FAGOR

FAGOR AUTOMATION

Linear and angular encoders

for CNC Machines and High Accuracy Applications

FAGOR AUTOMATION

Linear, angular and rotary encoders

Over 30 years of continuous evolution

Fagor Automation has been manufacturing high quality linear and rotary encoders using precision optical technology for more than 30 years.

Over the years Fagor has created, developed and patented systems, components and technologies that allow us to offer best quality and features over the complete range of product utilizing innovative production methods.

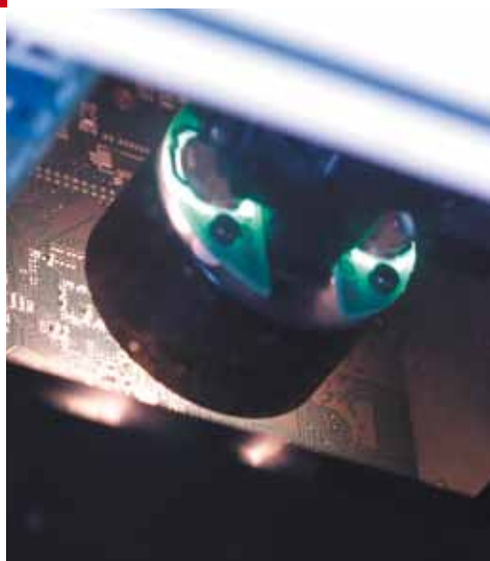
Hence making Fagor Automation the most efficient alternative in the world of feedback systems.

Modern facilities and innovative processes

In order to ensure quality and reliability in all its products Fagor Automation utilizes the most advanced technology and testing and manufacturing facilities. From centralized computer control temperature monitoring, cleanliness and relative humidity control, a must for the feedback system manufacturing process, to laboratories for climate, vibration and EMC testing to certify the designs.

With state-of-the-art technology

Fagor Automation's commitment to this technology and quality is evident by creation of **Aotek** in 2002, a dedicated research center providing various technological breakthroughs. This investment has resulted in large number of patents and customized solutions in electrical, optical and mechanical fields.



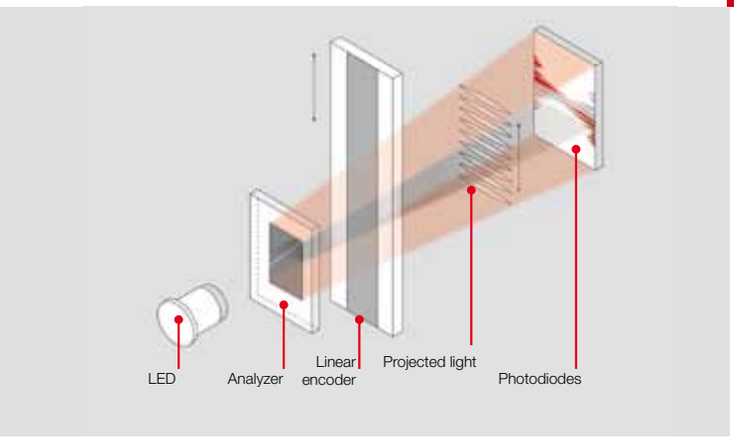
PATENT PENDING

Steel-tape tensioner

PATENT PENDING

Fringe scanning

The most reliable alternative



Fagor Automation develops with maximum professionalism the three cornerstones in encoder design: optical design, electronic design and mechanical design that result in a state-of-the-art product.

Optical design

Leader in measurement technologies, Fagor Automation uses transmissive and reflective optics in its range of encoders. With new scanning techniques such as single field and three-phase scanning that provide high quality signals that minimize interpolation errors.

Electronic design

Fagor Automation uses latest generation integrated electronic components in their design hence achieving accurate signal optimization at high speeds and nano resolution.

Mechanical design

Fagor Automation designs and manufactures the most innovative and reliable measuring systems using its advanced mechanical designs. These designs using titanium and stainless steel materials provide the encoders with optimum robustness ensuring best performance in machine tool applications.

Thermal performance

When designing the encoders Fagor Automation has taken into account the effect of temperature change on their performance.

Most machine shops do not operate in temperature controlled environment hence affecting the accuracy of finished part. Using the TDMS™ system, **Thermal Determined Mounting System** which controls expansion/ contraction, Fagor linear encoders can deliver consistent accuracy and repeatability.

For linear encoders more than three meters long, Fagor guarantees a thermal behavior identical to that of the machine surface it is mounted on thanks to the special mounting system at the end of the linear encoders.

The TDMS™ system is only available on G and SV series linear encoders.

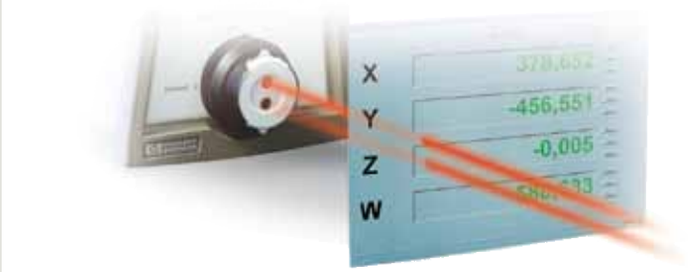
Quality

Accuracy certificate

Every single Fagor encoder is subjected to an extensive final accuracy check. This control is carried out on a computerized measuring bench equipped with a laser interferometer located inside a climate controlled chamber at 20 ºC. The resulting final accuracy graph is supplied with every Fagor encoder.

The quality of the measurement is mainly determined by:

- Etching quality
- The quality of the scanning process
- The quality of the electronics that processes the signals



A ABSOLUTE

Linear

Angular and rotary

I INCREMENTAL

Linear

Angular and rotary

Technology

The absolute measurement system is a direct digital measure of machine position. It is fast, accurate and does not require homing of the machine. The position value is available from the moment the machine is turned on and may be requested by the connected device (CNC) at any time.

The absolute encoders provide direct measure of machine position without using any intermediate device. The positioning errors originating from machine mechanics are minimized as the encoder is directly mounted to the machine surface and the guide ways. The encoder sends the real machine movement data to the CNC and mechanical errors caused due to thermal behavior of the machine, pitch error compensation and backlash etc. are minimized.

Linear encoders

Fagor Automation uses two measuring methods in their absolute linear encoders:

- **Graduated glass:** Linear encoders with a measuring length of up to 3 040 mm use optical transmission. The light from the LED goes through a graduated glass and a reticule before reaching the receiving photo diodes. The period of the generated electrical signals is the same as the graduation pitch.
- **Graduated steel:** Linear encoders with a measuring length over 3040 mm use the autoimage principle by means of diffuse light reflected on the graduated steel tape. The reading system consists of one LED, as the light source of the linear encoder; a mesh that makes the image and a monolithic photo detector element in the plane of the image specially designed and patented by Fagor Automation.

Both measuring methods have two different etchings:

- **Incremental graduation:** Used to generate incremental signals that are counted inside the reader head. The incremental graduation also provides the 1 Vpp analog signals except in systems that only use digital signals.
- **Absolute graduation:** It is a unique binary code which is imprinted along the measuring length of encoder.

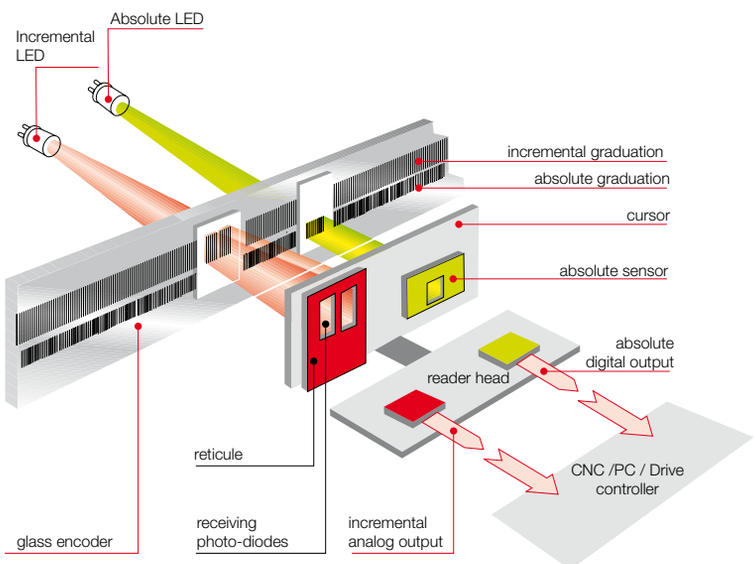
Fagor encoders calculate the absolute position by reading the unique binary code using a high precision optical sensor.

Enclosed design

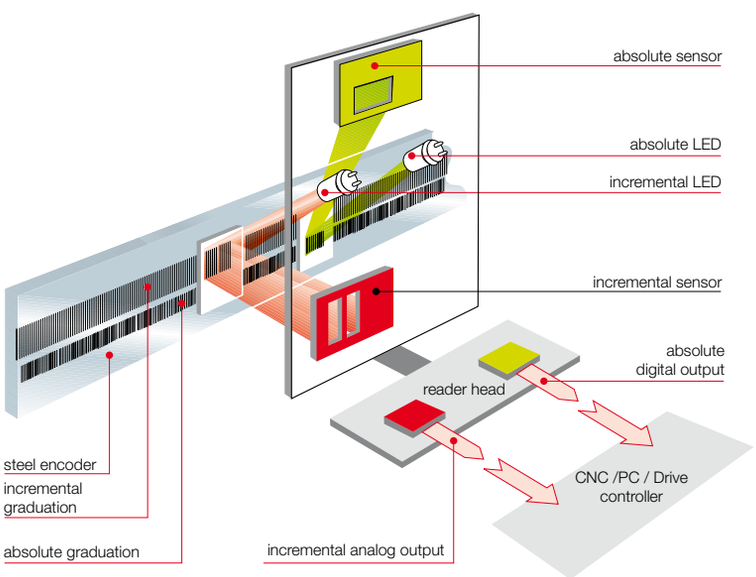
The robust aluminum profile encasing the graduated glass provides the primary protection. The sealing lips provides protection against contaminants and liquids as the reader head travels along the profile. The reader head movement along the graduated glass provides a perfectly balanced system accurately capturing the machine movement. The reader heard travels on precision bearing with minimum contact with the profile hence minimizing the friction.

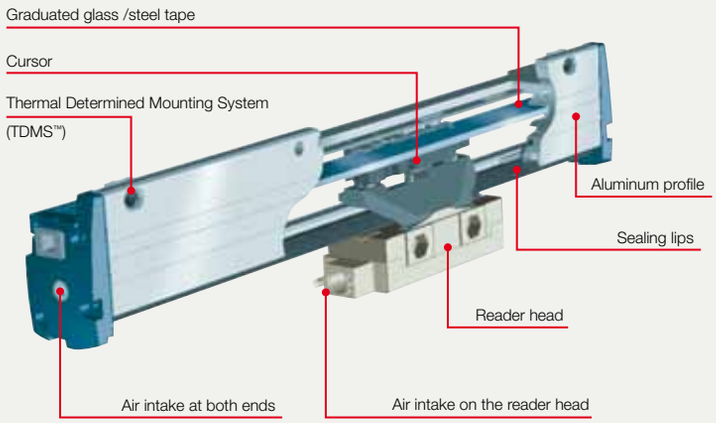
The optional air inlet at both ends of the encoder and at the reader head provides increased protection levels against contaminants and liquids.

Graduated glass encoder

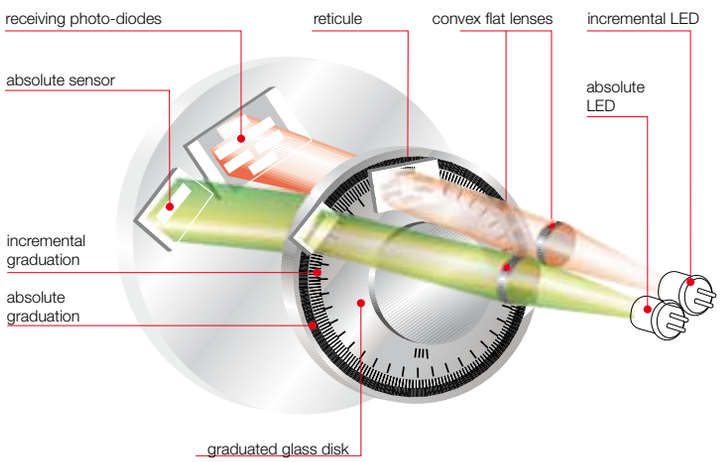


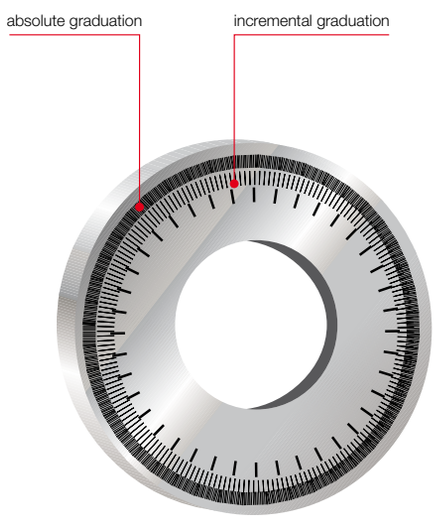
Graduated steel encoder





Graduated glass disk





Angular and rotary encoders

Angular encoders are used as angular movement sensors on machines that require high resolution and high accuracy.

Fagor angular encoders reach 23 and 27-bit angular resolution equivalent to 8 388 608 and 134 217 728 positions respectively and accuracy levels of ± 5”, ± 2.5”, ± 2” and ± 1” depending on the model. In them, the graduated disk of the measuring system is attached directly to the shaft. They have bearings and couplings that serve as guide and adjustment.

Couplings, besides minimizing the static and dynamic deviations, compensate for axial movements of the shaft providing easier mounting, smaller size and the possibility of hollow shafts.

Fagor Automation uses the **graduated glass** measuring method in their absolute angular and rotary encoders.

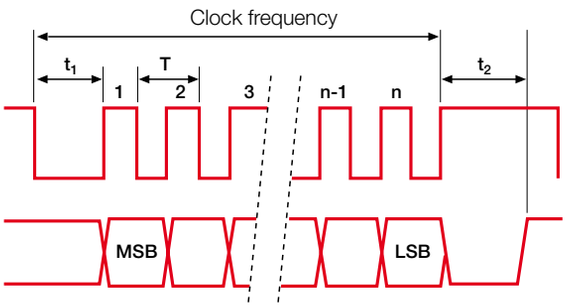
The measurement is based on the pitch determined by the number of pulses/turn. Like graduated glass linear encoders, they are based on optical transmission.

This measuring method has two different graduations: An **incremental** one and an **absolute** one, like linear encoders as described in the previous page.

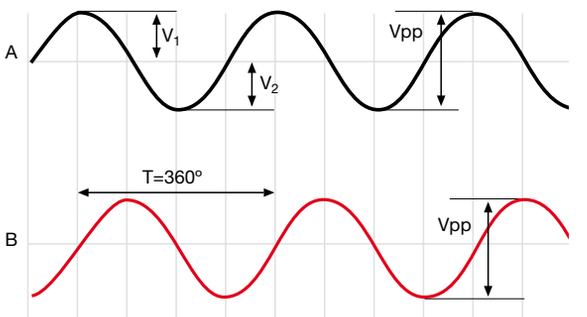
Electrical output signals

They are defined according to the communication protocol. Protocols are specific communication languages used by linear or angular encoders to communicate with the machine controller (CNC, drive, PLC, etc.). There are different communication protocols depending on the CNC manufacturer. Fagor Automation offers absolute encoders with different communication protocols compatible with the main CNC manufacturers on the market such as FAGOR, FANUC®, SIEMENS®, MITSUBISHI®, PANASONIC® and others.

absolute



1 Vpp differential



FAGOR systems

They may be connected to Fagor systems via:

1. Serial Synchronous Interface - SSI

These systems synchronize the SSI interface with the sinusoidal 1 Vpp signals. Once the absolute position has been obtained through the SSI interface, the encoders keep operating with incremental 1 Vpp signals.

ABSOLUTE signals

Transmission	SSI synchronous serial transfer via RS 485
Levels	EIA RS 485
Clock frequency	100 kHz - 500 kHz
Max. bit (n)	32
T	1 µs + 10 µs
t_1	> 1 µs
t_2	20 µs - 35 µs
SSI	Binary
Parity	No

1 Vpp DIFFERENTIAL signals

Signals	A, /A, B, /B
V_{App}	1 V +20%, -40%
V_{Bpp}	1 V +20%, -40%
DC offset	2.5 V ±0.5 V
Signal period	20, 40 µm
Supply V	5 V ±10%
Max. cable length	100 meters
A, B centered: $\|V_1-V_2\| / 2\ V_{pp}$	< 0.065
A&B relationship V_{App} / V_{Bpp}	0.8÷1.25
A&B phase shift	90°±10°

2. Fagor FeeDat Serial Interface

These systems only use digital signals.

The absolute encoder is connected via the SERCOS board.

A high communication speed of 10 MHz provides a loop time of 10 microseconds. Communication also includes alarms, analog signal values and other encoder parameters.

Fagor FeeDat is an open communication protocol that is also used to communicate with other CNC system manufacturers.

SERCOS counter board

SIEMENS® systems

They may be connected to Siemens® systems via:

1. Serial Synchronous Interface - SSI

These systems synchronize the SSI interface with sinusoidal 1 Vpp signals. Once the absolute position has been obtained through the SSI interface, the encoders keep operating with incremental 1 Vpp signals. These encoders are only valid to connect to SME 25 or SMC 20 modules of the Solution Line family.

ABSOLUTE signals

Transmission	SSI synchronous serial transfer via RS 485
Levels	EIA RS 485
Clock frequency	100 kHz - 500 kHz
Max. bit (n)	28
T	1 µs + 10 µs
t_1	> 1 µs
t_2	20 µs - 35 µs
SSI	Gray
Parity	Yes

1 Vpp DIFFERENTIAL signals

Signals	A, /A, B, /B
V_{App}	1 V +20%, -40%
V_{Bpp}	1 V +20%, -40%
DC offset	2.5 V ±0.5 V
Signal period	20, 40 µm
Supply V	5 V ±10%
Max. cable length	100 meters
A, B centered: $\|V_1-V_2\| / 2\ V_{pp}$	< 0.065
A&B relationship V_{App} / V_{Bpp}	0.8÷1.25
A&B phase shift	90°±10°

2. DRIVE-CLiQ® Interface

These systems only use digital signals.

The absolute encoder is connected through a cable having the electronics integrated into the connector and it is connected to the “Solution Line” family without the need for intermediate modules.

Sistemas FANUC® Serial Interface for position feedback encoder

These systems only use digital signals. The absolute encoder is connected through the SDU (Separate Detector Unit) device and is valid for communication protocol versions FANUC® 01 and 02 serial interface.

MITSUBISHI® systems High Speed Serial Interfface - HSSI

These systems only use digital signals. The absolute encoder is connected through the MDS Series drive and it is valid for MITSUBISHI® communication protocol versions Mit 03-2/4.

PANASONIC® systems Serial Communication

These systems only use digital signals. The absolute encoder is connected through the MINAS series drive.

As an example, here is the photo and characteristics of the Panasonic® MINAS A5L drive.

These systems use Analogue / Pulse signals.

- Systems can be connected to linear motors, shaft motors, DD motors
- Automatic drive/motor matching software available
- Vibration, resonance suppression filters available with setting done automatically / manually
- Drive range from 50 W to 15 kW at AC 100 V / 200 V / 400 V
- Safety Torque Off feature available

PANASONIC® A5L systems

Range

Analyze the application to make sure that the proper encoder will be selected for the machine.

To do this, bear in mind the following considerations

Linear

Installation

Consider the physical length of the installation and the space available for it.

These aspects are crucial to determine the type of linear encoder to use (type of profile).

Accuracy

Each linear encoder comes with a graph showing its accuracy along its measuring length.

Signal

The signal selection considers the communication protocols compatible with the main CNC manufacturers.

Resolution

The resolution of the control of machine-tools depends on the linear encoder.

Cable length

The length of the cable depends on the type of signal.

Compatibility

The signal must be compatible with the control system.

Speed

The speed requirements for the application must be analyzed before choosing the linear encoder.

Shock and Vibration

Fagor linear encoders withstand vibrations of up to 20 g and shocks of up to 30 g.

Angular

Installation

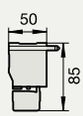
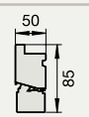
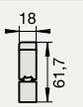
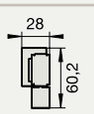
This point considers the physical dimensions of the installation and the space available for it.

It is essential to determine its type of shaft: Hollow or solid.

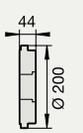
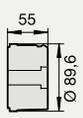
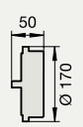
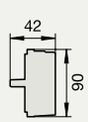
Accuracy

Each encoder comes with a graph showing its accuracy along its measuring length.

Linear

Series	Section	Measuring lengths
LA Long		440 mm to 50 m
GA Wide		140 mm to 3 040 mm
SA Reduced		70 mm to 1 240 mm
SVA Reduced		70 mm to 2 040 mm

Angular

Series	Section	Type of shaft
HA-D200		Hollow shaft
HA-D90		Hollow shaft
SA-D170		Solid shaft
SA-D90		Solid shaft

Accuracy	Signals	Pitch Resolution up to	Model	Page
± 5 µm	SSI + 1 Vpp FAGOR SSI + 1 Vpp SIEMENS®(*) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS®(*)	0.1 µm	LA	16 and 17
		1 µm	LAS	
		0.01 µm	LAF / LAM / LAP / LAD	
			LAD + EC-PA-DQ	
± 5 µm and ± 3 µm	SSI +1 Vpp FAGOR / SIEMENS®(*) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS®(*)	0.1 µm	GA / GAS	18 and 19
		0.01 µm	GAF / GAM / GAP / GAD GAD + EC-PA-DQ	
± 5 µm and ± 3 µm	SSI +1 Vpp FAGOR / SIEMENS®(*) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS®(*)	0.1 µm	SA / SAS	20 and 21
		0.01 µm	SAF / SAM / SAP / SAD SAD + EC-PA-DQ	
± 5 µm and ± 3 µm	SSI +1 Vpp FAGOR / SIEMENS®(*) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS®(*)	0.1 µm	SVA / SVAS	22 and 23
		0.01 µm	SVAF / SVAM / SVAP / SVAD SVAD + EC-PA-DQ	

Accuracy	Signals	Model	Page
± 2” and ±1”	SSI +1 Vpp FAGOR / SIEMENS® (*)	HA-D200/ HAS-D200	24
	FANUC® / MITSUBISHI® / PANASONIC® / FAGOR	HAF-D200 / HAM-D200 / HAP-D200 / HAD-D200	
	SIEMENS (*)	HAD-D200 + EC-PA-DQ	
± 5” and ±2,5”	SSI +1 Vpp FAGOR / SIEMENS® (*)	HA-D90 / HAS-D90	25
	FANUC® / MITSUBISHI® / PANASONIC® / FAGOR	HAF-D90 / HAM-D90 / HAP-D90 / HAD-D90	
	SIEMENS (*)	HAD-D90 + EC-PA-DQ	
± 2”	SSI +1 Vpp FAGOR / SIEMENS® (*)	SA-D170 / SAS-D170	26
	FANUC® / MITSUBISHI® / PANASONIC® / FAGOR	SAF-D170 / SAM-D170 / SAP-D170 / SAD-D170	
	SIEMENS (*)	SAD-D170 + EC-PA-DQ	
± 5” and ±2,5”	SSI +1 Vpp FAGOR / SIEMENS® (*)	SA-D90 / SAS-D90	27
	FANUC® / MITSUBISHI® / PANASONIC® / FAGOR	SAF-D90 / SAM-D90 / SAP-D90 / SAD-D90	
	SIEMENS (*)	SAD-D90 + EC-PA-DQ	

* SIEMENS®: valid for family Solution Line.

