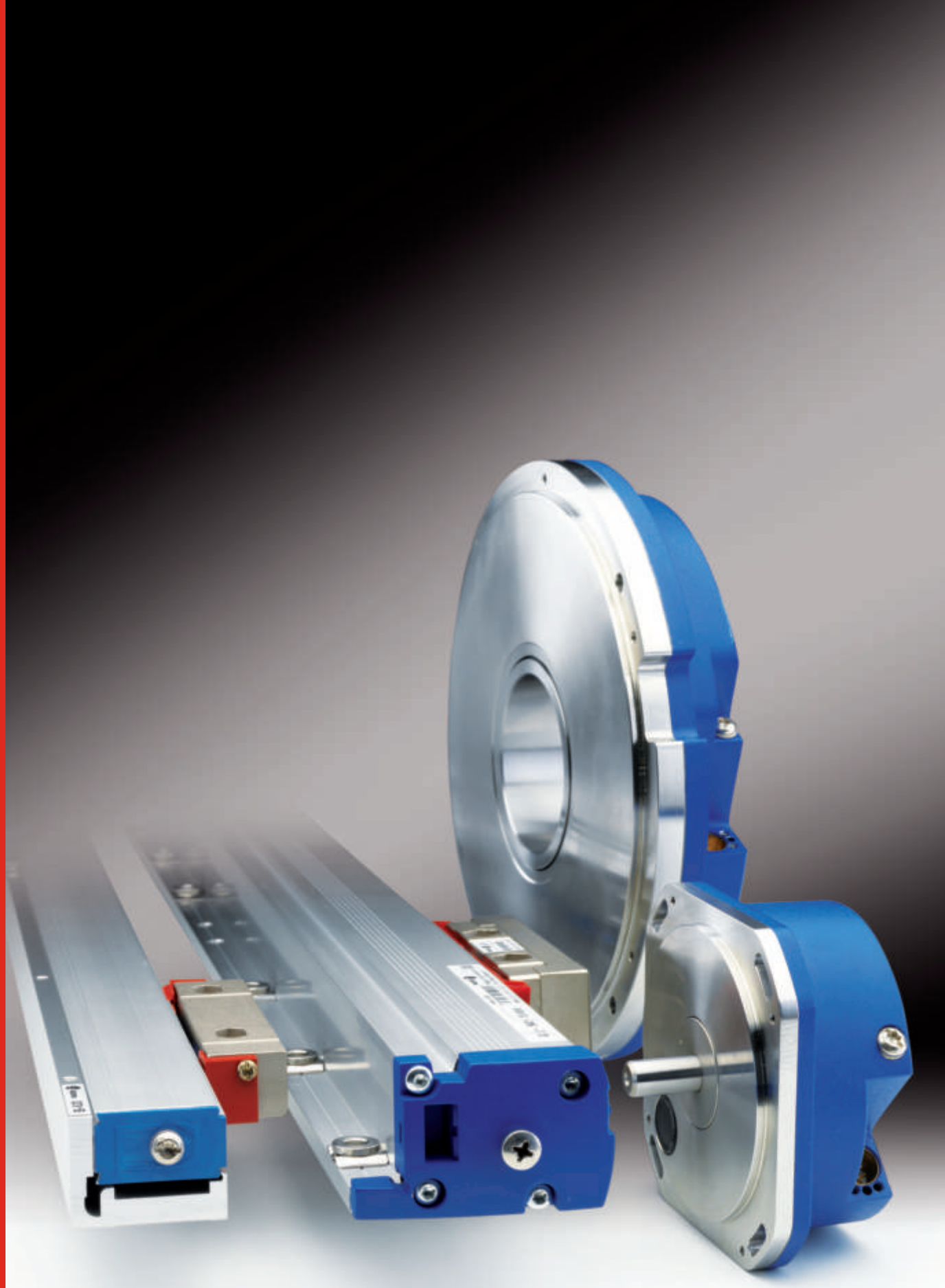
LINEAR AND ROTARY ENCODERS



FAGOR

FAGOR AUTOMATION

INDEX

FAGOR LINEAR AND ROTARY **ENCODERS**

The most efficient and profitable alternative

Over 30 years guaranteeing measurement and control solutions

Fagor Automation has been manufacturing linear and rotary encoders with high quality and highly reliable optic technology since 1975.

Nowadays, Fagor Automation's feedback systems are the most efficient and profitable alternative to be integrated into Machine-Tools.

In constant innovation

Fagor creates, develops and patents systems and components that offer quality and features at very competitive prices in a great variety of products by using innovative production methods.

Advanced facilities and processes

Reaching the high quality of FAGOR products requires very special manufacturing facilities and processes.

Both the masters and the copies for encoder manufacturing are made in clean rooms under specific and strict conditions of stable room temperature, pressure and humidity as well as perfect isolation against vibrations. FAGOR develops and builds many of the machines to etch and measure linear and circular gratings as well as the copying installations.

With state-of-the-art technology

FAGOR AUTOMATION has been using SMD (Surface Mounted Device) technology in their production process for many years.

This technology offers an incredible reduction in size and number of components used in the electronic circuits of FAGOR measuring systems while ensuring maximum reliability by including specific custom designed components.

Guaranteed Quality

Fagor AUTOMATION's efforts on the quality of their products, production processes and management are evident by the many quality certificates obtained.

Among the most important, the following are significant:

> Quality system,
  ISO 9001: 2000, which is implemented in all operational processes.

> CE certification according to European directives for our entire product line.

FAGOR LINEAR AND ROTARY **ENCODERS**

The most efficient and profitable alternative

Optical design

Fagor uses transmission and reflective optics in its range of encoders besides patented techniques and components.

Scanning techniques such as the single field and the three-phase scanning provide high-quality signals that minimize interpolation errors down to an insignificant level.

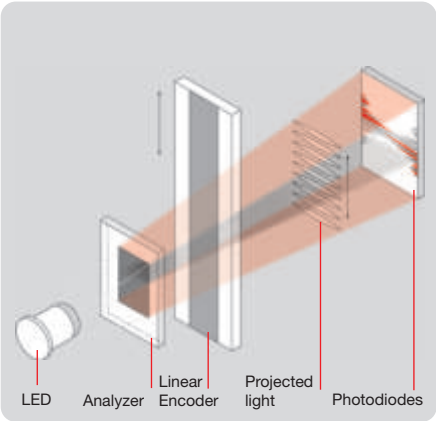
Electronic design

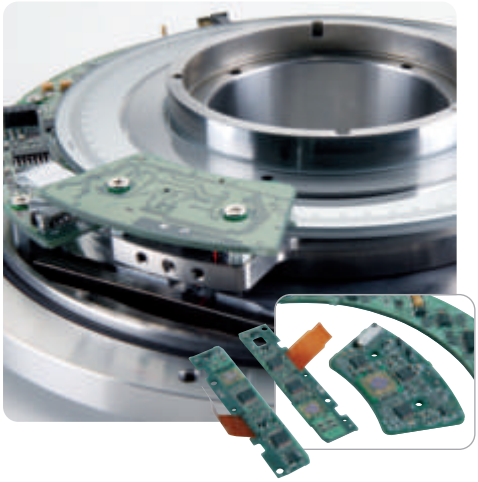
The electronic state of the art provides a perfect relationship between the reader head and the linear encoder. High resolution is achieved at high speed thanks to their great signal stability.

All the models meet the industrial standards. Their signals, protocols and hardware are compatible with most controllers on the market.

Mechanical design

FAGOR's mechanical developments have produced some of the most innovative and efficient methods for minimizing the effects of especially harsh environments often found in machine-tool applications.





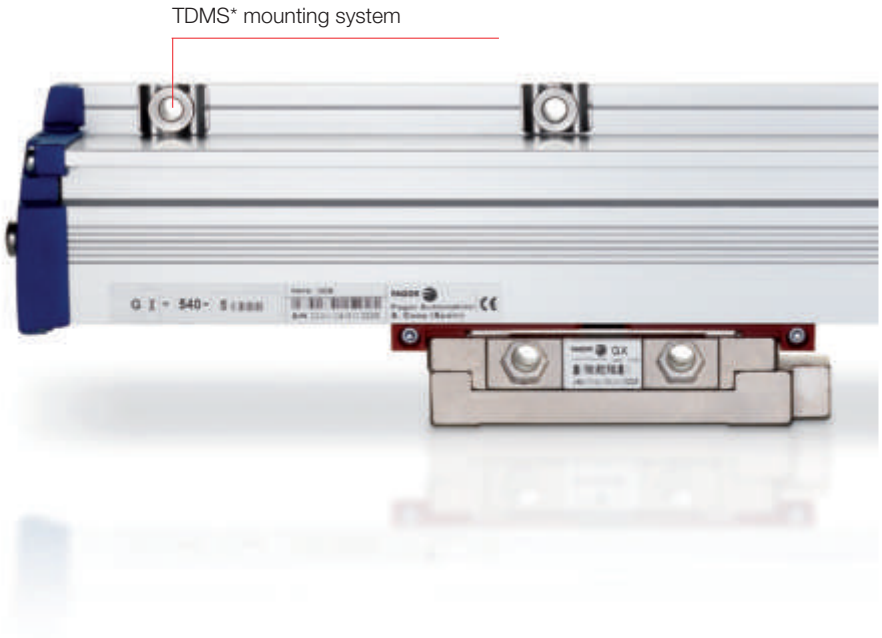
Thermal performance*

FAGOR has taken into considerations the effect of ambient temperature when designing their new linear encoders. Since the temperature cannot be controlled (in most workshops), its variations cause measuring errors.

These errors are drastically reduced using the mounting system patented by Fagor Thermal Determined Mounting System (TDMS®) that increases the accuracy and repeatability of the linear encoders.

The implementation of this technology results in a constant dilatation all along the travel of the linear encoder.

*The TDMS system is only available on G, S and L series linear encoders.



