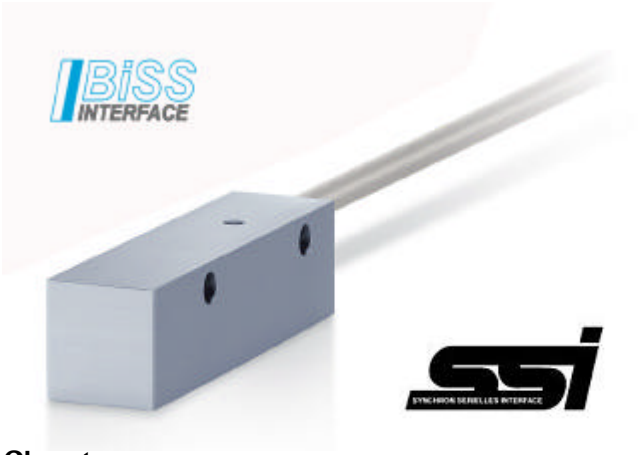
User manual

SMA1

Description

This manual describes the products of SMA1 series. The purpose of these sensors is to measure linear displacements on industrial machines and automation systems. The measurement system includes a magnetic tape and a magnetic sensor. The tape is magnetized with magnetic north-south poles. The poles are coded thus the magnetic tape is absolute. As the sensor is moved along the magnetic tape, it detects the displacement and produces an absolute SSI output or BiSS output signal (B-mode or C-mode) and an additional 1Vpp sin-cosine signal for speed feedback.
The sensor has to be matched with MTA1 magnetic tape.



Chapters

1 - Safety summary

Safety

- observe the professional safety and accident prevention regulations applicable to your country during device installation and operation;
- installation has to be carried out by qualified personnel only, without power supply and stationary mechanics parts;
- the device must be used only for the purpose appropriate to its design;
- high current, voltage and rotating parts can cause serious or fatal injury.

Electrical safety

- switch OFF the voltage before connecting the device;
- connect according to the chapter "Electrical connections";
- according to the 89/336/CEE norm on electromagnetic compatibility, following precautions must be taken:

  - before handling and installing, discharge electrical charge from your body and tools which may come in touch with the device;
  - power supply must be stable without noise, install EMC filters on device power supply if needed;
  - always use shielded and twisted cables if 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;
  - minimize noise by connecting shield or connector housing to ground (GND). Make sure that ground (GND) is not affected by noise. The shield 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.

Mechanical safety

- install according to the chapter "Mounting instructions" with stationary mechanics parts;
- do not disassemble the device;
- do not tool the device;
- do not subject the device to knocks or shocks;
- protect the system against solvents and substances damaging it;
- respect the environmental characteristics of the product;
- be sure that the system is mounted where hard or sharp objects (e.g. metal chips) do not come into contact with the magnetic tape and the bottom of the sensor head. If these conditions cannot be avoided provide a wiper or pressurized air.

2 - Identification

The device can be identified by the label's data (ordering code, serial number). This information is listed in the delivery document. For technical features of the product, refer to the technical catalogue.

3 - Mounting instructions

3.1 Magnetic tape

Install sensor and magnetic tape according to the above figure.
The arrow shows **standard counting direction**.
The system doesn't work if mounted incorrectly.

3.2 Sensor mounting

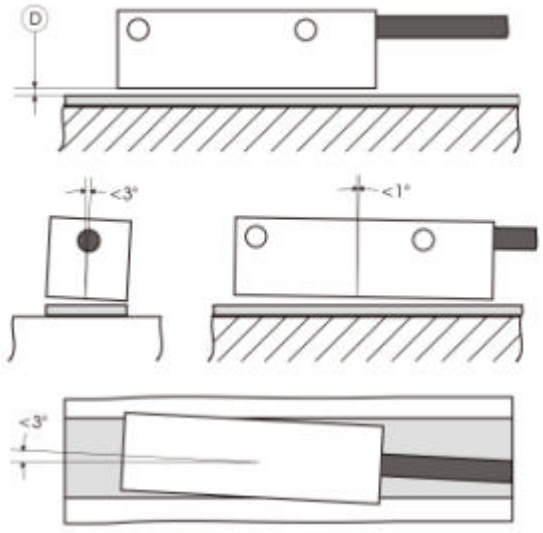


fig.6

Sensor can be fixed by means of two M4 screws over the buttonholes. Make sure that the gap between sensor and tape is in respect with (fig. 6) along the total measuring length. Avoid contact between the parts. You can check planarity and parallelism between sensor and magnetic tape using a feeler gauge.
The allowed gap (D) is 0.1 mm ÷ 0.3 mm (0.004" ÷ 0.012").
Do not use the cover strip, it would cause excessive gap between sensor and tape surface.