LA series

LINEAR

Specially designed for high performance environment requiring speed and accuracy.

Their special mounting system guarantees a thermal behavior identical to that of the machine surface the linear encoder is mounted on. This is achieved through floating fixtures at their ends with the base of the machine and by tensioning the etched steel tape. This system eliminates the errors caused by temperature changes and ensures maximum accuracy and repeatability of the linear encoders.

The steel tape graduation pitch is 0.04 mm. Measuring lengths over 4 040 mm require the use of modules.

Model description:

LA: Absolute linear encoders with SSI protocol for FAGOR and others.

LAS: Absolute linear encoders with SSI protocol for SIEMENS® (Solution Line).

LAF: Absolute linear encoders with FANUC® (01 and 02) protocol.

LAM: Absolute linear encoders with MITSUBISHI® CNC protocol.

LAP: Absolute linear encoders with PANASONIC® (Matsushita) protocol.

LAD: Absolute linear encoders with FeeDat protocol for FAGOR and others.

LAD + EC-PA-DQ: Linear and absolute encoders with DRIVE-CLiQ® protocol , for SIEMENS® (Solution Line).

Measuring lengths in millimeters

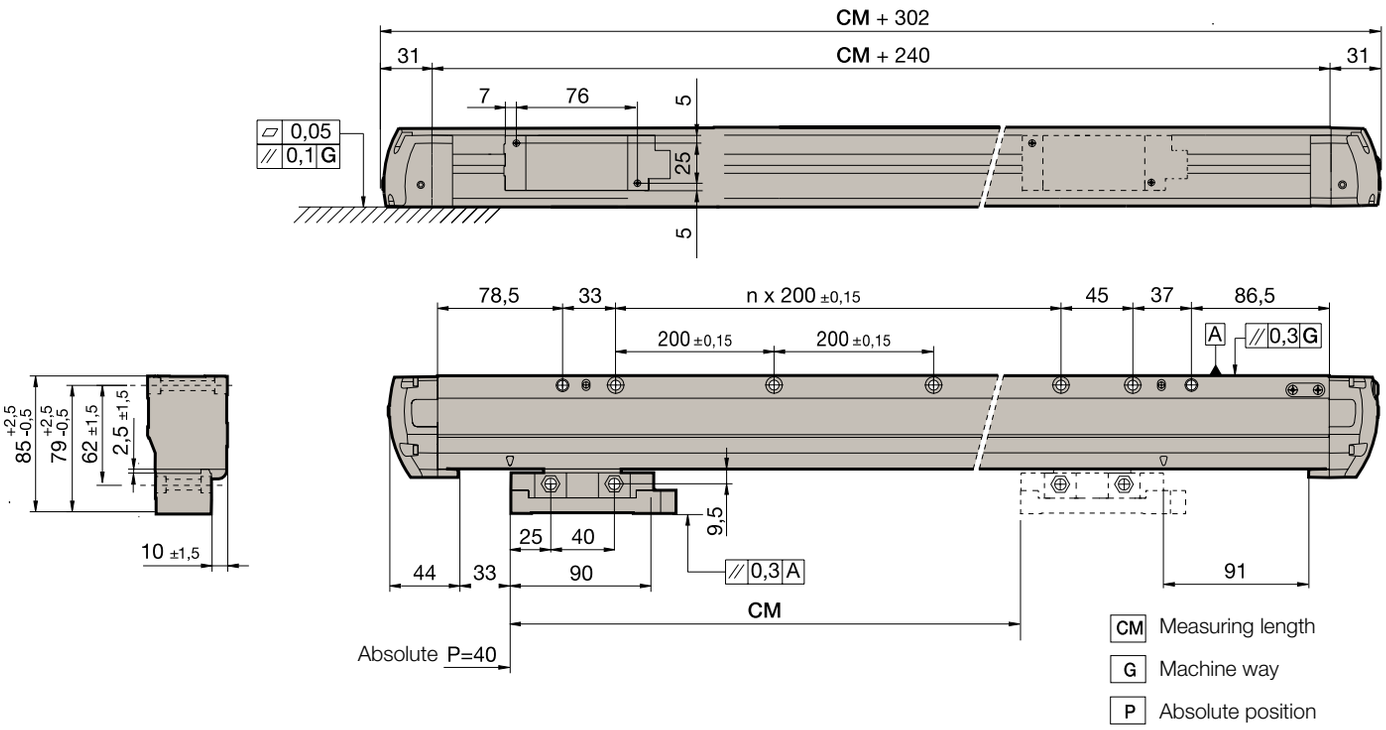
- Available in measuring lengths from 440 mm to 50 m in 200 mm increments. Contact Fagor Automation for custom solutions if your application requires longer lengths.

Characteristics

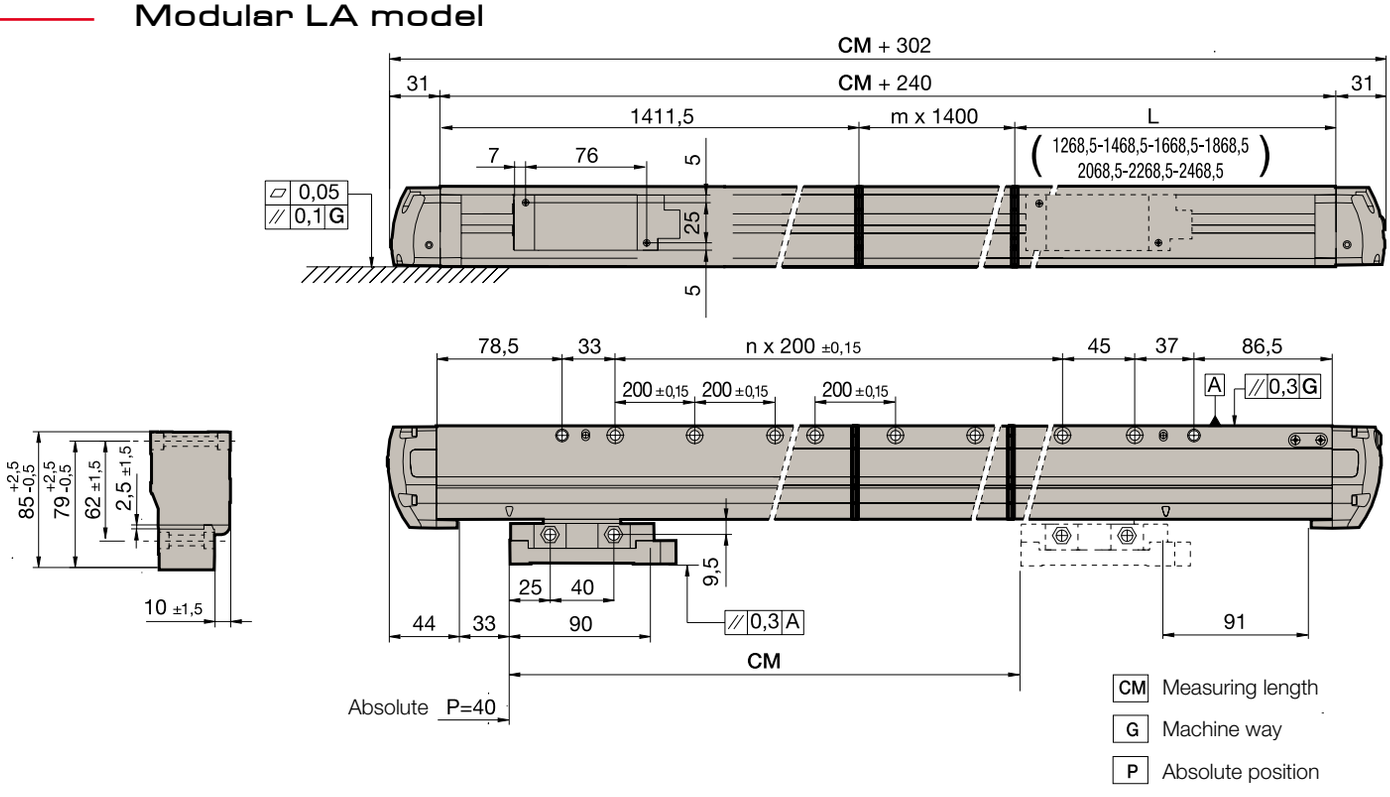
	LA / LAS	LAF		LAM		LAP		LAD		LAD+ EC-PA-DQ	
Measurement	**Incremental:** By means of a 40 µm-pitch stainless steel tape **Absolute:** Optical reading of sequential binary code										
Glass thermal expansion coefficient	α_{therm}: 11 ppm/K aprox.										
Measuring resolution	0.1 µm / 1 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm
Output signals	~ 1 Vpp	–		–		–		–		–	
Incremental signal period	40 µm	–		–		–		–		–	
Limit frequency	< 50 KHz for 1 Vpp	–		–		–		–		–	
Maximum cable length	100 m	30 m		30 m		30 m		100 m		30 m	
Supply voltage	5V ± 10%, 250 mA (without load)										
Steel tape accuracy	± 5 µm/m	± 5 µm/m		± 5 µm/m		± 5 µm/m		± 5 µm/m		± 5 µm/m	
Maximum speed	120 m/min	180 m/min	120 m/min	180 m/min	120 m/min	180 m/min	120 m/min	180 m/min		180 m/min	
Maximum vibration	10 g										
Maximum shock	30 g (11 ms) IEC 60068-2-27										
Maximum acceleration	10 g in the measuring direction										
Required moving force	< 5 N										
Operating temperature	0 ºC … 50 ºC										
Storage temperature	-20 ºC ... 70 ºC										
Weight	1.50 kg + 4 kg/m										
Relative humidity	20 … 80%										
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders										
Reader head	With built-in connector Connection at both ends of the reader head										

Single LA model

Dimensions in mm



Modular LA model



Order identification

Example of Linear Encoder: **LAF10-102-A**

L	A	F	10	102	A
Type of profile for long space	***Letter identifying the absolute encoder***	***Type of communications protocol:*** • Blank space: SSI protocol (FAGOR) • D: FeeDat protocol (FAGOR) • S: SIEMENS® (SL) protocol • **F: FANUC® (01 and 02) protocol** • M: MITSUBISHI® CNC protocol • P: PANASONIC® (Matsushita) protocol	***Resolution:*** • Blank space: 50 nm 50: 50 nm (*) **10: 10 nm**	***Ordering length code:*** In the example (102) = 10 240 mm	***Air intake on the reader head:*** • Blank space: Without air intake • **A: With air intake**

(*): identificador sólo para Protocolo FeeDat LAD50

GA series

LINEAR

Specially designed for high performance environment requiring high speed and accuracy.

The TDMS™ mounting system ensures greater accuracy, higher repeatability and ability to withstand vibrations without compromising machine performance.

Measuring lengths in millimeters

140 • 240 • 340 • 440 • 540 • 640 • 740 • 840 • 940
1 040 • 1 140 • 1 240 • 1 340 • 1 440 • 1 540 • 1 640
1 740 • 1 840 • 2 040 • 2 240 • 2 440 • 2 640 • 2 840 • 3 040

Model description:

GA: Absolute linear encoders with SSI protocol for FAGOR and others.

GAS: Absolute linear encoders with SSI protocol for SIEMENS® (Solution Line).

GAF: Absolute linear encoders with FANUC® (01 and 02) protocol.

GAM: Absolute linear encoders with MITSUBISHI® CNC protocol.

GAP: Absolute linear encoders with PANASONIC® (Matsushita) protocol.

GAD: Absolute linear encoders with FeeDat protocol for FAGOR and others.

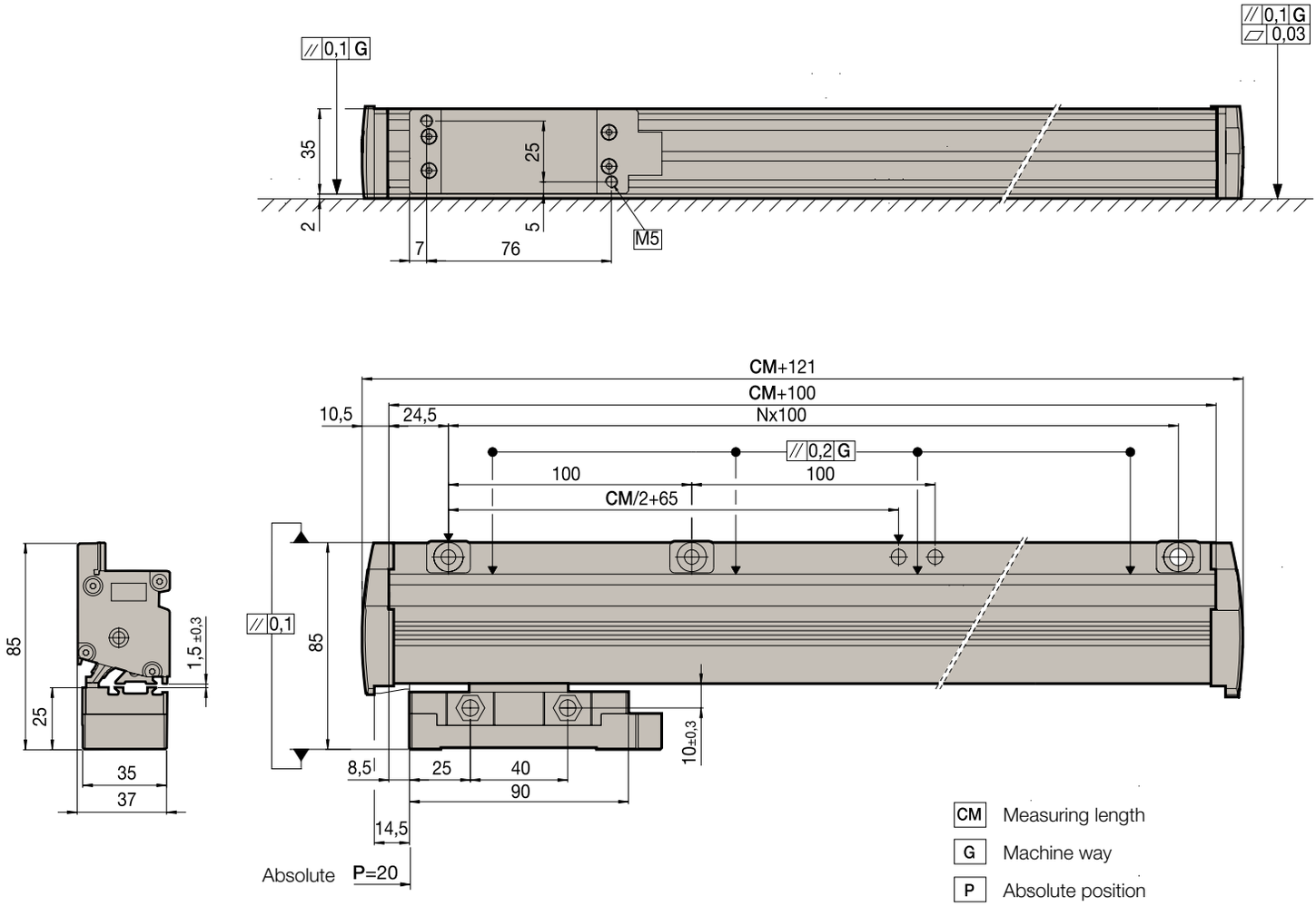
GAD + EC-PA-DQ: Linear and absolute encoders with DRIVE-CLiQ® protocol , for SIEMENS® (Solution Line).

Characteristics

	GA / GAS	GAF		GAM		GAP		GAD		GAD+ EC-PA-DQ	
Measurement	**Incremental:** By means of a 20 µm-pitch stainless steel tape **Absolute:** Optical reading of sequential binary code										
Glass thermal expansion coefficient	α_{therm}: 8 ppm/K aprox.										
Measuring resolution	0.1 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm
Output signals	~ 1 Vpp	–		–		–		–		–	
Incremental signal period	20 µm	–		–		–		–		–	
Limit frequency	< 100 KHz for 1 Vpp	–		–		–		–		–	
Maximum cable length	100 m	30 m		30 m		30 m		100 m		30 m	
Supply voltage	5V ± 10%, 250 mA (without load)										
Steel tape accuracy	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m	
Maximum speed	120 m/min	180 m/min	120 m/min	180 m/min	120 m/min	180 m/min	120 m/min	180 m/min		180 m/min	
Maximum vibration	20 g (55 … 2000 Hz) IEC 60068-2-6										
Maximum shock	30 g (11 ms) IEC 60068-2-27										
Maximum acceleration	10 g in the measuring direction										
Required moving force	< 5 N										
Operating temperature	0 ºC … 50 ºC										
Storage temperature	-20 ºC ... 70 ºC										
Weight	0.25 kg + 2.25 kg/m										
Relative humidity	20 … 80%										
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders										
Reader head	With built-in connector Connection at both ends of the reader head										

GA model

Dimensions in mm



Order identification

Example of Linear Encoder: **GAF10-1640-5-A**

G	A	F	10	1640	5	A
Type of profile for long space	***Letter identifying the absolute encoder***	***Type of communications protocol:*** • Blank space: SSI protocol (FAGOR) • D: FeeDat protocol (FAGOR) • S: SIE MENS® (SL) protocol • **F: FANUC® (01 and 02) protocol** • M: MITSUBISHI® CNC protocol • P: PANASONIC® (Matsushita) protocol	***Resolution:*** • Blank space: 50 nm 50: 50 nm (*) **10: 10 nm**	***Measuring lengths in millimeters:*** In the example (1640) = 1 640 mm	***Accuracy of the linear encoder:*** • **5: ± 5 µm** • 3: ± 3 µm	***Air intake on the reader head:*** • Blank space: Without air intake • **A: With air intake**

(*): identificador sólo para Protocolo FeeDat GAD50

SA series

LINEAR

Specially designed for high performance environment requiring high speed and accuracy. Ideal for limited mounting spaces.

Measuring lengths in millimeters

70 • 120 • 170 • 220 • 270 • 320 • 370 • 420 • 470 • 520
570 • 620 • 670 • 720 • 770 • 820 • 870 • 920 • 1 020
1 140 • 1 240

Model description:

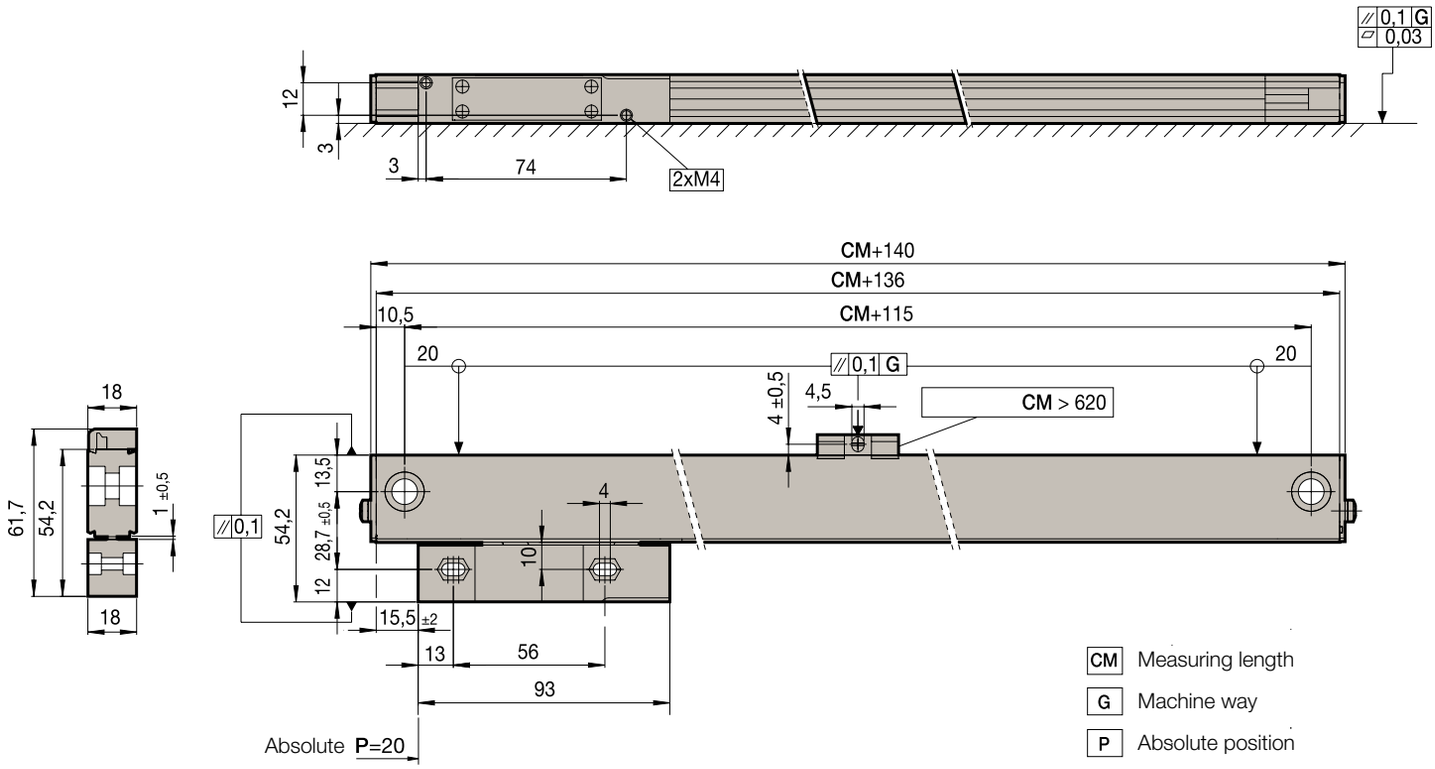
SA: Absolute linear encoders with SSI protocol for FAGOR and others.
SAS: Absolute linear encoders with SSI protocol for SIEMENS® (Solution Line).
SAF: Absolute linear encoders with FANUC® (01 and 02) protocol.
SAM: Absolute linear encoders with MITSUBISHI® CNC protocol.
SAP: Absolute linear encoders with PANASONIC® (Matsushita) protocol.
SAD: Absolute linear encoders with FeeDat protocol for FAGOR and others.
SAD + EC-PA-DQ: Linear and absolute encoders with DRIVE-CLiQ® protocol , for SIEMENS® (Solution Line).

