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Absolute Angle Encoder

“GMI-ANGLE” Series

based on the

Giant Magneto Impedance (GMI) principle

Technical Datasheet

2023-06 - rev03

www.flux.gmbh

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1. GMI-ANGLE encoders

The **GMI-ANGLE** series of axial, absolute, frameless, angle encoders from FLUX GmbH offers motor feedback solutions for a wide range of applications, fitting optimally in designs that require precise positioning with exact velocity and torque control.

The **GMI-ANGLE** series of axial encoders incorporates the FLUX patented GMI (Giant Magneto Impedance) position sensor to deliver high performance feedback as part of a closed loop motion control system.

The GMI position sensor technology and encoder architecture, developed and manufactured by FLUX, are the result of 40+ years experience in encoder development and manufacturing. It addresses in a purposeful and compact manner motion control feedback design requirements calling for:

High Accuracy:

- Better than ± 4 arc sec guaranteed accuracy
- Accuracy achievable even with as much as ± 0.15mm (±0.006”) mechanical eccentricity of the rotating Ring Scale (Rotor)
- Accuracy achievable even with as much as ± 0.15mm (±0.006”) mechanical displacement of the Encoder Stator relative to the Encoder Rotor

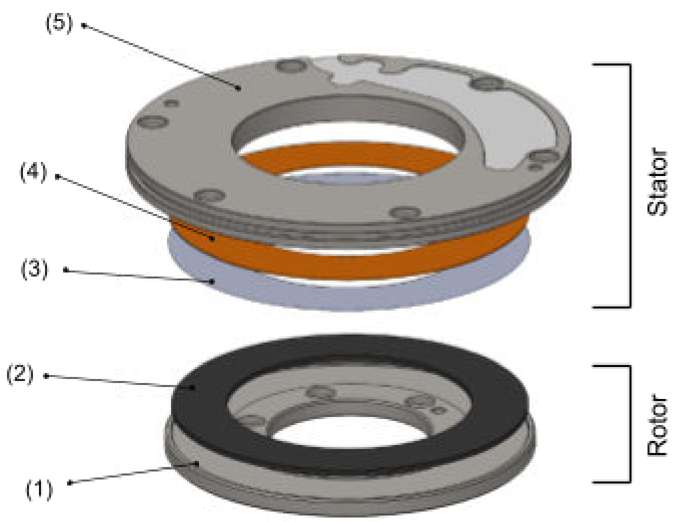
Ease of Installation:

- Air gap between Ring Scale (Rotor) and Encoder Head (Stator): 0.3 ± 0.3mm (0.012 ±0.012”)
- Ring Scale can be installed directly onto the Rotary Table Mounting Hub with screws. No special heating, cooling or press-fitting required.
- There are two dowel pin holes in each device, rotor and stator, for quick and easy centering and mounting. Alternatively, the fit of the inner or outer diameter can be used. The air gap between stator and rotor can be adjusted by using a 0.30 mm spacer foil.
- Status LED light informs installer of GOOD/BETTER/BEST alignment
- No special electronics required to verify proper Encoder installation.
- Does not require any signal- or accuracy calibration. High Accuracy and High Performance achieved via 360° sensing of the Ring Scale grating and dynamic signal compensation.

Simple Field Service:

- Ring Scale and Encoder Head do not need to be matched as a set. Replacement of one does not require replacement of both.
- In-field service can be done as simply as described above without any special electronic tools

1.1. Giant Magneto Impedance principle (simplified)



Encoder rotor
(1) Metall carrier
(2) Absolute magnetic ring

Encoder stator
(3) GMI layer
(4) Absolute GMI sensor
(5) Metal housing and evaluation electronic

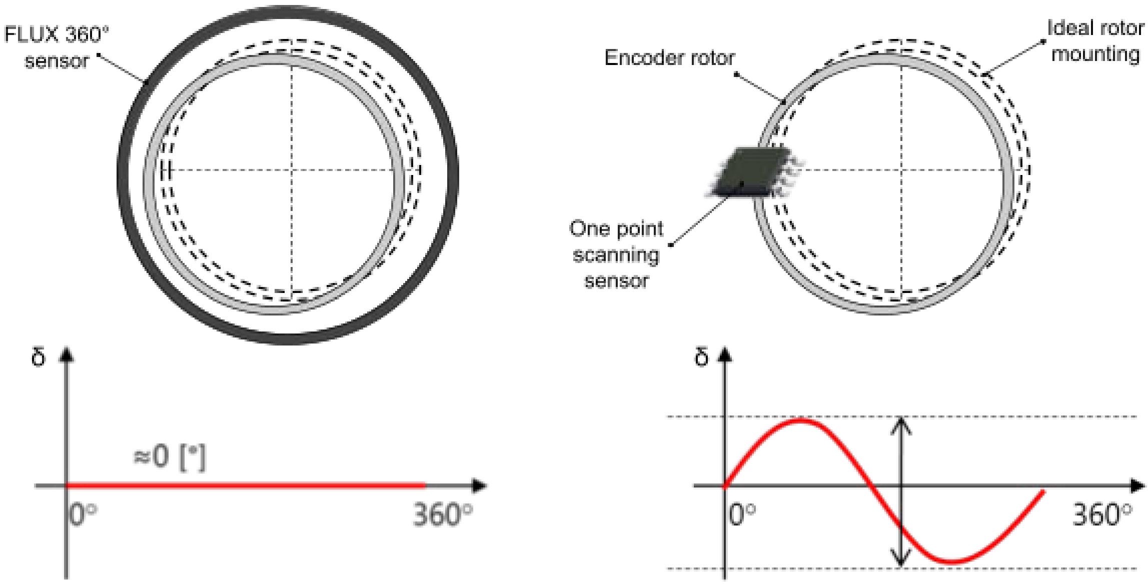
<u>HOW IT WORKS</u>

The magnetic field of the ring (2) generates in the thin metal foil (3) areas with variable electrical a.c. impedance. The variation of the generated a.c. impedance is converted to an electrical signal by the GMI sensor (4). The GMI sensor (4) is connected to the evaluation electronic (5) which converts the electrical signal in digital position.

1.2. Holistic, 360° scanning principle

FLUX encoders have a holistic scanning principle, meaning that they scan and read 360° around the encoder rotor. By comparison, many other rotary encoder technologies (magnetic xMR, Hall, optical, etc.) use segment or “one point” scanning.

360° scanning has many advantages, including improved signal quality, error averaging, and, most importantly, the reduction of the eccentricity error.
Eccentricity [e] is the displacement between the geometrical center of an encoder rotor and the rotation axis. The dotted disk in the figure below is the ideal position, and the gray disk shows the eccentric location of the encoder rotor.



Sensor geometry causes FLUX encoders to inherently average out eccentricity across the circumference of the rotor, resulting in significant reduction in eccentricity error. However, a sensor with a "one-point" scanning capability will exhibit eccentricity errors [δ] over a complete rotation in the form of a sinusoidal wave.

The eccentricity error [δ] for an “one-point” encoder can be calculated using the following formula:

$$\delta['']\ =\ \pm\ 412\ \times \frac{e\ [\mu m]}{D\ [mm]}$$

with:

- δ … encoder eccentricity error in arcseconds
- e … eccentricity (half of the runout) in µm
- D … encoder diameter in mm

The eccentricity may occur both statically as a result of manufacturing or mounting tolerances as well as dynamically as the result of external forces acting on the mechanical parts during operation.

A "one-point" scanning approach could partially correct the statical eccentricity with additional effort and expensive calibration procedures, but there is no possibility of correcting the dynamical eccentricity.
As a result of the 360° scanning approach of the FLUX encoders, they inherently compensate for both statically and dynamically eccentricities .

Eccentricity error is a significant source of additional error in applications that require accuracy. Using an "one-point" encoder can reduce the overall performance of the machine even for eccentricities under 20 μm. Using different sizes of encoder, a comparison of additional errors to the positioning system is presented in the following tables for both 10 and 20 μm eccentricities.

Additional error is the error exclusively generated by eccentricity and added to the error in the product inspection/calibration chart.

Additional error δ for e = 10 μm		
Diameter *D*	**FLUX GMI-ANG**	**One-Point**
96 mm	<± 1”	± 43”
160 mm	<± 1”	± 26”
180 mm	<± 1”	± 23”
250 mm	<± 1”	± 16”

Additional error δ for e = 20 μm		
Diameter *D*	**FLUX GMI-ANG**	**One-Point**
96 mm	<± 2”	± 86”
160 mm	<± 1”	± 52”
180 mm	<± 1”	± 46”
250 mm	<± 1”	± 32”

1.3. Environmental and EMC immunity

FLUX angle encoders based on Giant Magnetic Impedance (GMI) offer exceptional immunity to environmental and electromagnetic perturbations.

GMI-ANGLE encoders come standard with an IP67 rating. Moreover, the angle encoder can work in extreme environmental conditions, and its performance is not compromised by dust, condensation, or solvents.

2. GMI-ANGLE encoder specification

**GMI-ANGLE-160 (size 160mm)*

GMI-ANGLE size (OD)	96 mm	160 mm	180 mm	250 mm
System data				
Type	Axial, frameless, true absolute **Giant Magneto Impedance encoder** **GMI Technology** - FLUX GmbH proprietary			
Standard resolution	23 bits	24 bits	24 bits	25 bits
Standard accuracy *(no calibration required)*	± 14”	± 7”	± 7”	± 4”
	± 70 µrad	± 35 µrad	± 35 µrad	± 20 µrad
Hysteresis	none			
Repeatability	1 resolution count			
Position update rate and signal latency	Real-time			
Standard maximum speed	2’000 rpm *(higher on request)*			
Power-up time	max. 0.8 sec			

Electrical data	
Supply voltage *(at encoder connector)*	**Option 5V:** typ. 5 Vdc Min. 4.35 Vdc. Max. 6 Vdc
Reverse polarity protection	Yes
Current Consumption *(w/o output terminations)*	max. 150 mA @ 5 Vdc (**Option 5V**)

GMI-ROT size (OD)	96 mm	160 mm	180 mm	250 mm
Mechanical Data				
Stator base material	Stainless steel CTE ~ 10 ppm/°C			
Stator weight[(1)]	220 g	440 g	520 g	760 g
Rotor base material	Stainless steel CTE ~ 10 ppm/°C			
Rotor weight[(1)]	115 g	320 g	320 g	490 g
Vibration	EN 60068-2-6, 20 g, 55 .. 2000 Hz			
Shock	EN 60068-2-27, 200 g, 6 ms			

[(1)] Guiding values, without cable

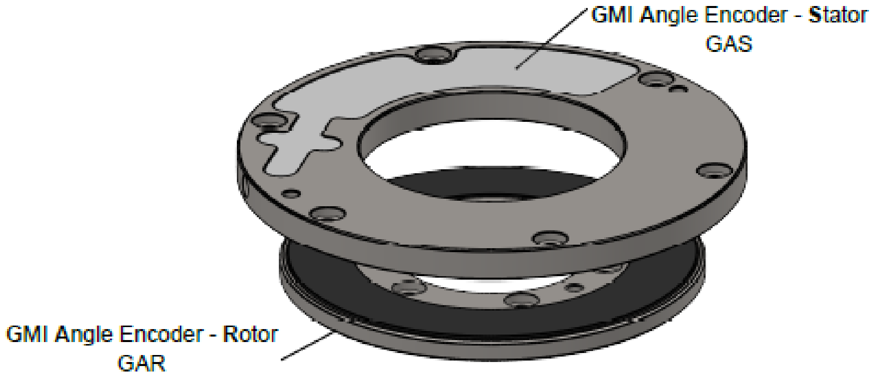
Mounting tolerances	
Nominal Axial Air-Gap	0.30 mm
Axial tolerances	±0.30 mm
Radial Tolerance	±0.20 mm

Environmental data	
Temperature range - Standard *(no additional option in order code)*	
Operating	-20°C .. +85°C
Storage	-20°C .. +85°C
Temperature range - Extended *(contact FLUX for more details)*	
Operating	-40°C .. +105°C
Storage	-55°C .. +125°C
Ingress Protection	IP67
EMC immunity	complies with EN IEC 61000-6-2
EMC emission	complies with EN IEC 61000-6-4

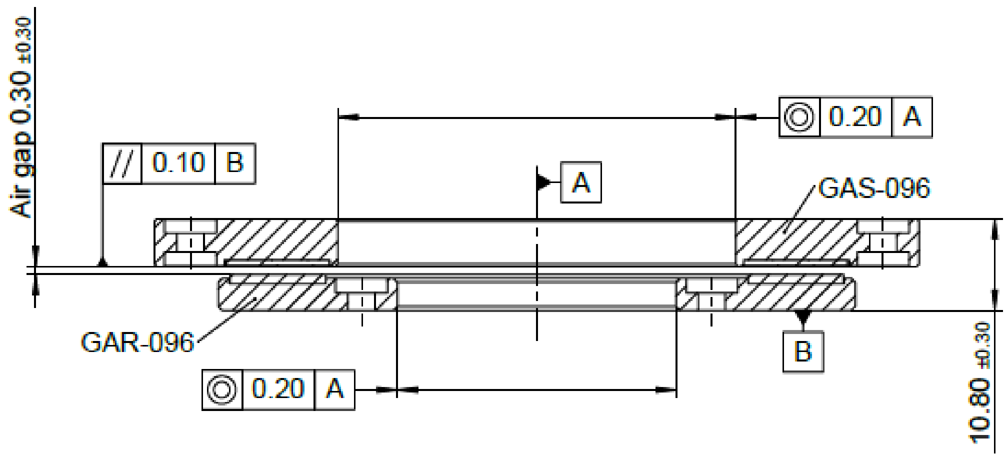
Output interfaces (See Chap.5)	
Absolute: **SSI**	SSI00, SSI01, SSI02
Absolute: **BiSS/C**	BIS10, BIS20 *(recommended for new designs),* BIS00
Incremental: **A/B/Z**	INCxx
Other synchronous or asynchronous	*contact FLUX for more details*

