GEFRAN

LS-A

Contactless linear position transducer with TWIIST technology
(Analog outputs)

Cod. 80722 Edit.09/2022 - ENG

REVISION HISTORY

Rev 0	09 - 2022	First release

SUMMARY

1. INTRODUCTION

The Gefran LSA is a linear position sensor with analog outputs:

- Current (i.e., 4...20 mA, 20...4 mA)
- Voltage (i.e., 0...10 V, 10...0 V, 0.5...4.5 V, 4.5...0.5 V)
- Ratiometric (i.e., 10...90% Vsupply, 90...10% Vsupply)

1.1. Working principle

Gefran LSA sensor exploits the patented TWIIST technology. The main components of this technology are the helical magnet and the triaxial Hall effect IC, as shown in Figure 1: the helical magnet, that composes the magnetic core, and the triaxial Hall effect IC, included in the sensor rod.

From the mathematical description of the helix, a unique pair of magnetic field values Bx, Bz is identified for each measurement position. The arctangent of the ratio between Bx and Bz identifies the rotation angle of the helix, corresponding to the measured position p.

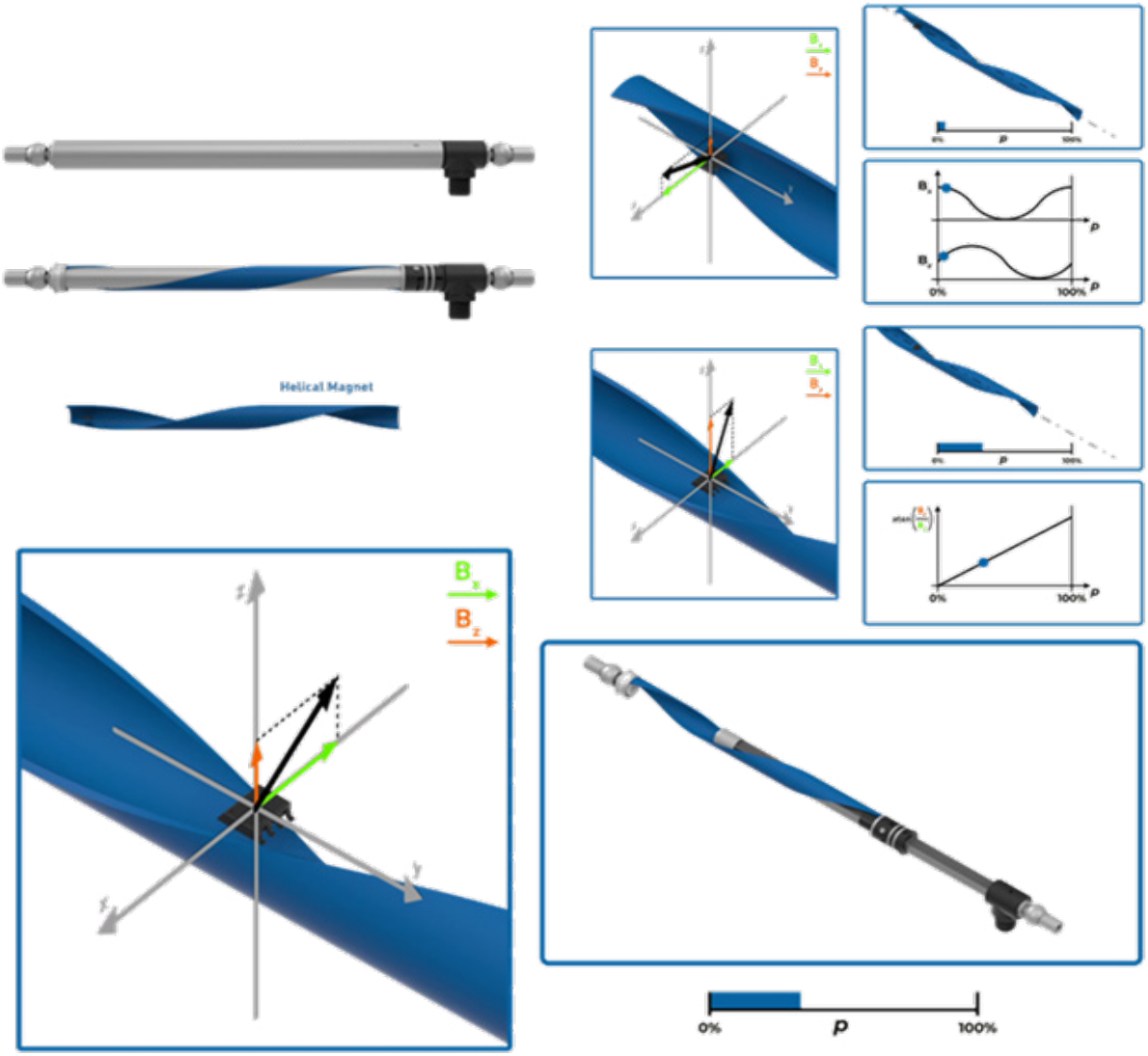


Figure 1. Working principle of position measurement

Gefran LSA sensor is proposed in single architecture for all analog versions; in addition, full redundant architecture is available for ratiometric output version.