System test

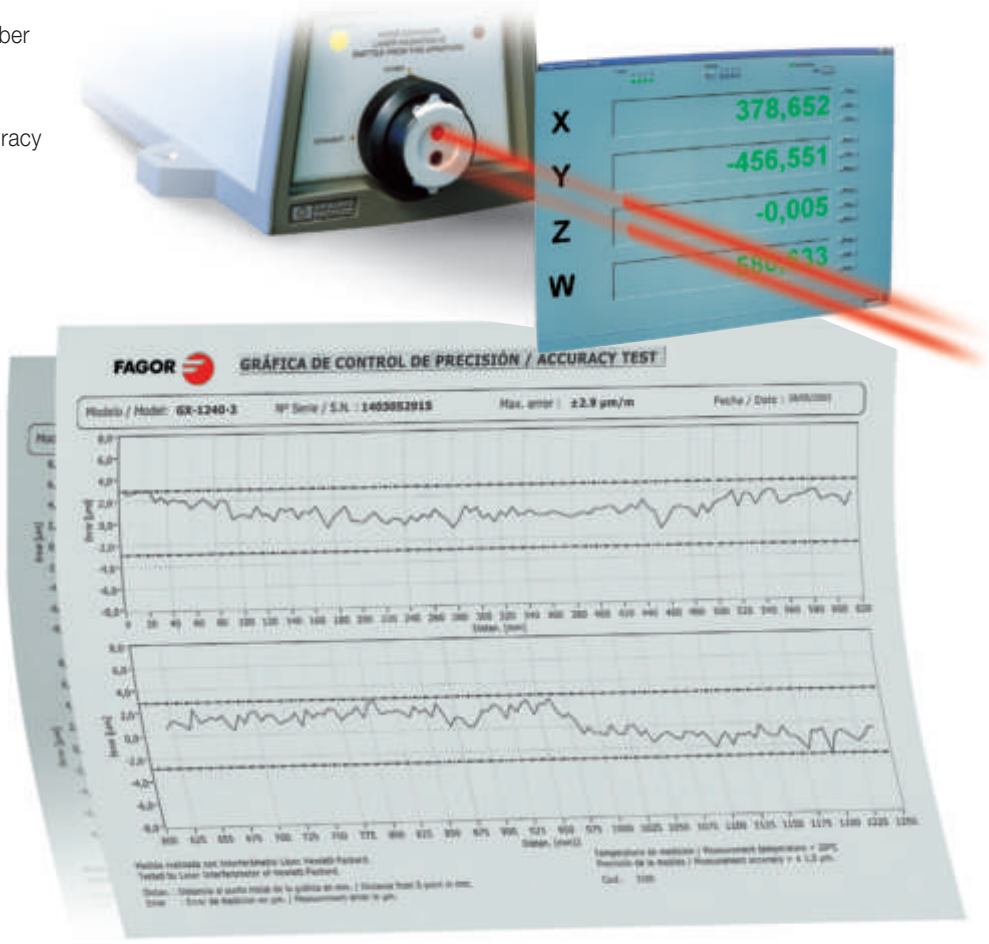
FAGOR encoders are integrated as components of a full system; this type of applications requires a thorough test on the whole system regardless of the specifications of the encoder.

The specifications shown in this catalog only apply to the specific encoder, not to the whole system.

Accuracy certificate

Every single FAGOR linear encoder is subjected a final accuracy test carried out on a computerized measuring bench equipped with a LASER interferometer located inside a climate-controlled chamber at a temperature of 20 ºC (68 ºF).

Each FAGOR linear encoder comes with the graphics resulting from the final accuracy test, except the F and L series modular encoders for measuring lengths over 4,040 mm.



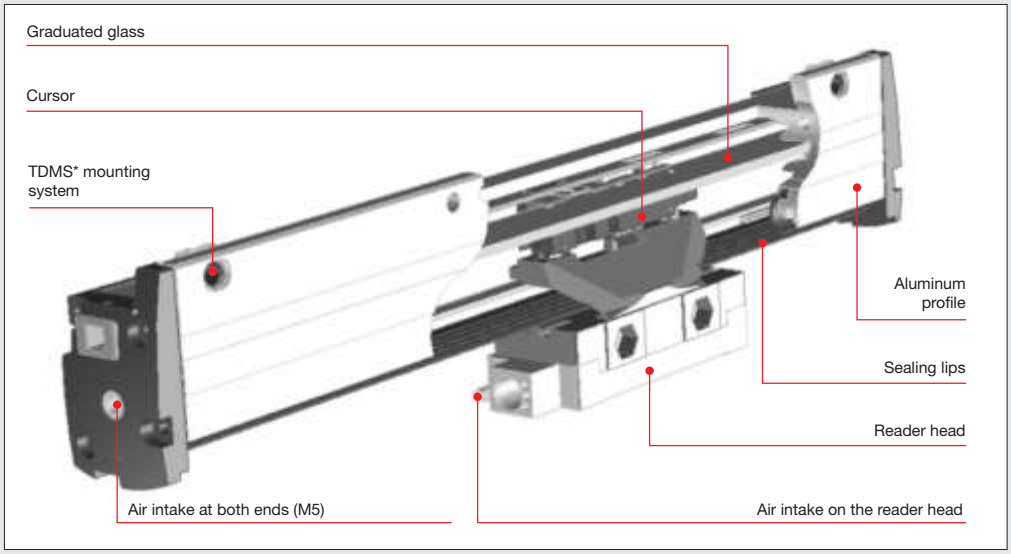
The quality of the linear measurement is mainly determined by:

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

ENCLOSED LINEAR **ENCODERS**

Linear encoders measure the axis position directly without any intermediate mechanical device. The errors originated in the mechanics of the machine are avoided because the encoder is mounted to the machine way and sends the real movement data to the controller; some of the potential sources of error, such as those caused by the thermal behavior of the machine or leadscrew pitch error may be minimized using linear encoders.

The aluminum profile protects the graduated glass. The rubber sealing lips from dust and liquid splashes as the reader head moves along the profile.
The reader head and the graduated glass make up a balanced tandem accurately capturing and transmitting the position and movement of the machine. The friction between the reader head and the graduated scale is minimum.



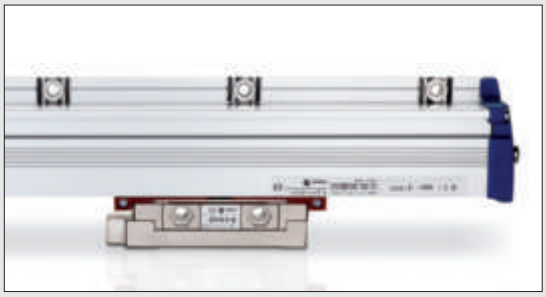
INCREMENTAL LINEAR ENCODERS

Incremental linear measuring systems show the current position referred to a reference point (datum) or origin, by emitting pulses with a particular period, these pulses are counted to display the position.

The home search procedure is particularly simple thanks to the distance-coded reference marks.

Incremental linear encoders for CNC machines

FAGOR linear measurement systems for CNC machines may be used in practically all applications. Their dynamic performance and reliable response against high speed and vibration make them the ideal feedback solution for conventional axes of a CNC-controlled machine (milling machines, machining centers, boring mills, lathes and grinders) as well as linear motors.



Incremental linear encoders for conventional machines

FAGOR incremental linear encoders for conventional machines are ideal for applications in milling machines, boring mills and grinders where the speed is lower than 60 m/min and withstand vibrations under 3g.

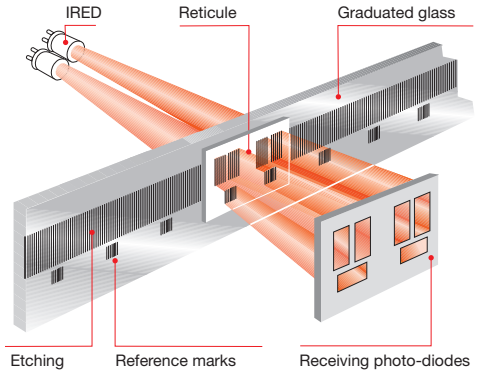
MEASURING PROCESS

Incremental linear encoders

FAGOR incremental linear encoders obtain their output signals through an opto-electronic process, based on reading a glass or steel scale with lines etched with a specific pitch.

FAGOR's photolithographic manufacturing processes including the making of the masters provide highly defined and homogenous etchings and, consequently, high quality output signals. This means more precise measurement in comparison with other optic systems.

All FAGOR encoders include mechanisms to eliminate harmonics and achieve a high degree of interpolation with no loss of precision.



FAGOR linear encoders based on graduated glass operate by transmitting the light of the LED's through the graduated glass up to a measuring length of 3040 mm.

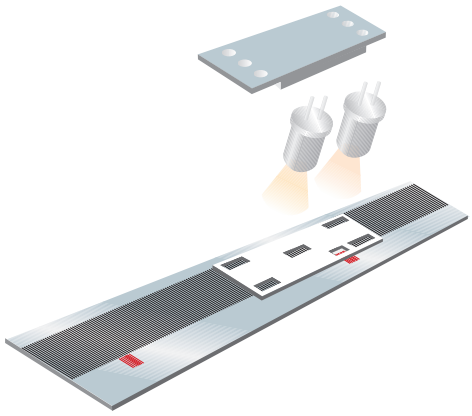
Incremental linear encoders with graduated glass

The light from the IRED goes through a graduated track and a reticule before reaching the receiving photo diodes. The period of the generated electrical signals is the same as the graduation pitch.

Incremental linear encoders with graduated steel tape

In this case, they use the autoimage principle by means of diffuse light reflected on the steel tape.

The reading system consists of a LED, as the light source of the steel tape; a mesh that makes the image and a monolithic photo detector element in the plane of the image especially designed and patented by FAGOR.



FAGOR steel tape linear encoders operate by reflecting a light on the marks etched on a steel tape.

Reference marks

A reference signal consists in a special etching that when scanned by the measuring system generates a pulse signal. Reference marks are used to restore the machine zero position and especially to avoid possible errors caused by accidentally moving the axes while the CNC or the DRO it is connected to is turned off. FAGOR incremental linear encoders have three types of reference marks Io:

• Incremental reference mark signals

One every 50 mm (1.97 inches) of travel.

The reference signal obtained is synchronized with the feedback signals to ensure perfect measuring repeatability.

• Distance-coded reference mark signals

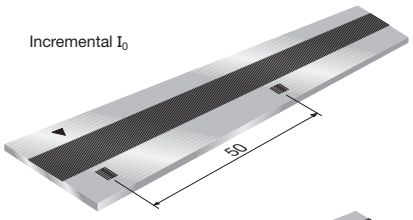
Every distance-coded reference mark is separated from the next one by a different distance because this gap varies according to a particular mathematical function. The position value is restored by moving through two consecutive reference marks.

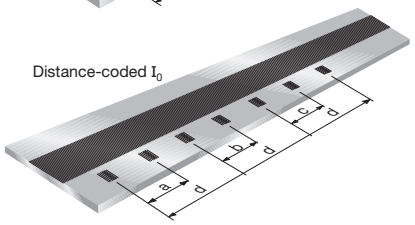
Using these signals, the movement needed to know the absolute position is always very small, thus minimizing unproductive time.

• Selectable reference mark signals

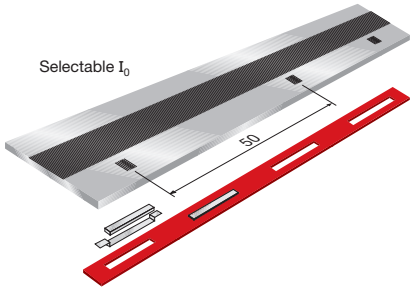
It is possible to select one or more reference points and ignore the rest by simply inserting a magnet at the selected point or points.

One of the advantages offered by this system is that it eliminates the need for external home switches along the machine travel.





Coordinates / Models	a	b	c	d
S, M, C and G	10.02	10.04	10.06	20
F	50.1	50.2	50.4	100
L	40.04	40.08	40.12	80



ELECTRICAL OUTPUT **SIGNALS**

Measurement through opto-electronic technology:

By means of a 20 µm (0.0008 inch) pitch graduated glass scale for measuring lengths of up to 3040 mm and by means of 40 µm (0.0016 inch) graduated steel tape on L model or 100 µm ((0.004 inch) pitch on F model, both for measuring lengths from 440 mm.

