, + AB /AB Line Driver RS-422 level incremental signals); SMA21-SCx-... (BiSS interface, C protocol + AB /AB Line Driver RS-422 level incremental signals). For any information please refer to the "8 – AB /AB incremental output signals" section on page 43.

4.2 Panasonic® RS-485 serial connections

Function	M12 8-pin	M12 12-pin	T12 cable
0Vdc	1	1	White_Green
+5Vdc ±5%	2	2	Brown_Green
reserved	3, 4	3, 4	Violet, Yellow
A (REQ+ / SD+)	5	5	Grey
B (REQ- / SD-)	6	6	Pink
not connected	7, 8	7, 8, 9, 10, 11, 12	White, Blue, Green, Brown, Red, Black
Shield	Case	Case	Shield

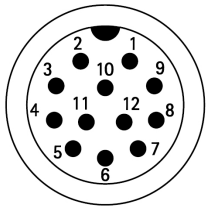
4.3 M12 8-pin connector specifications

M12 8-pin connector
male, frontal side
A coding



4.4 M12 12-pin connector specifications

M12 12-pin connector
male, frontal side



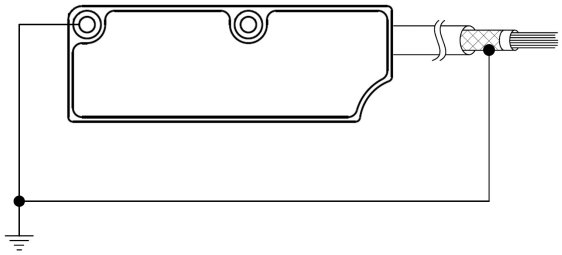
4.5 T12 cable specifications

Model:	LIKA High-Flex Twisted Encoder cable type T12
Cross section:	4 x 2 x 0.14 mm^2 + 4 x 0.25 mm^2 twisted pairs (26/24 AWG)
Jacket:	Matt Polyurethane (TPU) halogen free, oil, hydrolysis, abrasion resistant
Shield:	Tinned copper braid, coverage ≥ 85%
Outer diameter:	6.1 mm ± 0.10 mm / 0.24" ± 0.004"
Min. bend radius:	Outer diameter x 7.5
Work temperature:	-50°C +90°C / -58°F +194°F, fixed application -40°C +90°C / -40°F +194°F, dynamic application
Conductor resistance:	≤148 Ω/km (0.14 mm^2), ≤90 Ω/km (0.25 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' catalogue or indicated in this manual; they are specific for each type of output circuit. If you need to reach greater distances please contact Lika Electronic Technical Dept.

4.6 Ground connection

Minimize noise by connecting the cable shield (or the connector housing) and the sensor 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.



4.7 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 31. 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 incremental signals.

4.8 AB /AB incremental output signals

For any information on the AB /AB incremental output signals refer to the "8 – AB /AB incremental output signals" section on page 43. AB /AB incremental output signals are provided in specific versions only, see the order code.

4.9 Diagnostic LED

For complete information on the diagnostic LED please refer to the "9 - Error and fault diagnostics" section on page 46.

4.10 Features summary

Order code	Resolution µm	Max. travel speed m/s	Recommended travel speed m/s (for best signal performance)
SMA21-xxx-0050-...	50	10	< 7
SMA21-xxx-0010-...	10	10	< 7
SMA21-xxx-0005-...	5	10	< 7
SMA21-xxx-0002-...	2	4.7	< 2.8
SMA21-xxx-0001-...	1	2.4	< 1.4

Max. length of the scale	16,410 mm (for 1 µm resolution Panasonic® RS-485 version) 32,820 mm (for all other versions)
Max. measuring length	16,339 mm (for 1 µm resolution Panasonic® RS-485 version) 32,749 mm (for all other versions)
Pole pitch dimension	2 mm
Max. information (max. value)	25 bits, 33,554,432 counts (for SSI & BiSS versions) 24 bits, 16,777,216 counts (for Panasonic® RS-485 versions)

5 - SSI interface

Order codes: **SMA21-BGx-...**
SMA21-GGx-...
SMA21-G1x-...