Characteristics

	SA / SAS	SAF		SAM		SAP		SAD		SAD+ EC-PA-DQ	
Measurement	**Incremental:** By means of a 20 µm-pitch stainless steel tape **Absolute:** Optical reading of sequential binary code										
Glass thermal expansion coefficient	α_{therm}: 8 ppm/K aprox.										
Measuring resolution	0.1 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm
Output signals	~ 1 Vpp	–		–		–		–		–	
Incremental signal period	20 µm	–		–		–		–		–	
Limit frequency	< 100 KHz for 1 Vpp	–		–		–		–		–	
Maximum cable length	100 m	30 m		30 m		30 m		100 m		30 m	
Supply voltage	5V ± 10%, 250 mA (without load)										
Steel tape accuracy	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m	
Maximum speed	120 m/min	180 m/min	120 m/min	180 m/min	120 m/min	180 m/min	120 m/min	180 m/min		180 m/min	
Maximum vibration	10 g without mounting plate										
Maximum shock	30 g (11 ms) IEC 60068-2-27										
Maximum acceleration	10 g in the measuring direction										
Required moving force	< 4 N										
Operating temperature	0 ºC … 50 ºC										
Storage temperature	-20 ºC ... 70 ºC										
Weight	0.20 kg + 0.50 kg/m										
Relative humidity	20 … 80%										
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders										
Reader head	With built-in connector										

SA model

Dimensions in mm



Order identification

Example of Linear Encoder: **SAF10 - 420 - 5 - A**

S	A	F	10	420	5	A
Type of profile for reduced space: • **S: Standard mounting for vibrations of up to 10 g.**	***Letter identifying the absolute encoder***	***Type of communications protocol:*** • Blank space: SSI protocol (FAGOR) • D: FeeDat protocol (FAGOR) • S: SIEMENS® (SL) protocol • **F: FANUC® (01 and 02) protocol** • M: MITSUBISHI® CNC protocol • P: PANASONIC® (Matsushita) protocol	***Resolution:*** • Blank space: 50 nm 50: 50 nm (*) **10: 10 nm**	***Measuring lengths in millimeters:*** In the example (420) = 420 mm	***Accuracy of the linear encoder:*** • **5: ± 5 µm** • 3: ± 3 µm	***Air intake on the reader head:*** • Blank space: Without air intake • **A: With air intake**

(*): identificador sólo para Protocolo FeeDat SAD50

SVA series

LINEAR

Specially designed for high performance environment requiring high speed and accuracy and the need to withstand higher vibrations.

The TDMS™ mounting system incorporated through a separate back bar ensures greater accuracy, higher repeatability and ability to withstand vibrations without compromising machine performance.

Measuring lengths in millimeters

70 • 120 • 170 • 220 • 270 • 320 • 370 • 420 • 470 • 520
570 • 620 • 670 • 720 • 770 • 820 • 870 • 920 • 1 020
1 140 • 1 240 • 1 340 • 1 440 • 1 540 • 1 640 • 1 740
1 840 • 2 040

Model description:

SA: Absolute linear encoders with SSI protocol for FAGOR and others.

SVAS: Absolute linear encoders with SSI protocol for SIEMENS® (Solution Line).

SVAF: Absolute linear encoders with FANUC® (01 and 02) protocol.

SVAM: Absolute linear encoders with MITSUBISHI® CNC protocol.

SVAP: Absolute linear encoders with PANASONIC® (Matsushita) protocol.

SVAD: Absolute linear encoders with FeeDat protocol for FAGOR and others.

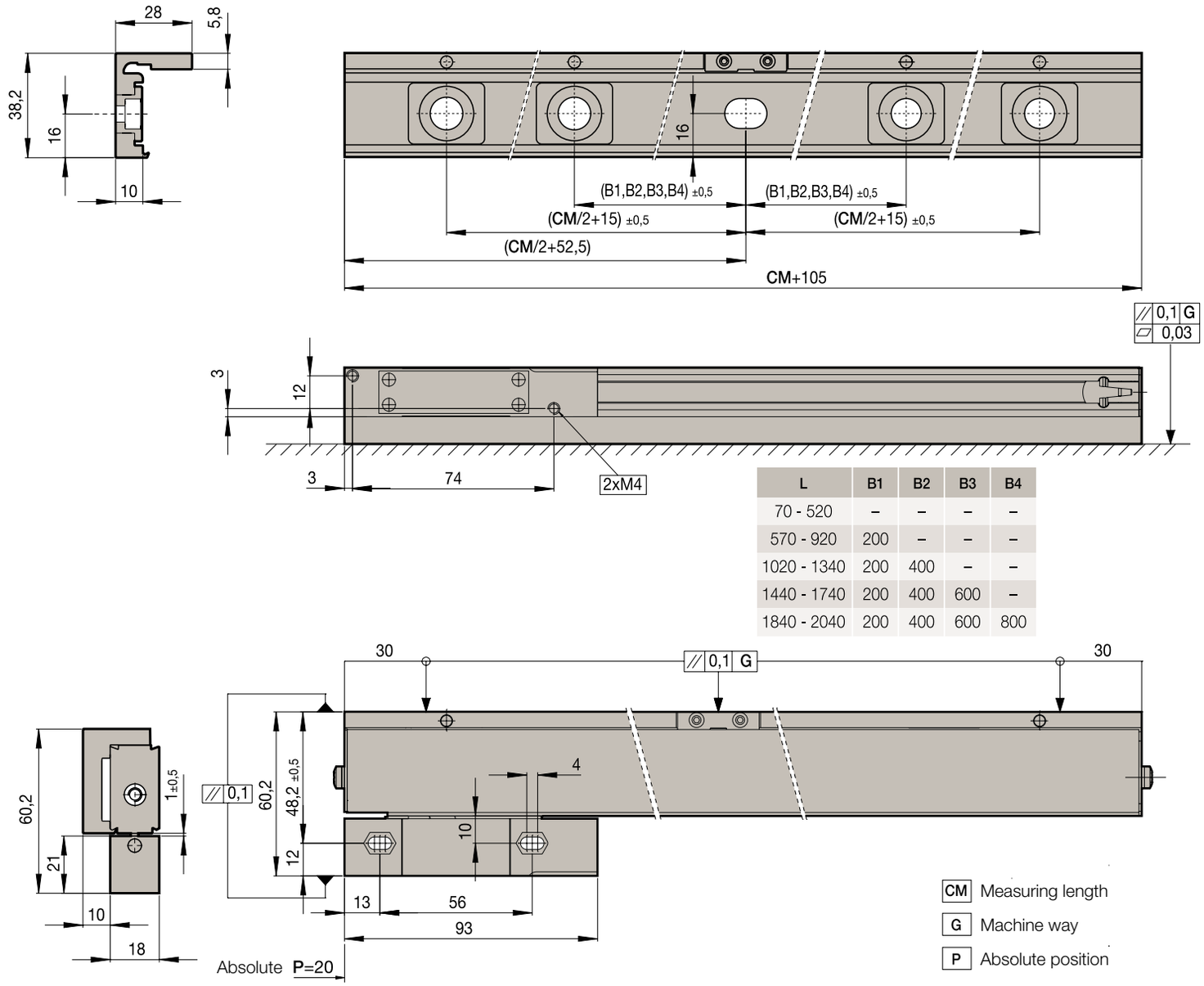
SVAD + EC-PA-DQ: Linear and absolute encoders with DRIVE-CLiQ® protocol , for SIEMENS® (Solution Line).

Characteristics

	SVA / SVAS	SVAF		SVAM		SVAP		SVAD		SVAD+ EC-PA-DQ	
Measurement	**Incremental:** By means of a 20 µm-pitch stainless steel tape **Absolute:** Optical reading of sequential binary code										
Glass thermal expansion coefficient	α_{therm}: 8 ppm/K aprox.										
Measuring resolution	0.1 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm	0.01 µm	0.05 µm
Output signals	~ 1 Vpp	–		–		–		–		–	
Incremental signal period	20 µm	–		–		–		–		–	
Limit frequency	< 100 KHz for 1 Vpp	–		–		–		–		–	
Maximum cable length	100 m	30 m		30 m		30 m		100 m		30 m	
Supply voltage	5V ± 10%, 250 mA (without load)										
Steel tape accuracy	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m		± 5 µm/m ± 3 µm/m	
Maximum speed	120 m/min	180 m/min	120 m/min	180 m/min	120 m/min	180 m/min	120 m/min	180 m/min		180 m/min	
Maximum vibration	20 g with mounting plate										
Maximum shock	30 g (11 ms) IEC 60068-2-27										
Maximum acceleration	10 g in the measuring direction										
Required moving force	< 4 N										
Operating temperature	0 ºC … 50 ºC										
Storage temperature	-20 ºC ... 70 ºC										
Weight	0.25 kg + 1.55 kg/m										
Relative humidity	20 … 80%										
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders										
Reader head	With built-in connector										

SVA model

Dimensions in mm



L	B1	B2	B3	B4
70 - 520	–	–	–	–
570 - 920	200	–	–	–
1020 - 1340	200	400	–	–
1440 - 1740	200	400	600	–
1840 - 2040	200	400	600	800

Order identification

Example of Linear Encode: **SVAF10 - 420 - 5 - B - A**

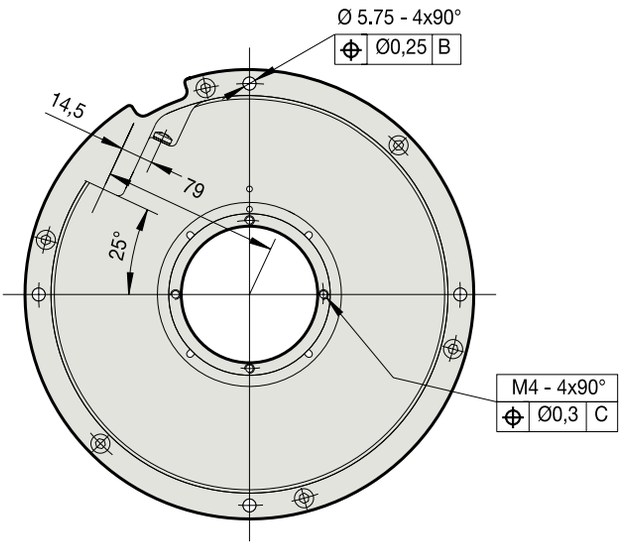
SV	A	F	10	420	5	B	A
Type of profile for reduced spaces: • **SV: Vibration mounting for up to 20 g**	*Letter identifying the absolute encoder*	*Type of communications protocol:* • Blank space: SSI protocol (FAGOR) • D: FeeDat protocol (FAGOR) • S: SIEMENS® (SL) protocol • **F: FANUC® (01 and 02) protocol** • M: MITSUBISHI® CNC protocol • P: PANASONIC® (Matsushita) protocol	*Resolution:* • Blank space: 50 nm 50: 50 nm (*) **10: 10 nm**	*Measuring lengths in millimeters:* In the example (420) = 420 mm	*Accuracy of the linear encoder:* • **5: ± 5 µm** • 3: ± 3 µm	*Linear encoder with mounting support:* • **B: With mounting support for vibrations of up to 20 g**	*Air intake on the reader head:* • Blank space: Without air intake • **A: With air intake**

(*): identificador sólo para Protocolo FeeDat SVAD50

HA-D200 series

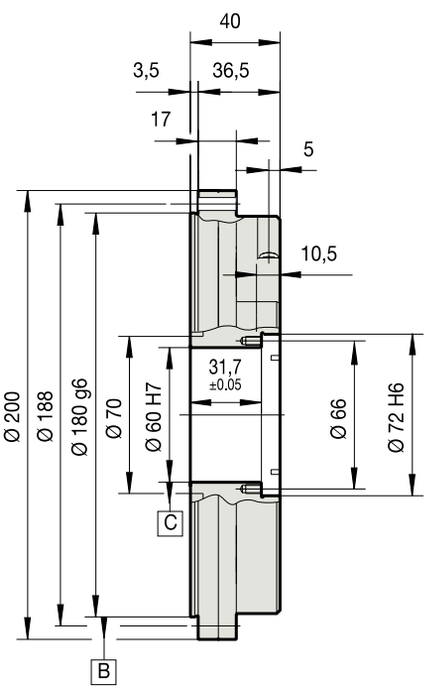
ANGULAR

Dimensions in mm



General characteristics

Measurement	By means of graduated glass disk
Accuracy	± 2" and ± 1"
Number of pulses/turn	27 bits (134 217 728 positions) 1 Vpp (32 768 pulses/ turn)
Vibration	100 m/s² (55 ÷ 2000 Hz) IEC 60068-2-6
Natural frequency	≥ 1000 Hz
Shock	1 000 m/s² (6 ms) IEC 60068-2-27
Inertia	10 000 gr. cm²
Maximum mechanical speed	1 000 rpm
Maximum electrical speed	300 rpm (SSI Fagor, SSI Siemens®) 750 rpm (FeeDat Fagor, DRIVE-CLiQ® Siemens®, Fanuc®, Mitsubishi®, Panasonic®)
Turning torque	≤ 0.5 Nm
Weight	3.2 kg
Ambient characteristics: Running temperature Storage temperature	 0 °C…+50 °C -30 °C…+80 °C
Protection	IP64 (DIN 40050) standard > IP64 with pressurized air at 0.8 ± 0.2 bar
Maximum frequency	180 KHz for 1 Vpp signal
Current under no load condition	Maximum 350 mA
Supply voltage	5 V (3.6...5.25)
Output signals	1 Vpp (32 768 pulses/turn) Differential TTL: EIA RS 485 / EIA RS 422
Maximum cable length	100 m (SSI Fagor, FeeDat Fagor, SSI Siemens®) 30 m (DRIVE-CLiQ®, Siemens®, Fanuc®, Mitsubishi®, Panasonic®)



Order identification

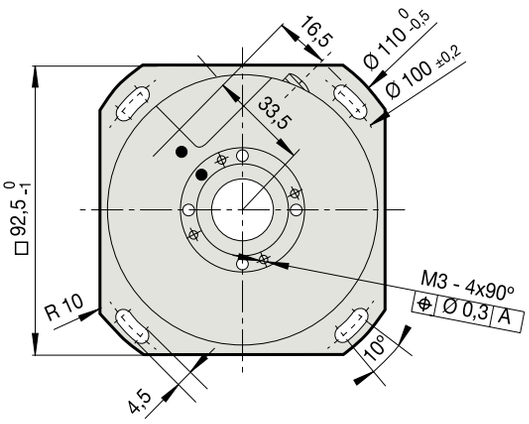
Example of Angular Encoder: **HAF-27-D200-2**

H	A	F	27	D200	2
Type of shaft: • **H: Hollow shaft**	*Letter identifying the absolute encoder*	*Type of communications protocol:* • Blank space: SSI protocol (FAGOR) • D: FeeDat protocol (FAGOR) • S: SIEMENS® (SL) protocol • **F: FANUC® (01 and 02) protocol** • M: MITSUBISHI® CNC protocol • P: PANASONIC® (Matsushita) protocol	*Absolute positions per turn:* • **27 bits (134 217 728 positions)**	*Outside diameter:* • **D200: 200 mm**	*Accuracy:* • **2: ±2" arc-seconds** • 1: ±1" arc-seconds

HA-D90 series

ANGULAR

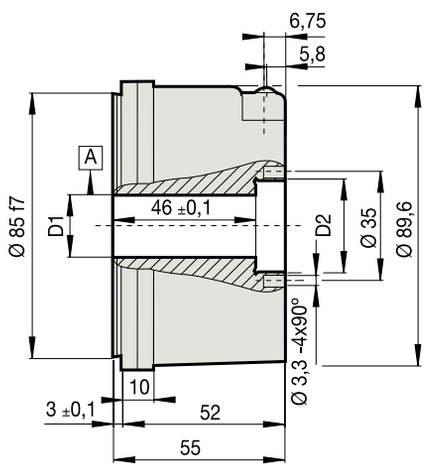
Dimensions in mm



General characteristics

Measurement	By means of graduated glass disk
Accuracy	± 5" and ± 2.5"
Number of pulses/turn	23 bits (8 388 608 positions) 27 bits (134 217 728 positions) 1 Vpp (16 384 pulses/turn)
Vibration	100 m/sec² (55 ÷ 2000 Hz) IEC 60068-2-6
Natural frequency	≥ 1 000 Hz
Shock	1 000 m/sec² (6 ms) IEC 60068-2-27
Inertia	650 gr.cm²
Maximum mechanical speed	3 000 rpm
Maximum electrical speed	1 500 rpm
Turning torque	≤ 0.08 Nm
Weight	1 kg
Ambient characteristics: Running temperature Storage temperature	 -20 ºC... +70 ºC (5"), 0 ºC...+50 ºC (2.5") -30 °C…+80 °C
Protection	IP64 (DIN 40050) standard >IP64 with pressurized air at 0.8 ± 0.2 bar
Maximum frequency	180 KHz for 1 Vpp signal
Current under no load condition	Maximum 150 mA
Supply voltage	5 V (3.6...5.25)
Output signals	1 Vpp (16 384 pulses/turn) Differential TTL: EIA RS 485 / EIA RS 422
Maximum cable length	100 m (SSI Fagor, FeeDat Fagor, SSI Siemens®) 30 m (DRIVE-CLiQ®, Siemens®, Fanuc®, Mitsubishi®, Panasonic®)

Accuracy	± 2.5"	± 5"
D1	Ø 20 H6	Ø 20 H7
D2	Ø 30 H6	Ø 30 H7



Order identification

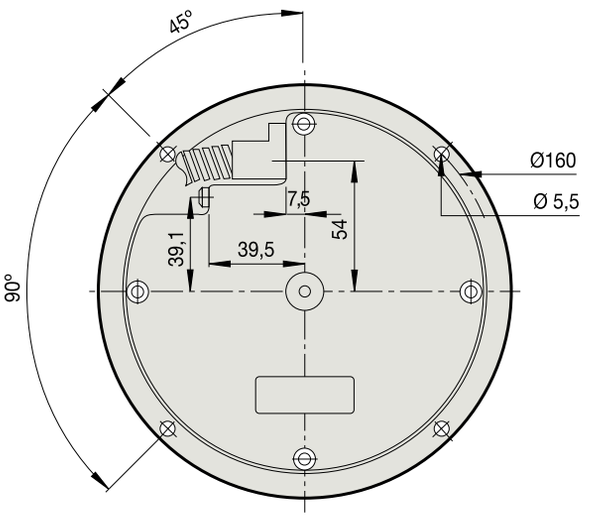
Example of Angular Encoder: **HAF-27-D90-2**

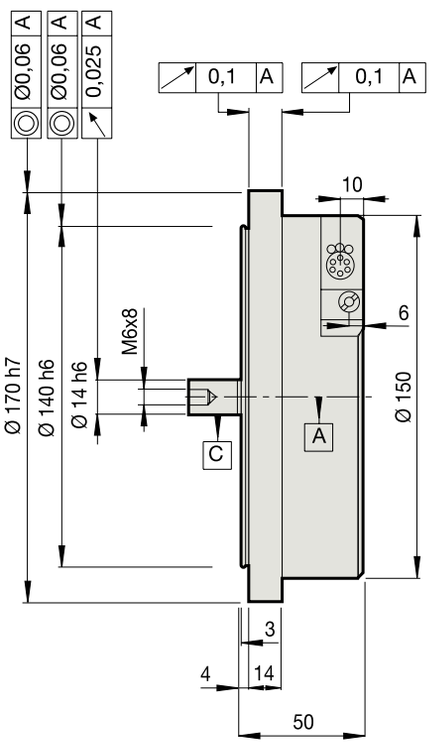
H	A	F	27	D90	2
Type of shaft: • **H: Hollow shaft**	*Letter identifying the absolute encoder*	*Type of communications protocol:* • Blank space: SSI protocol (FAGOR) • D: FeeDat protocol (FAGOR) • S: SIEMENS® (SL) protocol • **F: FANUC® (01 and 02) protocol** • M: MITSUBISHI® CNC protocol • P: PANASONIC® (Matsushita) protocol	*Absolute positions per turn:* • 23 bits (8 388 608 positions) • **27 bits (134 217 728 positions)**	*Outside diameter:* • **D90: 90 mm**	*Accuracy:* • Blank space: ±5" arc-seconds • **2: ±2.5" arc-seconds**

SA-D170 series

ANGULAR

Dimensions in mm





General characteristics

Measurement	By means of graduated glass disk
Accuracy	± 2"
Number of pulses/turn	23 bits (8 388 608 positions) 27 bits (134 217 728 positions) 1 Vpp (16 384 pulses/ turn)
Vibration	100 m/sec² (55 ÷ 2000 Hz) IEC 60068-2-6
Shock	1 000 m/sec² (6 ms) IEC-60068-2-27
Inertia	350 gr.cm²
Maximum mechanical speed	3 000 rpm
Maximum electrical speed	1 500 rpm
Turning torque	≤ 0,01 Nm
Load on the shaft	Axial: 1 kg Radial: 1 kg
Weight	2.65 kg
Ambient characteristics: Running temperature Storage temperature	 0 °C…+50 °C -30 °C…+80 °C
Protection	IP64 (DIN 40050) standard >IP64 with pressurized air at 0.8 ± 0.2 bar
Maximum frequency	180 KHz for 1 Vpp signal
Current under no load condition	Maximum 250 mA
Supply voltage	5 V (3.6...5.25)
Signales de salida	1 Vpp (16 384 pulses/turn) Differential TTL: EIA RS 485 / EIA RS 422
Maximum cable length	100 m (SSI Fagor, FeeDat Fagor, SSI Siemens®) 30 m (DRIVE-CLiQ®, Siemens®, Fanuc®, Mitsubishi®, Panasonic®)