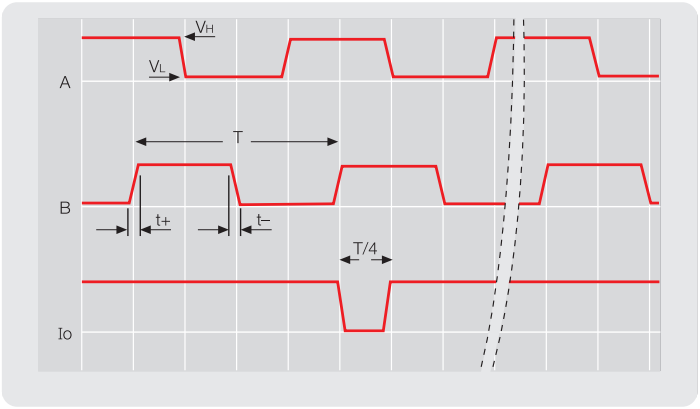
The generated signals are amplified by an electronic circuit incorporated into the reader head that converts the primary electrical signals obtained into square signals (TTL) or sinusoidal (1 Vpp) signals depending on the encoder model.

- Light source: IRED emitters.
- Capturing elements: Silicon photodiodes.

TTL Signals

Characteristics

Signals: Two quadrature signals A and B	$V_H \geq 3.5$ V $I_{Source} \leq 4$ mA $V_L \leq 0.4$ V $I_{SINK} \leq 4$ mA I_{OUT} Maximum = +/- 25 mA
Power supply	5 V ± 5%, 100 mA
Maximum cable length (with the cable recommended by FAGOR)	20 m (65 ft)
Reference marks (I_0) in two versions	I_0 mark every 50 mm (1.97“) Distance-coded I_0



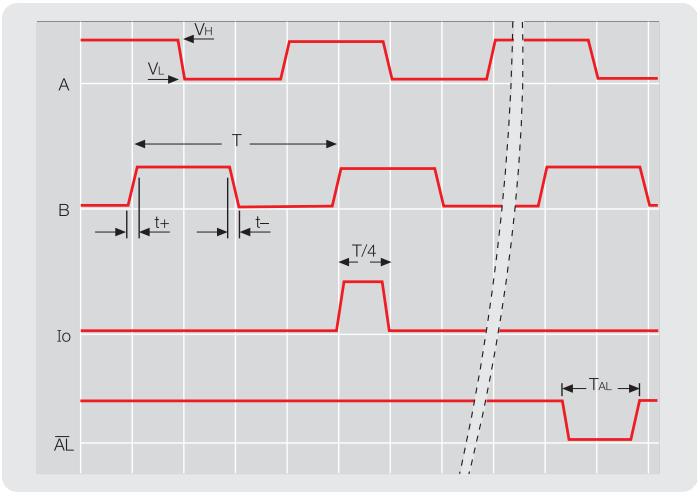
TTL Differential signals

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

The period of the signals depends on the interpolation factor applied to the natural period (pitch) of the etching. Depending on the products, these factors may be x1, x5, x10, x25 and x50

Characteristics

Signal level A,B,Io	V_L= 0.5V I_L= 20mA V_H= 2.5V I_H= 20mA With 1m cable
90º reference mark	Signal synchronized with A, B signals
Load impedance	Z_O= 120Ω between each differential signal
Switching Times	t_+/t_-< 30ns With 1m cable
Alarm signal	Wrong internal signals $t_{AL} \geq$ 10ms
Power supply	5 V ± 5%, 100 mA



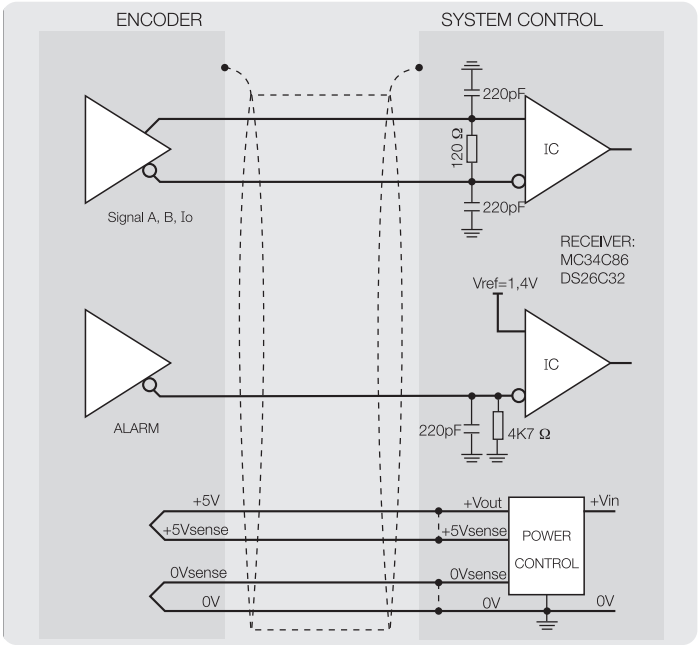
The **incremental signals** consist of two signals (A, B) shifted 90º. The I_0 signal is a reference etched on the linear scale or encoder disk used to reference (home) the machine.
The **/AL** signal is non-differential signal that indicates when the internal signals of the encoder are not within their proper limits.

Interface

Recommended circuit to receive the A, B, I_0. signals

Since the ALARM signal is not differential, a cutoff level of 1.4 V must be set at the differential receiver.

In control systems that do not use SENSE signals, we recommend to jumper these to the corresponding voltage supply signals in order to reduce the impedance between the encoder and the control system.



Voltage drop across the cable

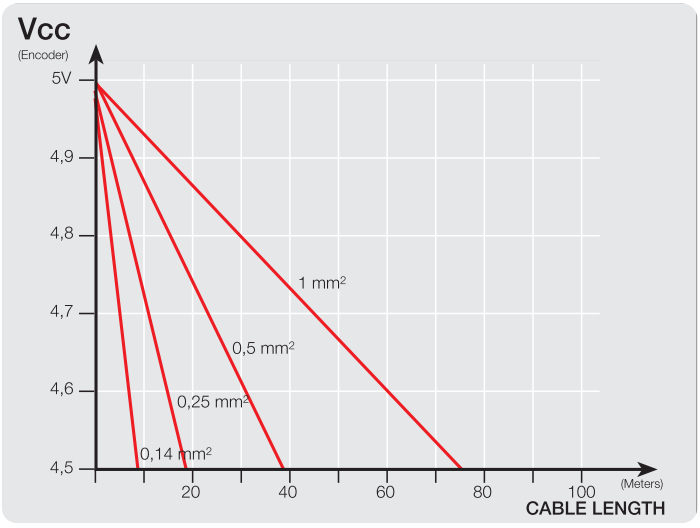
The voltage required for a TTL encoder must be 5V ±5%.

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:

V_{cc} = 5V, I_{MAX} = 0,2Amp (With a 120Ω load)			
Z(1mm²)	=	16,6 Ω/Km	**(L_{max}=75m)**
Z(0,5mm²)	=	32 Ω/Km	**(L_{max}=39m)**
Z(0,25mm²)	=	66 Ω/Km	**(L_{max}=19m)**
Z(0,14mm²)	=	132 Ω/Km	**(L_{max}=9m)**



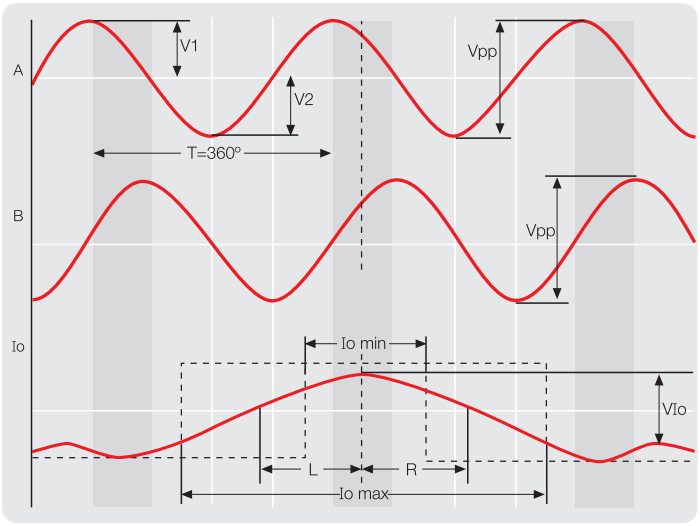
ELECTRICAL OUTPUT **SIGNALS**

1 Vpp Differential signals

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

Characteristics

Signals	A,B, /A & /B
$V_{A^{PP}}$	1V +20, -40%
$V_{B^{PP}}$	1V +20, -40%
DC offset	2.5V ±0.5V
Signal period	20 µm
A & B Ratio	0.8V to 1.25V
Supply V	5V ±10%
Max. cable length	150 meters (490 ft.)
Amplitude A,B: VA_{pp},VB_{pp}	0,6÷1,2Vpp
Centered A,B: $\|V_1-V_2\| / 2V_{pp}$	≤ 0,065
A&B relationship: $V_{pp/A} / V_{pp/B}$	0,8÷1,25
A&B phase shift:	90°±10°
I_0 amplitude: VI_0	0,2÷0,8V
I_0 width: L+R	Io_min:180°
normally 360°	Io_max: 540°
I_0 synchronism: L,R	180°±90°

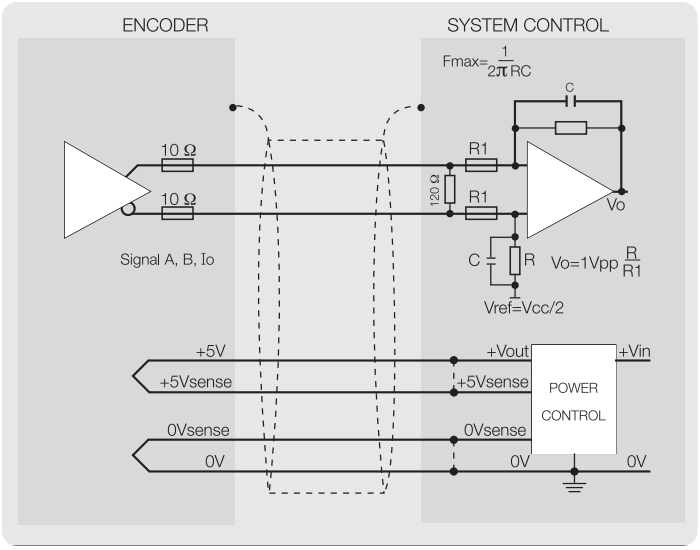


The incremental signals consist of two signals (A B) shifted 90° and an amplitude of 1 Vpp on an impedance of 120Ω. It must be borne in mind that both the frequency and the cable length affect the amplitude of the signals.
The I_0 signal is a reference etched on the linear scale or encoder disk used to reference (home) the machine; this reference may be single or multiple in the case of an encoder with distance-coded reference signal. The amplitude of the difference of their inverted signals on a 120Ω impedance is usually 0.5V.

Interface

Recommended circuit to receive the A, B, I_0 signals.

In control systems that do not use SENSE signals, we recommend to jumper these to the corresponding voltage supply signals in order to reduce the impedance between the encoder and the control system.