3. Mechanical dimensions and mounting tolerances

3.1. GMI-ANGLE encoder size 96 mm: GMI-ANG-096

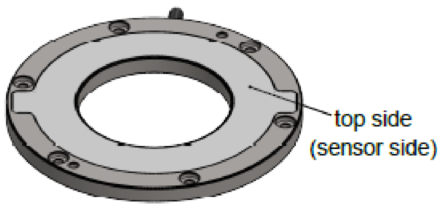


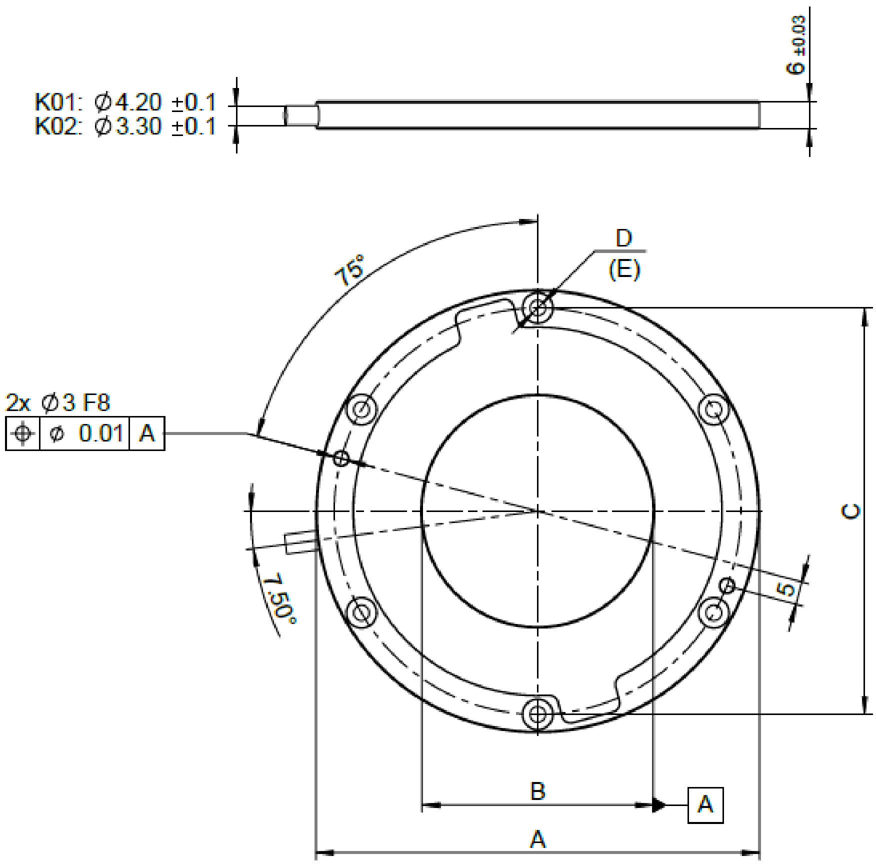
GMI Angle Encoder: Stator Size 96mm
GMI-ANG-096-ST
stainless steel



A ... axis of rotation
max. total runout GRS + GAR = 0.20mm | GAS + GAR | 0.20 | A
Dimensions are mm.

3.1.1. Stator for GMI-ANG-096: **GAS-096**



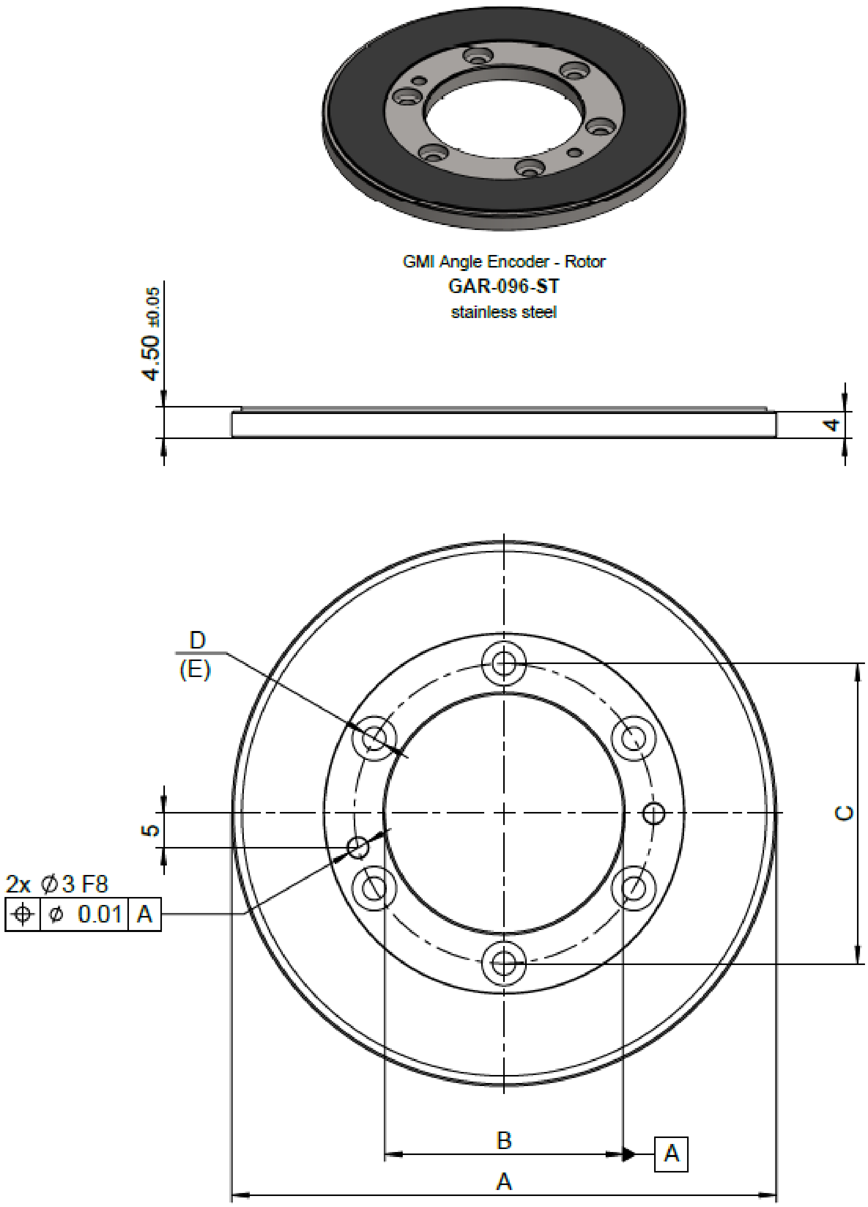


Size comparison table. The 096 mm size is highlighted.

GAS-xxx	A	B	C	D	E
096	**ø96 h7**	**ø50 H7**	**ø88**	**6 x ø3.40 (60°)**	**M3**
160	ø160 h7	ø110 H7	ø121.50	6 x ø4.50 (60°)	M4
180	ø180 h7	ø130 H7	ø169	6 x ø4.50 (60°)	M4
250	ø250 h7	ø200 H7	ø239	8 x ø4.50 (60°)	M4

Dimensions are in mm.
Screw hole dimensions for fastener according ISO 7380-1.
E ... screw size

3.1.2. Rotor for GMI-ANG-096: **GAR-096**



Size comparison table. The 096 mm size is highlighted.

GAR-xxx	A	B	C	D	E
096	**ø80 h7**	**ø35 H7**	**ø44**	**6 x ø3.40 (60°)**	**M3**
160	ø160 h7	ø110 H7	ø121.50	6 x ø4.50 (60°)	M4
180	ø160 h7	ø110 H7	ø121.50	6 x ø4.50 (60°)	M4
250	ø230 h7	ø180 H7	ø191.50	8 x ø4.50 (60°)	M4

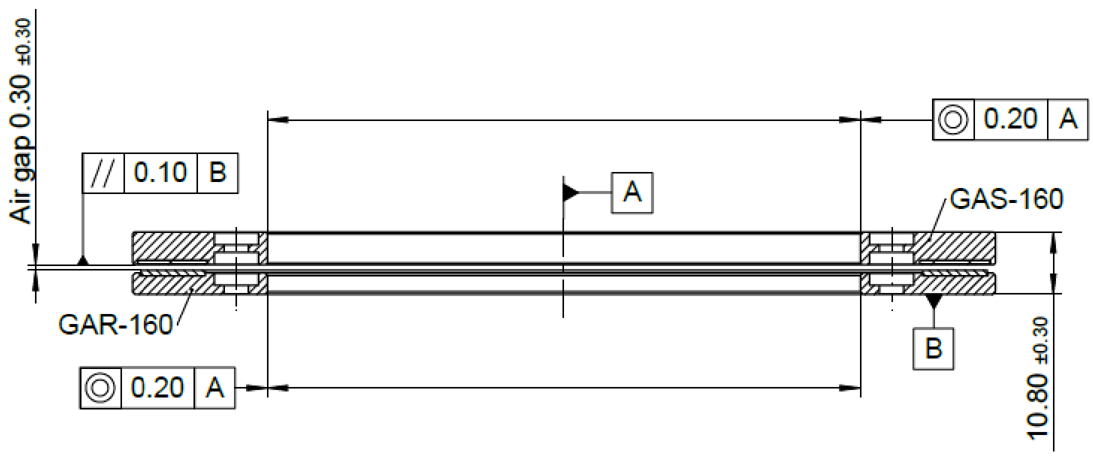
Dimensions are in mm.

Screw hole dimensions for fastener according ISO 7380-1.

E ... screw size

3.2. GMI-ANGLE encoder size 160 mm: **GMI-ANG-160**

GMI Angle Encoder: Stator Size 160mm
GMI-ANG-160-ST
stainless steel

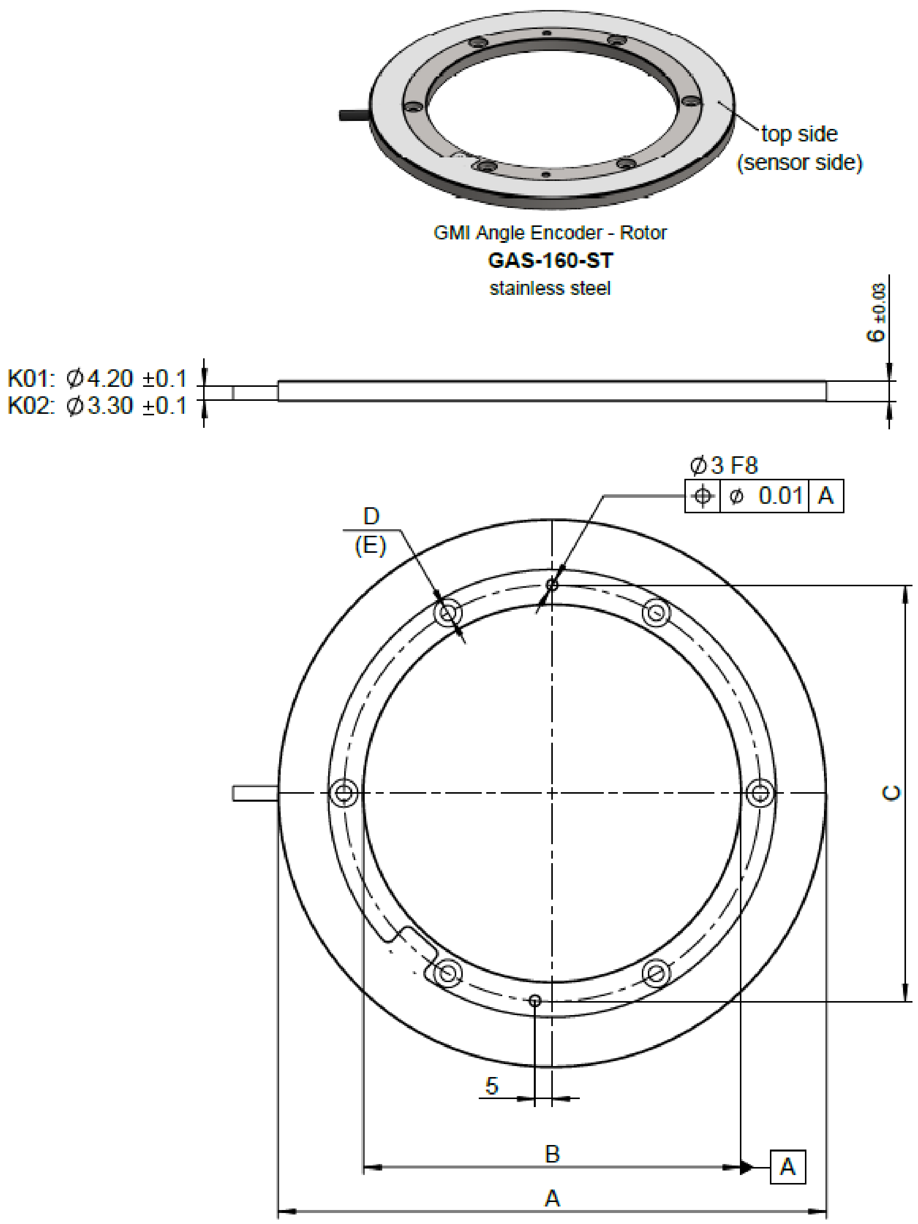


A ... axis of rotation

max. total runout GRS + GAR = 0.20mm | GAS + GAR | 0.20 | A

Dimensions are mm.