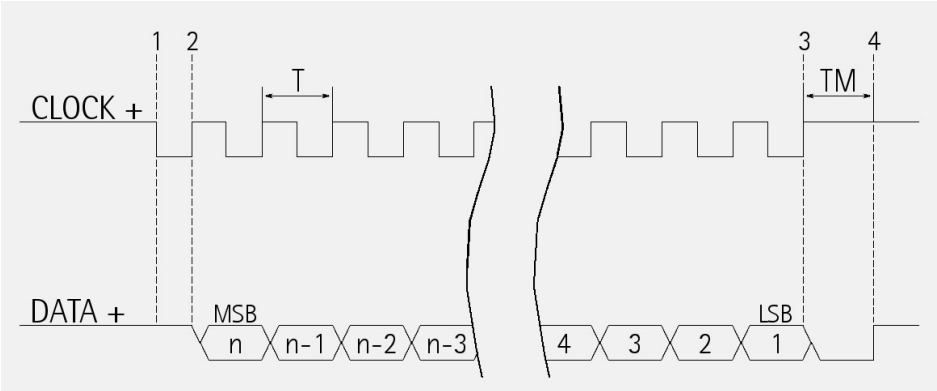
5.1 SSI (Synchronous Serial Interface)

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 by means of 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 monoflop 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 monoflop 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.

Model	Resolution	Max. length of the word	Max. number of information	Max. length of the travel
SMA21-BGx-0050-... **SMA21-GGx-0050-...** **SMA21-G1x-0050-...**	50 µm	21 bits	20 bits (1.048.576)	32,749 mm
SMA21-BGx-0010-... **SMA21-GGx-0010-...** **SMA21-G1x-0010-...**	10 µm	23 bits	22 bits (4.194.304)	32,749 mm
SMA21-BGx-0005-... **SMA21-GGx-0005-...** **SMA21-G1x-0005-...**	5 µm	24 bits	23 bits (8.388.608)	32,749 mm
SMA21-BGx-0002-... **SMA21-GGx-0002-...** **SMA21-G1x-0002-...**	2 µm	25 bits	24 bits (16.777.216)	32,749 mm
SMA21-BGx-0001-... **SMA21-GGx-0001-...** **SMA21-G1x-0001-...**	1 µm	26 bits	25 bits (33.554.432)	32,749 mm

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

Structure of the position information

SMA21-BGx-0050-... **SMA21-GGx-0050-...** **SMA21-G1x-0050-...**	**bit**	**20**	**...**	**1**	**0**
SMA21-BGx-0010-... **SMA21-GGx-0010-...** **SMA21-G1x-0010-...**	**bit**	**22**	**...**	**1**	**0**
SMA21-BGx-0005-... **SMA21-GGx-0005-...** **SMA21-G1x-0005-...**	**bit**	**23**	**...**	**1**	**0**
SMA21-BGx-0002-... **SMA21-GGx-0002-...** **SMA21-G1x-0002-...**	**bit**	**24**	**...**	**1**	**0**
SMA21-BGx-0001-... **SMA21-GGx-0001-...** **SMA21-G1x-0001-...**	**bit**	**25**	**...**	**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
SMA21-BGx-0050-...
resolution = 50 µm
detected counts = 123
position value = 123 * 50 = 6,150 µm = 6.15 mm

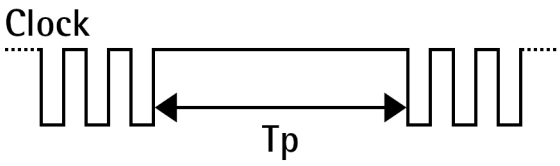
EXAMPLE 2
SMA21-BGx-0001-...
resolution = 1 µm
detected counts = 1,569
position value = 1,569 * 1 = 1,569 µm = 1.569 mm

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, the LED is off)
"0": an error is active, the diagnostic LED lights up red:

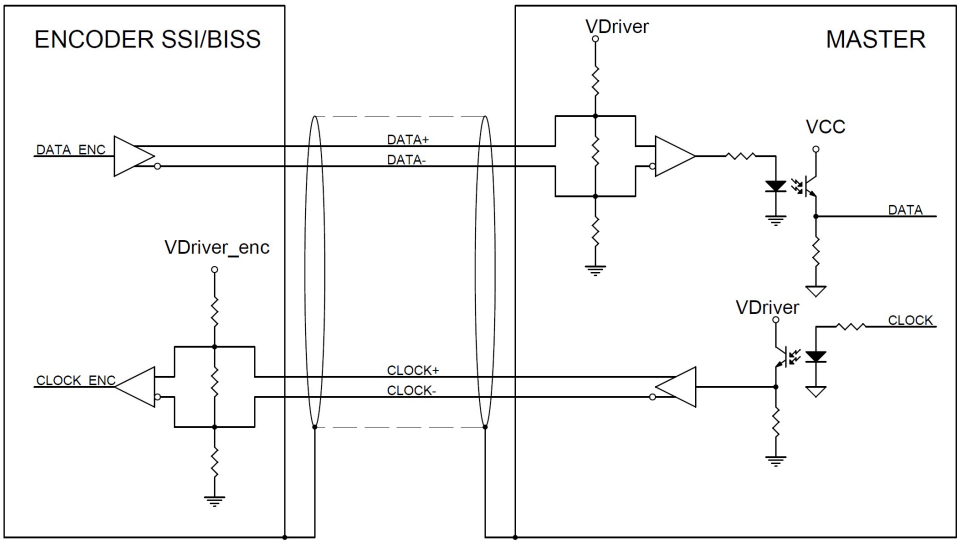
- reading error: the sensor is not able to read the scale correctly; among the possible causes are: the scale is not installed properly (for instance: the scale is mounted contrariwise to the sensor; or it is mounted upside down; see the "3 - Mounting instructions" section on page 11); the scale magnetic 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 20.

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 MTA-A154 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: SMA21-SCx-...

The SMA21 encoder 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.

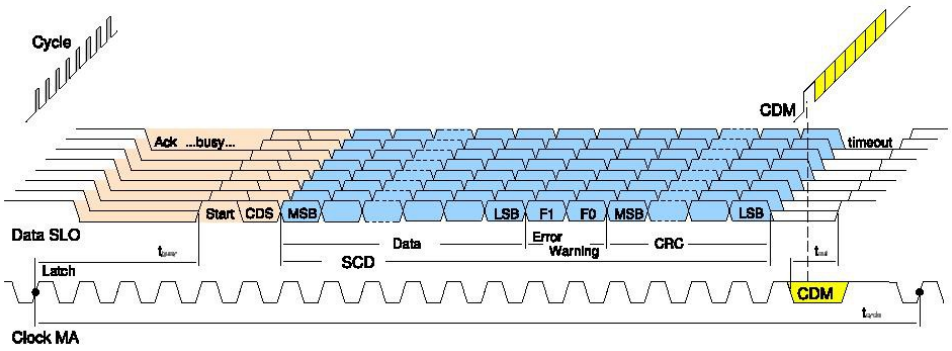
WARNING
Never connect the sensor in a "single Master - Multi Slave" network.

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

6.1 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 "6.2 Single Cycle Data" section on page 25.
- **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 "6.3 Control Data CD" section on page 27.



6.2 Single Cycle Data

SCD (32 bits) consists of the following values: 24-bit / 25-bit position value (**Position**, see also the Profile ID registers), 1 error bit (**Error**, nE), 1 warning bit (**Warning**, nW), and CRC checking (**CRC**, 6 bits).

SCD structure (for 50 µm to 2 µm resolution encoders):

bits	31 ... 8	7	6	5 ... 0
function	Position	Error	Warning	CRC

SCD structure (for 1 µm resolution encoder):

bits	32 ... 8	7	6	5 ... 0
function	Position	Error	Warning	CRC

Position

(24 bits for 50 µm to 2 µm resolution encoders; 25 bits for 1 µm resolution encoder, see also the Profile ID registers)
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).