Voltage drop across the cable

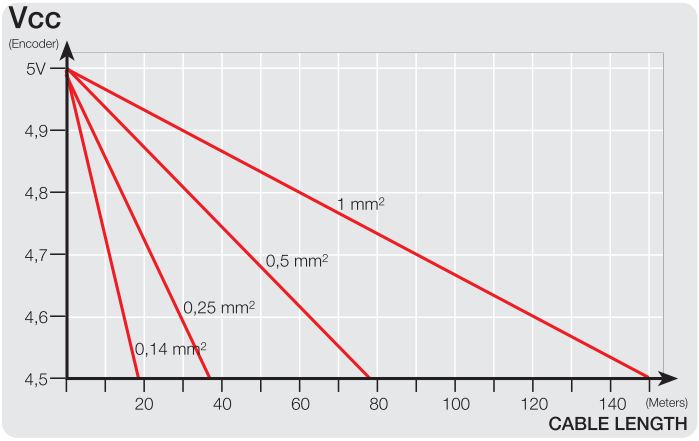
The voltage required for a $1V_{pp}$ encoder must be 5V ±10%.
A simple formula may be used to calculate the maximum cable length depending on the section of the supply cables.

L_{max} = **$(V_{CC}-4,5)500 / (Z_{CABLE/Km} * L_{Km} * I_{MAX})$**

Example:

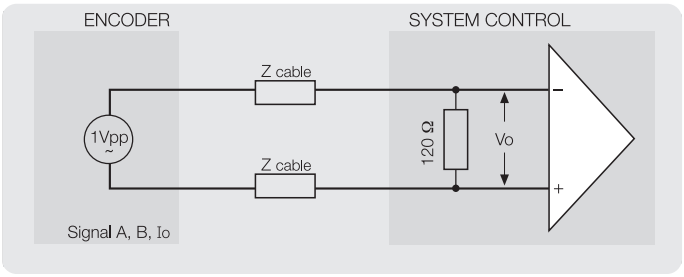
V_{cc} = 5V, I_{MAX}= 0,1Amp

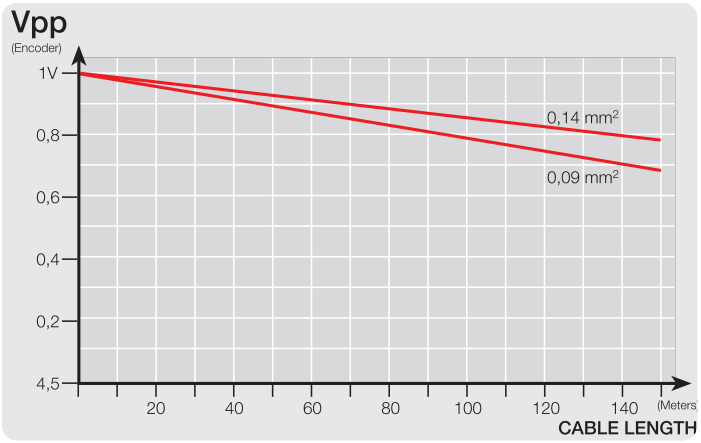
Z(1mm²)	=	16,6 Ω/Km	**(L_{max}=150m)**
Z(0,5mm²)	=	32 Ω/Km	**(L_{max}=78m)**
Z(0,25mm²)	=	66 Ω/Km	**(L_{max}=37m)**
Z(0,14mm²)	=	132 Ω/ Km	**(L_{max}=18m)**



1 V_{pp} 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.





Absolute linear encoders

Digital measurement, accurate, fast and direct without having to home the machine

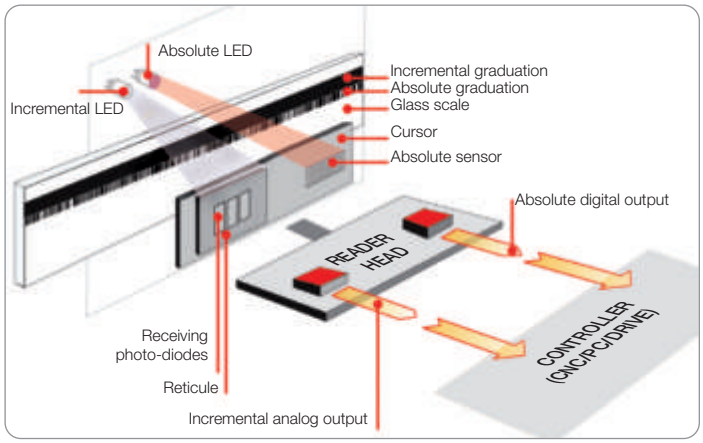
In absolute measurement, the position value is available at the encoder from the instant the unit is turned on and may be read at any time by the controller (CNC, PC, servo drive, DRO, etc.) to which it is connected.

Operating principle

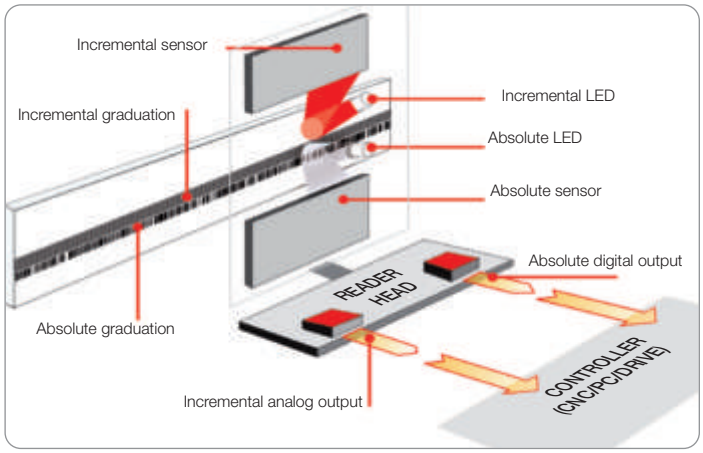
FAGOR uses two measuring methods in their absolute encoders: One based on **graduated glass** using optical transmission for linear encoders of measuring lengths up to 3040 mm and another one based on **graduated steel tape** that uses optical diffraction for steel tape linear encoders.

Both glass and steel tape linear encoders have two different etchings: one is used to generate the incremental 1 Vpp signals (like on typical linear encoders) and the other one is a binary code with a special sequence that avoids repetition all along the measuring length of the linear encoder.

On FAGOR absolute linear encoders, the absolute position is calculated using the data of that code read by means of a high precision optical sensor.



Graduated glass

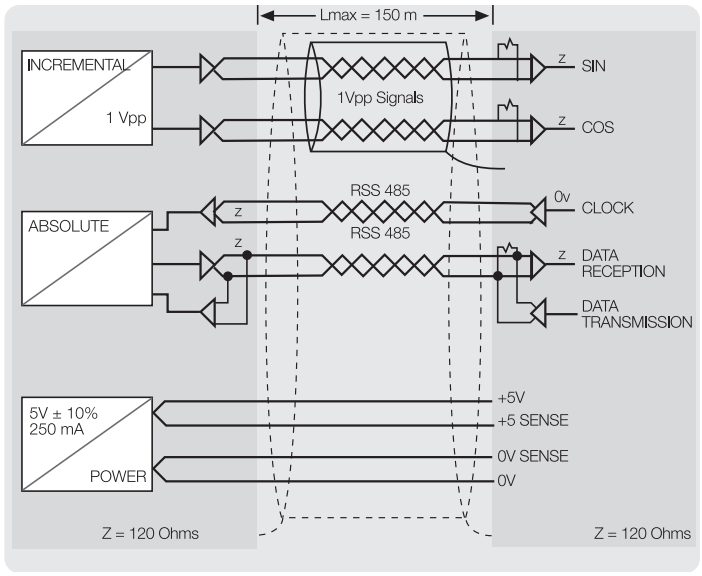


Graduated steel tape

Digital Communication Protocol

Protocols are encoder-controller communication languages used by absolute linear encoders to communicate with the machine controller (Drive, CNC, PLC, etc.).

There are several protocols depending on the manufacturer of the controller; FAGOR offers absolute encoders with different protocols that are compatible with the main controller manufacturers on the market such as FAGOR, FANUC, SIEMENS, MITSUBISHI CNC, PANASONIC, etc.

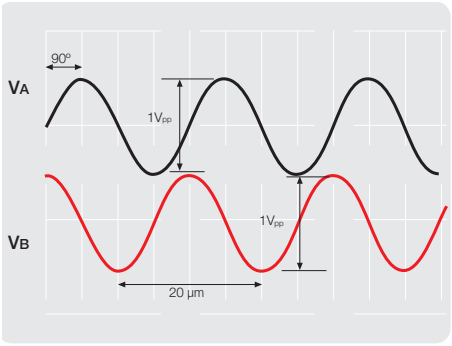


Encoder cable: (4 x 0.08 mm²) + 4 x 0.08 mm² + 4 x 0.14 mm²
Extension cable: (4 x 0.14 mm²) + 4 x 2 x 0.14 mm² + 4 x 0.14 mm²

Absolute linear encoder signals

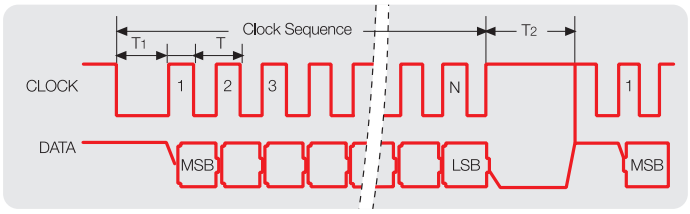
1 Vpp SIGNAL SPECIFICATIONS

Signals	A,B, /A & /B
V_{APP}	1V +20, -40%
V_{BPP}	1V +20, -40%
DC offset	2.5V ±0.5V
Signal period	20 µm
A & B ratio	0.8V to 1.25V
Freq. @120m/min	100kHz
Supply V	5V ±10%
Supply Imax	250mA (no load) (sense possible)
Max. cable length	150 meters (490 ft)



SSI DIGITAL SIGNAL CHARACTERISTICS

Transmission	SSI synchronous serial transfer via RS 485
Levels	EIA RS 485
Clock frequency	100kHz - 500kHz
Max bits (n)	32 (configurable)
T	2 µs to 10 µs
t_1	> 1 µs
t_2	20 µs to 35 µs
SSI	Grey or binary (configurable)
Parity	Fully configurable



In certain applications, the controllers to which FAGOR absolute encoders are connected use incremental 1 Vpp signals as well as digital signals and in other applications some controllers only use digital signals.

In FAGOR systems

These systems use the SSI interface as well as incremental 1 Vpp signals coming from the encoder. The encoder is directly connected to the FAGOR drive.

In SIEMENS systems (with Sinamics)

These systems use the SSI interface as well as incremental 1 Vpp signals coming from the encoder. The encoder is connected to the Sinamics drive through a "SSI/drive click" module called SME 25 or SME 20. This "drive click" module, supplied by Siemens converts the SSI protocol into their own communications protocol.

OTHER INTERFACES

In FANUC (01 and 02) systems

FAGOR absolute encoders are connected to FANUC systems through a "separate detector unit" supplied by FANUC.

In MITSUBISHI CNC systems (high speed serial interface)

FAGOR absolute encoders are connected to MITSUBISHI CNC systems through their Drive Unit.

In PANASONIC systems (Matsushita)

FAGOR absolute encoders are connected to Panasonic systems using the Matsushita protocol.

Connection to a PC through the USB port

Using a FAGOR adapter, the absolute encoders may be connected to a PC through the USB port.

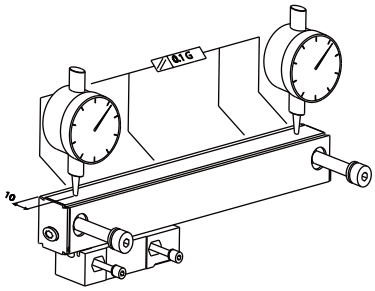
Linear encoders for limited space

S series linear encoders for limited space may be easily installed onto the surface of the machine; guides are used for measuring lengths over 620 mm to ensure immunity against vibration due to the length of the encoder.