Full redundant architecture allows to obtain two independent position measurements. Therefore, the block diagram of the sensor includes two independent Hall-effect primary elements, conditioning electronics and power management circuits.

Single and redundant architecture are represented in Figure 2 and Figure 3 respectively.

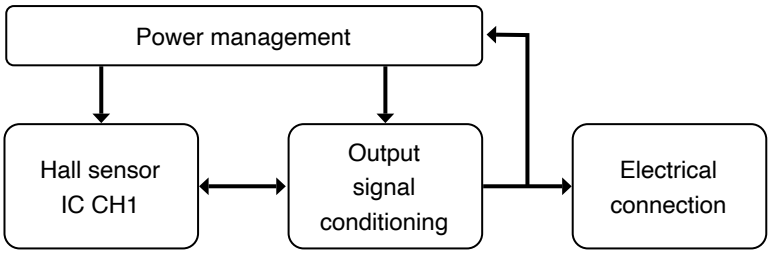


Figure 2. Single architecture description: block diagram

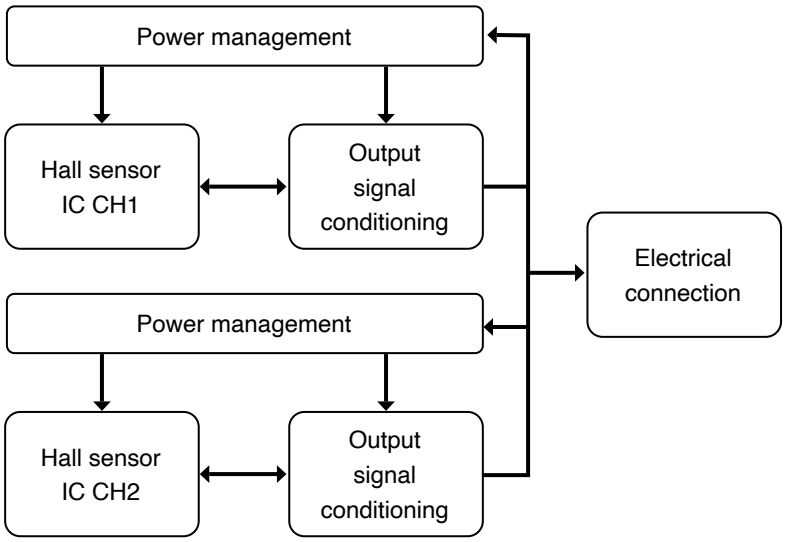


Figure 3. Full redundant architecture description: block diagram

In Figure 4 and Figure 5 two examples of position measurement performed with the Gefran LSA sensor are presented.

The sensor is fixed at both ends to the process to be measured. It does not matter which end moves and which one remains fixed. The sensor will detect the sliding of the magnetic core on the rod, connected at the end with the electrical connection, as an absolute position measurement. The magnetic core can slide on the sensor rod for a length equal to the stroke (FS).

For safety reasons about 1,5 mm of overtravel have been included. Below the ZERO position (0 mm), the sensor will provide negative saturation values. Similarly, above FS the sensor will provide positive saturation values. In order not to irreparably damage the sensor, please do not move the cursor beyond the overtravel thresholds.