4 - Position errors diagnostics

In case of bad alignment between of the sensor on the tape, the following errors may occur during power-on or operation:

- during power-on: "LED on", invalid data could be transmitted until the sensor is correctly aligned (LED off);
- during operation: last valid position is freezed until the next valid position on the tape is detected.

4.1 Diagnostic LED

When lit, the LED indicates an incorrect alignment of the sensor to the tape, like:

- gap between sensor and tape out of tolerance (see fig. 6)
- incorrect installation of sensor
- sensor overlaps the tape

With BiSS interface, LED status is transmitted on **nE** bit.

Note:
"LED off" confirms correct detection of absolute position, but not correct detection of sine-cosine signals.

5 - Electrical connections

Connections

Colour	Function
Violet	Clock in +
Yellow	Clock in -
Grey	Data out +
Pink	Data out -
Green	A
Brown	/A
Red	B
Black	/B
Brown/ Green	+Vdc *
White/ Green	0Vdc GND
White	not connected
Blue	not connected

*: +10Vdc +30Vdc for standard SMA1
+5Vdc for SMA1-.../S188
+5Vdc for SMA1-.../S682

Specifications of the cable

T12 cable (TKD 4444)
Twisted pair 4 x 2 x 0,14mm^2 + 4 x 0,25mm^2
Screening : braided
Outside Ø : Ø 6.1 mm (Ø 0.24")
Resistance : according to DIN VDE 0295 class 6
according to IEC

6 - SSI interface
SMA1-BA-5-...
SMA1-GA-5-...

6.1 LSB right aligned protocol

The type of transmission protocol is "right aligned" with a length of 25 bits. The transmission starts with MSB (most significant bit) and ends with LSB (less significant bit).
The device uses 20 bits for the position, unused bits are set to 0 (zero).
The output code of the sensor can be GRAY or BINARY (see ordering code).
The measuring step is equal to the resolution (5µm).

Position structure:

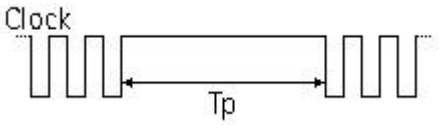
bit	24...20	19	...	0
value	00000	MSB	...	LSB

6.2 Recommended transmission rates

The SSI interface has a frequency of data transmission from 100 kHz to 1 MHz.
The CLOCK signal and DATA signal follow the "EIA standard RS-422".
The transmission rate (baud rate) depends on the length of cables.

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 16µs (Tp > 16µs).



7 - BiSS B-mode interface
SMA1-I7-.../S682

SMA1 is a slave device according to "BiSS B-mode interface" and "Standard encoder profile".
Refer to the official BiSS website for all information not listed in this manual (www.biss-interface.org).
The sensor works in point-to-point configuration, and has to be installed on a "single master, single slave" network (not on a "single master, multi slave" network).
CLOCK and DATA signals level are according to the "EIA standard RS-422".

7.1 Communication

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

- **Register Mode:** used to read or write data into the registers of the slave.
- **Sensor mode:** used to send process data from the slave to the master.

7.2 Register Mode

See official BiSS documents for complete structure.
Main control data is described in this chapter.

Register address (7 bits)
Specifies the register to read or write.

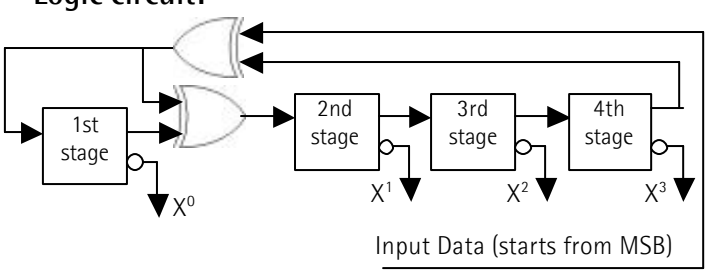
DATA (8 bit)
Write register: value to write into the register (transmitted from master to slave).
Read register: value read from the register (transmission from slave to master).