The encoder must be mounted so its sealing lips are not directly exposed to lubricants or chips while machining.

Direct mounting of the encoder onto the machine (S series)

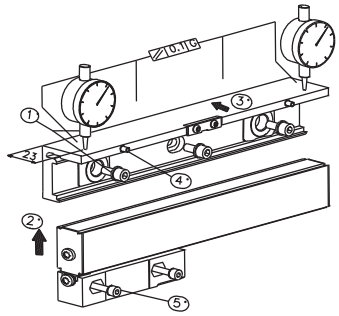
Proper mounting only requires correct alignment of the linear encoder throughout the measuring length. The shipping bracket that holds the reader head to the linear encoder ensures a proper gap between them as well as their lateral alignment. The S series encoder is mounted to the machine at its ends; it can also be secured to the mounting surface using the brackets that come with the encoder. This mounting method is especially recommended when the measuring length exceeds 620 mm and it is going to be used in applications at high speed and high vibration.



Mounting of the encoder onto the machine using the mounting guide (SV series)

Using the mounting guide improves the characteristics of the encoder in terms of vibration and thermal performance even for great measuring lengths.

This guide may be mounted during machine assembly; at the end of the assembly, just simply mount the linear encoder onto the guide. The simple dismounting procedure also makes commissioning (servicing) faster and easier.

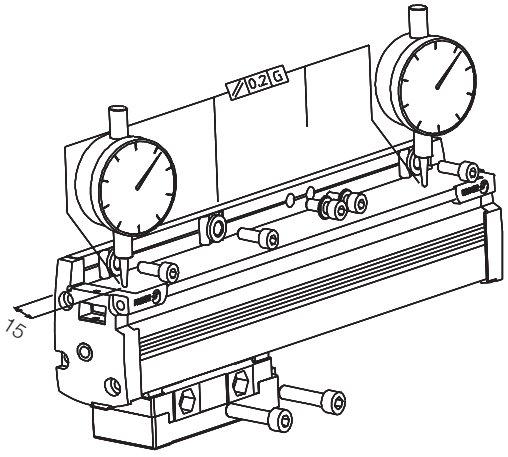


Choice of cable exit side

The SV series may be mounted onto the guide on either side of the encoder; this makes it possible to choose which side of the reader head the cable will exit from (from the right or from the left) which is a great advantage when mounting in limited spaces.

Standard section linear encoders

G series thick linear encoders are easily mounted onto the machine surface along their whole length providing them with high vibration immunity.

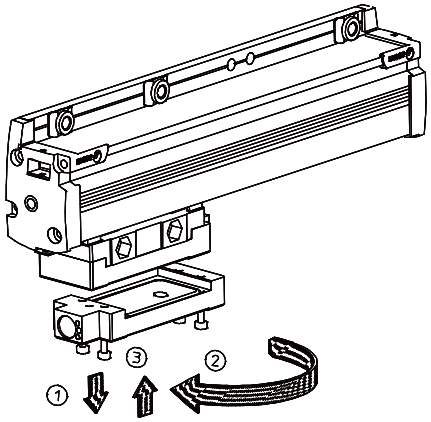


Mounting

Proper mounting of the G series encoder only requires aligning the linear encoder throughout the measuring length. The shipping bracket that holds the reader head to the linear encoder ensures a proper gap between them as well as their lateral alignment.

Mounting possibilities

The G encoder must be mounted so its sealing lips are not directly exposed to lubricants or chips while machining.

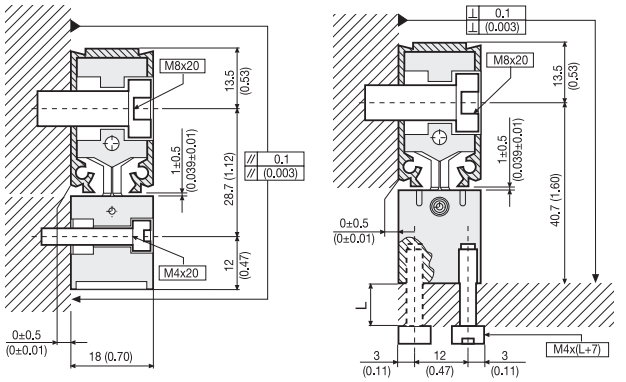


Choice of cable exit side

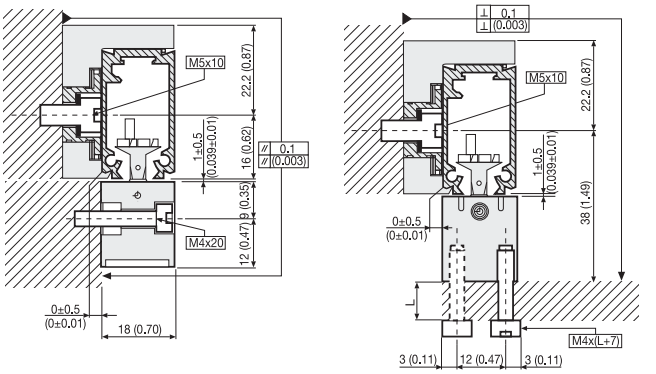
The G series offers the possibility to choose in which direction the cable must exit the reader head (to the right or to the left) which is a great help for the machine designer when mounting space is limited.

Mounting Possibilities

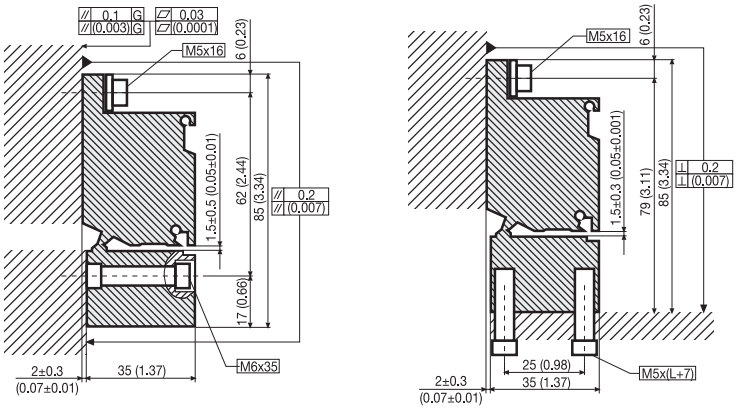
S Series



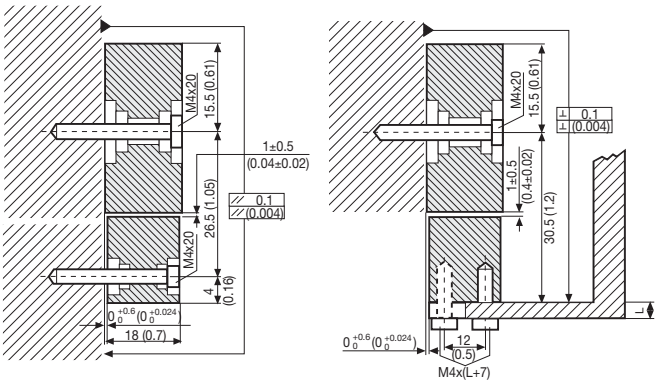
SV Series



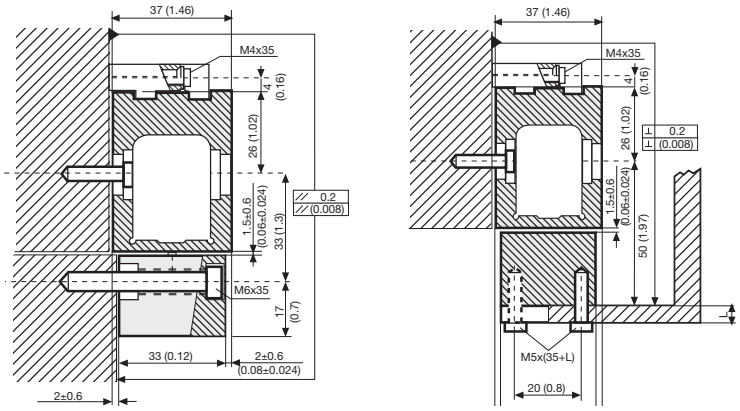
G Series



M Series



C Series



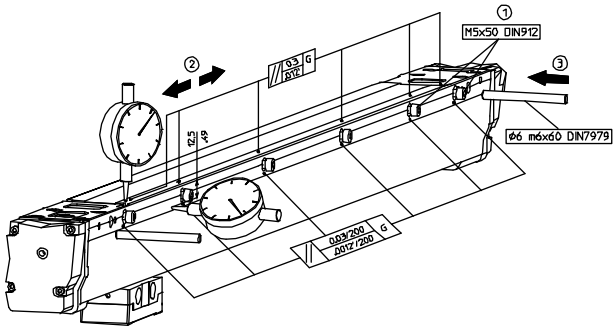
Linear encoders for great lengths

L and F series linear encoders for greater lengths offer two different types of installation depending on their length:

* Up to a measuring length of 4040 mm, in a single module
* From a measuring length of 4240 mm up to 30 m, in successive modules

Mounting of single-module L or F encoder

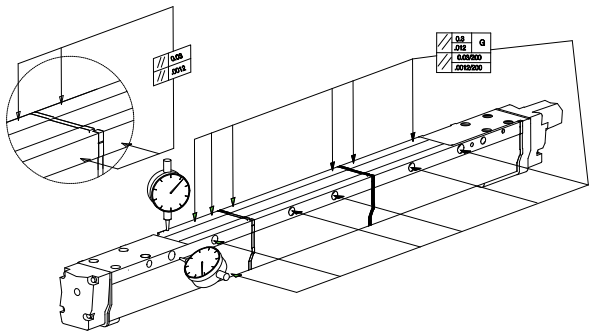
Proper mounting of the L and F series encoders only requires aligning the linear encoder throughout the measuring length. The shipping bracket that holds the reader head to the linear encoder ensures a proper gap between them as well as their lateral alignment.



Mounting of modular L or F encoders

The L and F series encoders must be mounted on a previously machined surface; if it has not been machined, it must be mounted using brackets for properly supporting the encoder.

* The successive modules are put in place maintaining proper alignment and spacing between them.
* Once the encoder has been aligned along its length, the graduated steel tape is inserted, secured at both ends and is tensioned accordingly.
* The mounting operation ends by inserting the sealing lips and then the reader head.



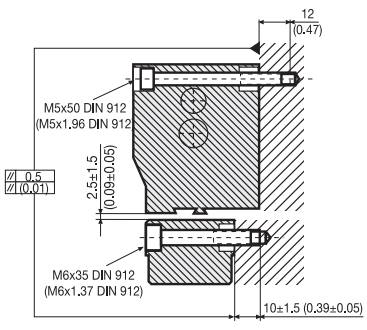
Mounting possibilities

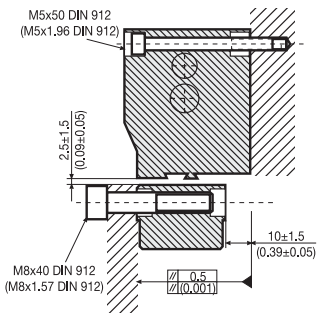
The L and F encoders must be mounted so its sealing lips are not directly exposed to lubricants or chips while machining.