Table 1 indicates the output values produces by LSA sensor at ZERO position (0 mm), as shown in Figure 4:

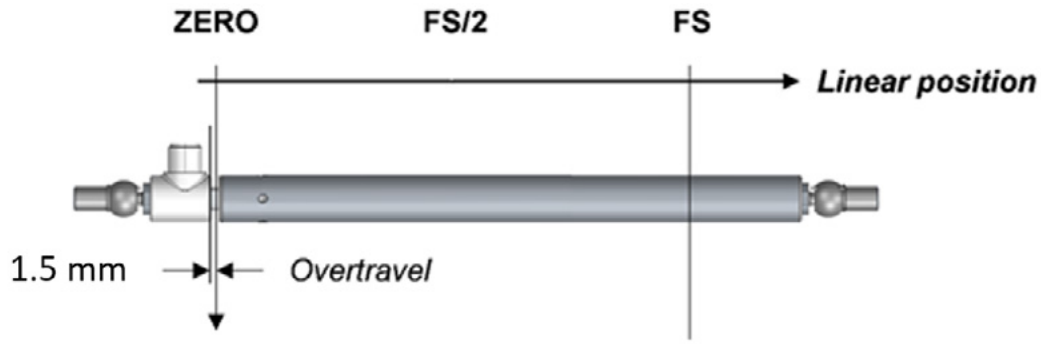


Figure 4. Example of position measurement: ZERO position

Table 1. Output signal for different LSA versions

Version	Output signal value at ZERO position
4…20 mA	4 mA
20…4 mA	20 mA
0…10 V	Typical 25 mV
10…0 V	10 V considering voltage supply > 11 Vdc 10 V -0.025 V considering 10 Vdc voltage supply
0.5…4.5 V	Typical 25 mV
4.5…0.5 V	5 V
10…90% Vsupply	0.5 V considering 5 Vdc voltage supply
90…10% Vsupply	4.5 V considering 5 Vdc voltage supply

Table 2 indicates the output values produces by LSA sensor at FS position, as shown in Figure 5:

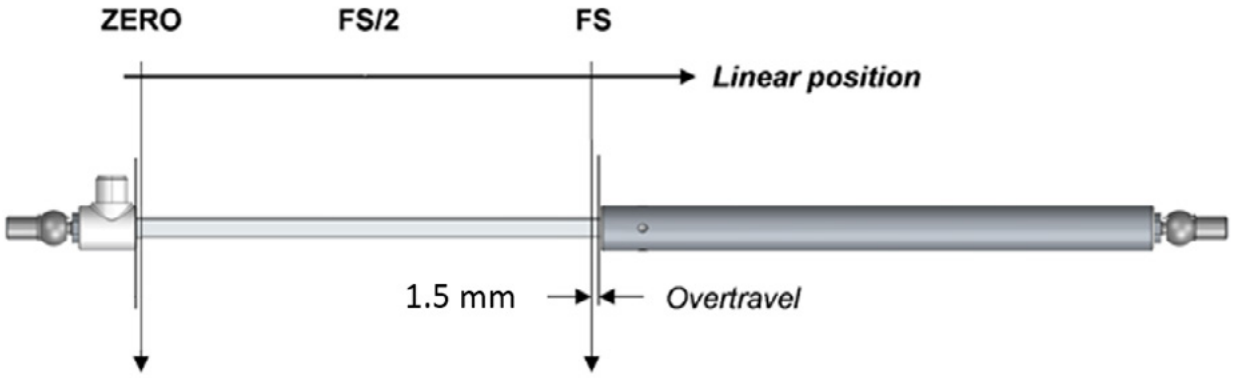


Figure 5. Example of position measurement: FS position

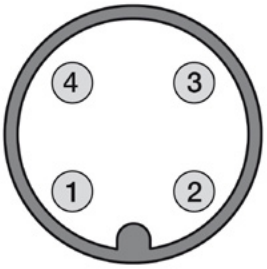
Table 2. Output signal for different LSA versions