3.2.1. Stator for GMI-ANG-160: **GAS-160**

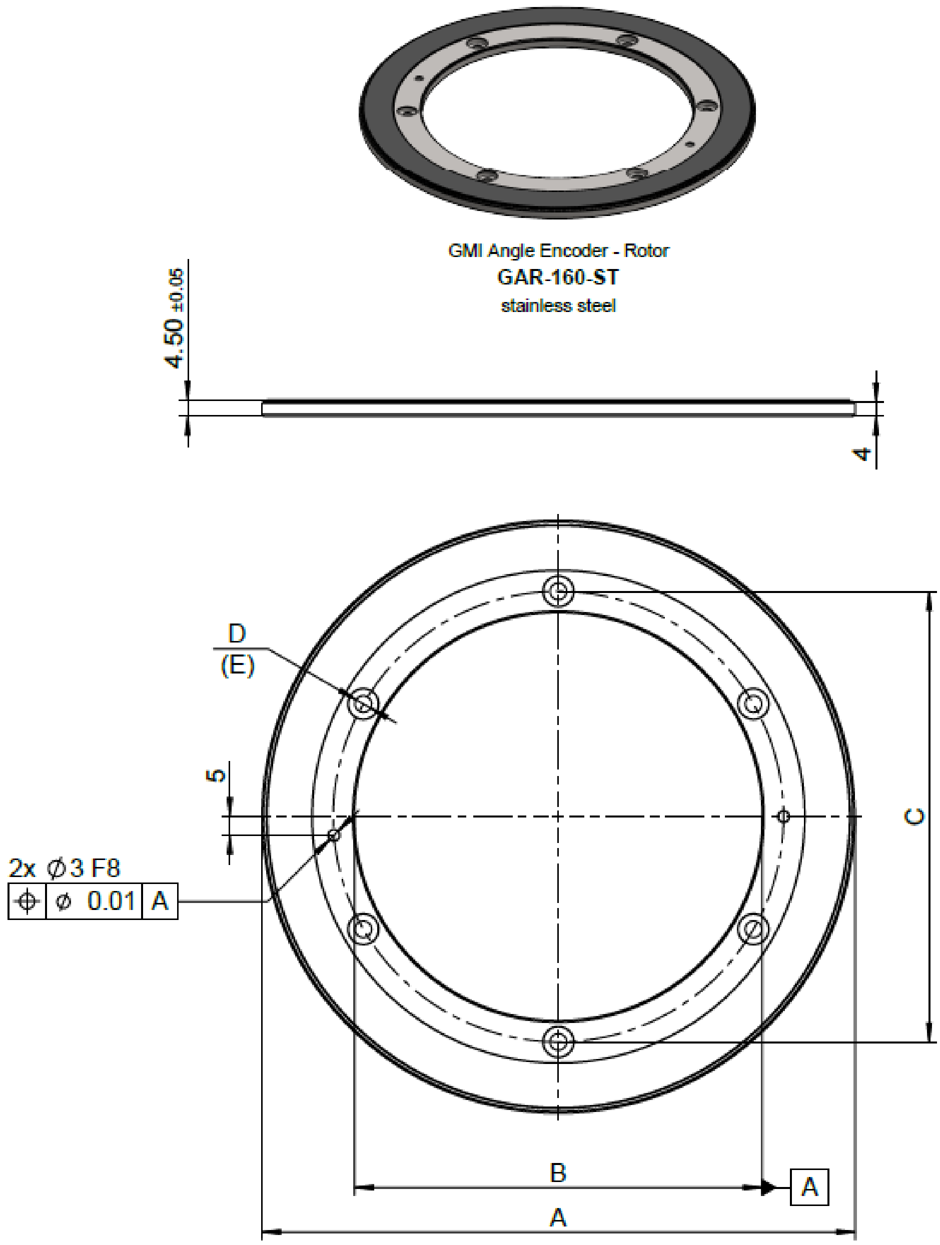


Size comparison table. The 160 mm size is highlighted.

GAS-xxx	A	B	C	D	E
096	ø96 h7	ø50 H7	ø87	6 x ø3.40 (60°)	M3
160	**ø160 h7**	**ø110 H7**	**ø121.50**	**6 x ø4.50 (60°)**	**M4**
180	ø180 h7	ø130 H7	ø169	6 x ø4.50 (60°)	M4
250	ø250 h7	ø200 H7	ø239	8 x ø4.50 (60°)	M4

Dimensions are in mm.
Screw hole dimensions for fastener according ISO 7380-1.
E ... screw size

3.2.2. Rotor for GMI-ANG-160: **GAR-160**

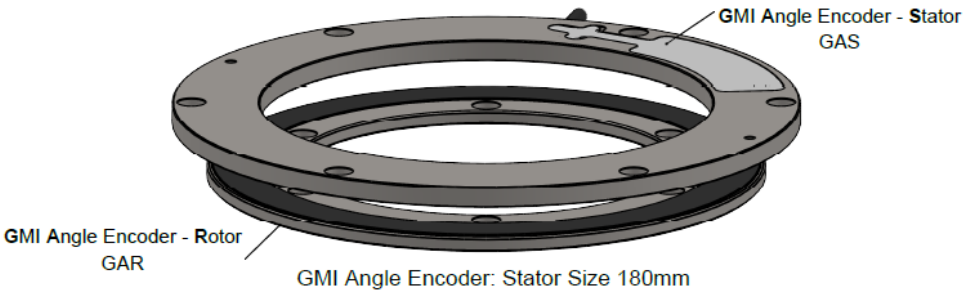


Size comparison table. The 160 mm size is highlighted.

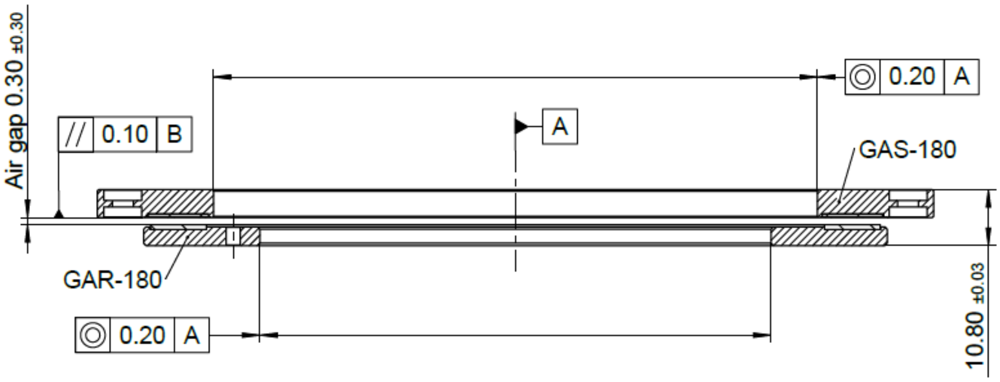
GAR-xxx	A	B	C	D	E
096	ø80 h7	ø35 H7	ø44	6 x ø3.40 (60°)	M3
160	**ø160 h7**	**ø110 H7**	**ø121.50**	**6 x ø4.50 (60°)**	**M4**
180	ø160 h7	ø110 H7	ø121.50	6 x ø4.50 (60°)	M4
250	ø230 h7	ø180 H7	ø191.50	8 x ø4.50 (60°)	M4

Dimensions are in mm.
Screw hole dimensions for fastener according ISO 7380-1.
E ... screw size

3.3. GMI-ANGLE encoder size 180 mm: **GMI-ANG-180**

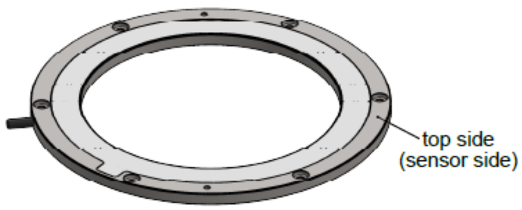


GMI Angle Encoder: Stator Size 180mm
GMI-ANG-180-ST
stainless steel

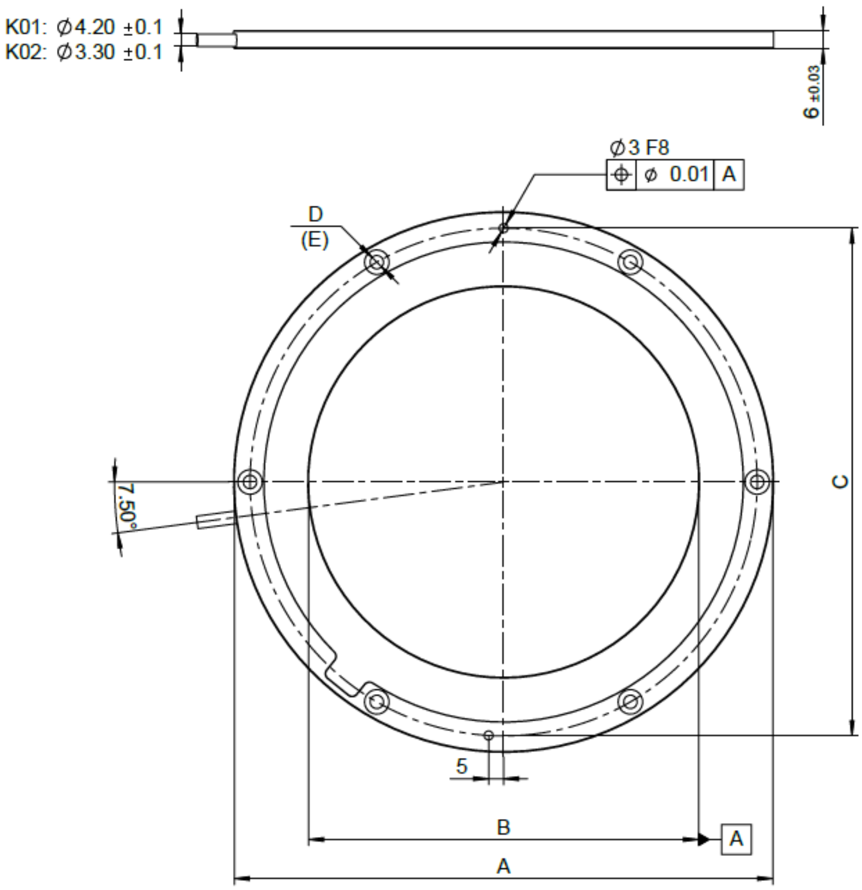


A ... axis of rotation
max. total runout GRS + GAR = 0.20mm | ↗ | GAS + GAR | 0.20 | A |
Dimensions are mm.

3.3.1. Stator for GMI-ANG-180: **GAS-180**



GMI Angle Encoder - Rotor
GAS-180-ST
stainless steel

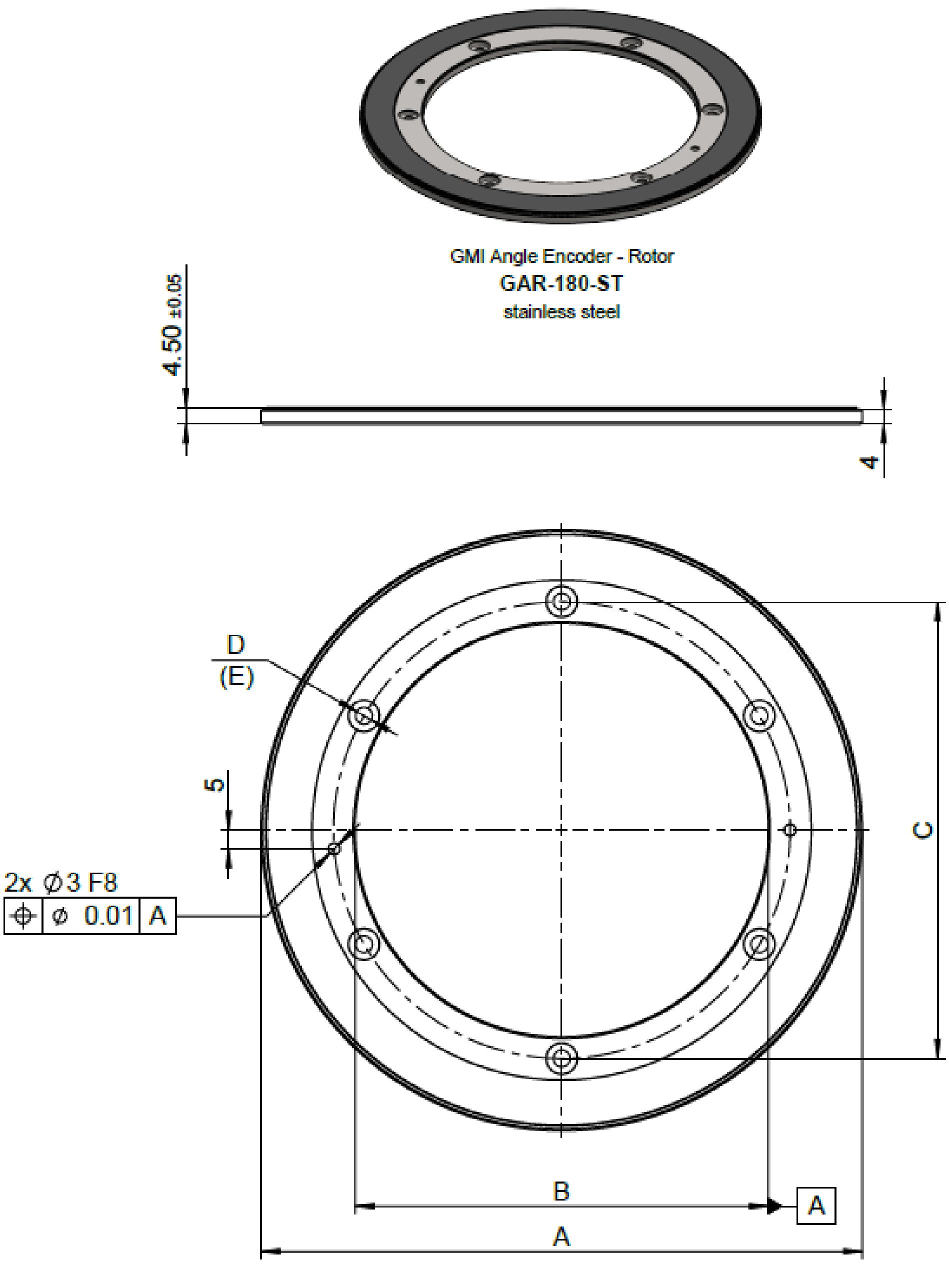


Size comparison table. The 180 mm size is highlighted.