SMA21-SCx-0050-...	**31 ... 28**	**27**	**...**	**8**	**bits**
SMA21-SCx-0010-...	**31 & 30**	**29**	**...**	**8**	
SMA21-SCx-0005-...	**31**	**30**	**...**	**8**	
SMA21-SCx-0002-...	**-**	**31**	**...**	**8**	
	0	MSB	...	LSB	**value**

SMA21-SCx-0001-...	**32**	**...**	**8**	**bits**
	MSB	...	LSB	**value**

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

EXAMPLE 1
SMA21-SCx-0050-..., **Absolute resolution** = 32 hex, 50 µm
detected counts = 123
position value = 123 * 50 = 6,150 µm = 6.15 mm

EXAMPLE 2
SMA21-SCx-0001-..., **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, the diagnostic LED is off)
= "0": error status: an error is active, the diagnostic LED lights up red:

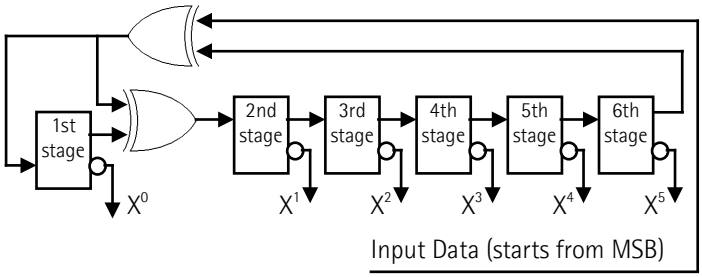
- reading error: the sensor is not able to read the scale correctly; among the possible causes are: the scale is not installed properly (for instance: the scale is mounted contrariwise to the sensor; or it is mounted upside down; see the "3 - Mounting instructions" section on page 11); the scale magnetic surface is damaged somewhere; the sensor is not working properly;
- frequency error: the sensor is travelling too fast on the scale.

Warning
(1 bit)
This is used along with the **Position control** register (see on page 33) to perform an automatic position control.

WARNING
The use of both the **Position control** register and this **Warning** bit is strictly reserved to Lika Electronic 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:



6.3 Control Data CD

For complete CD structure information please refer to the official BiSS documents: "Protocol description C-mode".
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).

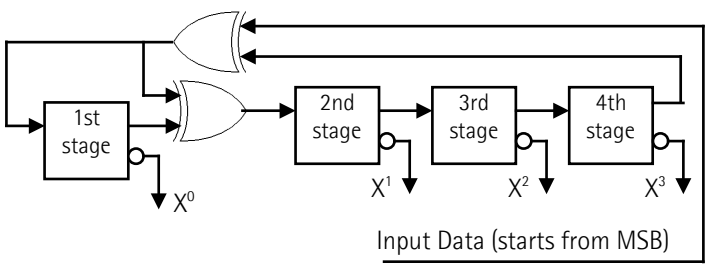
Data bit structure:

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:



6.4 Used registers

Register (hex)	Function
42 - 43	Profile ID
44 ... 47	Serial number
48	Command
49	Configuration
4D	Absolute resolution
50 ... 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.
It is: "Standard encoder profile", "data format", "Variant 0-24" for 50 µm to 2 µm resolution encoders.

Register	42	43	
Hex	28	14	SMA21-SCx-0050-...
		16	SMA21-SCx-0010-...
		17	SMA21-SCx-0005-...
		18	SMA21-SCx-0002-...

It is: "Standard encoder profile", "data format", "Variant 0-24++" for 1 µm resolution encoders.

Register	42	43	
Hex	28	19	SMA21-SCx-0001-...

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 Lika Electronic 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 which 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 Lika Electronic engineers are available on page 50. 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 min. 30 ms (EEPROM writing time) before using a new function.

Default = 00 (**Normal operation**)

Configuration

[49, rw]

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

*****: it affects the absolute position information, not the additional signals

Set preset / offset

This parameter is available only if the **Enable preset / offset** parameter is set to ENABLE (0). 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 must be set in the **Preset / Offset** register. After having enabled the preset / offset functions (**Enable preset / offset** = ENABLE), this item allows to activate 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 32.

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 sensor moving as indicated by the arrow in Figure 1. This parameter allows to reverse 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 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 to read the resolution of the absolute sensor.