Version	Output signal value at FS position
4…20 mA	20 mA
20…4 mA	4 mA
0…10 V	10 V considering voltage supply > 11 Vdc 10 V -0.025 V considering 10 Vdc voltage supply
0.5…4.5V	4.5 V
4.5…0.5 V	0.5 V
10…0 V	Typical 25 mV
10…90% Vsupply	4.5 V considering 5 Vdc voltage supply
90…10% Vsupply	0.5 V considering 5 Vdc voltage supply

2. ELECTRICAL CONNECTIONS

The LSA can have different output connectors, pinout is described from Figure 6 to Figure 8. In particular:

- M12 4 poles connector
- M12 5 poles connector
- M12 8 poles connector (only for redundant ratiometric output version)



PIN	M12 5 pole connector
1	V+
2	OUT
3	V-
4	TEST*

Figure 6. M12 4 poles connections

Note: TEST*: test pin for internal use, it must not be connected.

PIN	M12 5 pole connector
1	V+
2	OUT
3	V-
4	TEST*
5	N.C. (not internally conn.)

Figure 7. Figure 7 - M12 5 poles connections

Note: TEST*: test pin for internal use, it must not be connected.

PIN	M12 5 pole connector
1	V+ CH1
2	OUT VH1
3	V- CH1
4	TEST* CH1
5	V+ CH2
6	OUT CH2
7	V- CH2
8	TEST* CH2

Figure 8. M12 8 poles connections

Note: TEST*: test pin for internal use, it must not be connected.

Note: Pins from 1 to 4 are related to channel 1 (CH1) while pins from 5 to 8 are related to channel 2 (CH2).

During installation, load condition has to be verified. In particular:

- Current version:
  - a load resistance is recommended < 500 Ω when operating up to 15 Vdc power supply.
  - a load resistance is recommended < 200 Ω when operating from 15 Vdc to 32 Vdc power supply.
- Voltage version: a load resistance is recommended > 10 Ω
- Ratiometric version: a load resistance is recommended > 10 Ω

In addition, please consider the following general precautions:

- The system must be used only in accordance with the required protection level.
- The sensor must be protected against accidental knocks and used in accordance with the instrument's ambient characteristics.
- To prevent interference, separate the power cables from signal cables.

3. OUTPUT SIGNAL

In this section graphs of principal output signals, considering available versions, are presented.

3.1. Current output 4…20 mA

In the input range given by ZERO position (0 mm) and full-scale (FS), the output signal ranges between 4 and 20 mA.

As represented in Figure 9, below the ZERO position (0 mm) the sensor will provide negative saturation values (output value smaller than 4 mA). Similarly, above FS the sensor will provide positive saturation values (output value higher than 20 mA).

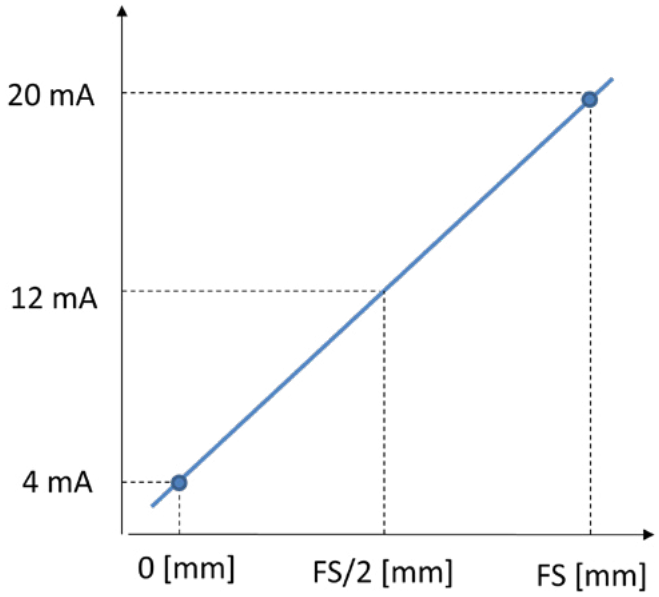


Figure 9. Current output 4…20 mA

3.2. Voltage output 0…10 V

In the input range given by ZERO position (0 mm) and full-scale (FS), the output signal ranges between 0 and 10 V.

As represented in Figure 10 Figure 12, below the ZERO position (0 mm) the sensor will provide negative saturation values (negative saturation value is not 0 V, typical it is 25 mV). Similarly, above FS the sensor will provide positive saturation values (output value higher than 10 V).