Data bit structure:

bit	7	...	...	0
	MSB	...	...	LSB

CRC (4 bits)
Correct transmission control (inverted output).
Polynomial: X^4+X^1+1 (binary: 10011)

Logic circuit:



7.3 Sensor mode

Sensor mode (32 bits) is composed by position value, 1 error bit (nE), 1 warning bit (nW) and CRC checking (6 bits).

Sensor data structure:

Start	DATA				Stop
	31...8	7	6	5...0	
	position	error	warning	CRC	

Attention: Multi-Cycle-Data bit (MCD) is not used, the master mustn't ask it!

Position (24 bits)
Process data transmitted from slave to master.
The transmission starts with MSB (most significant bit) and ends with LSB (less significant bit).

bit	31...28	27	...	8
value	0000	MSB	...	LSB

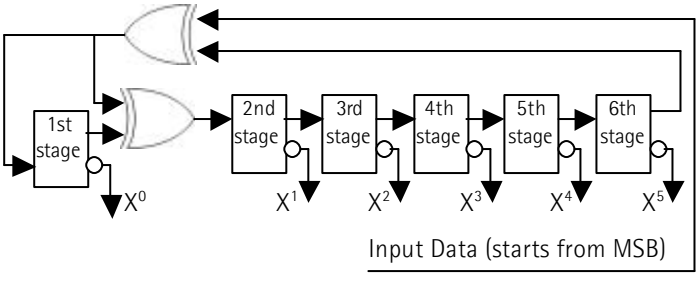
To see position value in mm, multiply the data value received for the resolution (see 4Dhex register).

Error (1 bit)
Communicates an error of the slave.
nE = "1": correct status (no error)
= "0": error status: tape not read.
Check gap between sensor and tape, planarity and parallelism of the system.

Warning (1 bit)
Not used (nW = "1")

CRC (6 bits)
Correct transmission control (inverted output).
Polynomial: X^6+X^1+1 (binary: 1000011)

Logic circuit:



7.4 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	SIN/COS resolution
78...7D	Device ID
7E...7F	Manufacturer ID

All registers in this chapter are listed according to the following outline:

Address Function name [access]
Description of the function and default value.
- Address: register address in hexadecimal values.
- Access: ro = read only
  rw = read and write
  wo = write only
- Default parameter values are written in **bold**.

42...43 Profile ID [ro]
These registers contain the identification code of the used profile.

Register	42	43
Hex	28	14

See "Standard encoder profile", "data format", "Variant 0-24".

44...47 Serial number [ro]
These registers contain the serial number (hex value) of the device.
reg.44: year of production
reg.45: week of production
reg.46, 47: progressive serial number

48 Command [wo]

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

This register will set back to "00" automatically.
Wait min. 30ms (EPROM writing time) before using the next function.

49 Configuration [rw]

Bit	Function	bit=0	bit=1
0	SELSSI	**BiSS**	SSI
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		

*: related to absolute position (not to sin/cos signal)

The new setting will be active immediately after transmission. Use the function "Save parameters" (set "01" register 48) to store the new value.
Default = **20h**

4D Absolute resolution [rw]
Contains the resolution of absolute sensor.
64hex : Res.=0.1mm (max position = 00 FF FFh)
32hex : Res.=0.05mm (max position = 01 FF FFh)
0Ahex : Res.=0.01mm (max position = 07 FF FFh)
05hex : Res.=0.005mm (max position = 0F FF FFh)

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

After the modification of reg.4D Preset and Offset values have to be updated according to the new resolution!
Default = **05h**.

51...53 Preset/Offset [rw]
This function has to be enabled by setting reg.49 bit 2 = "0". Setting of Preset or Offset register can be carried out only when the sensor is not moving.

Preset: any desired position value can be set (e.g. "0", zero setting)
Offset: adds an offset to actual position.
Position = actual position + Offset.

Preset/Offset structure:

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

Use the function "Save and activate Preset/ Offset" (set "02" register 48) to store and activate the new value.
The max. allowed Preset values are depending on the resolution.

resolution = 0.1 → max preset =00 FF FFh (16bit)
resolution = 0.05 → max preset =01 FF FFh (17bit)
resolution = 0.01 → max preset =07 FF FFh (19bit)
resolution = 0.005→ max preset =0F FF FFh (20bit)
Default = **00h**.

55 Device type [ro]
Describes the type of device.
Default = **06h**: linear encoder BiSS + SIN/COS

58 SIN/COS resolution [ro]
Describes the period of sin/cos signal
Default = **01h**: resolution = 1mm

78...7D Device ID [ro]
These registers contain the Device ID.