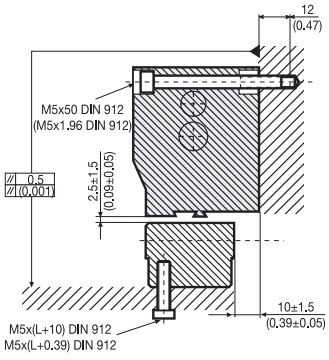
Choice of cable exit side

The L and F series offer the possibility to choose in which direction the cable can exit the reader head (to the right or to the left) which is a great help for the machine designer when mounting space is limited.

Mounting possibilities for L and F Series







GENERAL **MECHANICAL INFORMATION**

Protection

Enclosed **linear encoders** meet the protection requirements IP 53 of the **IEC 60 529** standard. For further protection, a separate protection guard must be mounted.

• AI-400

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 (82 ft) long with an inside diameter of 4 mm (0.16 inch) and outside diameter of 6 mm (0.24 inch)

• AI-500

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

AI-500 MODELS

For 2 axes: AI-525
For 4 axes: AI-550
For 6 axes: AI-590

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 recommends their **Air filter units** AI-400 and AI-500.

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 linear feedback systems require the following air conditions:

- Class 1 - Maximum particle 0,12µ
- Class 4 (7 bars) - Dew point 3ºC
- Class 1 - Maximum oil concentration: 0,01 mg/m^3

Safety switch

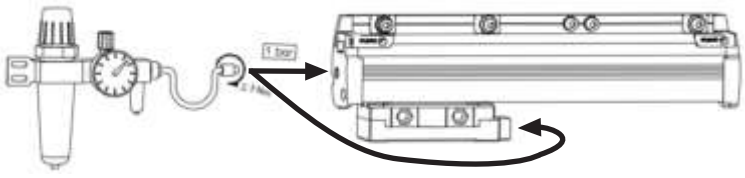
It consists of a preostat capable of activating an alarm switch when the pressure gets below 0.6 Kg/cm^2.

The switching pressure may be adjusted between 0.3 and 1.5 Kg/cm^2.

Technical data:

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

• AIR INTAKE AT ONE END OF THE LINEAR ENCODER OR THROUGH THE READER HEAD



LINEAR ENCODER SELECTION GUIDE

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

To do this, bear in mind the following considerations:

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 throughout 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 the machine tool 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

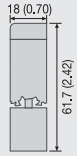
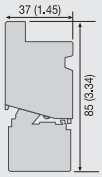
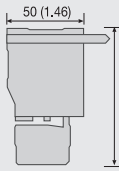
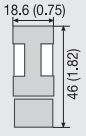
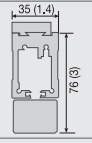
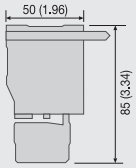
The speed requirements for the application must be analyzed before choosing the linear encoder.

Strike and vibration

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

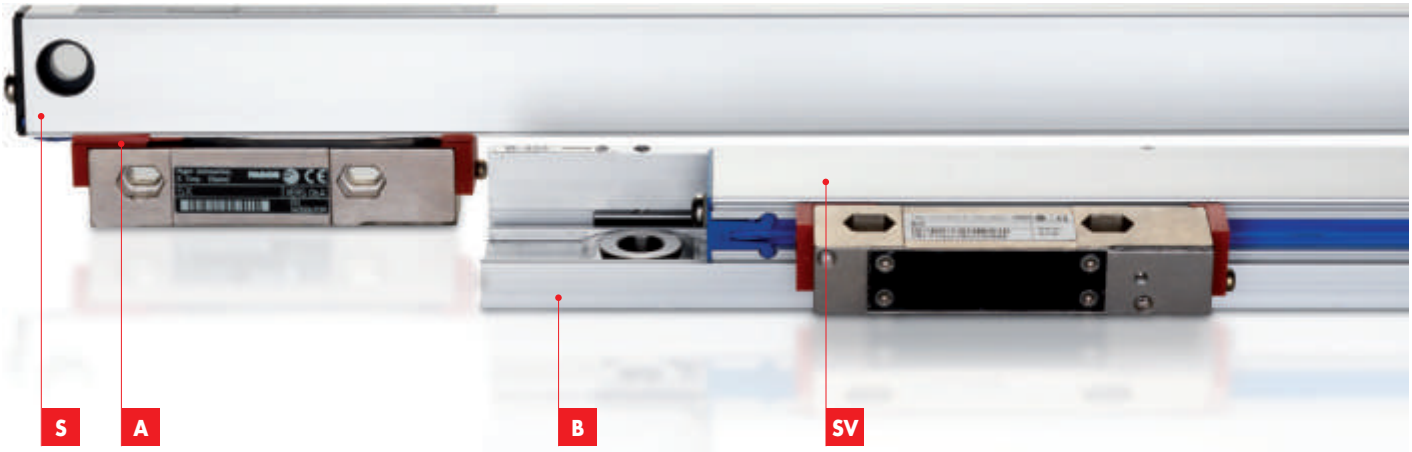
Alarm signal

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

	Series	Design	Cross section
Linear encoders for CNC machines	**S series Incremental**	Small section for installation in limited space	
	S series Absolute		
	G series Incremental	Wide section	
	G series Absolute		
	L series Incremental	For great measuring lengths	
	L series Absolute		
Linear encoders for conventional machines	**M**	Small section for installation in limited space	
	C	Wide section	
	F	For great measuring lengths	

Measuring lengths	Accuracy	Incremental signals Signal period	Pitch (Resolution up to)	Model	Page
• Without guide bar: 70 mm to 1240 mm • With guide bar: 70 mm to 2040 mm	± 5 µm & ± 3 µm	⊓⊓ Differential TTL, 4 µm	1 µm	SX / SOX / SSX	20 & 21
		⊓⊓ Differential TTL, 2 µm	0.5 µm	SY / SSY	
		⊓⊓ Differential TTL, 0.4 µm	0.1 µm	SW / SOW / SSW	
		∿ 1 Vpp, 20 µm	–	SP / SOP / SSP	
		∿ 1 Vpp, 20 µm	0.1 µm	SA	
		–	0.05 µm	SAF / SAM / SAP	
140 mm to 3040 mm	± 5 µm & ± 3 µm	⊓⊓ Differential TTL, 4 µm	1 µm	GX / GOX / GSX	22 & 23
		⊓⊓ Differential TTL, 2 µm	0.5 µm	GY / GOY / GSY	
		⊓⊓ Differential TTL, 0,4 µm	0.1 µm	GW / GOW / GSW	
		∿ 1 Vpp, 20 µm	–	GP / GOP / GSP	
		∿ 1 Vpp, 20 µm	0.1 µm	GA	
		–	0.05 µm	GAF / GAM / GAP	
440 mm to 30 m. Up to 4040 mm in a single module; with successive modules from this length on	± 5 µm	⊓⊓ Differential TTL, 4 µm	1 µm	LX	24 & 25
		∿ 1 Vpp, 40 µm	–	LP	
		∿ 1 Vpp, 40 µm	–	LA	
		–	0.05 µm	LAF / LAM / LAP	
140 mm to 1540 mm	± 10 µm	⊓⊓ TTL, 20 µm	5 µm	MT / MKT	26 & 27
140 mm to 1240 mm		⊓⊓ Differential TTL, 20 µm	5 µm	MTD	
140 mm to 1240 mm	± 5 µm	⊓⊓ Differential TTL, 4 µm	1 µm	MX / MKX	
		∿ 1 Vpp, 20 µm	–	MP	
220 mm to 3040 mm	± 10 µm	⊓⊓ TTL, 20 µm	5 µm	CT	28 & 29
	± 5 µm	⊓⊓ Differential TTL, 4 µm	1 µm	CX	
		∿ 1 Vpp, 20 µm	–	CP	
440 m to 30 m. Up to 4040 mm in a single module; with successive modules from this length on	± 10 µm	⊓⊓ TTL, 20 µm	5 µm	FT	30 & 31
		⊓⊓ Differential TTL, 4 µm	1 µm	FX	
		∿ 1 Vpp, 100 µm	–	FP	

S / SV series



GENERAL CHARACTERISTICS	
Measurement	By means of a 20 µm-pitch (0.0008 inch) graduated glass
Glass thermal expansion coefficient	α_{therm} = 8 ppm/K
Accuracy	± 5 µm (± 0.0002") ± 3 µm (± 0.00012")
Maximum speed	120 m/min.
Maximum vibration	10g without mounting plate (S) 20g with mounting plate (SV)
Moving thrust	<4N
Operating temperature	0º...50ºC
Storage temperature	-20º...70ºC
Weight	0.20 Kg + 0.50 Kg/m
Relative humidity	20...80%
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air in linear encoders
Reader head	With built-in connector

Especially recommended for applications with a measuring length of up 2040 mm in high speed, high vibration environments with limited space.

Model description:

S / SV: Incremental linear encoders

SA / SVA: Absolute linear encoders with SSI protocol for FAGOR, SIEMENS (with Drive Click) etc.

SAF / SVAF: Absolute linear encoders with FANUC (01 and 02) protocol

SAM / SVAM: Absolute linear encoders with MITSUBISHI CNC (high speed serial interface) protocol

SAP / SVAP: Absolute linear encoders with PANASONIC (Matsushita) protocol

(*) Contact FAGOR for other communication protocols or for controllers other than those mentioned here.

Measuring lengths in millimeters (inches)

Without mounting plate:
70 (2.7) • 120 (4.7) • 170 (6.7) • 220 (8.6) • 270 (10.6) • 320 (12.6) • 370 (14.5) • 420 (16.5) • 470 (18.5) • 520 (20.5) • 570 (22.4)

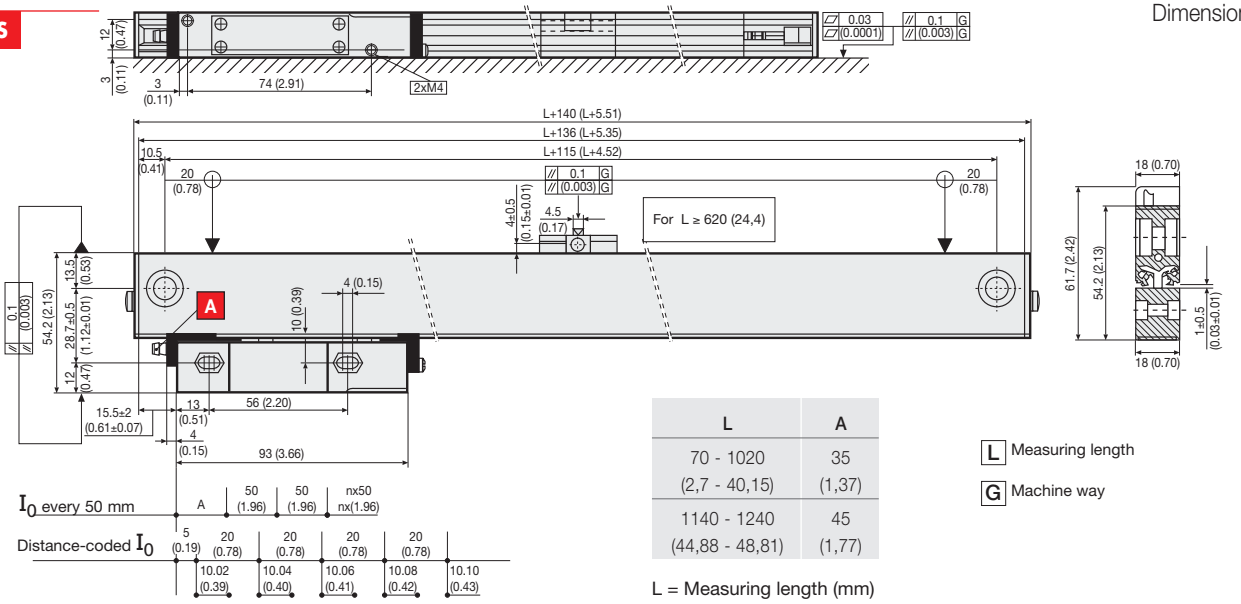
Mounting plate recommended:
620 (24.4) • 720 (28) • 770 (30) • 820 (32) • 920 (36) • 1020 (40) • 1140 (44) • 1240 (48)