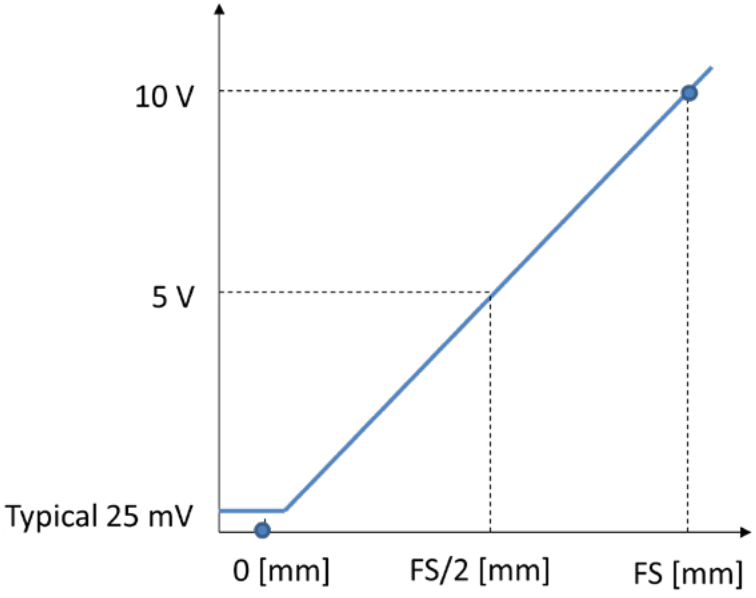


Figure 10. Voltage output 0...10 V

Note: Output signal presents a negative saturation value which is typical around 25 mV.

Note: Output voltage of 10 V, or higher values in case of positive saturation, is guaranteed only when power supply is higher than 11 *Vdc.*

When voltage supply is less than 11 *Vdc*, output voltage will saturate to a typical value given by voltage supply minus 25 *m*V.

For example, Figure 11 represents output voltage considering 10 Vdc voltage supply; positive saturation output is equal to 10 *V* - 0.025 *V* while negative saturation output is equal to 0.025 *V*.

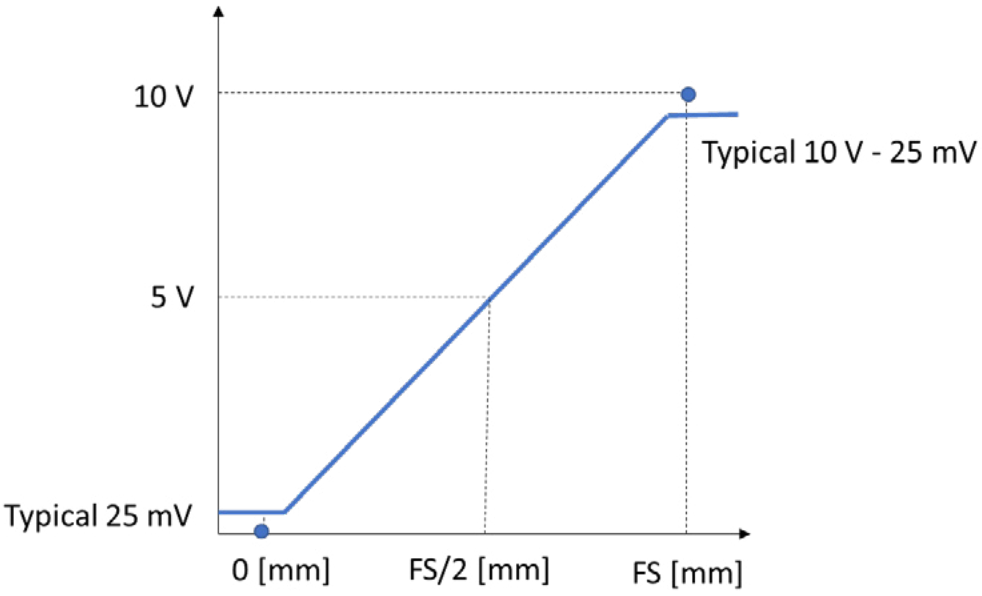


Figure 11. Ratiometric output 0.5...4.5 V considering 5 Vdc voltage supply

Note: Sensitivity is given by the position full-scale in millimeter divided by the voltage output full-scale, as calculated by the formula:

$$\text{Sensitivity} \left[\frac{\text{mm}}{\text{V}}\right] = \frac{\text{FS } [mm]}{10\ \text{V}}$$

3.3. Voltage output 0.5…4.5 V

In the input range given by ZERO position (0 mm) and full-scale (FS), the output signal ranges between 0.5 and 4.5 V.