Order identification

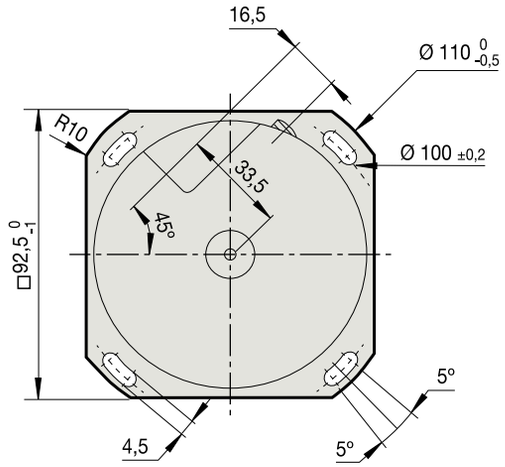
Example of Angular Encoder: **SAF-27-D170-2**

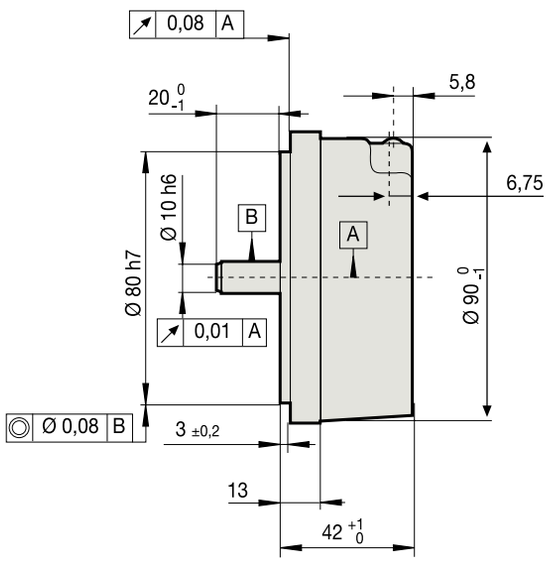
S	A	F	27	D170	2
Type of shaft • **S: Solid shaft**	*Letter identifying the absolute encoder*	*Type of communications protocol:* • Blank space: SSI protocol (FAGOR) • D: FeeDat protocol (FAGOR) • S: SIEMENS® (SL) protocol • **F: FANUC® (01 and 02) protocol** • M: MITSUBISHI® CNC protocol • P: PANASONIC® (Matsushita) protocol	*Absolute positions per turn:* • 23 bits (8 388 608 positions) • **27 bits (134 217 728 positions)**	*Outside diameter:* • **D170: 170 mm**	*Accuracy:* • **2: ±2" arc-seconds**

SA-D90 series

ANGULAR

Dimensions in mm





General characteristics

Measurement	By means of graduated glass disk
Accuracy	± 5" and ± 2.5"
Number of pulses/turn	23 bits (8 388 608 positions) 27 bits (134 217 728 positions) 1 Vpp (16 384 pulses/ turn)
Vibration	100 m/seg² (55 ÷ 2000 Hz) IEC 60068-2-6
Shock	1 000 m/seg²
Inertia	250 gr.cm²
Maximum mechanical speed	10 000 rpm
Maximum electrical speed	1 500 rpm
Turning torque	≤ 0.01 Nm
Load on the shaft	Axial: 1 kg Radial: 1 kg
Weight	0.8 kg
Ambient characteristics: Running temperature Storage temperature	 -20 ºC... +70 ºC (5"), 0 ºC...+50 ºC (2.5") -30 ºC…+80 ºC
Protection	IP64 (DIN 40050) standard >IP64 with pressurized air at 0.8 ± 0.2 bar
Maximum frequency	180 KHz for 1 Vpp signal
Current under no load condition	Maximum 150 mA
Supply voltage	5 V (3.6...5.25)
Signales de salida	1 Vpp (16 384 pulses/turn) Differential TTL: EIA RS 485 / EIA RS 422
Maximum cable length	100 m (SSI Fagor, FeeDat Fagor, SSI Siemens®) 30 m (DRIVE-CLiQ®, Siemens®, Fanuc®, Mitsubishi®, Panasonic®)

Order identification

Example of Angular Encoder: **SAF-23-D90**

S	A	F	23	D90	
Type of shaft • **S: Solid shaft**	*Letter identifying the absolute encoder*	*Type of communications protocol:* • Blank space: SSI protocol (FAGOR) • D: FeeDat protocol (FAGOR) • S: SIEMENS® (SL) protocol • **F: FANUC® (01 and 02) protocol** • M: MITSUBISHI® CNC protocol • P: PANASONIC® (Matsushita) protocol	*Absolute positions per turn:* • **23 bits (8 388 608 positions)** • 27 bits (134 217 728 positions)	*Outside diameter:* • **D90: 90 mm**	*Accuracy:* • **Blank space: ±5" arc-seconds** • 2: ±2" arc-seconds

direct connection cables

Conexión SSI

UP TO 9 METERS

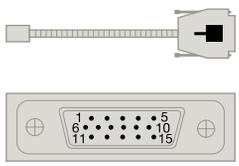
Connector for direct connection to Fagor

EC...B-D

Lengths: 1, 3, 6 and 9 meters

SUB D 15 HD connector (male Pin)

Pin	Signal	Color
1	A	Green
2	/A	Yellow
3	B	Blue
4	/B	Red
5	Data	Grey
6	/Data	Pink
7	Clock	Black
8	/Clock	Purple
9	+5 V	Brown
10	+5 V sensor	Light green
11	0 V	White
12	0 V sensor	Orange
15	Ground	Internal shield
Housing	Ground	External shield



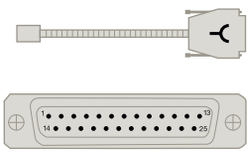
Connector for direct connection to Siemens® SMC20

EC-...B-S1

Lengths: 1, 3, 6 and 9 meters

SUB D 25 connector (female Pin)

Pin	Signal	Color
3	A	Green
4	/A	Yellow
6	B	Blue
7	/B	Red
15	Data	Grey
23	/Data	Pink
10	Clock	Black
12	/Clock	Purple
1	+5 V	Brown
14	+5 V sensor	Light green
2	0 V	White
16	0 V sensor	Orange
5	Ground	Internal shield
Housing	Ground	External shield



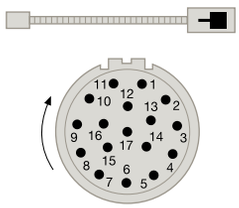
Connector for direct connection to Siemens® SME25

EC...B-C9

Lengths: 1, 3, 6 and 9 meters

CIRCULAR 17 connector (male Pin)

Pin	Signal	Color
15	A	Green
16	/A	Yellow
12	B	Blue
13	/B	Red
14	Data	Grey
17	/Data	Pink
8	Clock	Black
9	/Clock	Purple
7	+5 V	Brown
1	+5 V sensor	Light green
10	0 V	White
4	0 V sensor	Orange
11	Ground	Internal shield
Housing	Ground	External shield



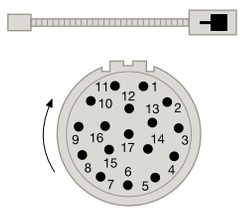
FROM 9 METERS ON

To FAGOR: EC-...B-C9 cable + XC-C8-...F-D extension cable
To Siemens® SMC20: EC-...B-C9 cable + XC-C8-....F-S1 extension cable
To Siemens® SME25: EC-...B-C9 cable + XC-C8-...F-C9 extension cable

EC...B-C9

Lengths: 1 and 3 meters
(consult Fagor Automation for others)

Pin	Signal	Color
15	A	Green
16	/A	Yellow
12	B	Blue
13	/B	Red
14	Data	Grey
17	/Data	Pink
8	Clock	Black
9	/Clock	Purple
7	+5 V	Brown
1	+5 V sensor	Light green
10	0 V	White
4	0 V sensor	Orange
11	Ground	Internal shield
Housing	Ground	External shield

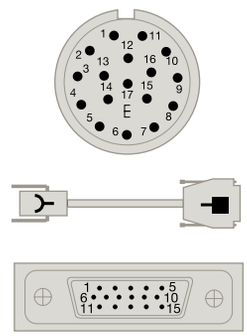


XC-C8-...F-D extension cable

Lengths: 5, 10, 15, 20 and 25 meters

CIRCULAR 17 connector (female Pin)
SUB D 15 HD connector (male Pin)

Pin	Pin	Signal	Color
15	1	A	Green-Black
16	2	/A	Yellow-Black
12	3	B	Blue-Black
13	4	/B	Red-Black
14	5	Data	Grey
17	6	/Data	Pink
8	7	Clock	Purple
9	8	/Clock	Yellow
7	9	+5 V	Brown/Green
1	10	+5 V sensor	Blue
10	11	0 V	White/Green
4	12	0 V sensor	White
11	15	Ground	Internal shield
Housing	Housing	Ground	External shield

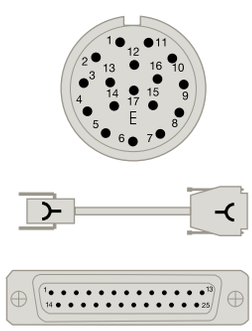


XC-C8-...F-S1 extension cable

Lengths: 5, 10, 15, 20 and 25 meters

CIRCULAR 17 connector (female Pin)
SUB D25 connector (female Pin)

Pin	Pin	Signal	Color
15	3	A	Green-Black
16	4	/A	Yellow-Black
12	6	B	Blue-Black
13	7	/B	Red-Black
14	15	Data	Grey
17	23	/Data	Pink
8	10	Clock	Purple
9	12	/Clock	Yellow
7	1	+5 V	Brown/Green
1	14	+5 V sensor	Blue
10	2	0 V	White/Green
4	16	0 V sensor	White
11	5	Ground	Internal shield
Housing	Housing	Ground	External shield

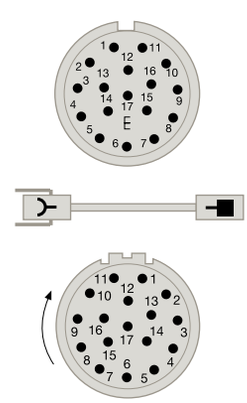


XC-C8-...F-C9 extension cable

Lengths: 5, 10, 15, 20 and 25 meters

CIRCULAR 17 connector (female Pin)
CIRCULAR 17 connector (male Pin)

Pin	Pin	Signal	Color
15	15	A	Green-Black
16	16	/A	Yellow-Black
12	12	B	Blue-Black
13	13	/B	Red-Black
14	14	Data	Grey
17	17	/Data	Pink
8	8	Clock	Purple
9	9	/Clock	Yellow
7	7	+5 V	Brown/Green
1	1	+5 V sensor	Blue
10	10	0 V	White/Green
4	4	0 V sensor	White
11	11	Ground	Internal shield
Housing	Housing	Ground	External shield



direct connection cables

Connection to other CNC's

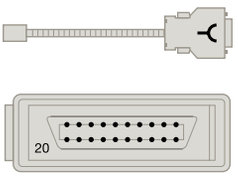
UP TO 9 METERS

Connector for direct connection to FANUC®

EC...PA-FN

Lengths: 1, 3, 6 and 9 meters

Pin	Signal	Color
1	Data	Green
2	/Data	Yellow
5	Request	Blue
6	/Request	Red
9	+5 V	Brown
18-20	+5 V sensor	Grey
12	0 V	White
14	0 V sensor	Pink
16	Ground	Shield

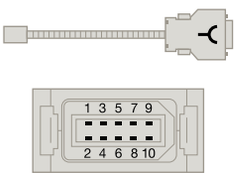


Connector for direct connection to MITSUBISHI®

EC...AM-MB

Lengths: 1, 3, 6 and 9 meters

Pin	Signal	Color
7	SD (MD)	Green
8	/SD (MD)	Yellow
3	RQ (MR)	Grey
4	/RQ (MR)	Pink
1	+5 V	Brown + purple
2	0 V	White + black + blue
Housing	Ground	Shield

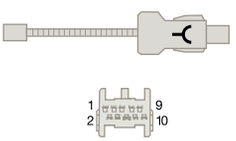


Connector for direct connection to Panasonic® MINAS A5

EC-...PA-PN5

Lengths: 1, 3, 6 and 9 meters

Pin	Signal	Color
3	Data	Green
4	/Data	Yellow
1	+5 V	Brown and grey
2	0 V	White and pink
Housing	Ground	Shield



Connector for connection with extension cable (M12 H-RJ45) to Siemens® Sinamics/Sinumerik

EC-...PA-DQ

Lengths: 1, 3, 6 and 9 meters

Pin	Signal	Color
3	RXP	
4	RXN	
6	TXN	
7	TXP	
1	Vcc (24 V)	
2	0 V	

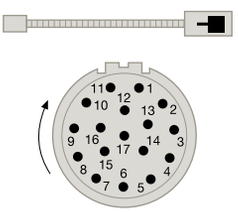
FROM 9 METERS ON

To Fanuc®: EC... B-C9 cable+ XC-C8... FN extension cable
To Mitsubishi®: EC... B-C9-F cable + XC-C8... MB extension cable
To Panasonic® MINAS A5: EC...B-C9 cable + XC-C8-...A-PN5 extension cable
To Siemens®: EC-...PA-DQ cable + (M12 H-RJ45) extension cable

EC...B-C9

Lengths: 1 and 3 meters
(consult Fagor Automation for others)

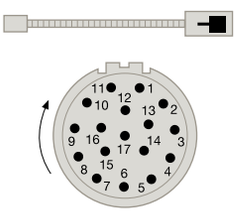
Pin	Signal	Color
14	Data	Grey
17	/Data	Pink
8	Request	Black
9	/Request	Purple
7	+5 V	Brown
1	+5 V sensor	Light green
10	0 V	White
4	0 V sensor	Orange
Housing	Ground	Shield



EC-...B-C9-F

Lengths: 1 and 3 m with Ferrite
(consult Fagor Automation for others)

Pin	Signal	Color
14	Data	Grey
17	/Data	Pink
8	Request	Black
9	/Request	Purple
7	+5 V	Brown
1	+5 V sensor	Light green
10	0 V	White
4	0 V sensor	Orange
Housing	Ground	Shield

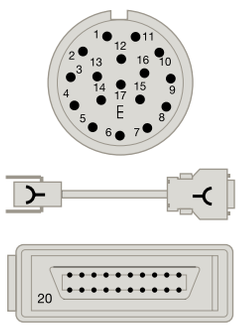


XC-C8... FN extension cable

Lengths: 5, 10, 15, 20 and 25 meters

CIRCULAR 17 connector (female Pin)
HONDA / HIROSE connector (female Pin)

Pin	Pin	Signal	Color
14	1	Data	Grey
17	2	/Data	Pink
8	4	Request	Purple
9	6	/Request	Yellow
7	9	+5 V	Brown/Green
1	18-20	+5 V sensor	Blue
10	12	0 V	White/Green
4	14	0 V sensor	White
Housing	16	Ground	Shield

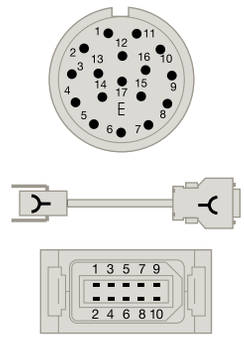


XC-C8... MB extension cable

Lengths: 5, 10, 15, 20 and 25 meters

CIRCULAR 17 connector (female Pin)
10-pin MOLEX/3M RECTANGULAR connector (female Pin)

Pin	Pin	Signal	Color
8	7	SD (MD)	Purple
9	8	/SD (MD)	Yellow
4	3	RQ (MR)	Grey
17	4	/RQ (MR)	Pink
7	1	+5 V	Brown / green
1	-	+5 V sensor	Blue
10	2	GND	White / green
4	-	0 V sensor	White
Housing	Housing	Ground	Shield

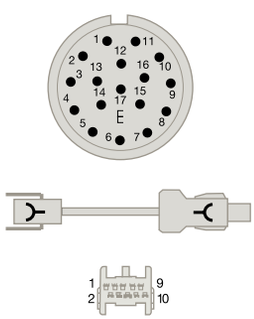


XC-C8-...A-PN5 extension cable

Lengths: 5, 10, 15, 20 and 25 meters

CIRCULAR 17 connector (female Pin)
Panasonic 10 pin connector (female Pin)

Pin	Pin	Signal	Color
14	3	Data	Grey
17	4	/Data	Pink
7	4	+5 V	Brown+Black
1	1	+5 V sensor	Green+ Yellow
10	2	GND	White+Purple
4	2	GND sensor	Blue+Red
Housing	Housing	Ground	Shield



Technology

The incremental encoders provide direct measure of machine position without using any intermediate device. The positioning errors originating from machine mechanics are minimized as the encoder is directly mounted to the machine surface and the guide ways. The encoder sends the real machine movement data to the CNC and mechanical errors caused due to thermal behavior of the machine, pitch error compensation and backlash etc. are minimized.

Measuring Methods

Fagor Automation uses two measuring methods in their incremental encoders:

- **Graduated glass:** Linear encoders with a measuring length of up to 3040 mm use optical transmission. The light from the LED goes through a graduated glass and a reticule before reaching the receiving photo diodes. The period of the generated electrical signals is the same as the graduation pitch.
- **Graduated steel:** Linear encoders over 3040 mm measuring length use graduated steel tape and image captured through diffused light as a measuring principle. The reading system consists of an LED as a light source, a mesh to make the image and a monolithic photo detector element in the plane of the image specially designed and patented by Fagor Automation.

Types of incremental encoders

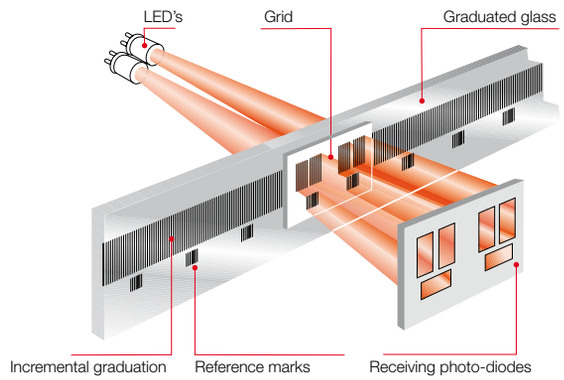
- **Linear encoder:** Ideal for milling, grinding, lathe and boring mill applications requiring federates of up to 120 m/min and vibrations of up to 20 g.
- **Angular encoder:** Used as an angular movement sensor on machines/devices requiring high resolution and accuracy. Fagor Angular encoders offer from 18000 to 360000 pulses/turn and accuracy levels of ±5", ±2.5" and ±2" depending on the model.
- **Rotary encoder:** Used as a measuring sensor for rotary movements, angular speeds and also linear movement when connected to a mechanical device like ball screw. They are also used on various types of machine tools and robotic applications.

Enclosed design

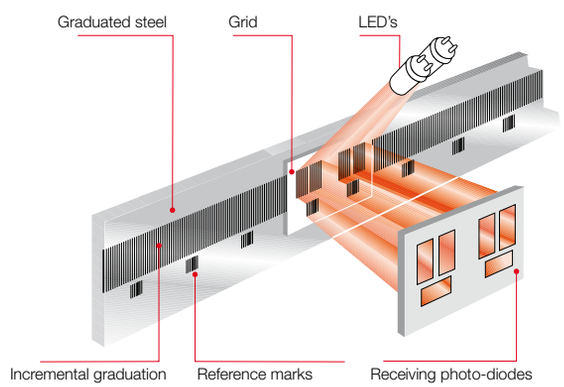
The robust aluminum profile encasing the graduated glass provides the primary protection. The sealing lips provides protection against contaminants and liquids as the reader head travels along the profile. The reader head movement along the graduated glass provides a perfectly balanced system accurately capturing the machine movement. The reader heard travels on precision bearings with minimum contact with the profile hence minimizing the friction.

The optional air inlet at both ends of the encoder and at the reader head provides increased protection levels against contaminants and liquids.

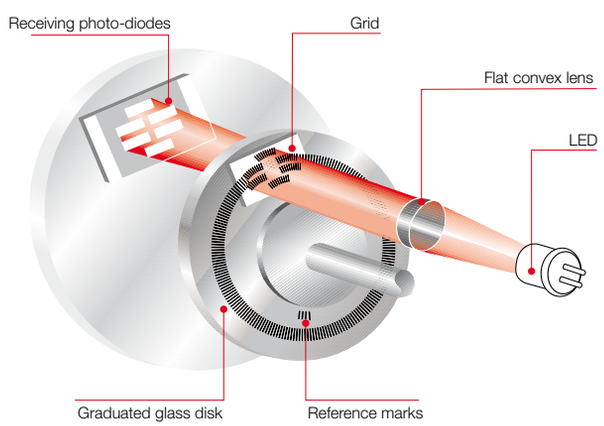
Graduated glass encoder

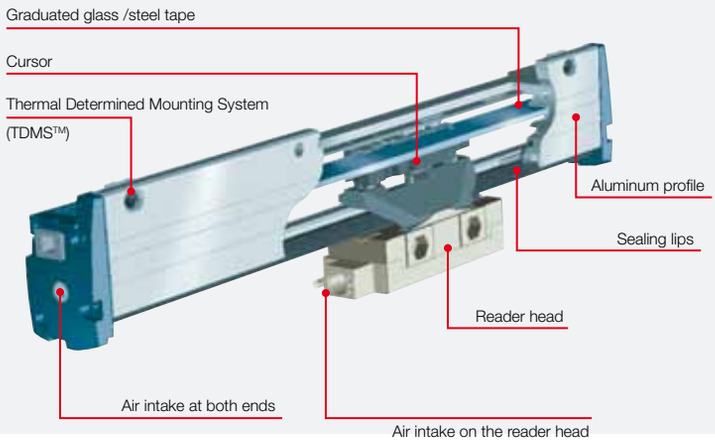


Graduated steel encoder



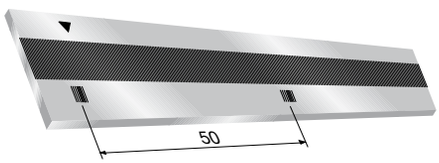
Graduated glass disk



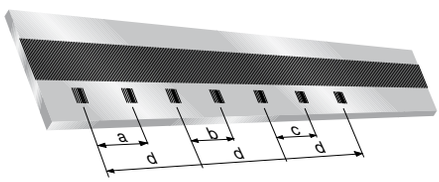


Linear encoder

Incremental

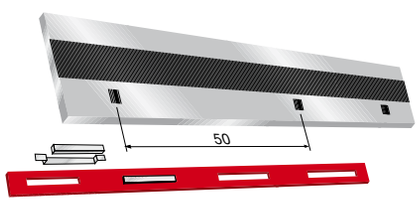


Distance-coded



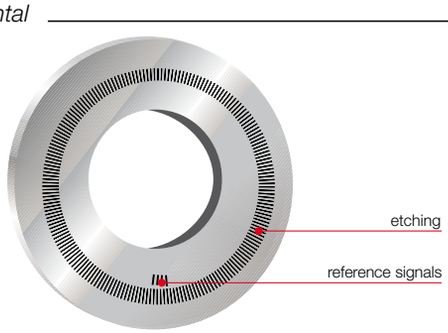
Series	Distances			
	a	b	c	d
L	40.04	40.08	40.12	80
G and S	10.02	10.04	10.06	20

Selectable

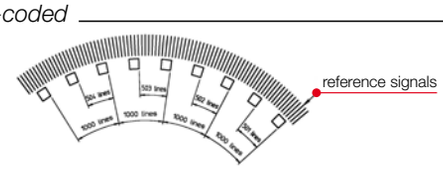


Angular and rotary encoder

Incremental



Distance-coded



Reference signals (I_0)

It is a reference signal etched on a graduation and when scanned by the measuring system generates a pulse. Reference marks are used to validate and restore the machine zero position specially after turning on the machine power.