32hex :	Resolution = 50 µm	(max position = 00 0F FF FFh, 20 bits)
0Ahex :	Resolution = 10 µm	(max position = 00 3F FF FFh, 22 bits)
05hex :	Resolution = 5 µm	(max position = 00 7F FF FFh, 23 bits)
02hex :	Resolution = 2 µm	(max position = 00 FF FF FFh, 24 bits)
01hex :	Resolution = 1 µm	(max position = 01 FF FF FFh, 25 bits)

Preset / Offset

[50 ... 53, rw]

This function is available only if the **Enable preset / offset** parameter in the **Configuration** register is set to ENABLE (0). Furthermore it has a double function depending on whether the **Set preset / offset** parameter in the **Configuration** register 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.

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 and 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 in 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 max 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 in the moment when the offset value is activated. To activate the offset, 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).

Preset / Offset structure:

Reg.	50	51	52	53
	MSB	...	...	LSB
	2^{31} - 2^{24}	2^{23} - 2^{16}	2^{15} - 2^{8}	2^{7} - 2^{0}

Use the **Save and activate Preset / Offset** function (set "02" in the register 48) to store and activate the new value.

The max. allowed Preset value depends on the set resolution:
resolution = 50 µm → max preset = 00 0F FF FFh (20 bits)
resolution = 10 µm → max preset = 00 3F FF FFh (22 bits)
resolution = 5 µm → max preset = 00 7F FF FFh (23 bits)
resolution = 2 µm → max preset = 00 FF FF FFh (24 bits)
resolution = 1 µm → max preset = 01 FF FF FFh (25 bits)

The Offset value must be less than or equal to the difference between the overall position information (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 = **08h**: BiSS C-mode linear encoder + AB /AB incremental signals

SINE-COSINE resolution

[58, ro]
This register describes the period of the Sine-Cosine signals.
Default = **00h**: no Sine-Cosine signals provided

Position control

[59, rw]
This is used in combination with the **Warning** bit (see on page 26) to perform an automatic position control.
Default = **00h**

WARNING
Do not change the value in this register, its use is strictly reserved to Lika Electronic technicians.

Device ID

[78 ... 7D, ro]

These registers contain the Device ID (name and hardware-software release). Identification name is expressed in hexadecimal ASCII code.
Registers 78 ... 7B show the name of the device.
Registers 7C and 7D show the hardware-software release.

Reg.	78	79	7A	7B	7C	7D
Hex	53	4D	32	31	xx	xx
ASCII	S	M	2	1	-	-

xx: hardware-software version

Manufacturer ID

[7E – 7F, ro]

These registers contain the Manufacturer ID. Identification name is expressed in hexadecimal ASCII code.

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

Li = Lika Electronic.

6.5 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

6.6 Examples

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

6.6.1 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

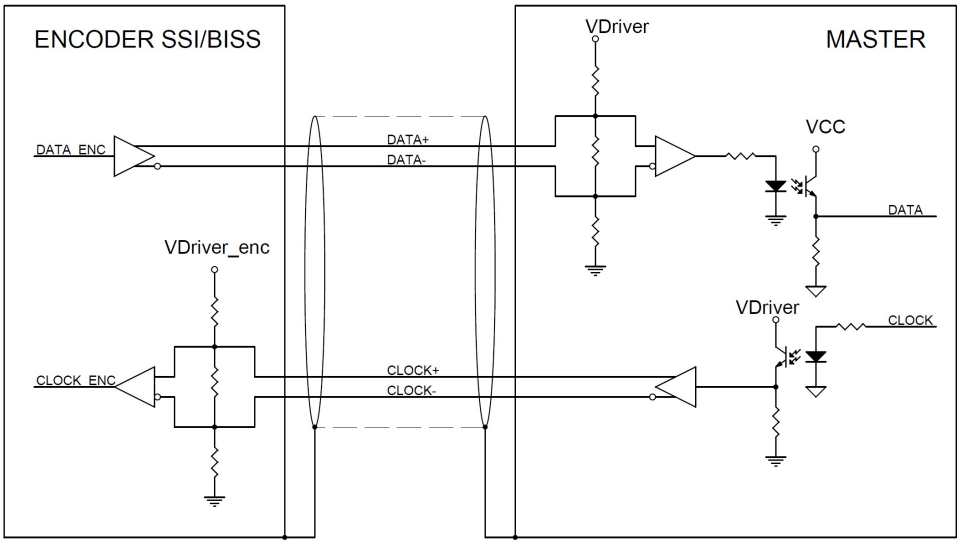
Function	ADR	DATA Tx
writing the Configuration register	49	60
Save parameters on EEPROM	48	01