GAS-xxx	A	B	C	D	E
096	ø96 h7	ø50 H7	ø87	6 x ø3.40 (60°)	M3
160	ø160 h7	ø110 H7	ø121.50	6 x ø4.50 (60°)	M4
180	**ø180 h7**	**ø130 H7**	**ø169**	**6 x ø4.50 (60°)**	**M4**
250	ø250 h7	ø200 H7	ø239	8 x ø4.50 (60°)	M4

Dimensions are in mm.
Screw hole dimensions for fastener according ISO 7380-1.
E ... screw size

3.3.2. Rotor for GMI-ANG-180: **GAR-180**



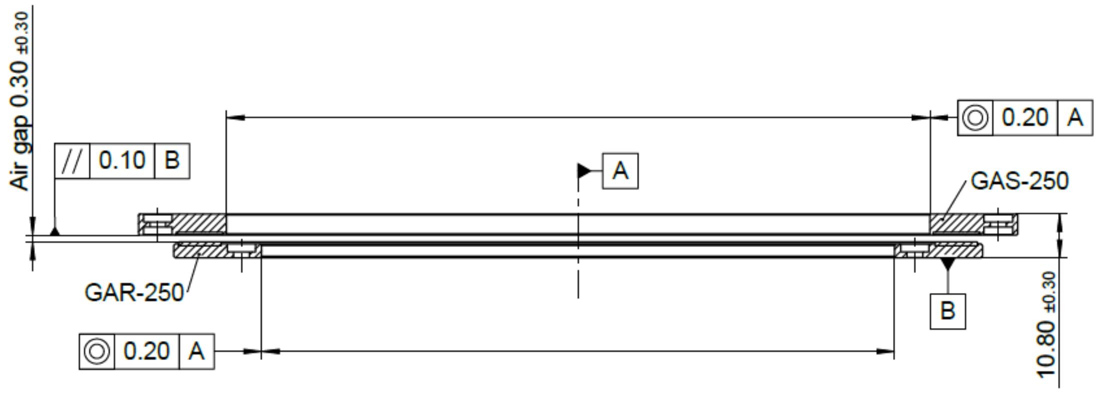
Size comparison table. The 180 mm size is highlighted.

GAR-xxx	A	B	C	D	E
096	ø80 h7	ø35 H7	ø44	6 x ø3.40 (60°)	M3
160	ø160 h7	ø110 H7	ø121.50	6 x ø4.50 (60°)	M4
180	**ø160 h7**	**ø110 H7**	**ø121.50**	**6 x ø4.50 (60°)**	**M4**
250	ø230 h7	ø180 H7	ø191.50	8 x ø4.50 (60°)	M4

Dimensions are in mm.
Screw hole dimensions for fastener according ISO 7380-1.
E ... screw size

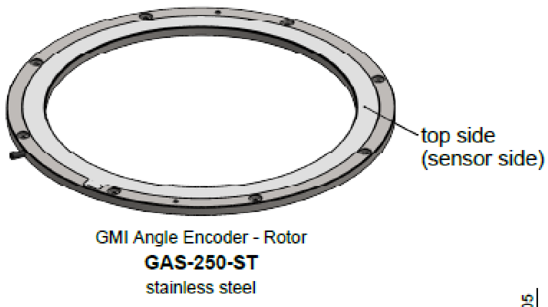
3.4. GMI-ANGLE encoder size 250 mm: **GMI-ANG-250**

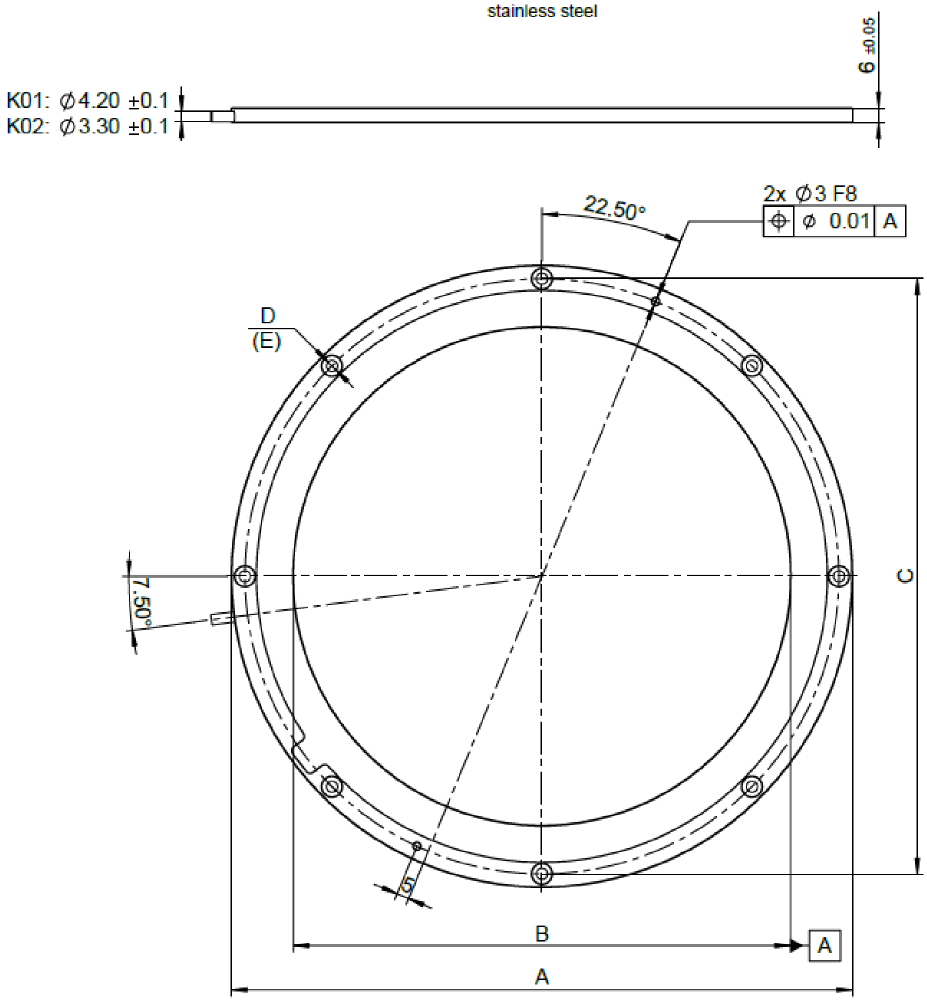
GMI Angle Encoder: Stator Size 250mm
GMI-ANG-250-ST
stainless steel



A ... axis of rotation
max. total runout GRS + GAR = 0.20mm | GAS + GAR | 0.20 | A |
Dimensions are mm.

3.4.1. Stator for GMI-ANG-250: **GAS-250**



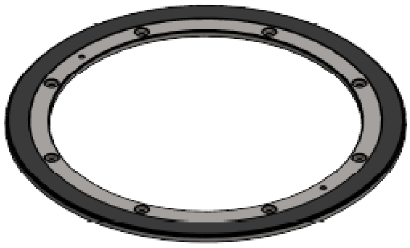


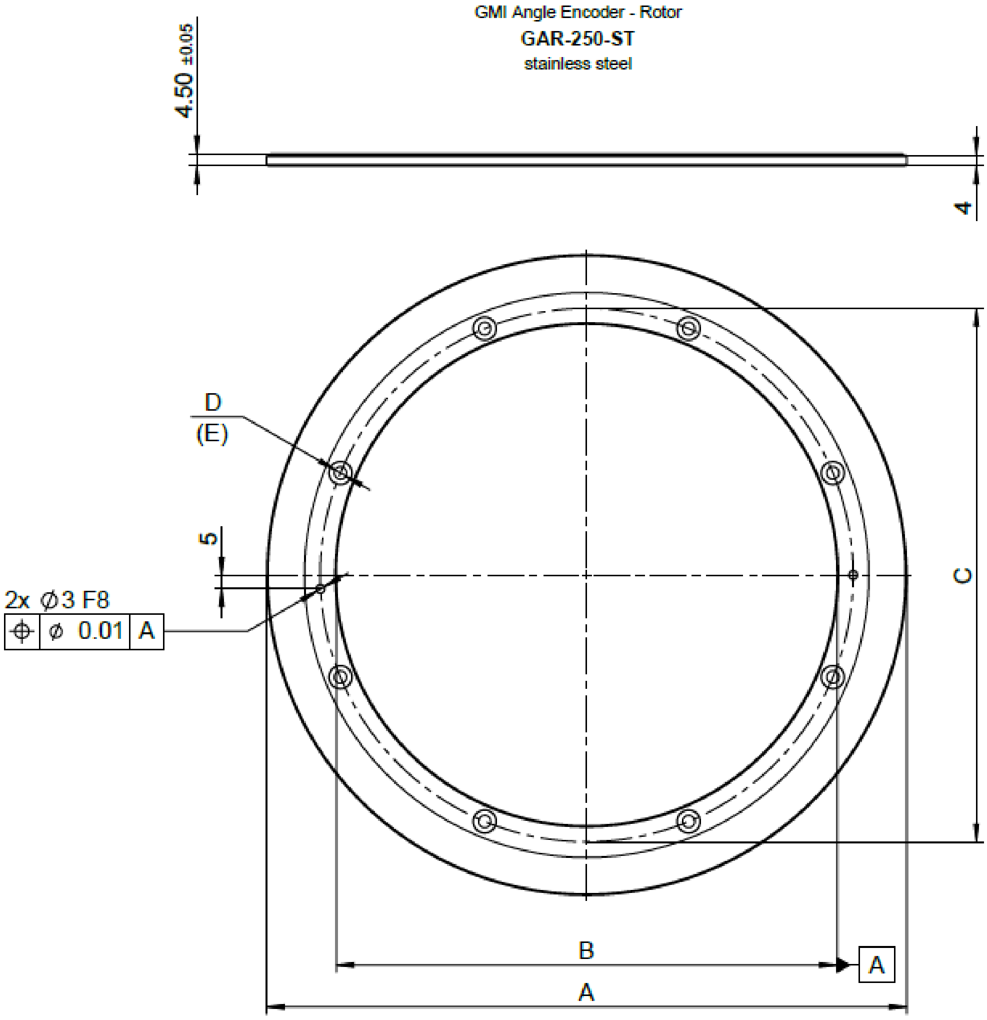
Size comparison table. The 250 mm size is highlighted.

GAS-xxx	A	B	C	D	E
096	ø96 h7	ø50 H7	ø87	6 x ø3.40 (60°)	M3
160	ø160 h7	ø110 H7	ø121.50	6 x ø4.50 (60°)	M4
180	ø180 h7	ø130 H7	ø169	6 x ø4.50 (60°)	M4
250	**ø250 h7**	**ø200 H7**	**ø239**	**8 x ø4.50 (45°)**	**M4**

Dimensions are in mm.
Screw hole dimensions for fastener according ISO 7380-1.
E ... screw size

3.4.2. Rotor for GMI-ANG-250: **GAR-250**





Size comparison table. The 250 mm size is highlighted.