Reg.	78	79	7A	7B	7C	7D
Hex	53	4D	41	31	xx	xx
ASCII	S	M	A	1	-	-

xx: software version

7E...7F Manufacturer ID
These registers contain the Manufacturer ID.

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

Li = Lika Electronic.

7.5 Application note
Device communication characteristics:

Parameter	Min	Max
Clock Frequency Sensor Mode	350KHz	10MHz
Clock Frequency Register Mode	50KHz	250KHz
Timeout Sensor Mode	1.5µs	3.5µs
Timeout Register mode	15.5µs	17.5µs

7.6 Examples
All values are hexadecimal.

Set configuration register:
DATA Tx = 06h: set preset, Binary output code, inverted counting direction.

Function	ADR	DATA Tx
write register	49	60
save parameters	48	01

Set Preset:
Preset = 01 86 A0h

Function	ADR	DATA Tx
write register	51	01
	52	86
	53	A0
save and active Preset	48	02

8 - BiSS C-mode interface
SMA1-I7-... standard

SMA1 is a slave device according to "BiSS C-mode interface" and "Standard encoder profile".
Refer to the official BiSS website for all information not listed in this manual (www.biss-interface.org).
The sensor works in point-to-point configuration, and has to be installed on a "single master, single slave" network (not on a "single master, multi slave" network).
CLOCK and DATA signals level are according to the "EIA standard RS-422".

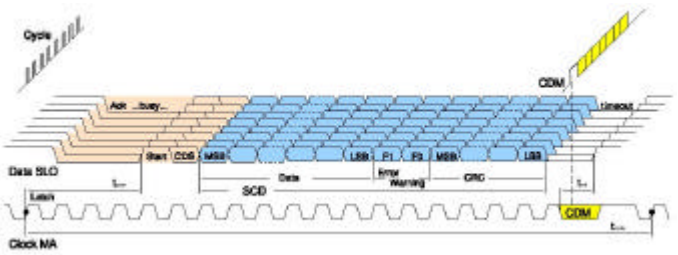
8.1 XML file

The product is supplied with XML file **idbiss4C69.xml** (see enclosed support or **www.lika.biz > PRODUCTS > LINECOD > SMA1**).
Install XML file on BiSS master device.

8.2 Communication

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

- **Single Cycle Data (SCD):** is the primary data transmission protocol. It's used to send process data from the slave to the master.
- **Control Data (CD):** transmission of a single bit following the SCD data. It is used to read or write data into the registers of the slave.



8.3 Single Cycle Data

SCD (32 bits) is composed by position value, 1 error bit (nE), 1 warning bit (nW) and CRC checking (6 bits).

SCD structure:

bits	31...8	7	6	5...0
function	position	error	warning	CRC

Position (24 bits)

Process data transmitted from slave to master.
The transmission starts with MSB (most significant bit) and ends with LSB (less significant bit).

bit	31...28	27	...	8
value	0000	MSB	...	LSB

To see position value in mm, multiply the data value received for the resolution (see 4Dhex register).

Error (1 bit)

Communicates an error of the slave.
nE = "1": correct status (no error)
= "0": error status: tape not read.
Check gap between sensor and tape, planarity and parallelism of the system.

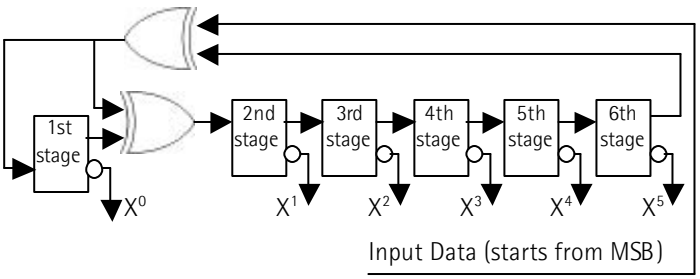
Warning (1 bit)

Not used (nW = "1")

CRC (6 bits)

Correct transmission control (inverted output).
Polynomial: X^6+X^1+1 (binary: 1000011)

Logic circuit:



8.4 Control Data CD

See official BiSS documents for complete CD structure: "Protocol description C-mode".
Main control data is described in this chapter.

Register address (7 bits)
Specifies the register to read or write.