Fagor Automation encoders have three types of reference marks I_0:

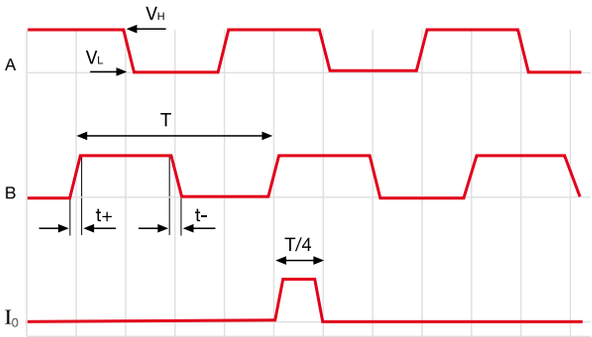
- **Incremental:** The reference signal obtained is synchronized with the feedback signals to ensure perfect measuring repeatability.
  Linear: One every 50 mm of travel.
  Angular and rotary: One signal per turn
- **Distance-coded:** Both on linear and angular encoders each distance coded reference signal is graduated in a non linear way based on the predefined mathematical function. The machine position value can be restored by moving through two consecutive reference signals. The machine movement needed to know the real position is always very small and this is a very useful feature for large travel machines.
- **Selectable:** With selectable linear encoders the customer can select one or more reference points and ignore the rest by simply inserting a magnet at the selected point or points.

Series	Nr. of lines	Nr. of references	Angle
H-D90	18000	36	20º
S-D90			
S-D170			
H-D200			
H-D200	36000	72	10º

Electrical output signals

Differential TTL

These are complementary signals in compliance with the EIA standard RS-422. This characteristic together with a line termination of 120 Ω, twisted pair, and an overall shield provide greater immunity to electromagnetic noise caused by their environment.



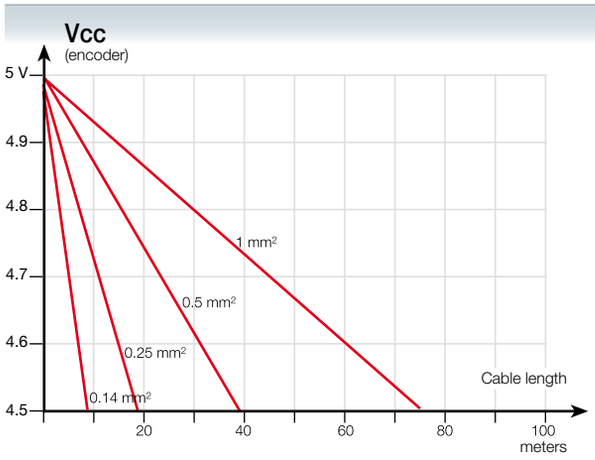
Characteristics

Signals	A, /A, B, /B, I_0, / I_0
Signal level	$V_H \geq 2.5V$ $I_H = 20$ mA $V_L \leq 0.5V$ $I_L = 20$ mA With 1 m cable
90° reference signal (I_0)	Synchronized with A and B
Switching time	t+/t-< 30 ns With 1 m cable
Supply voltage and consumption	5 V ± 5%, 100 mA
T period	4, 2, 0.4, 0.2 µm
Max. cable length	50 meters
Load impedance	Zo= 120 Ω between differential

Voltage drop across cable

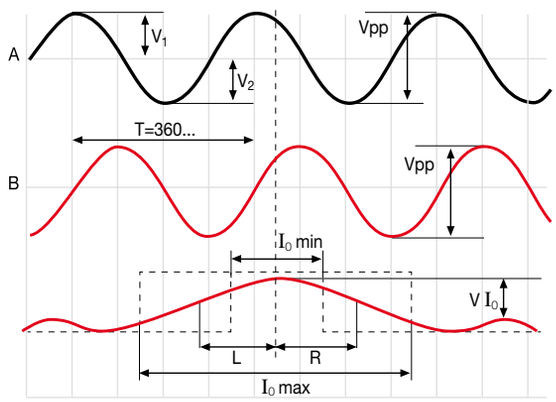
The voltage required for a TTL encoder must be 5V ± 5%. A simple formula may be used to calculate the maximum cable length depending on the section of the supply cables.

L_{max} = (V_{CC}-4.5)* 500 / ($Z_{CABLE/Km}$* I_{MAX})



Example

Vcc = 5V, IMAX	=	0.2 Amp (With 120 Ω load)	
Z (1 mm²)	=	16.6 Ω/Km	**(L_{max}= 75 m)**
Z (0.5 mm²)	=	32 Ω/Km	**(L_{max}= 39 m)**
Z (0.25 mm²)	=	66 Ω/Km	**(L_{max}=19 m)**
Z (0.14 mm²)	=	132 Ω/Km	**(L_{max}= 9 m)**

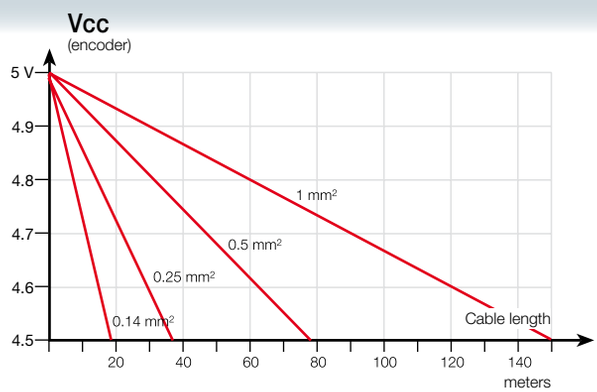


Differential 1 Vpp

They are complementary sinusoidal signals whose differential value is 1 Vpp centered on $V_{CC/2}$. This characteristic together with a line termination of 120 Ω, twisted pair, and an overall shield provide greater immunity to electromagnetic noise caused by their environment.

Characteristics

Signals	A, /A, B, /B, I_0, / I_0
V_{App}	1 V +20%, -40%
V_{Bpp}	1 V +20%, -40%
DC offset	2.5 V ± 0.5 V
Signal period	20 µm, 40 µm
Supply V	5 V ± 10%
Max. cable length	150 meters
A, B centered: $\|V_1-V_2\| / 2\ V_{pp}$	≤ 0.065
A&B relationship: V_{App} / V_{Bpp}	0.8 ÷ 1.25
A&B phase shift:	90° ± 10°
I_0 amplitude: V_{I_0}	0.2 ÷ 0.8 V
I_0 width: L + R	I_0_min: 180° I_0_typ: 360° I_0_max: 540°
I_0 synchronism: L, R	180° ± 90°



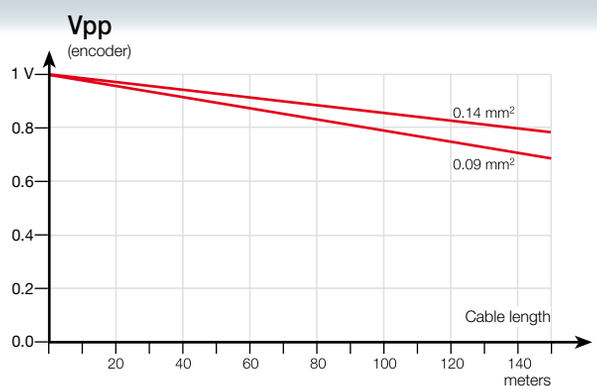
Voltage drop across cable

The voltage required for a 1 Vpp encoder must be 5 V ± 10%. A simple formula may be used to calculate the maximum cable length depending on the section of the supply cables:

L_{max} = (V_{CC}-4.5)* 500 / ($Z_{CABLE/Km}$* I_{MAX})

Example

Vcc	=	5V, IMAX= 0.1Amp	
Z (1 mm²)	=	16.6 Ω/Km	**(L_{max}= 150 m)**
Z (0.5 mm²)	=	32 Ω/Km	**(L_{max}= 78 m)**
Z (0.25 mm²)	=	66 Ω/Km	**(L_{max}= 37 m)**
Z (0.14 mm²)	=	132 Ω/ Km	**(L_{max}= 18 m)**



1 Vpp signal damping due to the cable section

Besides attenuation due to signal frequency, there is another signal attenuation caused by the section of the cable connected to the encoder.

Range

Analyze the application to make sure that the proper encoder will be selected for the machine.

To do this, bear in mind the following considerations

Linear

Installation

Consider the physical length of the installation and the space available for it.

These aspects are crucial to determine the type of linear encoder to use (type of profile).

Accuracy

Each linear encoder comes with a graph showing its accuracy along its measuring length.

Signal

Consider the following variables for selecting the type of signal: Resolution, cable length and compatibility.

Resolution

The resolution of the control of machine-tools depends on the linear encoder.

Cable length

The length of the cable depends on the type of signal.

Speed

The speed requirements for the application must be analyzed before choosing the linear encoder.

Shock and Vibration

Fagor linear encoders withstand vibrations of up to 20 g and shocks of up to 30 g.

Alarm signal

Models SW / SOW / SSW and GW / GOW /GSW offer the alarm signal AL.

Angular

Installation

This point considers the physical dimensions of the installation and the space available for it.

It is essential to determine its type of shaft: Hollow or solid.

Accuracy

Each encoder comes with a graph showing its accuracy along its measuring length.

Alarm signal

Models H-D200, H-D90, S-D170, S-1024-D90 and S-D90 offer the alarm signal AL.

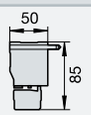
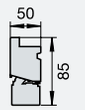
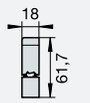
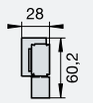
Rotary

Installation

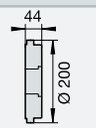
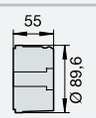
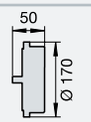
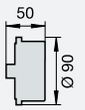
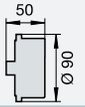
This point considers the physical dimensions of the installation and the space available for it.

It is essential to determine its type of shaft: Hollow or solid.

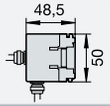
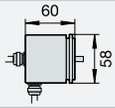
Linear

Series	Section	Measuring lengths
L Long		400 mm to 60 m
G Wide		140 mm to 3 040 mm
S Reduced		70 mm to 1 240 mm
SV Reduceds		70 mm to 2 040 mm

Angular

Series	Section	Type of shaft
H-D200		Hollow shaft
H-D90		Hollow shaft
S-D170		Solid shaft
S-1024-D90		Solid shaft
S-D90		Solid shaft

Rotary

Series	Section	Type of shaft
H		Hollow shaft
S		Solid shaft

Accuracy	Signals	Pitch Resolution up to	Model	Page
± 5 µm	~ 1 Vpp	0.1 µm	LP / LOP	38 and 39
	⊓ TTL	1 µm	LX / LOX	
± 5 µm and ± 3 µm	~ 1 Vpp	0.1 µm	GP / GOP / GSP	40 and 41
	⊓ TTL	1 µm	GX / GOX / GSX	
	⊓ TTL	0.5 µm	GY / GOY / GSY	
	⊓ TTL	0.1 µm	GW / GOW / GSW	
	⊓ TTL	0.05 µm	GZ / GOZ / GSZ	
± 5 µm and ± 3 µm	~ 1 Vpp	0.1 µm	SP / SOP / SSP	42 and 43
	⊓ TTL	1 µm	SX / SOX / SSX	
	⊓ TTL	0.5 µm	SY / SOY / SSY	
	⊓ TTL	0.1 µm	SW / SOW / SSW	
	⊓ TTL	0.05 µm	SZ / SOZ / SSZ	
± 5 µm and ± 3 µm	~ 1 Vpp	0.1 µm	SVP / SVOP / SVSP	44 and 45
	⊓ TTL	1 µm	SVX / SVOX / SVSX	
	⊓ TTL	0.5 µm	SVY / SVOY / SVSY	
	⊓ TTL	0.1 µm	SVW / SVOW / SVSW	
	⊓ TTL	0.05 µm	SVZ / SVOZ / SVSZ	

Accuracy	Signals	Model	Page
± 2” (arc-seconds)	~ 1 Vpp	HP-D200 / HOP-D200	46
	⊓ TTL	H-D200 / HO-D200	
± 5”, ± 2,5” (arc-seconds)	~ 1 Vpp	HP-D90 / HOP-D90	47
	⊓ TTL	H-D90 / HO-D90	
± 2” (arc-seconds)	~ 1 Vpp	SP-D170 / SOP-D170	48
	⊓ TTL	S-D170 / SO-D170	
± 5” (arc-seconds)	~ 1 Vpp (dual feedback)	SP/SOP 18000-1024-D90	49
	⊓ TTL (dual feedback)	S/SO 18000-1024-D90 S/SO 90000-1024-D90	
± 5”, ± 2,5” (arc-seconds)	~ 1 Vpp	SP-D90 / SOP-D90	50
	⊓ TTL	S-D90 / SO-D90	

Accuracy	Signals	Model	Page
± 1/10 of the pitch	~ 1 Vpp	HP	52 and 53
	⊓ TTL	H / HA	
± 1/10 of the pitch	~ 1 Vpp	SP	52 and 53
	⊓ TTL	S	

L series

LINEAR

Specially designed for high performance environment requiring speed and accuracy.

Their special mounting system guarantees a thermal behavior identical to that of the machine surface the linear encoder is mounted on. This is achieved through floating fixtures at their ends with the base of the machine and by tensioning the etched steel tape. This system eliminates the errors caused by temperature changes and ensures maximum accuracy and repeatability of the linear encoders.

The steel tape graduation pitch is 40 µm. Measuring lengths over 4 040 mm require the use of modules.

Measuring lengths

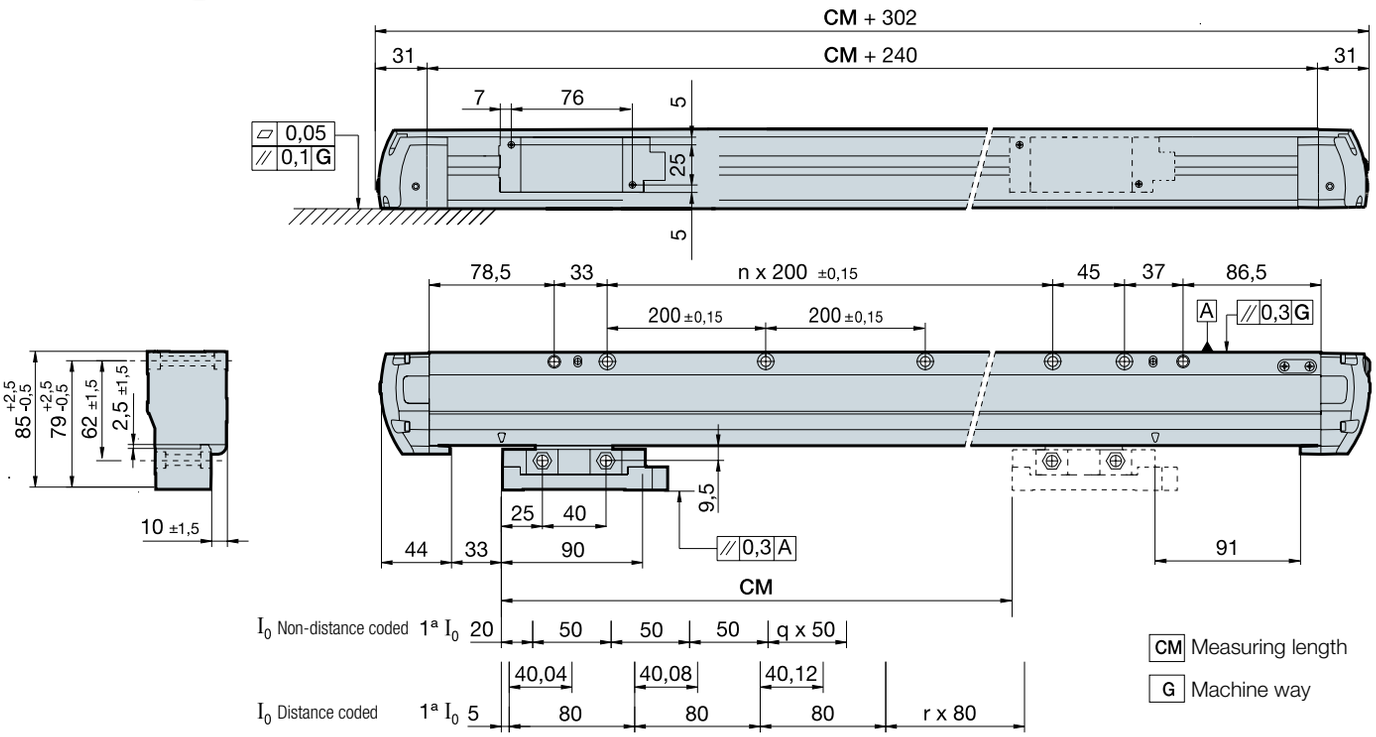
- Available in measuring lengths from 440 mm to 60 m in 200 mm increments. Contact Fagor Automation for custom solutions if your application requires longer lengths than 60 meters.

Characteristics

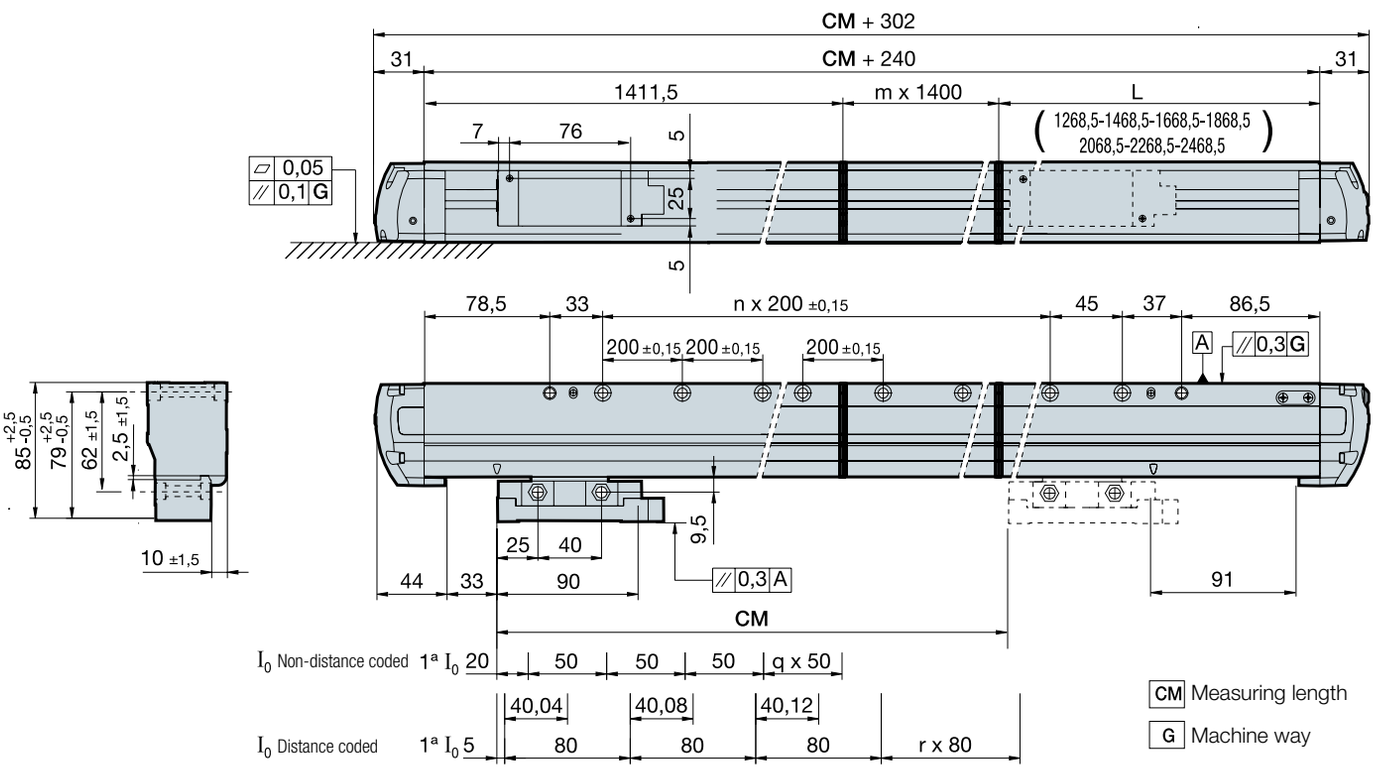
	LX	LP
Measurement	By means of a 40 µm-pitch stainless steel tape	
Glass thermal expansion coefficient	α_{therm}: 11 ppm/K aprox.	
Measuring resolution	1 µm	Up to 0.1 µm
Output signals	⊔⊓ TTL differential	⌒ 1 Vpp
Incremental signal period	4 µm	40 µm
Limit frequency	500 KHz	50 KHz
Maximum speed	120 m/min	120 m/min
Minimum distance between flanks	0.5 microseconds	–
Reference marks I_0	LX and LP: every 50 mm LOX and LOP: distance-coded I_0	
Maximum cable length	50 m	150 m
Supply voltage	5 V ± 10%, < 150 mA (without load)	
Accuracy of shaft	± 5 µm/m	± 5 µm/m
Maximum vibration	10 g (55 … 2000 Hz) IEC 60068-2-6	
Maximum shock	30 g (11 ms) IEC 60068-2-27	
Maximum acceleration	10 g in the measuring direction	
Required moving force	< 5 N	
Operating temperature	0 ºC … 50 ºC	
Storage temperature	-20 ºC ... 70 ºC	
Weight	1.50 kg + 4 kg/m	
Relative humidity	20 … 80%	
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders	
Reader head	With built-in connector Connection at both ends of the reader head	

Single L model

Dimensions in mm



Modular Lmodel



Order identification

Example of Linear Encoder **LOP - 102 - A**

L	O	P	102	A
Type of profile for long space	***Type of reference mark I_0:*** • Blank space: Incremental, one mark every 50 mm • **O: Distance-coded marks**	***Type of signal:*** • X: 1 µm resolution differential TTL • **P: 1 Vpp sinusoidal**	***Ordering length code:*** In the example (102) = 10 240 mm	***Air intake on the reader head:*** • Blank space: Without air intake • **A: With air intake**

G series

LINEAR

Specially designed for high performance environment requiring high speed and accuracy.