GAR-xxx	A	B	C	D	E
096	ø80 h7	ø35 H7	ø44	6 x ø3.40 (60°)	M3
160	ø160 h7	ø110 H7	ø121.50	6 x ø4.50 (60°)	M4
180	ø160 h7	ø110 H7	ø121.50	6 x ø4.50 (60°)	M4
250	**ø230 h7**	**ø180 H7**	**ø191.50**	**8 x ø4.50 (45°)**	**M4**

Dimensions are in mm.
Screw hole dimensions for fastener according ISO 7380-1.
E ... screw size

4. Mounting recommendation

4.1. Mounting using inner diameter - H7 sliding fit

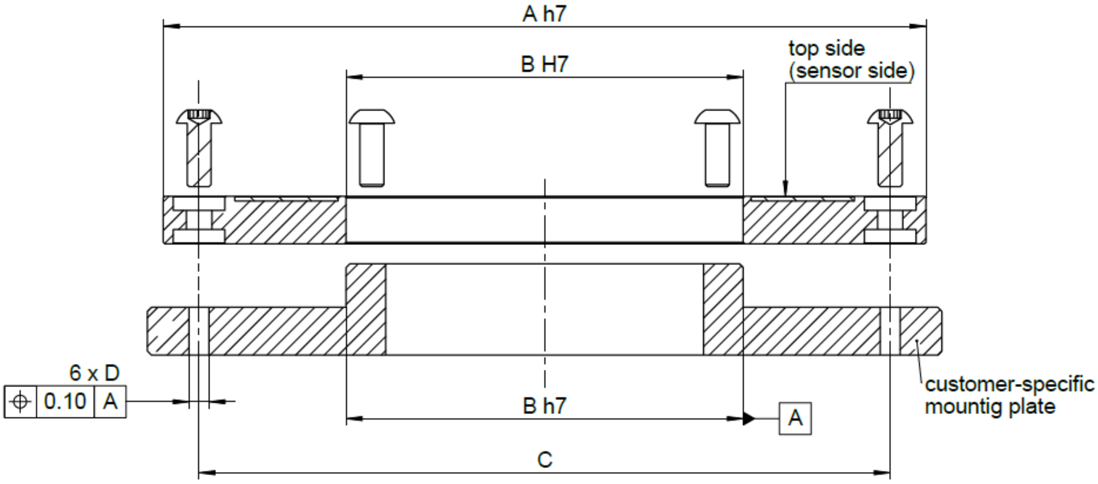
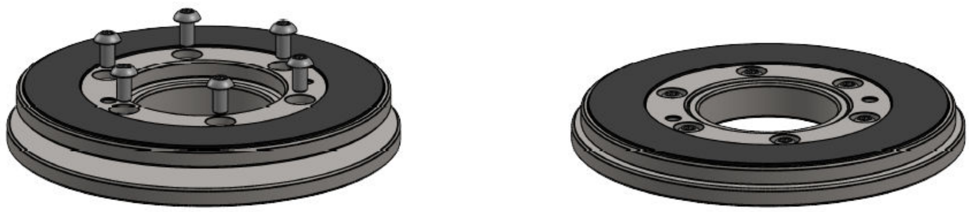


Fig.4.1.: Stator (GAS) mounting using ID sliding fit

GAS-xxx	A	B	C	D
096	ø96	ø50	ø88	M3
160	ø160	ø110	ø121.50	M4
180	ø180	ø130	ø169	M4
250	ø250	ø200	ø239	M4

Dimensions are in mm.

The use of a medium-strength screw retainer is recommended for secure mounting.
The mounting of the Stator (GAS) needs to be adapted according to the application. The customer-specific mounting plate is shown only as an example.



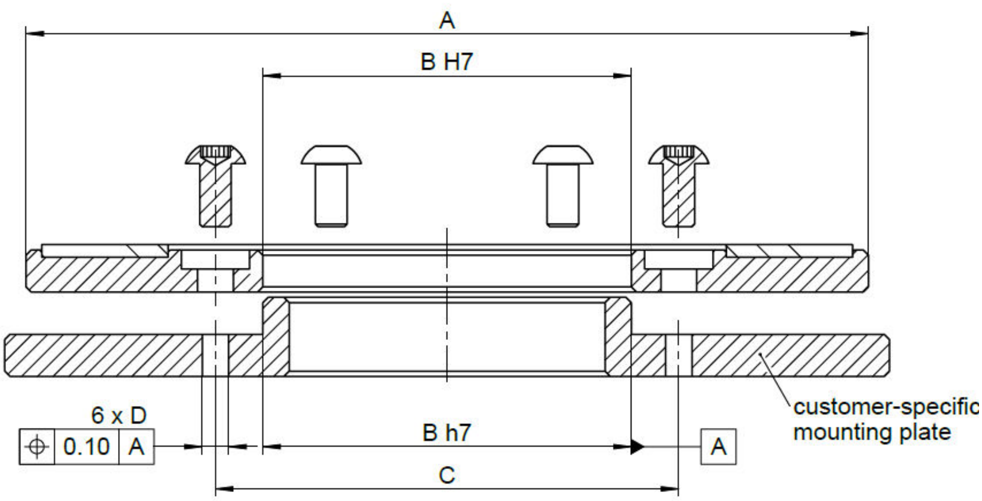


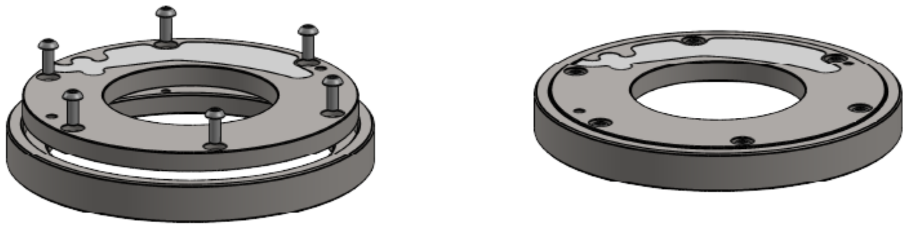
Fig.4.2.: Rotor (GAR) mounting using ID sliding fit

GAR-xxx	A	B	C	D
096	ø80	ø35	ø44	M3
160	ø160	ø110	ø121.50	M4
180	ø160	ø110	ø121.50	M4
250	ø230	ø180	ø191.50	M4

Dimensions are in mm.

The use of a medium-strength screw retainer is recommended for secure mounting.
The mounting of the Rotor (GAR) needs to be adapted according to the application. The customer-specific mounting plate is shown only as an example.

4.2. Mounting using outer diameter h7 sliding fit



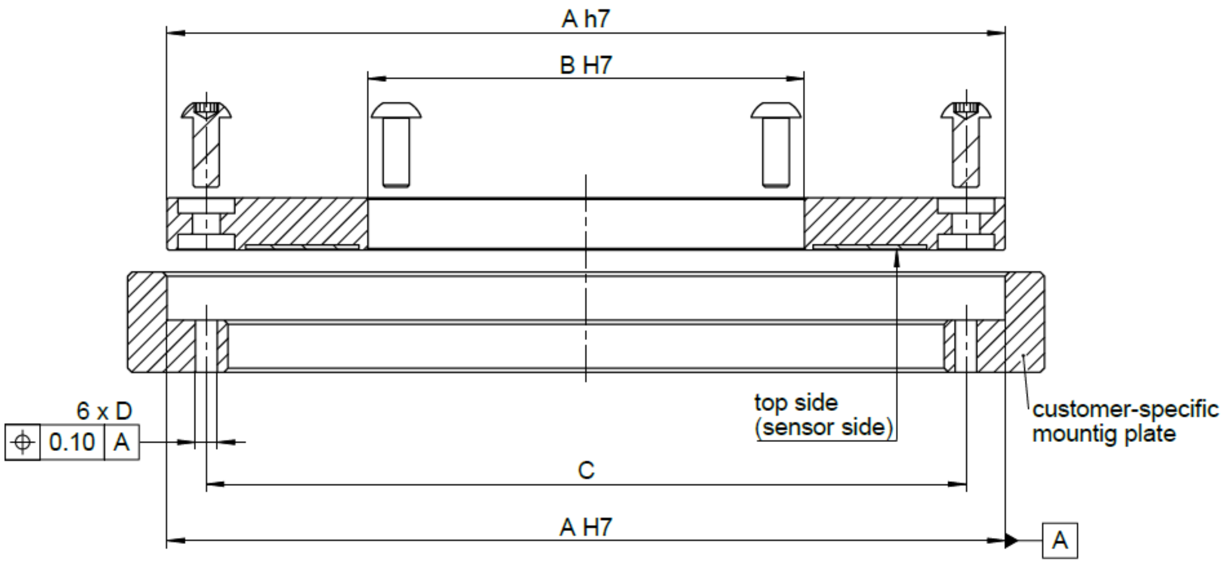
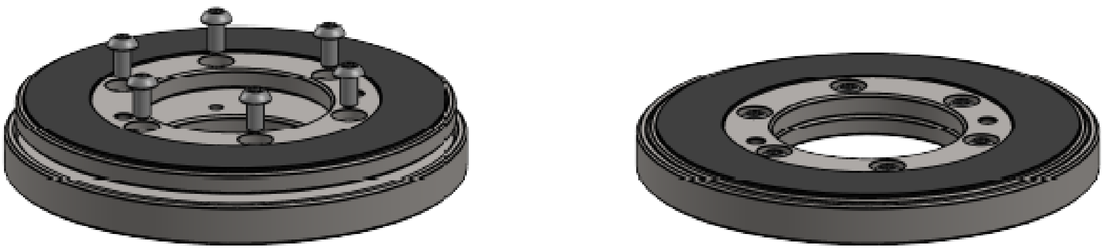


Fig.4.3.: Stator (GAS) mounting using OD sliding fit

GAS-xxx	A	B	C	D
096	ø96	ø50	ø88	M3
160	ø160	ø110	ø121.50	M4
180	ø180	ø130	ø169	M4
250	ø250	ø200	ø239	M4

Dimensions are in mm.

The use of a medium-strength screw retainer is recommended for secure mounting.
The mounting of the Stator (GAS) needs to be adapted according to the application. The customer-specific mounting plate is shown only as an example.



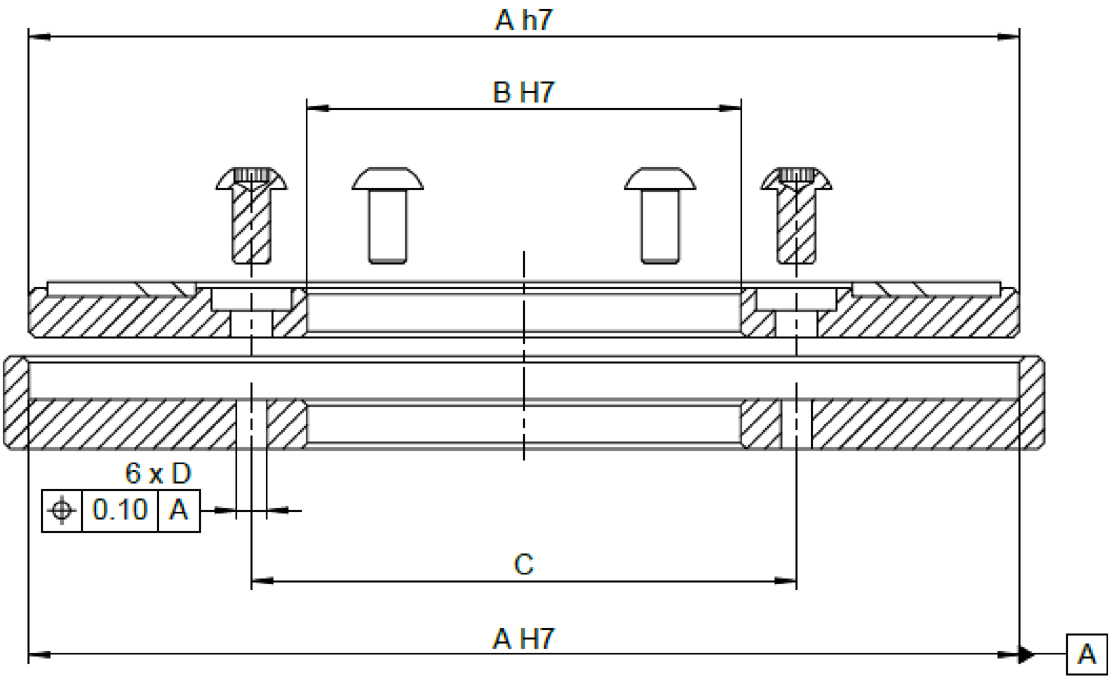


Fig.4.3.: Rotor (GAR) mounting using OD sliding fit

GAR-xxx	A	B	C	D
096	ø80	ø35	ø44	M3
160	ø160	ø110	ø121.50	M4
180	ø160	ø110	ø121.50	M4
250	ø230	ø180	ø191.50	M4

Dimensions are in mm.

The use of a medium-strength screw retainer is recommended for secure mounting.
The mounting of the Rotor (GAR) needs to be adapted according to the application. The customer-specific mounting plate is shown only as an example.

4.3. Dowel-Pin mounting

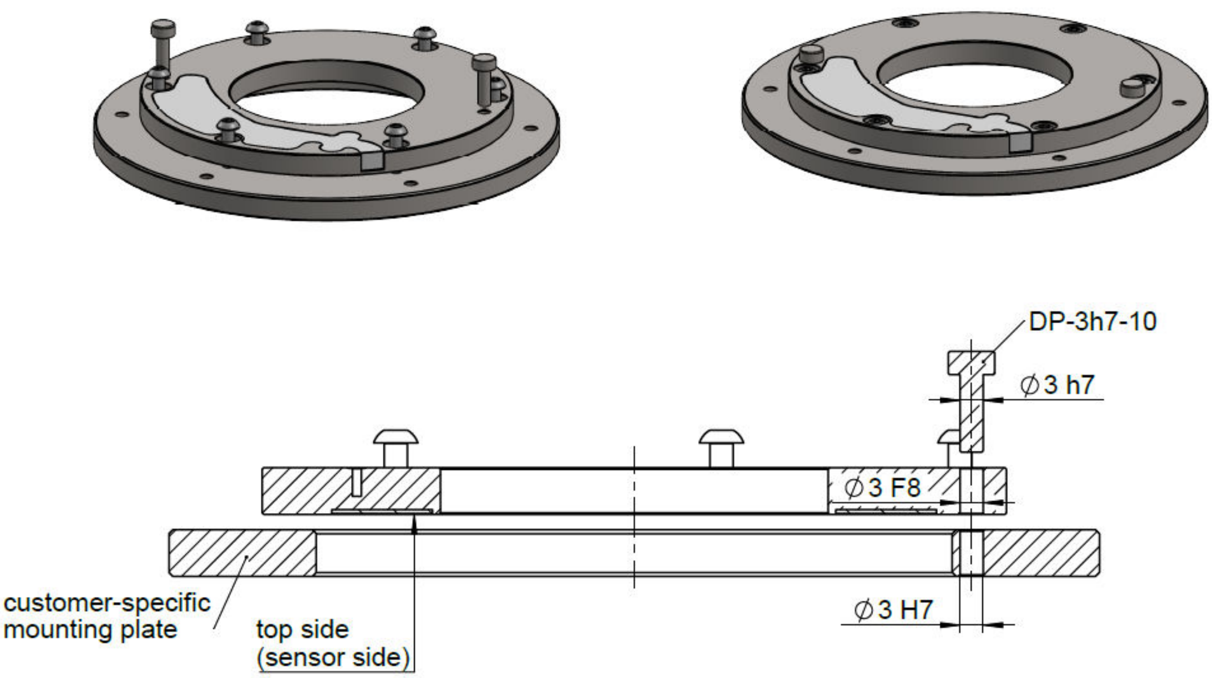


Fig.4.5.: AMH Dowel-Pin mounting

The position of the centering holes for the dowel pins depends on the stator GAS size. Please see Chapter 3.
Remove Dowel-Pins after screwing the stator.