Mounting plate is a must:
1340 (52) • 1440 (56) • 1540 (60) • 1640 (64) • 1740 (68) • 1840 (72)• 2040 (80)

SPECIFIC characteristics

	INCREMENTAL ENCODERS				ABSOLUTE ENCODERS			
	SX SOX SSX	**SY SOY SSY**	**SW SOW SSW**	**SP SOP SSP**	**SA SVA**	**SAF SVAF**	**SAM SVAM**	**SAP SVAP**
Measuring resolution	1 µm (0.00004")	0,5 µm (0.00002")	0,1 µm (0.000004")	Up to 0,1 µm (0.000004")	0,1 µm (0.00004")	0,05 µm (0.000002")		
Absolute position measuring	–	–	–	–	Optical reading of sequential binary code			
Output signals	TTL differential			1 Vpp	1 Vpp	–	–	–
Incremental signal period	4 µm (0.00004")	2 µm (0.00002")	0,4 µm (0.000004")	20 µm (0.000004")	20 µm (0.000004")			
Limit frequency	600 Khz	1.2 Mhz	1.5 Mhz	120 Khz	> 130 kHz for 1 Vpp			
Maximum cable length	50 m (165 ft)			150 m (495 ft)	150 m (495 ft)			
Reference marks I_0	SX, SY, SW and SP: every 50 mm (1.97 inches) SOX, SOY, SOW and SOP: Distance-coded I_0 SSX, SSY, SSW and SSP: Selectable I_0				–			
USB connection	–	–	–	–	Through an RS-485-to-USB converter (optional)			
Supply voltage	5V ± 5%, 150 mA (without load)			5V ± 10%, <150 mA (without load)	5V ± 10%, 250 mA (without load)			

S



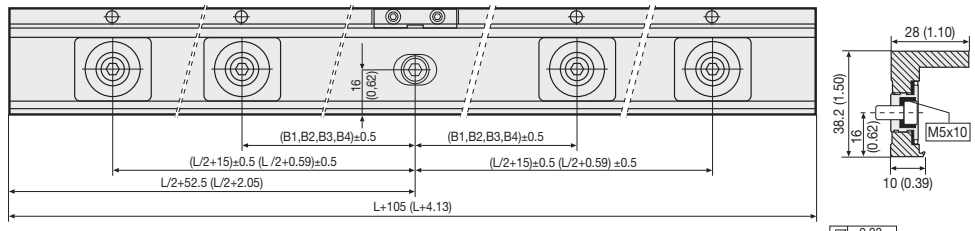
L	A
70 - 1020 (2,7 - 40,15)	35 (1,37)
1140 - 1240 (44,88 - 48,81)	45 (1,77)

L = Measuring length (mm)

L Measuring length

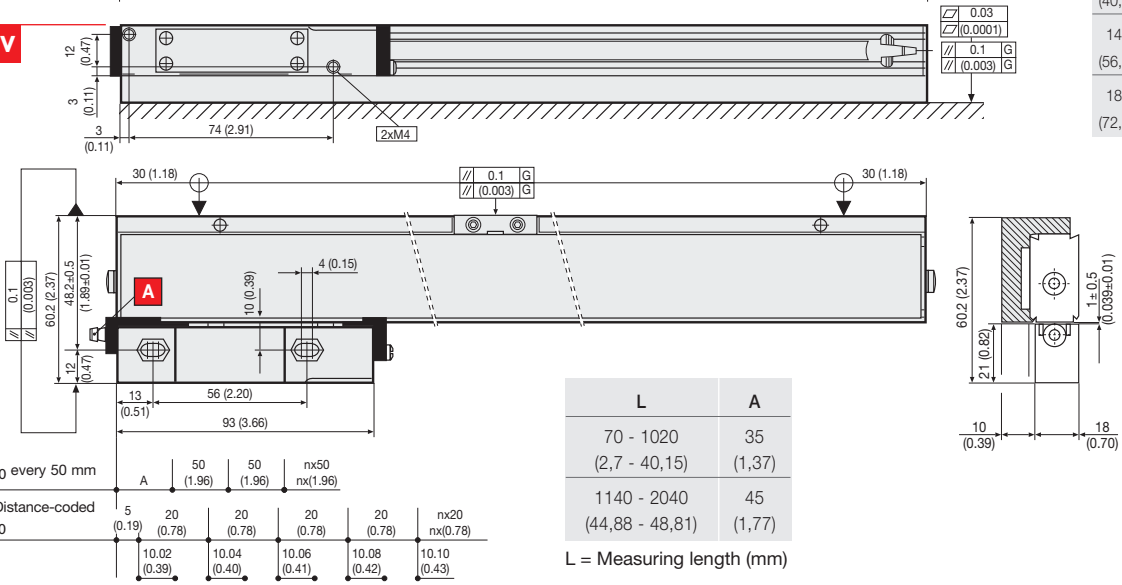
G Machine way

B (Mounting support)



L	B1	B2	B3	B4
70 - 520 (2,7 - 20,47)	- -	- -	- -	- -
570 - 920 (22,44 - 36,22)	200 (7,87)	- -	- -	- -
1020 - 1340 (40,15 - 52,75)	200 (7,87)	400 (15,74)	- -	- -
1440 - 1740 (56,69 - 68,50)	200 (7,87)	400 (15,74)	600 (23,62)	- -
1840 - 2040 (72,44 - 80,31)	200 (7,87)	400 (15,74)	600 (23,62)	800 (31,49)

SV



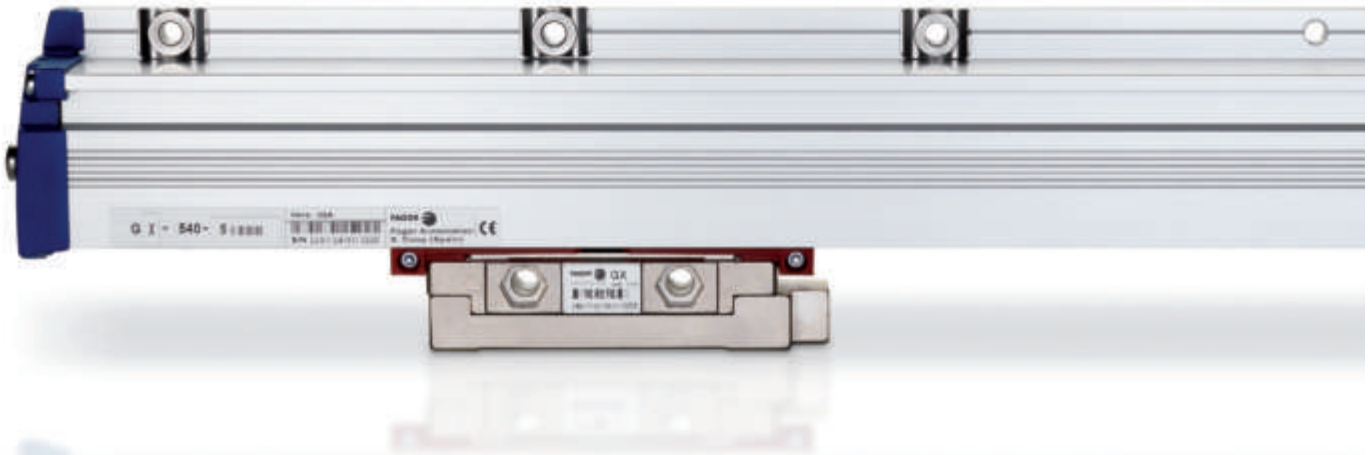
L	A
70 - 1020 (2,7 - 40,15)	35 (1,37)
1140 - 2040 (44,88 - 48,81)	45 (1,77)

L = Measuring length (mm)

Order identification

Example for an incremental encoder: SVOP - 420 - 5 - B - A		Example for an absolute encoder: SAF - 420 - 5 - B - A	
S	**Type of profile: for limited space** • S: Standard mounting for vibrations of up to 10g. • **SV: Mounted onto the support for vibrations of up to 20g.**	**S**	**Type of profile: for limited space** • **S: Standard mounting for vibrations of up to 10g.** • SV: Mounted onto the support for vibrations of up to 20g.
O	**Type of reference mark (I_0)** • Blank space: One I0 mark every 50 mm (1.97") • **O: Absolute distance-coded marks** • S: Selectable reference marks	**A**	Letter identifying the absolute encoder
P	**Type of signal** • X: 1 µm resolution differential TTL • Y: 0,5 µm resolution differential TTL • W: 0,1 µm resolution differential TTL • **P: 1 Vpp sinusoidal**	**F**	Type of communications protocol • Blank space: SSI protocol (FAGOR, SIEMENS, etc.) • **F: FANUC (01 and 02) protocol** • M: MITSUBISHI CNC (high speed serial interface) protocol • P: PANASONIC (Matsushita) protocol
420	Measuring length in mm. **In the example (420) = 420 mm**	**420**	Measuring length in mm. **In the example (420) = 420 mm**
5	**Accuracy of the linear encoder** • **5: ± 5 µm** • 3: ± 3 µm	**5**	**Accuracy of the linear encoder** • **5: ± 5 µm** • 3: ± 3 µm
B	**Linear encoder with or without mounting support** • Blank space: Without mounting support for vibrations of up to 10g. • **B: With mounting support for vibrations of up to 20g.**	**B**	**Linear encoder with or without mounting support** • Blank space: Without mounting support for vibrations of up to 10g. • **B: With mounting support for vibrations of up to 20g.**
A	• Blank space: Without air intake on the reader head • **A: With air intake on the reader head**	**A**	• Blank space: Without air intake on the reader head • **A: With air intake on the reader head**

G series



GENERAL CHARACTERISTICS	
Measurement	By means of a 20 µm-pitch (0.0008 inch) graduated glass.
Glass thermal expansion coefficient	α_{therm} = 8 ppm/K
Accuracy	± 5 µm (± 0.0002") ± 3 µm (± 0.00012")
Maximum speed	120 m/min.
Maximum vibration	20g
Moving thrust	<5N
Operating temperature	0º...50ºC
Storage temperature	-20º...70ºC
Weight	0.25 Kg + 2.25 Kg/m
Relative humidity	20...80%
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air in linear encoders
Reader head	With built-in connector

Especially recommended for applications with a measuring length of up 3040 mm in high speed, high vibration environments.

Model description:

G: Incremental linear encoders

GA: Absolute linear encoders with SSI protocol for FAGOR, SIEMENS (with Drive Click) etc.