The TDMS™ mounting system ensures greater accuracy, higher repeatability and ability to withstand vibrations without compromising machine performance.

Measuring lengths in millimeters

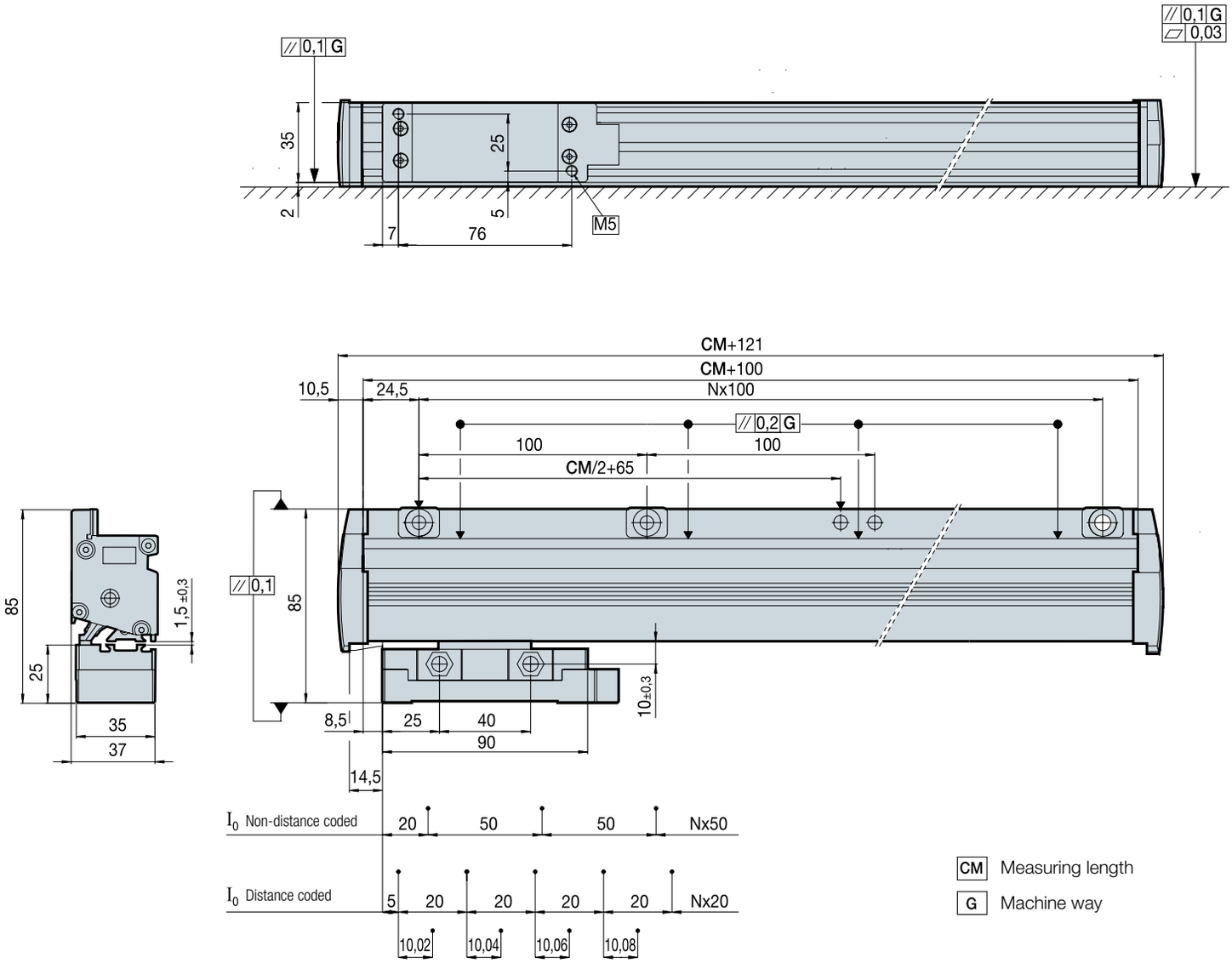
140 • 240 • 340 • 440 • 540 • 640 • 740 • 840 • 940
1 040 • 1 140 • 1 240 • 1 340 • 1 440 • 1 540 • 1 640
1 740 • 1 840 • 2 040 • 2 240 • 2 440 • 2 640 • 2 840
3 040

Characteristics

	GX	GY	GW	GZ	GP
Measurement	By means of a 20 µm-pitch graduated glass				
Glass thermal expansion coefficient	α_{therm}: 8 ppm/K aprox.				
Measuring resolution	1 µm	0.5 µm	0.1 µm	0.05 µm	Up to 0.1 µm
Output signals	⊓⊓ TTL differential	⊓⊓ TTL differential	⊓⊓ TTL differential	⊓⊓ TTL differential	∿ 1 Vpp
Incremental signal period	4 µm	2 µm	0.4 µm	0.2 µm	20 µm
Limit frequency	500 KHz	1 MHz	1,5 MHz	500 KHz	100 KHz
Maximum speed	120 m/min	120 m/min	36 m/min	6 m/min (*)	120 m/min
Minimum distance between flanks	0.5 microseconds	0.25 microseconds	0.1 microseconds	0.3 microseconds	–
Reference marks I_0	GX, GY, GW, GZ and GP: every 50 mm GOX, GOY, GOW, GOZ and GOP: distance-coded I_0 GSX, GSY, GSW, GSZ and GSP: selectable I_0				
Maximum cable length	50 m	50 m	50 m	50 m	150 m
Supply voltage	5 V ± 10%, < 150 mA (without load)				
Accuracy of shaft	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m
Maximum vibration	20 g (55 … 2000 Hz) IEC 60068-2-6				
Maximum shock	30 g (11 ms) IEC 60068-2-27				
Maximum acceleration	10 g in the measuring direction				
Required moving force	< 5 N				
Operating temperature	0 ºC … 50 ºC				
Storage temperature	-20 ºC ... 70 ºC				
Weight	0.25 kg + 2.25 kg/m				
Relative humidity	20 … 80%				
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders				
Reader	With built-in connector Connection at both ends of the reader head				

(*): contact FAGOR for higher speed.

Dimensions in mm



Order identification

Example of Linear Encoder: **GOX - 1640 - 5 - A**

G	O	X	1640	5	A
Type of profile for wide space	***Type of reference mark I_0:*** • Blank space: Incremental, one mark every 50 mm • **O: Distance-coded marks** • S: Selectable reference marks	***Type of signal:*** • **X: 1 µm resolution differential TTL** • Y: 0.5 µm resolution differential TTL • W: 0.1 µm resolution differential TTL • Z: 0.05 µm resolution differential TTL • P: 1 Vpp sinusoidal	***Measuring lengths in millimeters:*** In the example (1640) = 1 640 mm	***Accuracy of the linear encoder:*** • **5: ± 5 µm** • 3: ± 3 µm	***Air intake on the reader head:*** • Blank space: Without air intake • **A: With air intake**

S series

LINEAR

Specially designed for high performance environment requiring high speed and accuracy. Ideal for limited mounting spaces.

Measuring lengths in millimeters

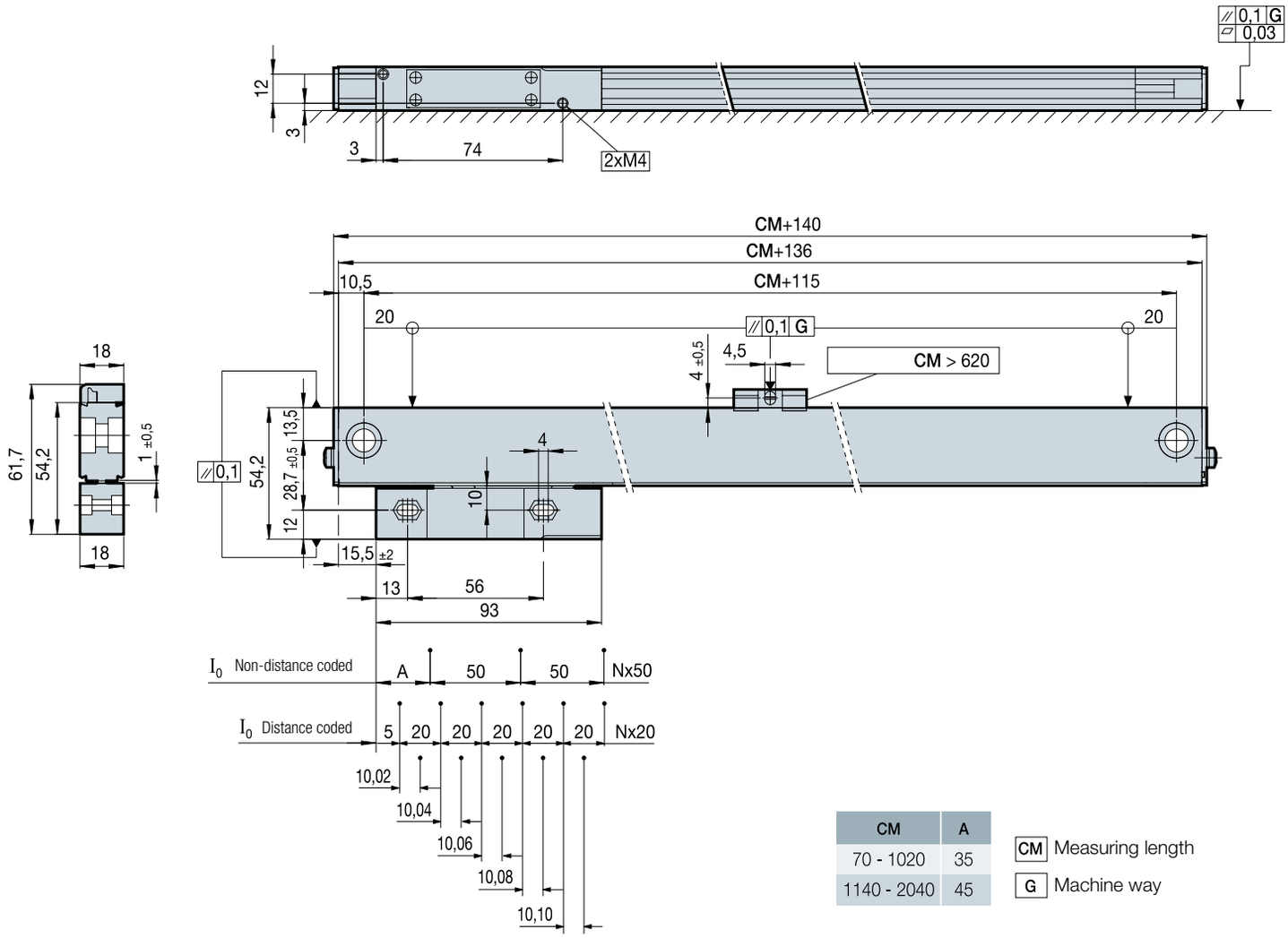
70 • 120 • 170 • 220 • 270 • 320 • 370 • 420 • 470 • 520
570 • 620 • 670 • 720 • 770 • 820 • 870 • 920 • 1 020
1 140 • 1 240

Characteristics

	SX	SY	SW	SZ	SP
Measurement	By means of a 20 µm-pitch graduated glass				
Glass thermal expansion coefficient	α_{therm}: 8 ppm/K aprox.				
Measuring resolution	1 µm	0.5 µm	0.1 µm	0.05 µm	Up to 0.1 µm
Output signals	⊔⊓ TTL differential	⊔⊓ TTL differential	⊔⊓ TTL differential	⊔⊓ TTL differential	∿ 1 Vpp
Incremental signal period	4 µm	2 µm	0.4 µm	0.2 µm	20 µm
Limit frequency	500 KHz	1 MHz	1.5 MHz	500 KHz	100 KHz
Maximum speed	120 m/min	120 m/min	36 m/min	6 m/min (*)	120 m/min
Minimum distance between flanks	0.5 microseconds	0.25 microseconds	0.1 microseconds	0.3 microseconds	–
Reference marks I_0	SX, SY, SW, SZ and SP: every 50 mm SOX, SOY, SOW, SOZ and SOP: distance-coded I_0 SSX, SSY, SSW, SSZ and SSP: selectable I_0				
Maximum cable length	50 m	50 m	50 m	50 m	150 m
Supply voltage	5 V ± 10%, < 150 mA (without load)				
Accuracy of shaft	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m
Maximum vibration	10 g without mounting plate				
Maximum shock	30 g (11 ms) IEC 60068-2-27				
Maximum acceleration	10 g in the measuring direction				
Required moving force	< 4 N				
Operating temperature	0 ºC … 50 ºC				
Storage temperature	-20 ºC ... 70 ºC				
Weight	0.20 kg + 0.50 kg/m				
Relative humidity	20 … 80%				
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders				
Reader	With built-in connector				

(*): contact FAGOR for higher speed.

Dimensions in mm



CM	A
70 - 1020	35
1140 - 2040	45

CM Measuring length

G Machine way

Order identification

Example of Linear Encoder: **SOP - 420 - 5 -A**

S	O	P	420	5	A
Type of profile for wide space	***Type of reference mark I_0:*** • Blank space: Incremental, one mark every 50 mm • **O: Distance-coded marks** • S: Selectable reference marks	***Type of signal:*** • **X: 1 µm resolution differential TTL** • Y: 0.5 µm resolution differential TTL • W: 0.1 µm resolution differential TTL • Z: 0.05 µm resolution differential TTL • P: 1 Vpp sinusoidal	***Measuring lengths in millimeters:*** In the example (420) = 420 mm	***Accuracy of the linear encoder:*** • **5: ± 5 µm** • 3: ± 3 µm	***Air intake on the reader head:*** • Blank space: Without air intake • **A: With air intake**

SV series

LINEAR

Specially designed for high performance environment requiring high speed and accuracy and the need to withstand higher vibrations.

The TDMS™ mounting system incorporated through a separate back bar ensures greater accuracy, higher repeatability and ability to withstand vibrations without compromising machine performance.

Measuring lengths in millimeters

70 • 120 • 170 • 220 • 270 • 320 • 370 • 420 • 470 • 520
570 • 620 • 670 • 720 • 770 • 820 • 870 • 920 • 1 020
1 140 • 1 240 • 1 340 • 1 440 • 1 540 • 1 640 • 1 740 • 1 840
2 040

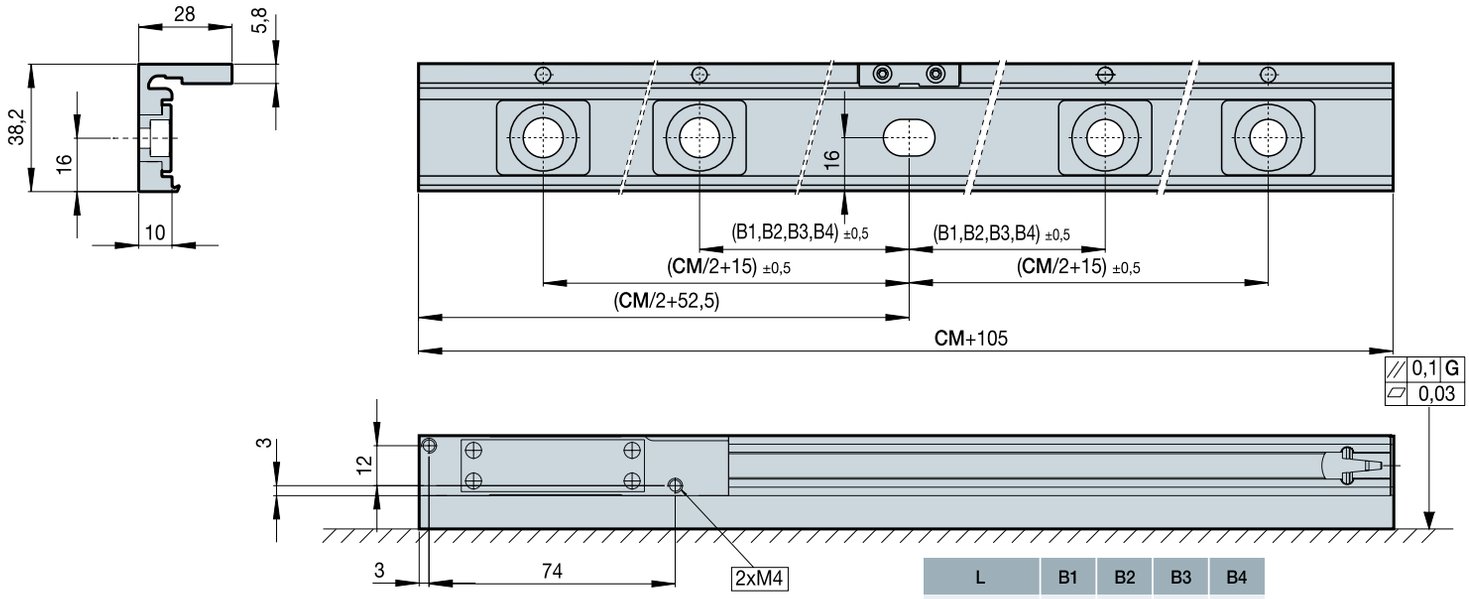
Characteristics

	SVX	SVY	SVW	SVZ	SVP
Measurement	By means of a 20 µm-pitch graduated glass				
Glass thermal expansion coefficient	α_{therm}: 8 ppm/K aprox.				
Measuring resolution	1 µm	0.5 µm	0.1 µm	0.05 µm	Up to 0.1 µm
Output signals	⊓⊓ TTL differential	⊓⊓ TTL differential	⊓⊓ TTL differential	⊓⊓ TTL differential	∿ 1 Vpp
Incremental signal period	4 µm	2 µm	0.4 µm	0.2 µm	20 µm
Limit frequency	500 KHz	1 MHz	1,5 MHz	500 KHz	100 KHz
Maximum speed	120 m/min	120 m/min	36 m/min	6 m/min (*)	120 m/min
Minimum distance between flanks	0.5 microseconds	0.25 microseconds	0.1 microseconds	0.3 microseconds	–
Reference marks I_0	SVX, SVY, SVW, SVZ and SVP: every 50 mm SVOX, SVOY, SVOW, SVOZ and SVOP: distance-coded I_0 SVSX, SVSY, SVSW, SVSZ and SVSP: selectable I_0				
Maximum cable length	50 m	50 m	50 m	50 m	150 m
Supply voltage	5 V ± 10%, < 150 mA (without load)				
Accuracy of shaft	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m	± 5 µm/m ± 3 µm/m
Maximum vibration	20 g with mounting plate				
Maximum shock	30 g (11 ms) IEC 60068-2-27				
Maximum acceleration	10 g in the measuring direction				
Required moving force	< 4 N				
Operating temperature	0 ºC … 50 ºC				
Storage temperature	-20 ºC ... 70 ºC				
Weight	0.25 kg + 1.35 kg/m				
Relative humidity	20 … 80%				
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders				
Reader	With built-in connector				

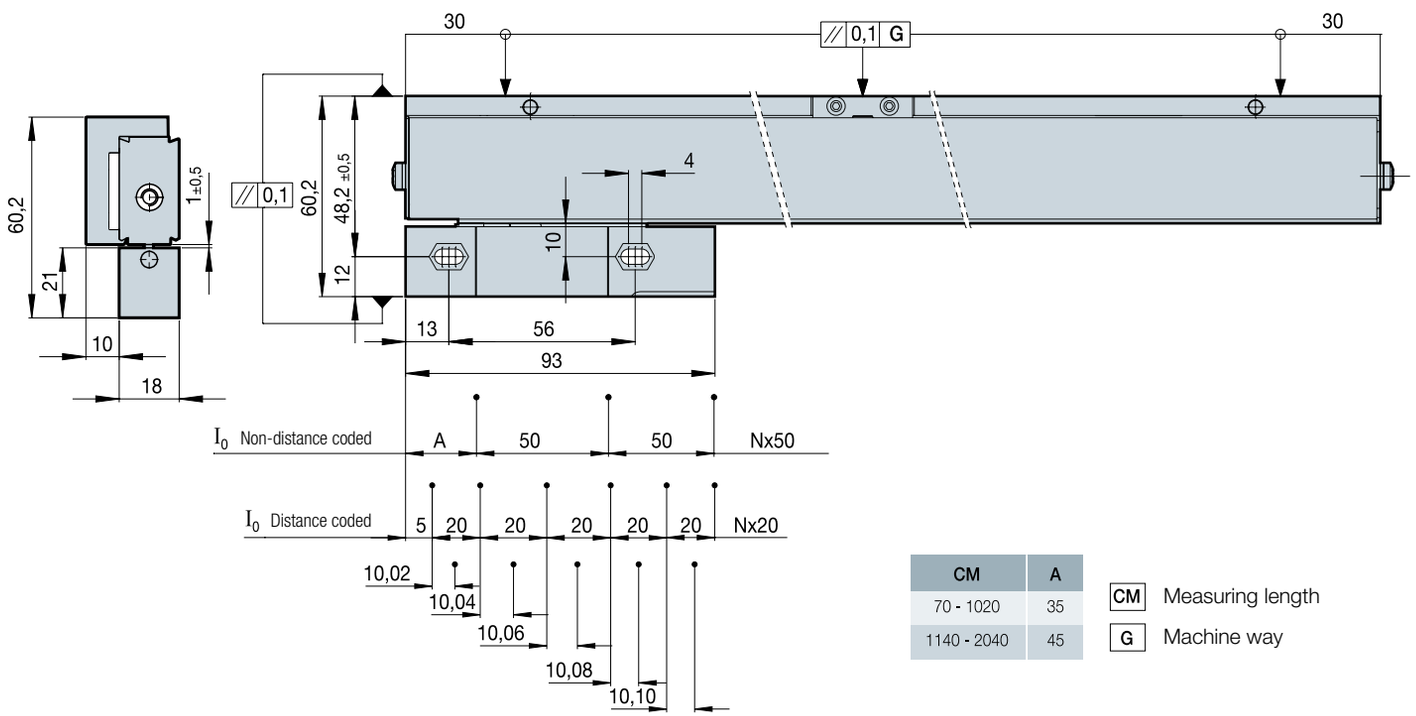
(*): contact FAGOR for higher speed.