RW (2 bits)
RW = "01" : write register
RW = "10" : read register

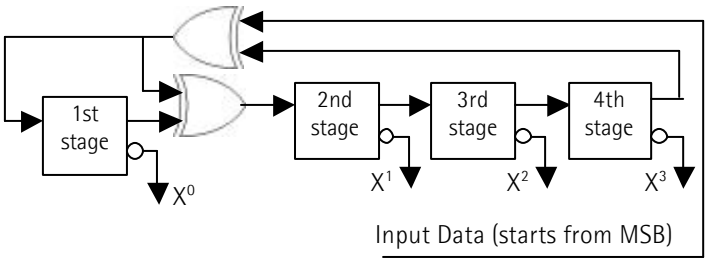
DATA (8 bit)
Write register: value to write into the register (transmitted from master to slave).
Read register: value read from the register (transmission from slave to master).

Data bit structure:

bit	7	...	...	0
	MSB	...	...	LSB

CRC (4 bits)
Correct transmission control (inverted output).
Polynomial: X^4+X^1+1 (binary: 10011)

Logic circuit:



8.5 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	SIN/COS resolution
78...7D	Device ID
7E...7F	Manufacturer ID

All registers in this chapter are listed according to the following outline:

Address Function name [access]
Description of the function and default value.
- Address: register address in hexadecimal values.
- Access: ro = read only
  rw = read and write
  wo = write only
- Default parameter values are written in **bold**.

42...43 Profile ID [ro]
These registers contain the identification code of the used profile.

Register	42	43
Hex	28	14

See "Standard encoder profile", "data format", "Variant 0-24".

44...47 Serial number [ro]
These registers contain the serial number (hex value) of the device.
reg.44: year of production
reg.45: week of production
reg.46, 47: progressive serial number

48 Command [wo]

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

This register will set back to "00" automatically.
Wait min. 30ms (EPROM writing time) before using the next function.

49 Configuration [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		

*: related to absolute position (not to sin/cos signal)

The new setting will be active immediately after transmission. Use the function "Save parameters" (set "01" register 48) to store the new value.
Default = **20h**

4D Absolute resolution [rw]
Contains the resolution of absolute sensor.
64hex : Res.=0.1mm (max position = 00 FF FFh)
32hex : Res.=0.05mm (max position = 01 FF FFh)
0Ahex : Res.=0.01mm (max position = 07 FF FFh)
05hex : Res.=0.005mm (max position = 0F FF FFh)

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

After the modification of reg.4D Preset and Offset values have to be updated according to the new resolution!
Default = **05h**.

51...53 Preset/Offset [rw]
This function has to be enabled by setting reg.49 bit 2 = "0". Setting of Preset or Offset register can be carried out only when the sensor is not moving.

Preset: any desired position value can be set (e.g. "0", zero setting)
Offset: adds an offset to actual position.
Position = actual position + Offset.

Preset/Offset structure:

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

Use the function "Save and activate Preset/ Offset" (set "02" register 48) to store and activate the new value.
The max. allowed Preset values are depending on the resolution.

resolution = 0.1 → max preset =00 FF FFh (16bit)
resolution = 0.05 → max preset =01 FF FFh (17bit)
resolution = 0.01 → max preset =07 FF FFh (19bit)
resolution = 0.005→ max preset =0F FF FFh (20bit)
Default = **00h**.

55 Device type [ro]
Describes the type of device.
Default = **06h**: linear encoder BiSS + SIN/COS

58 SIN/COS resolution [ro]
Describes the period of sin/cos signal
Default = **01h**: resolution = 1mm

78...7D Device ID [ro]
These registers contain the Device ID.

Reg.	78	79	7A	7B	7C	7D
Hex	53	4D	41	31	xx	xx
ASCII	S	M	A	1	-	-

xx: software version

7E...7F Manufacturer ID
These registers contain the Manufacturer ID.

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

Li = Lika Electronic.

8.6 Application note

Data transmission:

Parameter	Value
Clock Frequency	min 200KHz, max 10MHz
BiSS Timeout	auto adaptation to clock, max 16µs
Internal position update frequency	6KHz

8.7 Examples

All values are hexadecimal.

Set configuration register:

DATA Tx = 06h: set preset, Binary output code, inverted counting direction.

Function	ADR	DATA Tx
write register	49	60
save parameters	48	01

Set Preset:

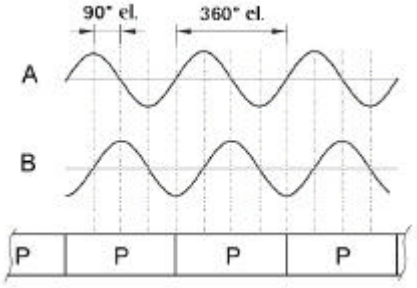
Preset = 01 86 A0h

Function	ADR	DATA Tx
write register	51	01
	52	86
	53	A0
save and active Preset	48	02

9 - 1Vpp sine/cosine output signals

The frequency of output signals is proportional to the displacement speed of the sensor.