The use of a medium-strength screw retainer is recommended for secure mounting.
The mounting of the Stator (GAS) needs to be adapted according to the application and its orientation with respect to rotor (GAR) must be taken into account.The customer-specific mounting plate is shown only as an example.

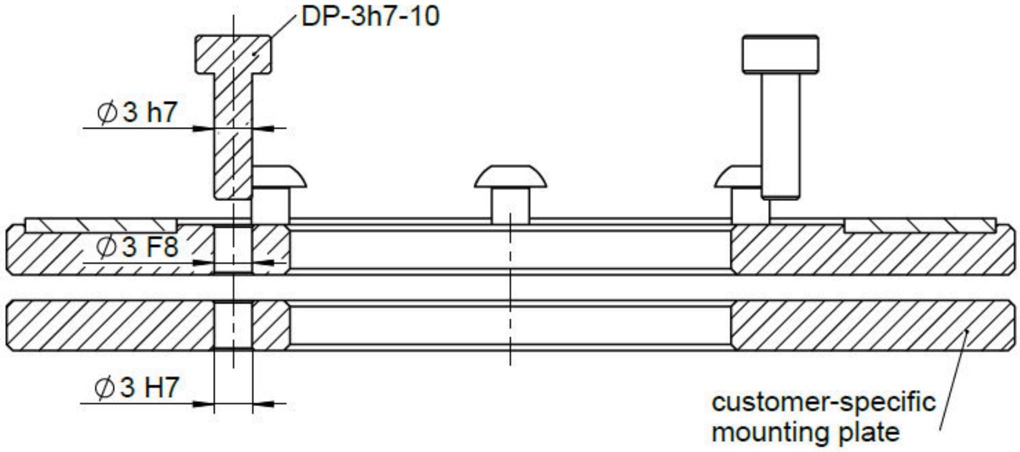


Fig.4.6.: AMR Dowel-Pin mounting

⚠	The position of the centering holes for the dowel pins depends on the rotor (GAR) size. Please see Chapter 3. Remove Dowel-Pins after screwing the rotor.

⚠	The use of a medium-strength screw retainer is recommended for secure mounting. The mounting of the rotor(GAR) needs to be adapted according to the application and its orientation with respect to the stator (GAS) must be taken into account.The customer-specific mounting plate is shown only as an example.

5. Interface description

5.1. SSI00

The synchronous serial interface SSI is an unidirectional point to point communication channel. The transmission of the sensor output signal SSI DATA is synchronized by the common clock signal SSI CLOCK. The DATA and CLOCK signals are transmitted according to the RS-485 (EIA-485) standard, driven by RS-485 buffers.

Parameter	Note	Min.	Typ.	Max.	Unit
Clock frequency f_{clk}	data updated on rising clock edge	0.2		1.0	MHz
Monoflop time t_{mf}		30			µs
Total number for bits			28		bits
Number of data bits *N*			25		bits
Data alignment		right aligned unused MSB set LOW-"0"			
Number of status bits *S*	Error *E* (active high) Warning *W* (active high) Parity P (even)		3		bits

The data transmission and position latch starts with the first falling edge of the clock signal. The serial data update occurs on the rising clock edge.

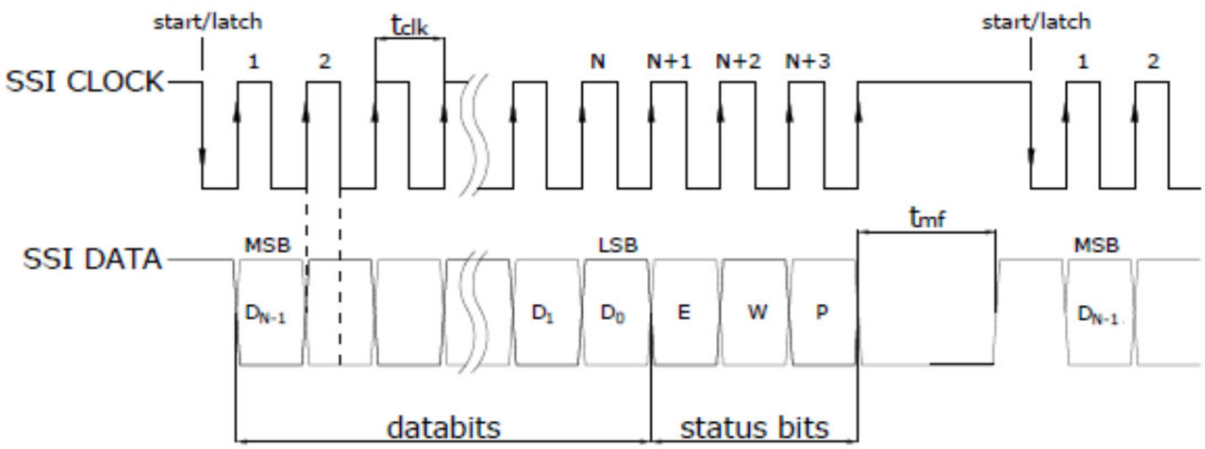


Fig.5.1.: SSI00 time diagram

5.2. SSI01

The synchronous serial interface SSI is an unidirectional point to point communication channel. The transmission of the sensor output signal SSI DATA is synchronized by the common clock signal SSI CLOCK. The DATA and CLOCK signals are transmitted according to the RS-485 (EIA-485) standard, driven by RS-485 buffers.

Parameter	Note	Min.	Typ.	Max.	Unit
Clock frequency f_{clk}	data updated on rising clock edge	0.2		1.0	MHz
Monoflop time t_{mf}		20			µs
Total number for bits	only data bits transmitted		N		bits
Number of data bits *N*	only data bits transmitted		N		bits
Data alignment		not relevant			
Number of status bits *S*	no status bit is transmitted		0		bits

The data transmission and position latch starts with the first falling edge of the clock signal. The serial data update occurs on the rising elock edge.

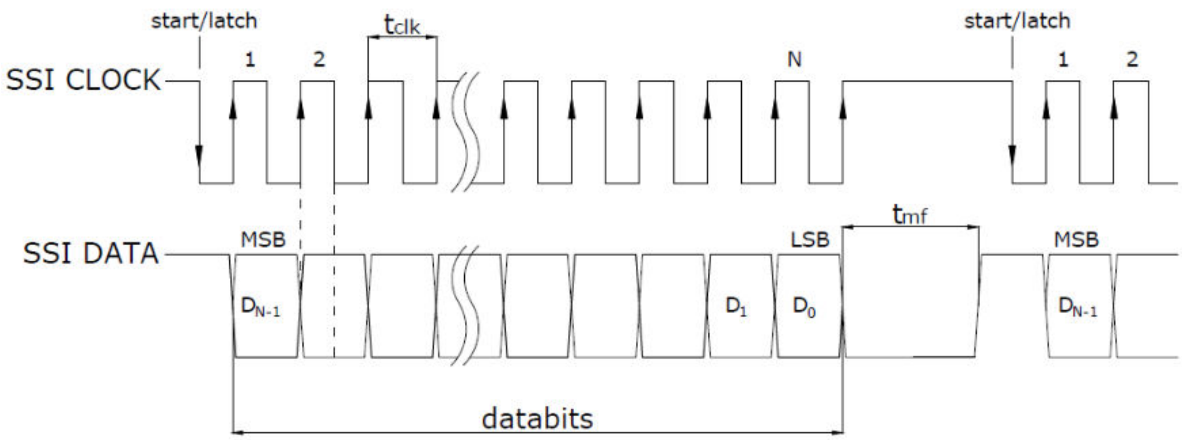


Fig.5.2.: SSI01 time diagram

5.3. SSI02

The SSI02 version of the Synchronous Serial Interface SSI can be used to communicate with a Serial Peripheral Interface (SPI) controller.

The transmission of the sensor output signal SSI DATA is synchronized by the common clock signal SSI CLOCK. The DATA and CLOCK signals are transmitted according to the RS-485 (EIA-485) standard, driven by RS-485 buffers (compatible with RS-422).

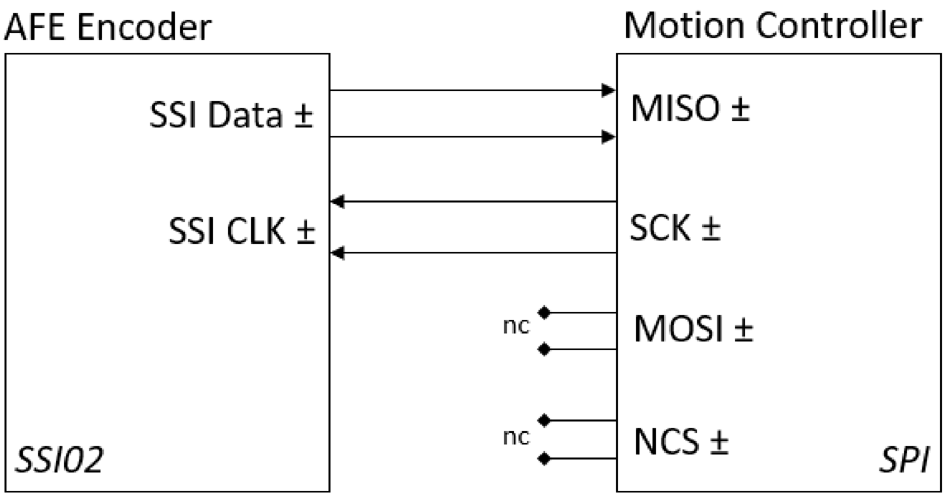


Fig.5.3.: Interfacing the SSI02 to the SPI master

For interfacing the SSI02 the following connections are required:

- SSI Data must be connected to the SPI Master Input, Slave Output (MISO)
- SSI Clock must be connected to the SPI Serial Clock (SCK)
-

The SPI lines Master Output, Slave Input (MOSI) and SPI Not Chip Select (NCS) are not connected. In this configuration the encoder is continuously enabled and answers with the current position.

SPI Mode#2 is the only mode supported by SSI02. The required SPI configuration for Mode#2 is:

CPOL = ‘1’	SPI Clock (SCK) Idle Polarity is “1” / High
CPHA = ‘0’	SPI Data (MISO) is received/sampled on falling edge of the clock

Data transmission and position latch starts with the first falling edge of the clock signal. The serial data update occurs on the rising clock edge.

Parameter	Note	Min.	Typ.	Max.	Unit
Clock frequency f_{clk}	data updated on rising clock edge	0.2		1.0	MHz
Monoflop time t_{mf}		30			µs
Total number for bits	number of clock falling edges		24		bits
Number of position bits			22		bits
Data alignment		right aligned unused MSB set LOW-"0"			
Number of status bits *S*	Error *E* (active high)		1		bits

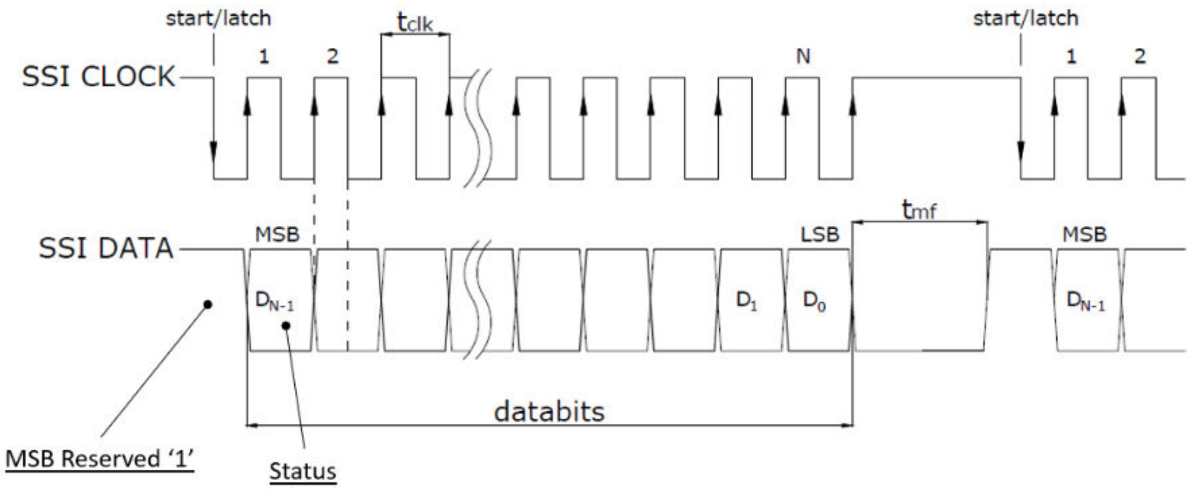


Fig.5.4.: Time Diagram for the SSI02 interface

Bits conversion for the 24 bits (23 down to 0) for the SPI master:

Bit		Description
Reserved	23 (MSB)	To be ignored. Bit always on "1"
Status	22 (**D_{N-1}**)	Error bit (active high) '0' position valid / '1' encoder error
Data bits	21 … 0 (LSB)	Position, right aligned. Unused MSB bits set on '0'

5.4. INCxx

Incremental TTL output consists of two square-wave position signals – A and B – in quadrature differential format which are phase shifted 90° relative to each other. Additionally a differential square wave Reference Index pulse (Z) is delivered for homing procedure.