SV model

Dimensions in mm



L	B1	B2	B3	B4
70 - 520	–	–	–	–
570 - 920	200	–	–	–
1020 - 1340	200	400	–	–
1440 - 1740	200	400	600	–
1840 - 2040	200	400	600	800



CM	A
70 - 1020	35
1140 - 2040	45

CM Measuring length

G Machine way

Order identification

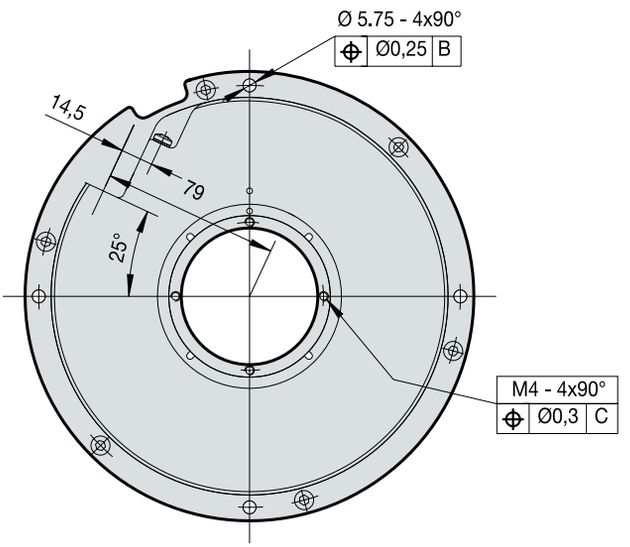
Example of Linear Encoder: **SVOP - 420 - 5 - B - A**

SV	O	P	420	5	B	A
Type of profile for reduced spaces: • **SV: Vibration mounting for up to 20 g**	*Type of reference mark I_0:* • Blank space: Incremental, one mark every 50 mm • **O: Distance-coded marks** • S: Selectable reference marks	*Type of signal:* • X: 1 µm resolution differential TTL • Y: 0.5 µm resolution differential TTL • W: 0.1 µm resolution differential TTL • Z: 0.05 µm resolution differential TTL • **P: 1 Vpp sinusoidal**	*Measuring lengths in millimeters:* In the example (420) = 420 mm	*Precisión del encoder lineal:* • **5: ± 5 µm** • 3: ± 3 µm	*Linear encoder built-in support:* • **B: With built-in support for vibration up to 20 g**	*Air intake on the reader head:* • Blank space: Without air intake • **A: With air intake**

H-D200 series

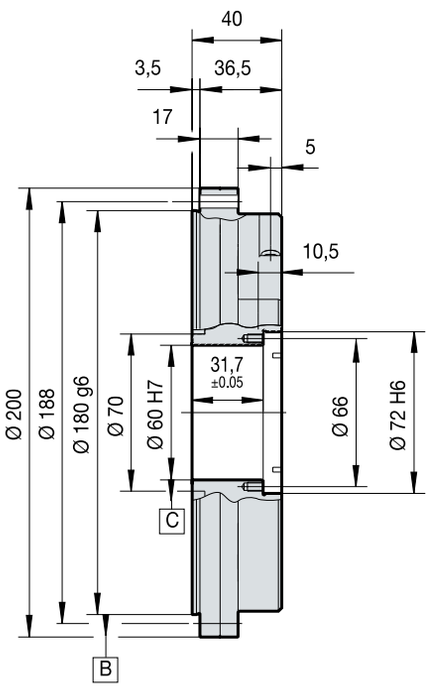
ANGULAR

Dimensions in mm



General characteristics

Measurement	By means of graduated glass disk
Accuracy	± 2"
Number of pulses/turn	18 000, 36 000, 90 000, 180 000 and 360 000
Vibration	100 m/sec² (55 ÷ 2000 Hz) IEC 60068-2-6
Natural frequency	≥ 1 000 Hz
Shock	1 000 m/sec² (6 ms) IEC 60068-2-27
Inertia	10 000 gr/cm²
Maximum mechanical speed	1 000 rpm
Maximum electrical speed	Pulses / TTL / 1 vpp 18 000: < 1 000 min⁻¹ / < 600 min⁻¹ 36 000: < 1 000 min⁻¹ / < 300 min⁻¹ 90 000: < 666 min⁻¹ 180 000: < 333 min⁻¹ 360 000: < 166 min⁻¹
Turning torque	≤ 0.5 Nm
Weight	3.2 kg
Ambient characteristics: Running temperature Storage temperature	 0 °C…+50 °C -30 °C…+80 °C
Protection	IP64 (DIN 40050) standard >IP64 with pressurized air at 0.8 ± 0.2 bar
Maximum frequency	180 KHz for 1 Vpp signal 1 MHz for TTL signal
Consumption without load	Maximum 150 mA
Supply voltage	5 V ± 5% (TTL); 5 V ± 10% (1 Vpp)
Reference signal I_0	One reference signal per encoder turn or distance-coded I_0
Output signals	⊓⊔ TTL differential (18 000, 36 000, 90 000, 180 000 and 360 000 Pulses/turn) ∿ 1 Vpp (18 000 and 36 000 Pulses/turn)
Maximum cable length	⊓⊔ Signals TTL: 50 m ∿ 1 Vpp: 150 m



Order identification

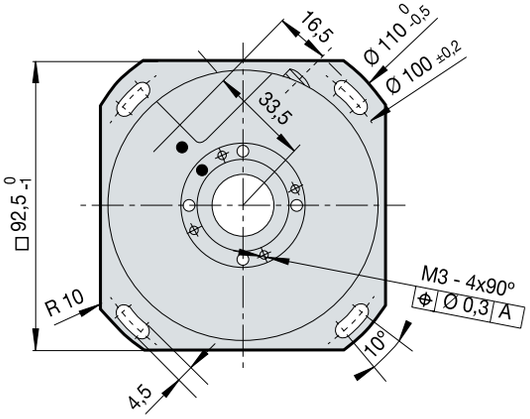
Example of Angular Encoder: **HOP - 18000 - D200-2**

H	O	P	18000	D200	2
Type of shaft: • **H: Hollow shaft**	*Type of reference mark I_0:* • Blank space: Incremental, one per revolution • **O: Distance-coded marks**	*Type of signal:* • Blank space: Differential TTL • **P: 1 Vpp sinusoidal**	*Number of pulses/turn of the first feedback:* • **18 000: on 1 Vpp and TTL models** • 36 000: on 1 Vpp and TTL models • 90 000: only on TTL models • 180 000: only on TTL models • 360 000: only on TTL models	*Diameter:* • **D200: 200 mm**	*Accuracy:* • **2: ±2" arc-seconds**

H-D90 series

ANGULAR

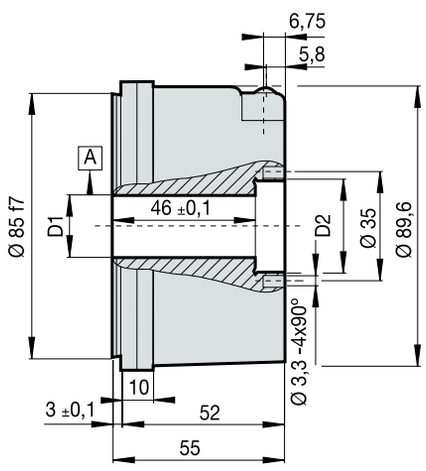
Dimensions in mm



General characteristics

Measurement	By means of graduated glass disk		
Accuracy	± 5" and ± 2.5"		
Number of pulses/turn	18 000, 90 000 and 180 000		
Vibration	100 m/sec² (55 ÷ 2 000 Hz) IEC 60068-2-6		
Natural frequency	≥ 1 000 Hz		
Shock	1 000 m/sec² (6 ms) IEC 60068-2-27		
Inertia	650 gr/cm²		
Maximum mechanical speed	3 000 rpm		
Maximum electrical speed	Pulses	TTL	1 vpp
	18 000 90 000 180 000	< 3 000 min⁻¹ < 666 min⁻¹ < 333 min⁻¹	< 600 min⁻¹
Turning torque	≤ 0.08 Nm		
Weight	1 kg		
Ambient characteristics: Running temperature Storage temperature	 -20 °C…+70 °C -30 °C…+80 °C		
Protection	IP64 (DIN 40050) standard >IP64 with pressurized air at 0.8 ± 0.2 bar		
Maximum frequency	180 KHz for 1 Vpp signal 1 MHz for TTL signal		
Consumption without load	Maximum 150 mA		
Supply voltage	5 V ± 5% (TTL); 5 V ±10% (1 Vpp)		
Reference signal I_0	One reference signal per encoder turn or distance-coded I_0		
Output signals	⊔⊓ TTL differential (18 000, 90 000 and 180 000 Pulses/turn) ∿ 1 Vpp (18 000 Pulses/turn)		
Maximum cable length	⊔⊓ Signals TTL: 50 m ∿ 1 Vpp: 150 m		

Accuracy	± 2.5"	± 5"
D1	Ø 20 H6	Ø 20 H7
D2	Ø 30 H6	Ø 30 H7



Order identification

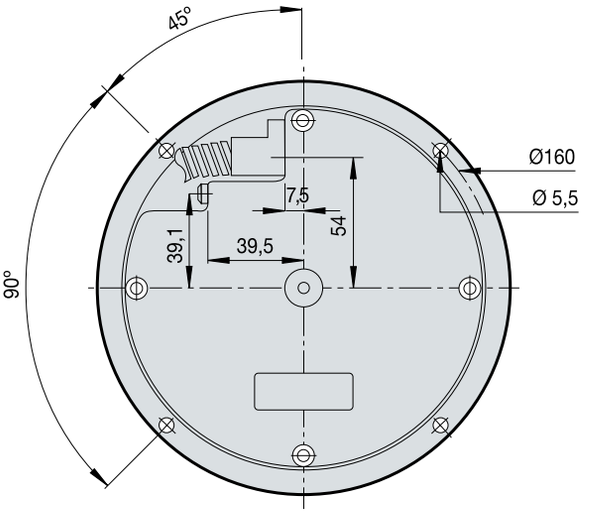
Example of Angular Encoder: **HOP - 18000 - D90-2**

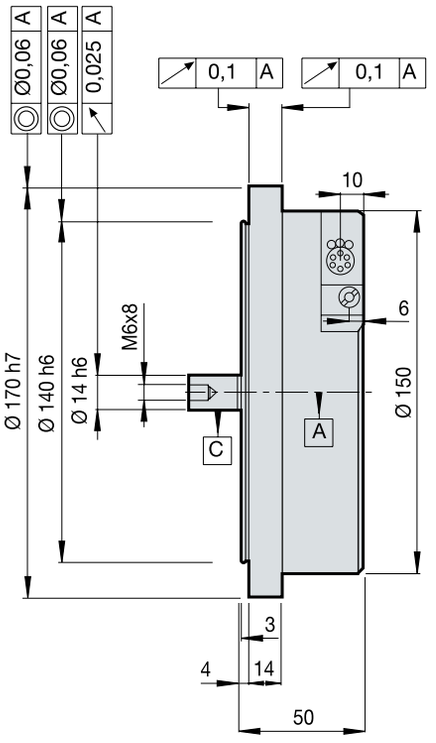
H	O	P	18000	D90	2
Type of shaft: • **H: Hollow shaft**	***Type of reference mark I_0:*** • Blank space: Incremental, one per revolution • **O: Distance-coded marks**	***Type of signal:*** • Blank space: Differential TTL • **P: 1 Vpp sinusoidal**	***Number of pulses/turn of the first feedback:*** • **18 000: On 1 Vpp and TTL models** • 90 000: Only on TTL models • 180 000: Only on TTL models	***Diameter:*** • **D90: 90 mm**	***Accuracy:*** • Blank space: ±5" arc-seconds • **2: ±2.5" arc-seconds**

S-D170 series

ANGULAR

Dimensions in mm





General characteristics

Measurement	By means of graduated glass disk		
Accuracy	± 2"		
Number of pulses/turn	18 000, 90 000 and 180 000		
Vibration	100 m/sec² (55 ÷ 2000 Hz) IEC 60068-2-6		
Natural frequency	300 m/sec² (6 ms) IEC 60068-2-27		
Inertia	350 gr/cm²		
Maximum mechanical speed	3 000 rpm		
Maximum electrical speed	Pulses	TTL	1 vpp
	18 000 90 000 180 000	< 3 000 min⁻¹ < 666 min⁻¹ < 333 min⁻¹	< 600 min⁻¹
Turning torque	≤ 0.01 Nm		
Load on the shaft	Axial: 1 kg Radial: 1 kg		
Weight	2.65 kg		
Ambient characteristics: Running temperature Storage temperature	 0 °C…+50 °C -30 °C…+80 °C		
Protection	IP64 (DIN 40050) standard > IP64 with pressurized air at 0.8 ± 0.2 bar		
Maximum frequency	180 KHz for 1 Vpp signal 1 MHz for TTL signal		
Consumption without load	Maximum 250 mA		
Supply voltage	5 V ± 5% (TTL); 5V ±10% (1 Vpp)		
Reference signal I_0	One reference signal per encoder turn or distance-coded I_0		
Output signals	TTL differential (18 000, 90 000 and 180 000 Pulses/turn) 1 Vpp (18 000 Pulses/turn)		
Maximum cable length	Signals TTL: 50 m 1 Vpp: 150 m		

Order identification

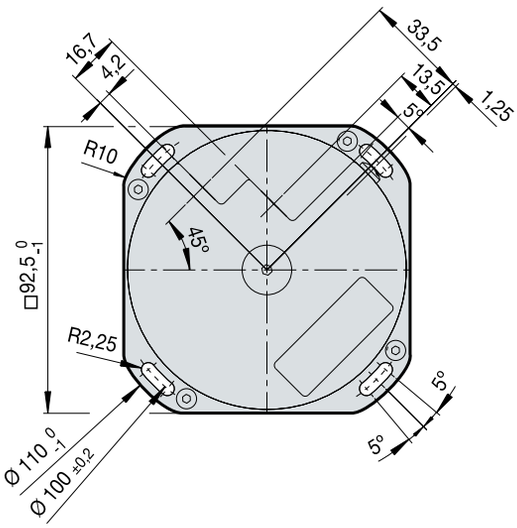
Example of Angular Encoder: **SOP - 18000 - D170-2**

S	O	P	18000	D170	2
Type of shaft: • **S: Solid shaft**	*Type of reference mark I_0:* • Blank space: Incremental, one per revolution • **O: Distance-coded marks**	*Type of signal:* • Blank space: Differential TTL • **P: 1 Vpp sinusoidal**	*Number of pulses/turn of the first feedback:* • **18 000: on 1 Vpp and TTL models** • 90 000: only on TTL models • 180 000: only on TTL models	*Diameter:* • **D170: 170 mm**	*Accuracy:* • **2: ±2" arc-seconds**

S-1024-D90 series

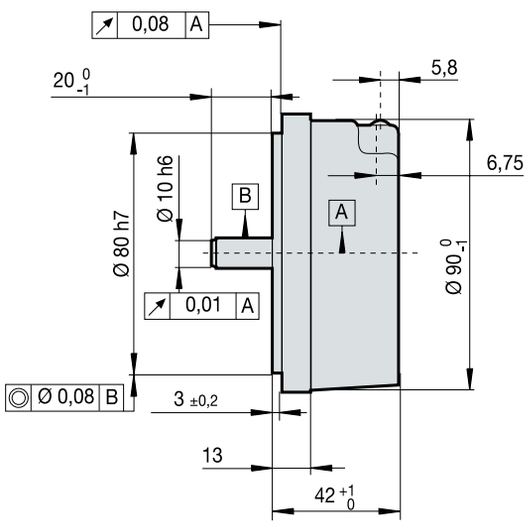
ANGULAR

Dimensions in mm



General characteristics

Measurement	By means of graduated glass disk
Accuracy	± 5"
Number of pulses/turn	90 000-1024 / 18 000-1024
Vibration	100 m/sec² (55 ÷ 2000 Hz) IEC 60068-2-6
Shock	1 000 m/sec² (6 ms) IEC 60068-2-27
Inertia	240 gr/cm²
Maximum mechanical speed	10 000 rpm
Maximum electrical speed	Pulses / TTL / 1 vpp 18 000 / < 3 000 min⁻¹ / < 600 min⁻¹ 90 000 / < 666 min⁻¹
Turning torque	≤ 0.01 Nm
Load on the shaft	Axial: 1 kg Radial: 1 kg
Weight	0.8 kg
Ambient characteristics: Running temperature Storage temperature	 -20 °C…+70 °C -30 °C…+80 °C
Protection	IP64 (DIN 40050) standard >IP64 with pressurized air at 0.8 ± 0.2 bar
Maximum frequency	180 KHz for 1 Vpp signal 1 MHz for TTL signal
Consumption without load	Maximum 250 mA
Supply voltage	5 V ± 5% (TTL); 5V ±10% (1 Vpp)
Reference signal I_0	One reference signal per encoder turn or distance-coded I_0
Output signals 1st Feedback	TTL differential (18 000 and 90 000 Pulses/turn) 1 Vpp (18 000 Pulses/turn)
Output signals 2nd Feedback	TTL differential (1 024 Pulses/turn) 1 Vpp (1 024 Pulses/turn)
Maximum cable length	Signals TTL: 50 m 1 Vpp: 150 m



Order identification

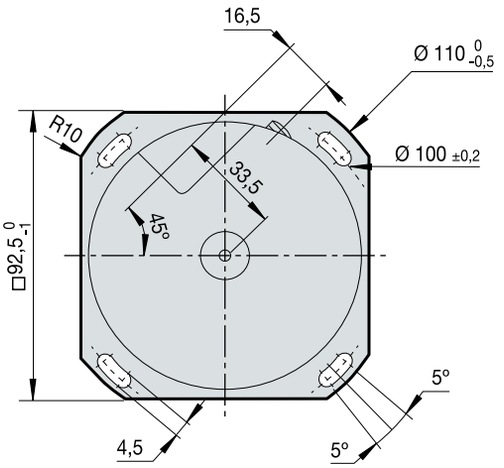
Example of Angular Encoder: **SOP - 18000-1024 - D90**

S	O	P	18000-1024	D90
Type of shaft:	***Type of reference mark I_0:***	***Type of signal:***	***Number of pulses/turn:***	***Diameter:***
• **S: Solid shaft**	• Blank space: Incremental, one per revolution • **O: Distance-coded marks**	• Blank space: Differential TTL • **P: 1 Vpp sinusoidal**	• **18 000-1024: On 1 Vpp and TTL models** • 90 000-1024: Only on TTL models	• **D90: 90 mm**

S-D90 series

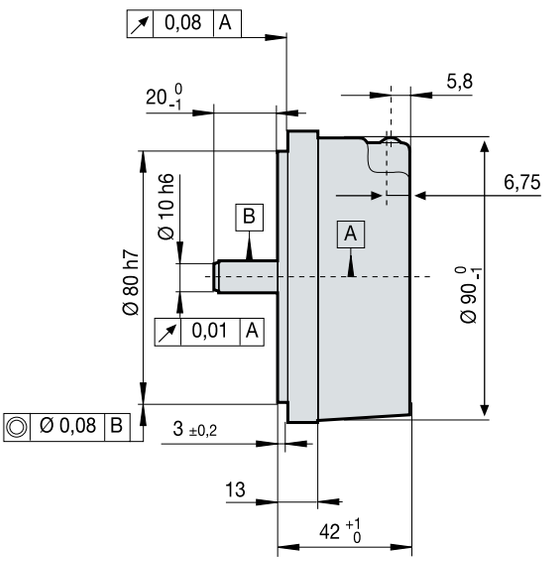
ANGULAR

Dimensions in mm



General characteristics

Measurement	By means of graduated glass disk		
Accuracy	± 5" and ± 2.5"		
Number of pulses/turn	18 000, 90 000 and 180 000		
Vibration	100 m/sec² (55 ÷ 2000 Hz) IEC 60068-2-6		
Shock	1 000 m/sec² (6 ms) IEC 60068-2-27		
Inertia	240 gr/cm²		
Maximum mechanical speed	10 000 rpm		
Maximum electrical speed	Pulses	TTL	1 vpp
	18 000 90 000 180 000	< 3 000 min⁻¹ < 666 min⁻¹ < 333 min⁻¹	< 600 min⁻¹
Turning torque	≤ 0.01 Nm		
Load on the shaft	Axial: 1 kg Radial: 1 kg		
Weight	0,8 kg		
Ambient characteristics: Running temperature Storage temperature	 -20 ºC... +70 ºC (5"), 0 ºC...+50 ºC (2,5") -30 °C…+80 °C		
Protection	IP64 (DIN 40050) standard >IP64 with pressurized air at 0.8 ± 0.2 bar		
Maximum frequency	180 KHz for 1 Vpp signal 1 MHz for TTL signal		
Consumption without load	Maximum 150 mA		
Supply voltage	5 V ± 5% (TTL); 5 V ±10% (1 Vpp)		
Reference signal I_0	One reference signal per encoder turn or distance-coded I_0		
Output signals	⊓⊔ TTL differential (18 000, 90 000 and 180 000 Pulses/turn) ~ 1 Vpp (18 000 Pulses/turn)		
Maximum cable length	⊓⊔ Signals TTL: 50 m ~ 1 Vpp: 150 m		



Order identification

Example of Angular Encoder: **S0P - 18000 - D90-2**

S	0	P	18000	D90	2
Type of shaft: • **S: Solid shaft**	***Type of reference mark I_0:*** • Blank space: Incremental, one per revolution • **0: Distance-coded marks**	***Type of signal:*** • Blank space: Differential TTL • **P: 1 Vpp sinusoidal**	***Number of pulses/turn of the first feedback*** • **18 000: On 1 Vpp and TTL models** • 90 000: Only on TTL models • 180 000: Only on TTL models	***Diameter:*** • **D90: 90 mm**	***Accuracy:*** • Blank space: ±5" arc-seconds • **2: ±2.5" arc-seconds**