A and B signals (standard counting direction)

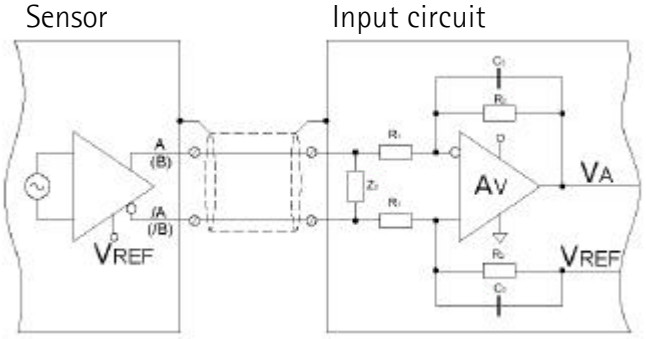


P is the electrical period length:
P = 1mm

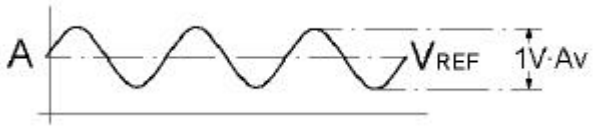
9.1 Output signals voltage level

The voltage level refers to the difference between normal and inverted signal (differential).

Recommended input circuit:

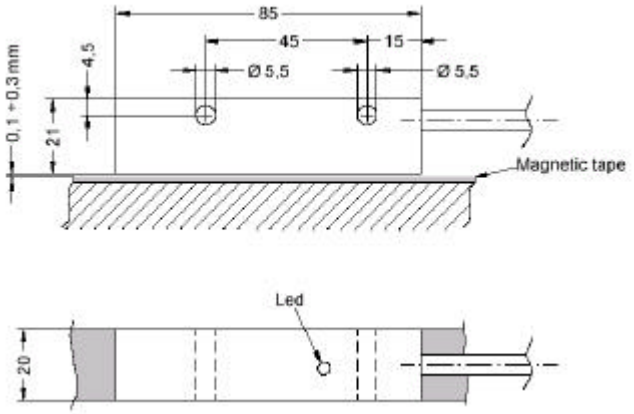


V_{REF} = 2,5V ± 0,5V V_A = 1Vpp · Av Av = R2/R1



10 - Dimensional drawing

Sensor and tape



11 - Maintenance

The magnetic measurement system doesn't need any particular maintenance but as with all precision devices it must be handled with care. From time to time we recommend the following operations:

- check the gap between sensor and magnetic tape along the measuring length. Wear of the machine may increase the tolerances;
- the surface of the magnetic tape should occasionally be cleaned using a soft cloth to remove dust, chips, moisture etc.

12 - Troubleshooting

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

Problem:
The system doesn't work (no pulse output):

- The tape or sensor has been mounted incorrectly (the active part of the tape doesn't face the sensor's active side). See chapter 3 for correct installation. **LED is lighted**.
- A magnetic piece or tape is in between the sensor and the tape. Only non-magnetic materials are allowed between sensor and tape. **LED is lighted.**
- The sensor touches the tape because tolerance gap between sensor and tape are not observed. Check sensor's active side if damaged.
- The sensor has been damaged by short circuit or wrong connection.

Problem:
The measured values are inaccurate or not present at some positions:

- The gap between sensor and tape is not observed along the total measurement length (see chap. 4) or the sensor is not mounted correctly to the tape (see chap. 3). LED is lighted.
- The connection cable runs near to high voltage cables or the shield is not connected correctly.
- The frequency of your clock is set too high or too low and the sensor cannot synchronize correctly (see chap. 6).
- A section of the magnetic tape has been damage mechanically or magnetically along the measuring length.
- The measuring error is caused by torsion of the machine structure. Check parallelism and symmetry of machine movement.

Rev.	Man.Vers.	Description
0	1.0	1^ issue
1	1.1	Add CRC calculations (chap.6.1.5) "Operating parameters": default=0
2	1.2	Chap.5 update
0	2.0	SW update
1	2.1	Add SSI interface Electrical connections (chap.5) update
2	2.2	Note about MCD bit (chap.7.3)
3	2.3	Chap. 6 update

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