6.6.2 Setting the Preset / Offset registers (50 ... 53)

After having enabled and chosen the PRESET function (**Enable preset / offset** = ENABLE; **Set preset / offset** = PRESET in the Configuration register, see the previous "6.6.1 Setting the Configuration register (49)") section, you want to set and activate the new Preset value = 100000_{10} = 00 01 86 A0h

Function	ADR	DATA Tx
writing the Preset / Offset registers	50	00
	51	01
	52	86
	53	A0
Save and activate Preset / Offset	48	02

6.7 Recommended BiSS input circuit



7 - Panasonic® RS-485 serial interface

Order code: SMA21-JP1-...

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 38
SF: Status Field, see the "7.3.2 Status Field" section on page 38
DF: Data Field, see the "7.3.3 Data Field" section on page 39
CRC: CRC Field, see the "7.3.4 CRC Field" section on page 42
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 39.

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 fixed value = "0".
ea0-ea1: encoder error status bits: they are set when an error or an alarm have 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. See **Signal on the strength alarm** and **Temperature alarm** in the "7.3.3.1 Encoder errors" section on page 40.
*	1	Encoder error. It is set because of an encoder failure or of 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 41. 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 40.

* 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 38.

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		

Blank field means that no byte is transmitted.
High bits that are not used have fixed value = "0".
ABS0-ABS5: 48 bit absolute positional data, ABS0 is the low byte, ABS5 is the high byte. 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 →

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 fixed value: 51h.
ENID2: encoder ID2, it has 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^2PROM. 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. 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. Positional data is reset to "0". 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^2PROM.

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 22 bit long position value:

23	22	Bit 21 ...	0
0	0	encoder positional data	

with 20 bit long position value:

23	22	21	20	Bit 19 ...	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

Generation algorithm is according to $G(X) = X^8 + 1$.
Data is configured in accordance with LSB first.
Calculation is executed by processing all bits except for 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 /AB incremental output signals

WARNING
AB /AB incremental output signals are provided in specific versions only, see the order code.

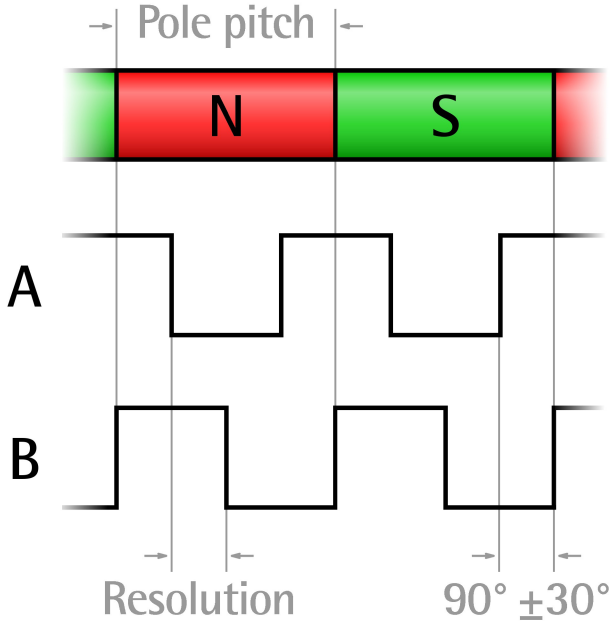
In addition to the absolute position information, the SMA21 sensor can provide AB /AB incremental signals through the Line Driver RS-422 output circuit.
I_{out} = 20 mA max.
The circuit is equipped with thermal and short-circuit protections.

Please note that in this case the MTA-A154 magnetic scale is fitted with two tracks: an absolute track on one side and a track for incremental signals on the other side (see Figure 1). Please always comply strictly with the mounting direction! For complete information refer to the "3 - Mounting instructions" section on page 11 and to the "4 - Electrical connections" section on page 15.