As represented in Figure 12, below the ZERO position (0 mm) the sensor will provide negative saturation values (output value smaller than 0.5 V). Similarly, above FS the sensor will provide positive saturation values (output value higher than 4.5 V).

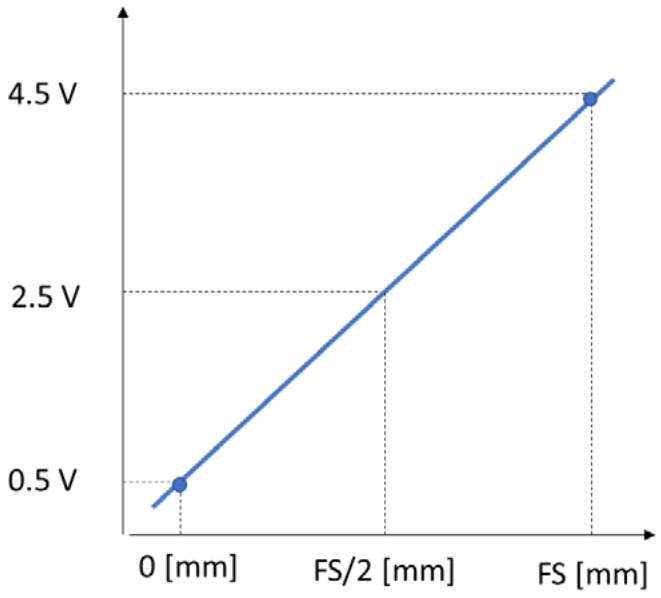


Figure 12. Voltage output 0.5...4.5 V

3.4. Ratiometric output 10…90% Vsupply

In the input range given by ZERO position (0 mm) and full-scale (FS), the output signal ranges between 10 and 90% of voltage supply.

Considering for example 5 Vdc voltage supply, below the ZERO position (0 mm) the sensor will provide negative saturation values (output value smaller than 0.5 V) as represented in Figure 13.

Similarly, above FS the sensor will provide positive saturation values (output value higher than 4.5 V).

Note: For ratiometric version, voltage supply is 5 *Vdc* ± 10%. For definition, variations of power supply voltage produce variations of the output voltage.

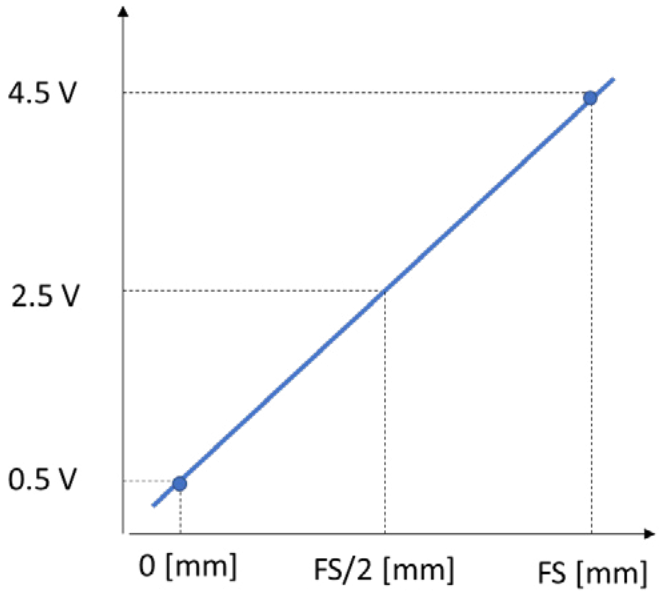


Figure 13. Ratiometric output 0.5...4.5 V considering 5 Vdc voltage supply

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