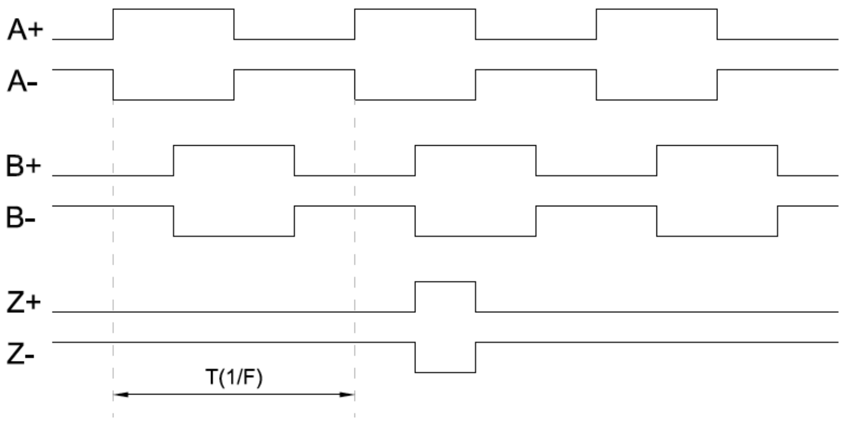


Fig.5.5.: Time diagram with differential TTL quadrature signal

INCxx	Maximum Output Frequency (F=1 / T)	Maximum Counts after x4 Decoding
INC00	5.000 MHz	20.0 Mio. / sec
INC01	2.500 MHz	10.0 Mio. / sec
INC02	1.250 MHz	5.0 Mio. / sec
INC03	0.625 MHz	2.5 Mio. / sec

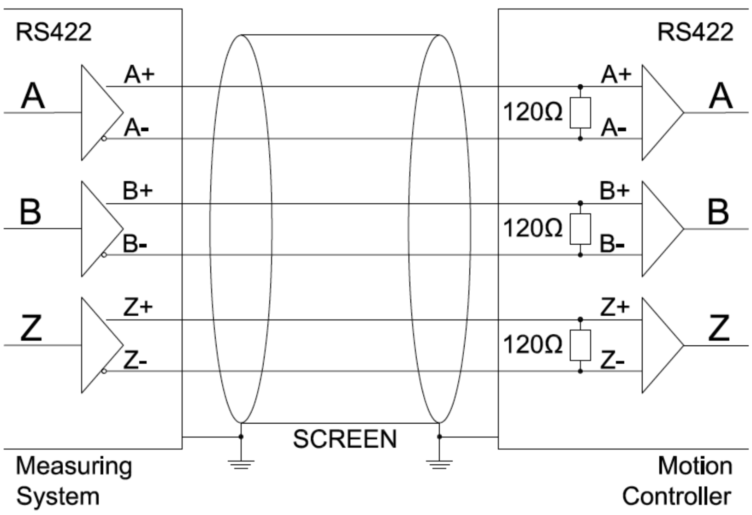


Fig.5.6.: Recommended electrical connection and buffering

The maximum operating speed of the encoder may be reduced from the standard maximum of 10 m/s due to the selection of higher resolutions or lower clock speeds. Maximum speed is computed using the following formula but is in no case more than 2000 rpm:

$$Maximum\ speed\ [rpm]\ = 60\ \times\ \frac{4\ x\ Maximum\ Output\ Frequency\ [Hz]}{2^{\ Encoder\ resolution\ [bit]}\ [1/rev]}$$

To provide more information, the maximum encoder speed has been calculated for two resolutions(20 bits/rev. and 18 bits/rev.) and for various output frequencies.

Interface	Max. Frequency (before x4)	Max. Counts (after x4)	Maximum speed	
			@ 20 bits/rev	@ 18 bits/rev
INC00	5.000 MHz	20.0 Mio. / sec	1144 rpm	4577 rpm
INC01	2.500 MHz	10.0 Mio. / sec	572 rpm	2288 rpm
INC02	1.250 MHz	5.0 Mio. / sec	286 rpm	1144 rpm
INC03	0.625 MHz	2.5 Mio. / sec	143 rpm	572 rpm

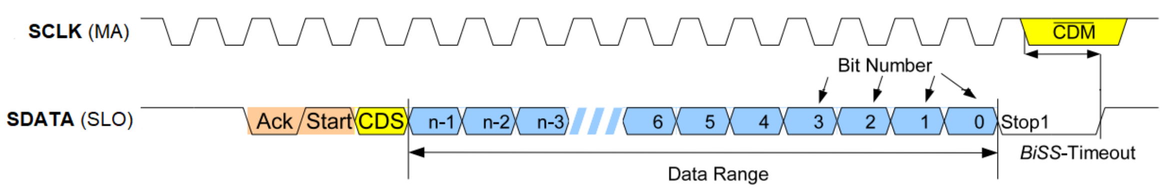
5.5. BIS00

The BIS00 is an implementation of the bidirectional interface BiSS/C® (registered trademark of IC-Haus GmbH) with the following main characteristics:

- data length reserved for encoder position is 32 bits
- encoder position data is right aligned (unused upper bits/MSB set on 0)

BIS00 is recommended for linear encoders. Despite being compatible with angle encoders, it may cause compatibility issues with some motion controllers.
BIS10 and BIS20 are strongly recommended for angle encoders.

Parameter	Note	Min.	Typ.	Max.	Unit
Clock frequency f_{clk}	data updated on rising clock edge	0		5.0	MHz
Processing time	not applicable, real-time encoder			0	ns
Total number for bits	n		40		bits
Number of position bits	Bits 39 down to 8		32		bits
Data alignment		right aligned unused MSB set LOW-"0"			
Number of status bits *S*	Bit 7 - not Error Bit 6 - not Warning		2		bits
CRC length	Bits 5 down to 0 Polynome: 0x43 ($X^6+X^1+X^0$) Start value: 0x00		6		bits



"Ack" bit is always 1 Clock length for all FLUX encoders.

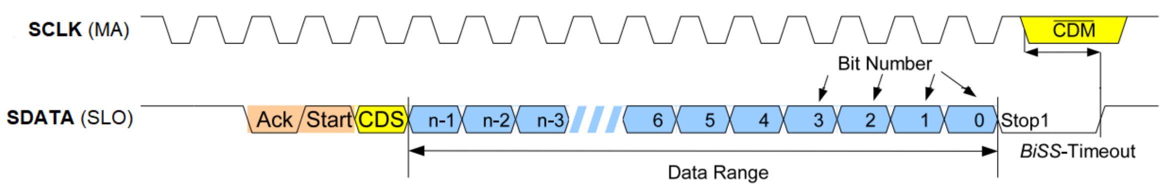
5.6. BIS10

The BIS10 is an implementation of the bidirectional interface BiSS/C® (registered trademark of IC-Haus GmbH) with the following main characteristics:

- data length reserved for encoder position is 24 bits
- encoder position data is left aligned (unused upper bits/MSB set on 0)

BIS10 is recommended for rotary encoders with resolution up to 24 bits.

Parameter	Note	Min.	Typ.	Max.	Unit
Clock frequency f_{clk}	data updated on rising clock edge	0		5.0	MHz
Processing time	not applicable, real-time encoder			0	ns
Total number for bits	n		32		bits
Number of position bits	Bits 31 down to 8		24		bits
Data alignment		left aligned unused LSB set LOW-"0"			
Number of status bits *S*	Bit 7 - not Error Bit 6 - not Warning		2		bits
CRC length	Bits 5 down to 0 Polynome: 0x43 ($X^6+X^1+X^0$) Start value: 0x00		6		bits



"Ack" bit is always 1 Clock length for all FLUX encoders.

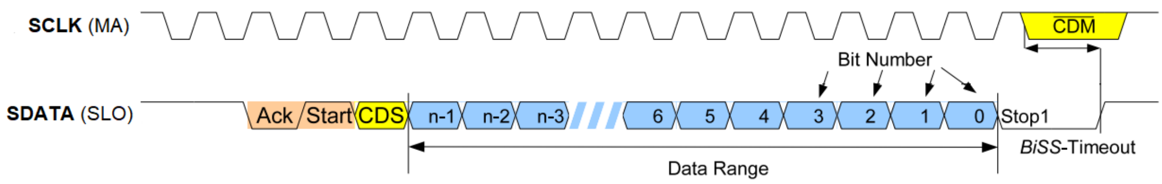
5.7. BIS20

The BIS20 is an implementation of the bidirectional interface BiSS/C® (registered trademark of IC-Haus GmbH) with the following main characteristics:

- data length reserved for encoder position is 32 bits
- encoder position data is left aligned (unused upper bits/MSB set on 0)

BIS20 is recommended for rotary encoders with resolution starting with 25 bits and above.

Parameter	Note	Min.	Typ.	Max.	Unit
Clock frequency f_{clk}	data updated on rising clock edge	0		5.0	MHz
Processing time	not applicable, real-time encoder			0	ns
Total number for bits	n		40		bits
Number of position bits	Bits 39 down to 8		32		bits
Data alignment		left aligned unused LSB set LOW-”0”			
Number of status bits *S*	Bit 7 - not Error Bit 6 - not Warning		2		bits
CRC length	Bits 5 down to 0 Polynome: 0x43 ($X^6+X^1+X^0$) Start value: 0x00		6		bits



“Ack” bit is always 1 Clock length for all FLUX encoders.

6. Commissioning and Debugging

6.1. Mounting and commissioning

GMI-ANGLE encoders must be mounted in accordance with the mounting tolerances described in Chapter 3. The recommended mounting options are presented in Chapter 4.

The **GMI-ANGLE** encoder requires no calibration or additional commissioning.

As soon as the **GMI-ANGLE** encoders are mounted according to the specifications and powered up, they will provide high accuracy and high resolution positioning over the interface.

6.2. Debugging

The **GMI-ANGLE** encoders are equipped with a status LED[1].

LED Color	Status	Recommended actions
No color	System is not (correctly) Powered-Up.	Check wiring connection to the motion controller
Red Color		
Continuous	System configuration error	Please contact FLUX
Fast blinking[2]	Encoder in error mode	Check encoder mounting
Slow blinking[3]	Out of operating range	Check encoder air-gap
Yellow		
Continuous	Normal operation, but error was detected	Check encoder shielding connection Check encoder mounting
Green		
Continuous	Optimal performance	
Fast blinking[2]	Normal operation, not optimal performance	Check encoder runout
Slow blinking[3]	Normal operation, not optimal performance	Check encoder air gap

(1) Except for high temperature applications. Please contact FLUX for more information.
(2) Fast blinking ~ 0.4 sec.
(3) Slow blinking ~ 1.6 sec

7. Additional features

7.1. Multi-turn position (memory saved)

In **GMI-ANGLE** encoders, the multi-turn position can be automatically saved at power off and restored after powering on. Therefore, even a frameless encoder such as **GMI-ANGLE** can implement a virtual multi-turn function.

The encoder does not have any mechanism for monitoring position changes when it is not powered up, so this function should only be used when movement is either not possible or restricted to less than ± 90° when power is turned off.

Please contact us at office@flux.gmbh for more information.

7.32. Setting zero position and counting direction

The GMI-ANGLE encoder allows setting of the zero position and changing of the counting direction.
Over the BiSS-C Interface registers, both functions can be performed.

For more details, please see the full BiSS-C Interface Manual for FLUX Encoders.