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)
SMA21-G1x-0050-... **SMA21-SCx-0050-...**	50	0.25	50	200	10	< 7
SMA21-G1x-0010-... **SMA21-SCx-0010-...**	10	0.25	250	1000	10	< 7
SMA21-G1x-0005-... **SMA21-SCx-0005-...**	5	0.25	500	2000	10	< 7
SMA21-G1x-0002-... **SMA21-SCx-0002-...**	2	0.25	580	2320	4.7	< 2.8
SMA21-G1x-0001-... **SMA21-SCx-0001-...**	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



Counting direction ⇨

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.

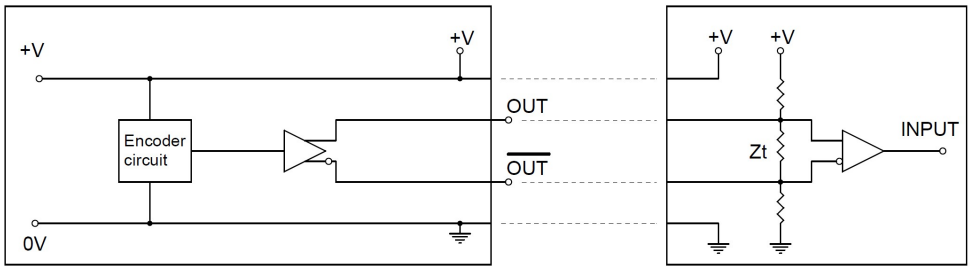
EXAMPLE
Let's suppose we have an SMA21-G1x-**0050**-... sensor
Resolution = 50 µm
Pole pitch size in µm = 2,000 µm (for all SMA21 devices)

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

Thus in the case of the SMA21-G1x-0050-... sensor, the system will provide 40 AB /AB edges per each pole.

NOTE
Please note that the **Counting direction** parameter available in the BiSS-C interface (see on page 31) affects the absolute position information, not the AB /AB incremental signals.

8.1 Recommended input circuit



I_{out} = 20 mA max.

Max. cable length = 150 m, 495 ft
The max. frequency allowed for the AB /AB signals depends on the length of the cable and the load applied.

The circuit is equipped with thermal and short-circuit protections.

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 the diagnostic LED lights up red and 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 11); 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 high logic level and the LED goes off;
- during operation the diagnostic LED lights up red and 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 11); the scale magnetic surface is damaged somewhere; the sensor is not working properly; furthermore, the alarm may be caused by a frequency error: the sensor is travelling too fast on the scale. The last valid position is "frozen" (kept in memory) until the next valid position is detected on the scale, the LED goes off.

9.1 Diagnostic LED

A two state OFF/ON LED is installed on the front side of the encoder.
When the diagnostic LED lights up red, it indicates that an error is active, such as for instance an incorrect alignment between the sensor and the scale:

- the gap between the sensor and the scale is out of tolerance (see Figure 2)
- the sensor is not installed properly
- the sensor or the scale are installed upside down
- the sensor is installed in the opposite direction to the one shown in the Figure 1
- the sensor is travelling too fast
- the power supply is not as required

NOTE
When the LED is off, it means that the sensor is working properly and the absolute position is output correctly. Please note that the additional signals affect the LED operation too.

In the SSI interface, the device status is transmitted via the error bit, see the "5.4 Error bit" section on page 22.
In the BiSS interface, the device status is transmitted via the **nE** error bit, see the **Error** bit on page 26.

In the Panasonic® RS-485 serial interface, the device status is transmitted via the Status Field SF, see the "7.3.2 Status Field" section on page 38.

NOTE

When the error bit has high logic level (SSI / BiSS interfaces: normal status, no alarm active) or the error / warning bits in the Status Field SF have 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 additional incremental signals.

For further information refer also to the "11 - Troubleshooting" section on page 49.

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 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 11.
- 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 met 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 short circuit or wrong connection.

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

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 travelling 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 46.

12 - Default parameters list

BiSS C-mode 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 00		

* All values are expressed in hexadecimal notation.

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Document release	Release date	Description	HW	SW	Interface
1.0	17.07.2023	First issue	-	-	-
1.1	10.11.2023	**Encoder inharmonious error** alarm removed	-	-	-
1.2	10.05.2024	Panasonic® information added to RS-485 serial interface	-	-	-

Dispose separately

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