H, S series

ROTARY

General characteristics

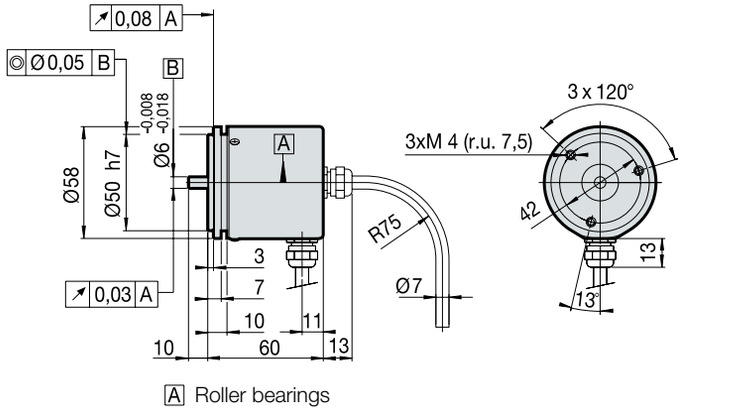
	S	SP	H	HP	HA
Measurement	**Up to 625 pulses/turn:** By means of perforated metallic disk **From 625 pulses/turn on:** By means of graduated glass disk				
Accuracy	± 1/10 of the pitch				
Maximum speed	12 000 rpm				6 000 rpm
Vibration	100 m/seg^2 (10 ÷ 2000 Hz)				
Shock	300 m/seg^2 (11 m/seg)				
Inertia	16 gr/cm^2				30 gr/cm^2
Turning torque	0.003 Nm (30 gr/cm) max. at 20 °C				0.02 Nm (200 gr/cm)
Type of shaft	Solid shaft		Hollow shaft		Hollow shaft
Maximum load on the shaft	Axial: 10 N Radial: 20 N		–		Axial: 40 N Radial: 60 N
Weight	0.3 kg				0.5 kg
Ambient characteristics:					
Running temperature	0 °C…+70 °C				
Storage temperature	-30 °C…+80 °C				
Relative humidity	98% non-condensing				
Protection	IP 64 (DIN 40050). On S and SP models: Optional IP 66				IP 65
Light source	IRED (InfraRed Emitting Diode)				
Maximum frequency	200 KHz				300 KHz
Reference signal I_0	One reference signal per encoder turn				
Supply voltage	5 V ± 5% (TTL)	5 V ± 10% (1 Vpp)	5 V ± 5% (TTL)	5 V ± 10% (1 Vpp)	5 V ± 5% (TTL)
Consumption	70 mA typical, 100 mA max. (without load)				
Output signals	⊓ TTL differential	~ 1 Vpp	⊓ TTL differential	~ 1 Vpp	⊓ TTL differential
Maximum cable length	50 m	150 m	50 m	150 m	50 m

Number of pulses/turn

S	SP	H	HP	HA
100	–	100	–	–
200	–	200	–	–
250	–	250	–	–
400	–	400	–	–
500	–	500	–	–
600	–	600	–	–
635	–	635	–	–
1 000	1 000	1 000	1 000	–
1 024	1 024	1 024	1 024	1 024
1 250	1 250	1 250	1 250	1 800
1 270	1 270	1 270	1 270	2 000
1 500	1 500	1 500	1 500	2 048
2 000	2 000	2 000	2 000	2 500
2 500	2 500	2 500	2 500	3 000
3 000	3 000	3 000	3 000	3 600
–	3 600	–	–	4 000
–	4 320	–	–	4 096
5 000	5 000	–	–	5 000
–	–	–	–	10 000

S, SP model

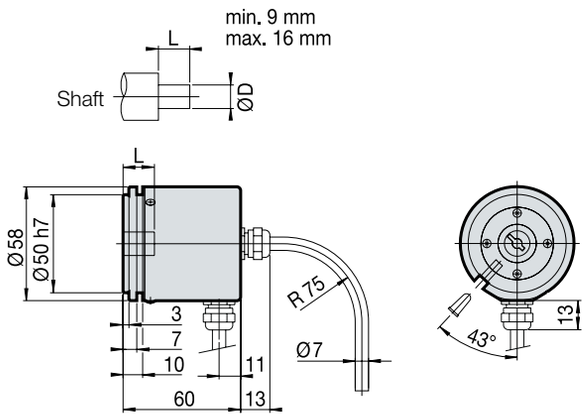
Dimensions in mm



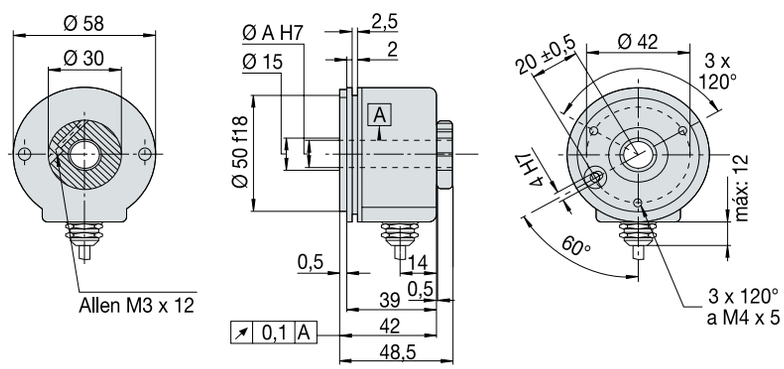
A Roller bearings

H, HP model

ØD g7 mm
3
4
6
6.35
7
8
9.53
10



HA model



Order identification - models H, HP, S and SP

Example for a Rotary Encoder: **SP-1024-C5-R-12-IP 66**

S	P	1024	C5	R	12	IP 66
Model: • **S: Solid shaft** • H: Hollow shaft	**Type of signal:** • Blank space: square signal (TTL or HTL) • **P: 1 Vpp sinusoidal signal**	***Number of pulses/turn*** (See table page 52)	**Type of connector:** • Blank space: 1 m cable without connector • C: Flange socket CONNEI 12 • **C5: 1 m cable with CONNEI 12 connector**	***Cable exit:*** • **R: Radial** • Blank space: Axial	***Voltaje:*** • Blank space: Standard 5 V supply • **12: Optional 12 V supply (only for HTL signal)**	***Protection*:** • Blank space: Standard protection (IP 64) • **IP 66: Protection IP 66**

Order identification - HA model

Example for a Rotary Encoder: **HA - 22132 - 250**

HA	2	2	1	3	2	2500
Model: • **H: Hollow shaft**	***Type of clamp:*** • 1: Rear clamp • **2: Front clamp**	Size of the hollow shaft (ØA): • **2: 12 mm**	***Output signals:*** • **1: A, B,** I_0 plus their inverted	***Type of connection:*** • **3: Radial cable (1 m) with CONNEI 12 connector**	***Supply voltage:*** • **2: RS-422 (5 V)**	***Number of pulses/turn*** (See table page 52)

Direct connection cables

Connection to FAGOR CNC

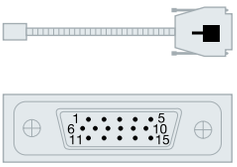
UP TO 12 METERS

EC...P-D

Lengths: 1, 3, 6 and 9 meters

SUB D 15 HD connector (male Pin)

Pin	Signal	Color
1	A	Green
2	/A	Yellow
3	B	Blue
4	/B	Red
5	I_0	Grey
6	$/I_0$	Pink
9	+5 V	Brown
11	0 V	White
15	Ground	Shield
Housing	Ground	Shield



FROM 12 METERS ON

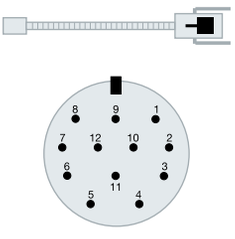
EC-...A-C1 cable + XC-C2… D extension cable

EC...A-C1

Lengths: 1 and 3 meters

12 CIRCULAR connector (male Pin)

Pin	Signal	Color
5	A	Green
6	/A	Yellow
8	B	Blue
1	/B	Red
3	I_0	Grey
4	$/I_0$	Pink
7	/Alarm	Purple
12	+5 V	Brown
2	+5 V sensor	
10	0 V	White
11	0 V sensor	
Housing	Ground	Shield

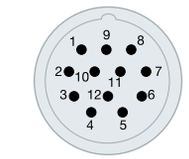


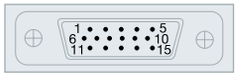
XC-C2-...D extension cable

Lengths: 5, 10, 15, 20 and 25 meters

12 CIRCULAR connector (female Pin)
SUB D 15 HD connector (male Pin)

Pin	Pin	Señal	Color
5	1	A	Brown
6	2	/A	Green
8	3	B	Grey
1	4	/B	Pink
3	5	I_0	Red
4	6	$/I_0$	Black
7	7	/Alarm	Purple
12	9	5 V	Brown/ Green
2	9	+5 V sensor	Blue
10	11	0 V	White/ Green
11	11	0 V sensor	White
Housing	Housing	Ground	Shield





Connection to other CNC's

UP TO 12 METERS

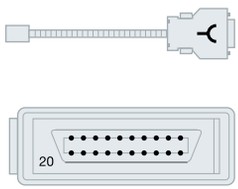
For direct connection to FANUC® (second feedback)

EC-...C-FN1

Lengths: 1, 3, 6 and 9 meters

HONDA / HIROSE connector (female Pin)

Pin	Signal	Color
1	A	Green
2	/A	Yellow
3	B	Blue
4	/B	Red
5	I_0	Grey
6	$/I_0$	Pink
9	+5 V	Brown
18-20	+5 V sensor	
12	0 V	White
14	0 V sensor	
16	Ground	Internal shield
Housing	Ground	External shield



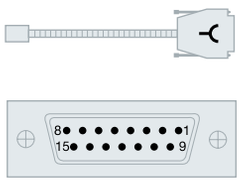
For direct connection to SIEMENS®, HEIDENHAIN, SELCA and others.

EC...AS-H

Lengths: 1, 3, 6, 9 and 12 meters

SUB D 15 HD connector (female Pin)

Pin	Signal	Color
3	A	Green
4	/A	Yellow
6	B	Blue
7	/B	Red
10	I_0	Grey
12	$/I_0$	Pink
1	+5 V	Brown
9	+5 V sensor	Purple
2	0 V	White
11	0 V sensor	Black
Housing	Ground	Shield



Without a connector at one end; for other applications.

EC...AS-O

Lengths: 1, 3, 6, 9 and 12 meters

Signal	Color
A	Green
/A	Yellow
B	Blue
/B	Red
I_0	Grey
$/I_0$	Pink
+5 V	Brown
+5 V sensor	Purple
0 V	White
0 V sensor	Black
Ground	Shield

FROM 12 METERS ON

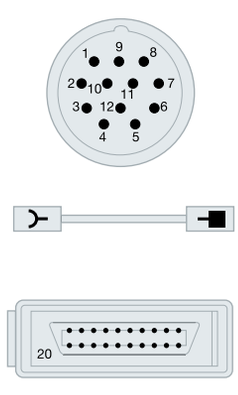
EC-...A-C1 cable + XC-C2... FN1 extension cable
EC-...A-C1 cable + XC-C2… H extension cable

XC-C2... FN1 extension cable

Lengths: 5, 10, 15, 20 and 25 meters

12 CIRCULAR connector (female Pin)
SUB D 15 HD connector (male Pin)

Pin	Pin	Signal	Color
5	1	A	Brown
6	2	/A	Green
8	3	B	Grey
1	4	/B	Pink
3	5	I_0	Red
4	6	$/I_0$	Black
12	9	+5 V	Brown/ Green
2	18-20	+5 V sensor	Blue
10	12	GND	White/ Green
11	14	GND sensor	White
Housing	16	Ground	Shield

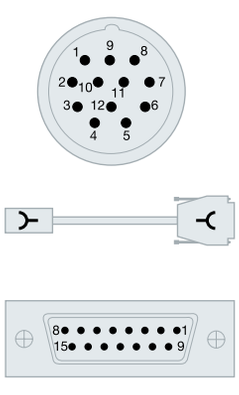


XC-C2... H extension cable

Lengths: 5, 10, 15, 20 and 25 meters

12 CIRCULAR connector (female Pin)
SUB D 15 HD connector (male Pin)

Pin	Pin	Signal	Color
5	3	A	Brown
6	4	/A	Green
8	6	B	Grey
1	7	/B	Pink
3	10	I_0	Red
4	12	$/I_0$	Black
12	1	+5 V	Brown/ Green
2	9	+5 V sensor	Blue
10	2	0 V	White/ Green
11	11	0 V sensor	White
Housing	Housing	Ground	Shield



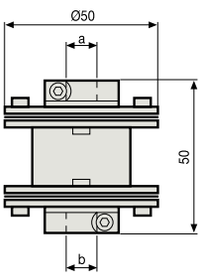
accessories

Couplings for solid-shaft encoders

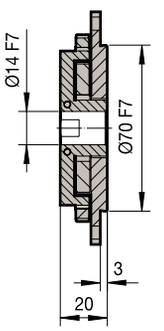
In order to ensure the accuracy of the solid-shaft angular encoder, it is a must to use couplings that provide them with long lasting stability. Fagor Automation recommends using our AA and AP couplings that have been designed for our encoders and provide a guarantee that other couplings cannot.

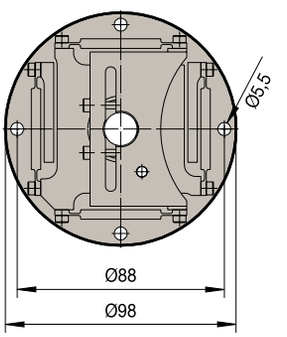
AA Model

The AA model comes in three versions depending on the diameter of the coupling as shown in the table below:

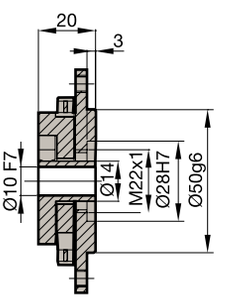


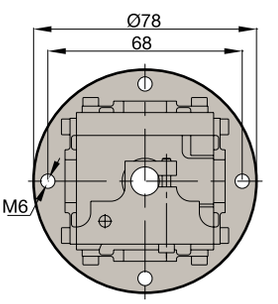
Model	a mm	b mm
AA 10/10	10	10
AA 10/14	10	14
AA 14/14	14	14





AP 14 model





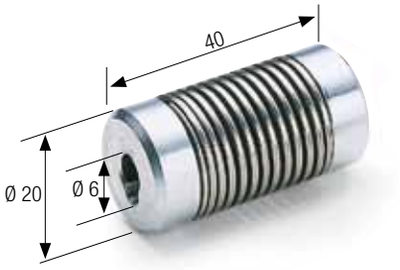
AP 10 model

Specific characteristics

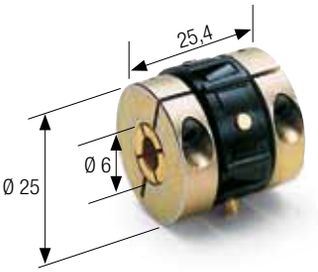
	AA 10/10 AA 10/14 AA 14/14	AP 10	AP 14
Maximum radial misalignment permitted λ	0.3 mm	0.3 mm	0.3 mm
Maximum angular misalignment permitted α	0.5º	0.5º	0.2º
Maximum axial misalignment permitted δ	0.2 mm	0.2 mm	0.1 mm
Kinematic transfer error	± 2" if λ ≤ 0.1 mm and α ≤ 0.09º	± 3" if λ ≤ 0.1 mm and α ≤ 0.09º	± 2" if λ ≤ 0.1 mm and α ≤ 0.09º
Maximum torque that may be transmitted	0.2 Nm	0.5 Nm	0.5 Nm
Torsion rigidity	1 500 Nm/rad.	1 400 Nm/rad.	6 000 Nm/rad.
Maximum rotating speed	10 000 rpm	1 000 rpm	1 000 rpm
Weight	93 gr	128 gr	222 gr
Inertia	20×10^{-6} kg/m²	100×10^{-6} kg/m²	200×10^{-6} kg/m²

accessories

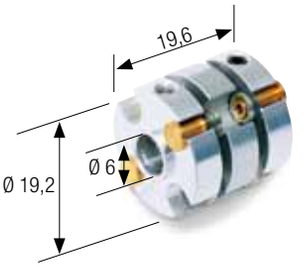
Coupling caps (solid shaft)



AF model



AC model



AL model

Specific characteristics

	AF	AC	AL
Maximum radial misalignment permitted λ	2 mm	1 mm	0.2 mm
Maximum angular misalignment permitted α	8°	5°	4°
Maximum axial misalignment permitted δ	± 1.5 mm	–	± 0.2 mm
Maximum torque that may be transmitted	2 Nm	1.7 Nm	0.9 Nm
Torsion rigidity	1.7 Nm/rad.	50 Nm/rad.	150 Nm/rad.
Maximum rotating speed	12 000 rpm		

AH coupling caps

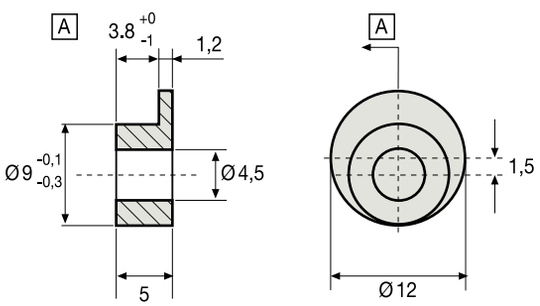
Rotary encoders: coupling caps (hollow shaft)

The hollow shaft encoders are accompanied by a standard 6 mm cap diameter (Ø 6).

Can also be supplied in the following diameters:
Ø 3, Ø 4, Ø 6, Ø 7, Ø 8 and Ø10 mm, 1/4" and 3/8".

AD-M washer

Washer for mounting rotary encoder models H, HP, S, SP.



accessories

Protection

Enclosed **linear encoders** meet the protection requirements IP 53 of the **IEC 60 529** standard when mounted so water splashes don't hit the sealing lips directly. For further protection, a separate protection guard must be mounted.

If the encoder is exposed to concentrated liquids and vapor, compressed air may be used to achieve a protection degree of IP 64 and prevent any contamination from getting inside. For these cases, Fagor Automation recommends their Air filter units AI-400 and AI-500.

- **AI-400 filter**

The air coming from an compressed air supply must be treated and filtered in the AI-400 unit which consists of:

- Filtering and pressure regulating group.
- Fast inlets and joints for 4 measuring systems.
- A plastic tube 25 m long with an inside diameter of 4 mm and outside diameter of 6 mm.

- **AI-500 filter**

Under extreme conditions where the air must be dried, Fagor Automation recommends using their air filter AI-500. This includes a drying module that makes it possible to reach the conditions required by Fagor Automation feedback systems.

AI-500 filter MODELS	
For 2 axes:	AI-525
For 4 axes:	AI-550
For 6 axes:	AI-590

Technical Characteristics	Filters AI-400 / AI-500	
	Standard	Special
Maximum input pressure	10.5 kg/cm^2	14 kg/cm
Maximum operating temperature	52 °C	80 °C
Output pressure of the unit	1 kg/cm^2	
Consumption per measuring system	10 l/min.	
Safety	Micro-filter saturation alarm	

Air conditions (Meets the standard DIN ISO 8573-1)

Fagor Automation linear feedback systems require the following air conditions:

- Class 1 - Maximum particle 0.12 µ
- Class 4 (7 bars) - Dew point 3 ºC
- Class 1 - Maximum oil concentration: 0.01 mg/m^3.

Safety switch

It consists of a pressostat capable of activating an alarm switch when the pressure gets below 0.66 kg/cm^2.

Technical data:
The switching pressure may be adjusted between 0.3 and 1.5 kg/cm^2.

- Load: 4 A.
- Voltage: 250 V approx.
- Protection: IP65.

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IQNet

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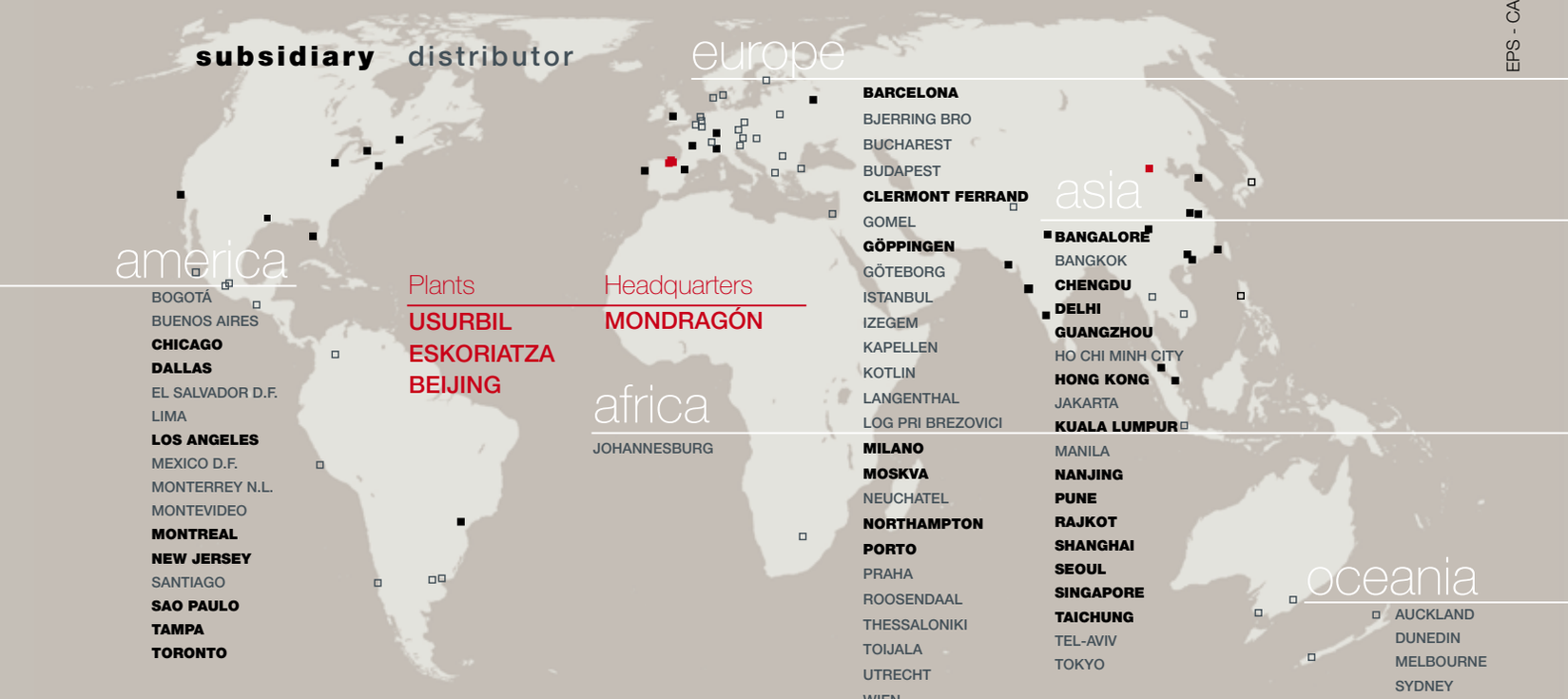

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