8. Cable Specification

8.1. Option “K01” - Cable

Recommended for:	Interfaces INCxx
Not applicable for:	Temperature exceeding -20°C .. +80°C range
Outer jacket	PUR, suitable for energy chains
Applicable Standard	UL - AWM Style 20963 80°C
Temperature rating	dynamic: -20°C .. +80°C
Wrapping	4 x 2 x AWG 30 + 2 x AWG 28, TPE Isolation
Shield	Tinned copper braided. Coverage ≥ 85 %
Outer diameter	4.2 ± 0.1mm
Bending radius	21 mm single / 42 mm continuous bending
Maximum length	6 m

No.	AWG	Color	SSI & BISS/C	A/B/Z	Comments
1	28	violett	Vdd	Vdd	Encoder Supply Voltage
2	28	black	GND	GND	Encoder Power Ground
3	30	white	Sense Line-	A+	
4	30	braun	Sense Line+	A-	
5	30	green	*not connected*	B+	
6	30	yellow	*not connected*	B-	
7	30	grey	SCLK+	Sense Line+	
8	30	pink	SCLK-	Sense Line-	
9	30	blue	SDATA+	Z+	
10	30	red	SDATA-	Z-	

8.2. Option “K02” - Cable

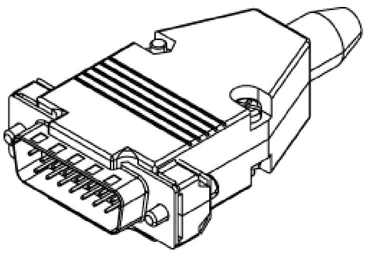
Recommended for:	Extended temperature ranges. Highest cable flexibility
Not applicable for:	Interfaces INCxx
Outer jacket	Silicone rubber-based
Applicable standard	IEC 60754-1, IEC 60332-1-2
Temperature rating	dynamic: -25°C .. +180°C / static: -60°C .. +180 °C
Wrapping	3 x 2 x AWG 30, FEP Isolation
Shield	Tinned copper braided. Coverage ≥ 95 %
Outer diameter	3.3 ± 0.1mm
Bending radius	18 mm single / 36 mm continuous bending
Maximum length	3 m

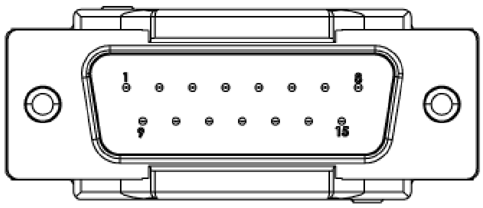
No.	AWG	Color	SSI & BISS/C	A/B/Z	Comments
1	30	red	Vdd	n.a.	Encoder Supply Voltage
2	30	black	GND		Encoder Power Ground
3	30	grey	SCLK+		
4	30	blue	SCLK-		
5	30	green	SDATA+		
6	30	yellow	SDATA-		

9. Pinout and Wiring

9.1. Option “D150”

Connector Type	DSUB, DB15, Male
Number of Pins	15

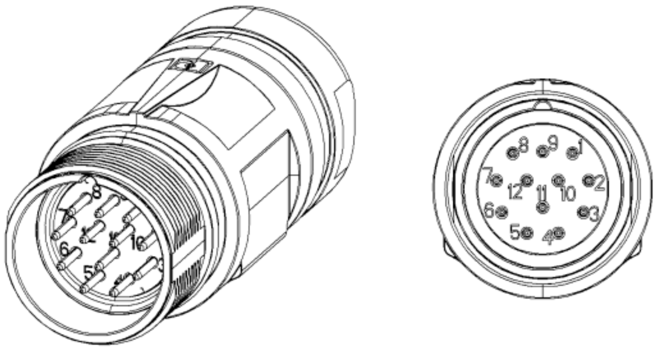




Pin	K01 - SSI & BISS/C		K02 - SSI & BISS/C		K01 - Incremental A/B/Z	
	Signal	**Color**	**Signal**	**Color**	**Signal**	**Color**
1	*not connected*		*not connected*		A+	white
2	Power Ground	black	Power Ground	black	Power Ground	black
3	*not connected*		*not connected*		B+	green
4	Power Supply	violet	Power Supply	red	Power Supply	violet
5	*not connected*		*not connected*		*not connected*	
6	*not connected*		*not connected*		*not connected*	
7	SDATA-	red	SDATA-	yellow	Z-	red
8	SCLK+	grey	SCLK+	grey	Sense Line+	grey
9	*not connected*		*not connected*		A-	brown
10	Sense Line-	white	*not connected*		*not connected*	
11	*not connected*		*not connected*		B-	yellow
12	Sense Line+	brown	*not connected*		*not connected*	
13	*not connected*		*not connected*		*not connected*	
14	SDATA+	blue	SDATA+	green	Z+	blue
15	SCLK-	pink	SCLK-	blue	Sense Line-	pink

9.2. Option “M230”

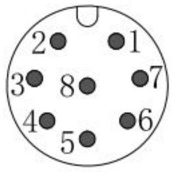
Connector Type	M23 coupler, connector, male
Number of Pins	12



<table>
<tr><th rowspan="2">Pin</th><th colspan="2">K01 - SSI & BISS/C</th><th colspan="2">K02 - SSI & BISS/C</th><th colspan="2">K01 - Incremental A/B/Z</th></tr>
<tr><th>Signal</th><th>Color</th><th>Signal</th><th>Color</th><th>Signal</th><th>Color</th></tr>
<tr><td>1</td><td colspan="2">not connected</td><td colspan="2" rowspan="12">not available</td><td>B-</td><td>yellow</td></tr>
<tr><td>2</td><td>Sense Line / +</td><td>brown</td><td>Sense Line+</td><td>grey</td></tr>
<tr><td>3</td><td>SDATA+</td><td>blue</td><td>Z+</td><td>blue</td></tr>
<tr><td>4</td><td>SDATA-</td><td>red</td><td>Z-</td><td>red</td></tr>
<tr><td>5</td><td>SCLK+</td><td>grey</td><td>A+</td><td>white</td></tr>
<tr><td>6</td><td>SCLK-</td><td>pink</td><td>A-</td><td>brown</td></tr>
<tr><td>7</td><td colspan="2">not connected</td><td colspan="2">not connected</td></tr>
<tr><td>8</td><td colspan="2">not connected</td><td>B+</td><td>green</td></tr>
<tr><td>9</td><td colspan="2">not connected</td><td colspan="2">not connected</td></tr>
<tr><td>10</td><td>Power Ground</td><td>black</td><td>Power Ground</td><td>black</td></tr>
<tr><td>11</td><td>Sense Line / -</td><td>white</td><td>Sense Line-</td><td>pink</td></tr>
<tr><td>12</td><td>Power Supply</td><td>violet</td><td>Power Supply</td><td>violet</td></tr>
</table>

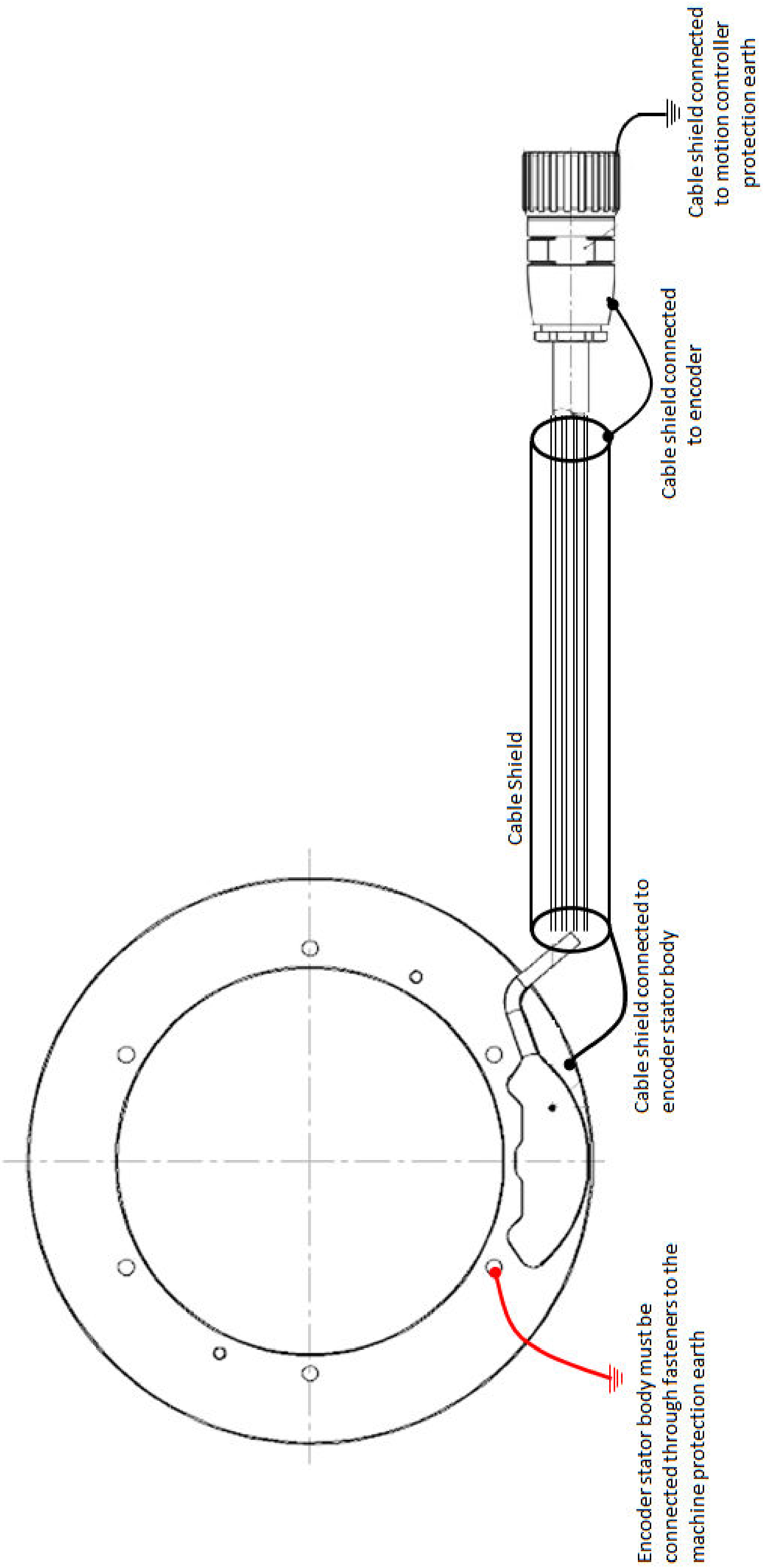
9.2. Option “M120”

Connector Type	M12 coupler, connector, male
Number of Pins	8



Pin	**K01 - SSI & BISS/C**		**K02 - SSI & BISS/C**		**K01 - Incremental A/B/Z**	
	Signal	**Color**	**Signal**	**Color**	**Signal**	**Color**
1	Sense Line / -	white	*not connected*		*not available*	
2	Sense Line / +	brown	*not connected*			
3	SDATA+	blue	SDATA+	green		
4	SDATA-	red	SDATA-	yellow		
5	Power Ground	black	Power Ground	black		
6	SCLK-	pink	SCLK-	blue		
7	SCLK+	grey	SCLK+	grey		
8	Power Supply	violet	Power Supply	red		

9.3. Recommended grounding and PE connection



10. Ordering code

GMI-ANG	-096	-22	-SSI00	-K01	-xxx	-DB15
Angle encoder	Diameter [mm]	Resolution [Bits/Rev]	Output Interface	Cable Type	Cable length	Connector Type
	096	**19**	**SSI00**	**K01-**Cable K01	**050** - 0.5 m	**DB150** - DSUB 15
	160	**20**	**SSI01**	**K02-**Cable K02	**100** - 1.0 m	**M230** - M23 coupler
	180	**21**	**SSI02**		**200** - 2.0 m	**M120** - M12 coupler
	250	**22**	**INC00**		**300** - 3.0 m	**OW** - Open wires
		23	**INC03**		**400** - 4.0 m	
		24	**BIS00**		**500** - 5.0 m	
		25	**BIS10**			
			BIS20			

Cable selection matrix

	K01	K02
Standard temperature range		
INCxx Interfaces	**yes**	no
BiSS Interfaces	**yes**	no
SSI Interfaces	**yes**	no
Extended temperature range		
INCxx Interfaces	no	no
BiSS Interfaces	no	**yes**
SSI Interfaces	no	**yes**

BiSS-C selection matrix

	resolution up to 24 bits	resolution from 25 bits
BIS00	**not recommended**	**not recommended**
BIS10	**yes**	no
BIS20	no	**yes**

11. Accessories

11.1. Mounting Screws

A set of mounting screws is included with the product.
NOTE: The use of a medium-strength screw retainer is recommended for secure mounting.

GMI-ANG	Stator	Rotor
-096	6x screws M3x8 TORX socket button head ~ISO 7380-1	6 x screws M3x6 TORX socket button head ~ISO 7380-1
-160	3 x screws M4x8 TORX socket button head ~ISO 7380-1	6 x screws M4x6 TORX socket button head ~ISO 7380-1
-180	6 x screws M4x8 TORX socket button head ~ISO 7380-1	6 x screws M4x6 TORX socket button head ~ISO 7380-1
-250	8 x screws M4x8 TORX socket button head ~ISO 7380-1	8 x screws M4x6 TORX socket button head ~ISO 7380-1

11.2. Dowel Pins

FLUX ordering code	• **DP-3g6-63**
Material	1.2210
Quantity	pack of 2 pieces
Compatibility	With any size of GMI-ANGLE encoder and stator See chapter 3. for dowel pin positions

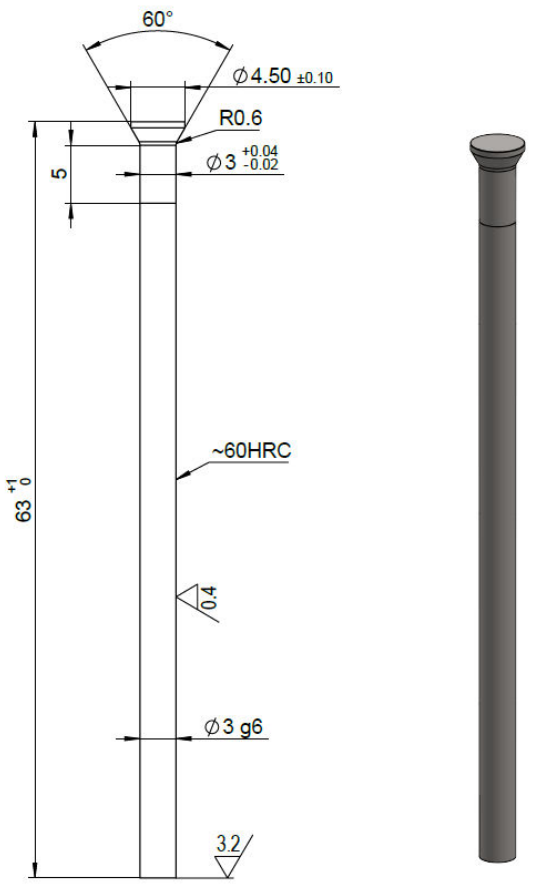


Fig.11.2.: Dowel pin DP-3g6-63 dimensions

12. Revision history

Date	Version	Comments
2022-05	00	First built - based on the AMS datasheet
2023-02	01	Drawing Updates. BIS10 and BIS20 added.
2023-04	02	Typo corrected. Pinout and wires cable in 9.2 updated.
2023-06	03	Drawing Updates. Mounting screws added.

All technical data is subject to change without notice.

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