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

GAM: Absolute linear encoders with MITSUBISHI CNC (high speed serial interface) protocol

GAP: Absolute linear encoders with PANASONIC (Matsushita) protocol

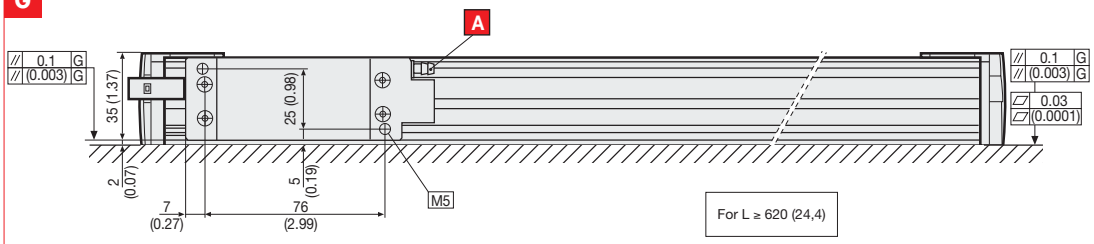
(*) Contact FAGOR for other communication protocols or for controllers other than those mentioned here.

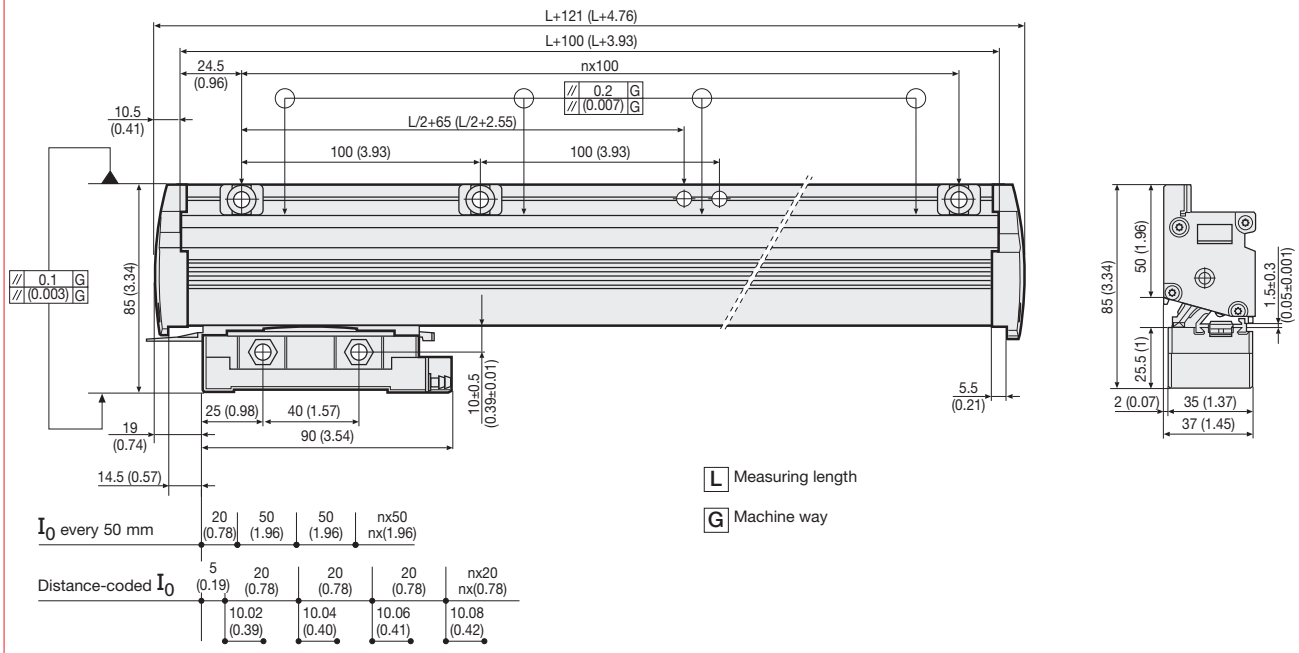
Measuring lengths in millimeters (inches)

140 (5.5) • 240 (9.5) • 340 (13.4) • 440 (17.3) • 540 (21.3) • 640 (25) • 740 (29) • 840 (33) • 940 (37) • 1040 (41) • 1140 (44) • 1240 (48) • 1340 (52) • 1440 (56) • 1540 (60) • 1640 (64) • 1740 (68) • 1840 (72) • 2040 (80) • 2240 (88) • 2440 (96) • 2640 (104) • 2840 (112) • 3040 (120)

SPECIFIC CHARACTERISTICS								
	INCREMENTAL ENCODERS				ABSOLUTE ENCODERS			
	GX GOX GSX	GY GOY GSY	GW GOW GSW	GP GOP GSP	GA	GAF	GAM	GAP
Measuring resolution	1 µm (0.00004")	0,5 µm (0.00002")	0,1 µm (0.000004")	Up to 0,1 µm (0.000004")	0,1 µm (0.00004")	0,05 µm (0.000002")		
Absolute position measuring	–	–	–	–	Optical reading of sequential binary code			
Output signals	Differential TTL			1 Vpp	1 Vpp	–	–	–
Incremental signal period	4 µm (0.00004")	2 µm (0.00002")	0,4 µm (0.000004")	20 µm (0.000004")	20 µm (0.000004")			
Limit frequency	600 Khz	1.2 Mhz	1.5 Mhz	120 Khz	> 130 kHz for 1 Vpp			
Maximum cable length	50 m (165 ft)			150 m (495 ft)	150 m (495 ft)			
Reference marks I_0	GX, GY, GW y GP: every 50 mm (1.97 inches) GOX, GOY, GOW and GOP: Distance-coded I_0 GSX, GSY, GSW and GSP: Selectable I_0				–			
USB connection	–	–	–	–	Through an RS-485-to-USB converter (optional)			
Supply voltage	5V ± 5%, 150 mA (without load)			5V ± 10%, <150 mA (without load)	5V ± 10%, 250 mA (without load)			

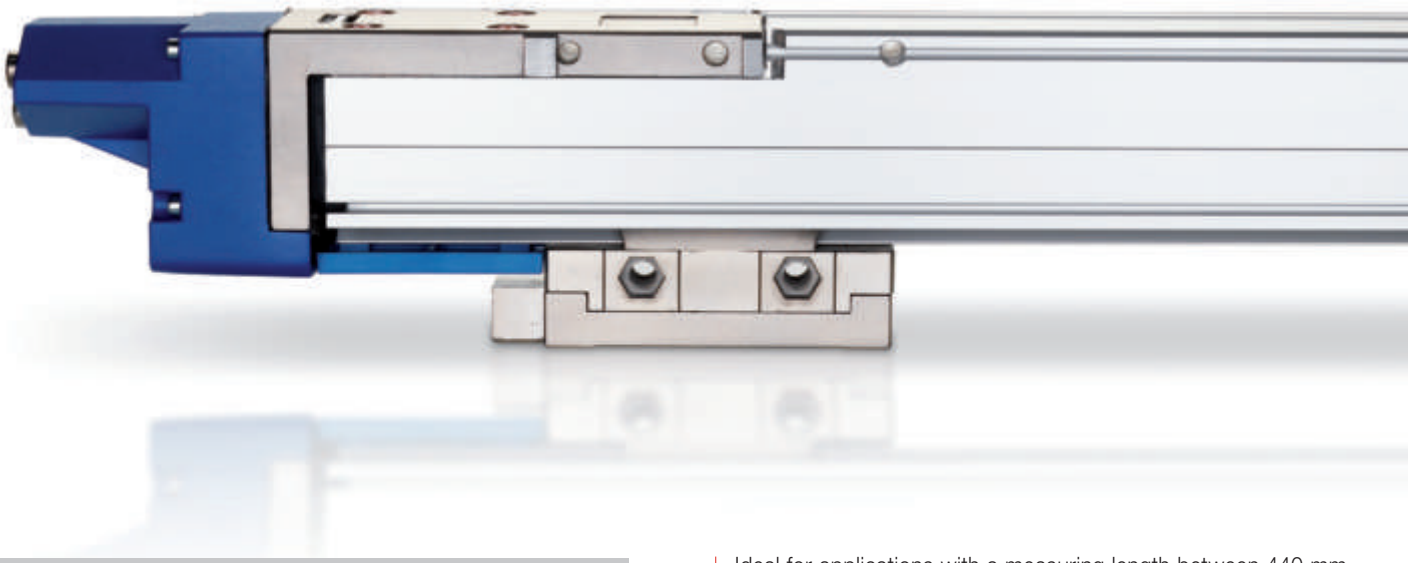
G





Order identification			
Example for an incremental encoder: GOX - 1640 - 5 - A		**Example for an absolute encoder: GA - 1640 - 5 - A**	
G	**Type of profile: for standard space**	**G**	**Type of profile: for standard space**
O	**Type of reference mark I_0** • Blank space: Incremental, one mark every 50 mm (1.97") • **O: Absolute distance-coded marks** • S: Selectable reference marks	**A**	**Letter identifying the absolute encoder**
X	Type of signal • **X: 1 µm resolution differential TTL** • Y: 0.5 µm resolution differential TTL • W: 0.1 µm resolution differential TTL • P: 1 Vpp sinusoidal	**F**	**Type of communications protocol** • **Blank space: SSI protocol (FAGOR, SIEMENS, etc.)** • F: FANUC (01 and 02) protocol • M: MITSUBISHI CNC (high speed serial interface) protocol • P: PANASONIC (Matsushita) protocol
1640	Measuring length in mm. **In the example (1640) = 1640 mm**	**1640**	Measuring length in mm. **In the example (1640) = 1640 mm**
5	**Accuracy of the linear encoder** • **5: ± 5 µm** • 3: ± 3 µm	**5**	**Accuracy of the linear encoder** • **5: ± 5 µm** • 3: ± 3 µm
A	• Blank space: Without air intake on the reader head • **A: With air intake on the reader head**	**A**	• Blank space: Without air intake on the reader head • **A: With air intake on the reader head**

L series



GENERAL CHARACTERISTICS	
Measurement	By means of a 40 µm-pitch (0.0016 inch) stainless steel tape
Steel tape accuracy	± 5 µm (± 0.0002")
Maximum speed	120 m/min.
Maximum vibration	10g
Moving thrust	<5N
Operating temperature	0º...50ºC
Storage temperature	-20º...70ºC
Weight	1.50 Kg + 4 Kg/m
Relative humidity	20...80%
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air in linear encoders
Reader head	With built-in connector

Ideal for applications with a measuring length between 440 mm and 30 m in high speed, high vibration environments. Their special and patented design of the securing points of the linear encoder (TDMS®), minimizes the effects on the accuracy of the linear encoder due to temperature changes.

The steel tape graduation pitch is 0.04 mm. Measuring lengths over 4040 mm require the use of modules.

Model description:

L:	Incremental linear encoders
LA:	Absolute linear encoders with SSI protocol for FAGOR, SIEMENS (with Drive Click) etc.
LAF:	Absolute linear encoders with FANUC (01 and 02) protocol
LAM:	Absolute linear encoders with MITSUBISHI CNC (high speed serial interface) protocol
LAP:	Absolute linear encoders with PANASONIC (Matsushita) protocol

(*) Contact FAGOR for other communication protocols or for controllers other than those mentioned here.

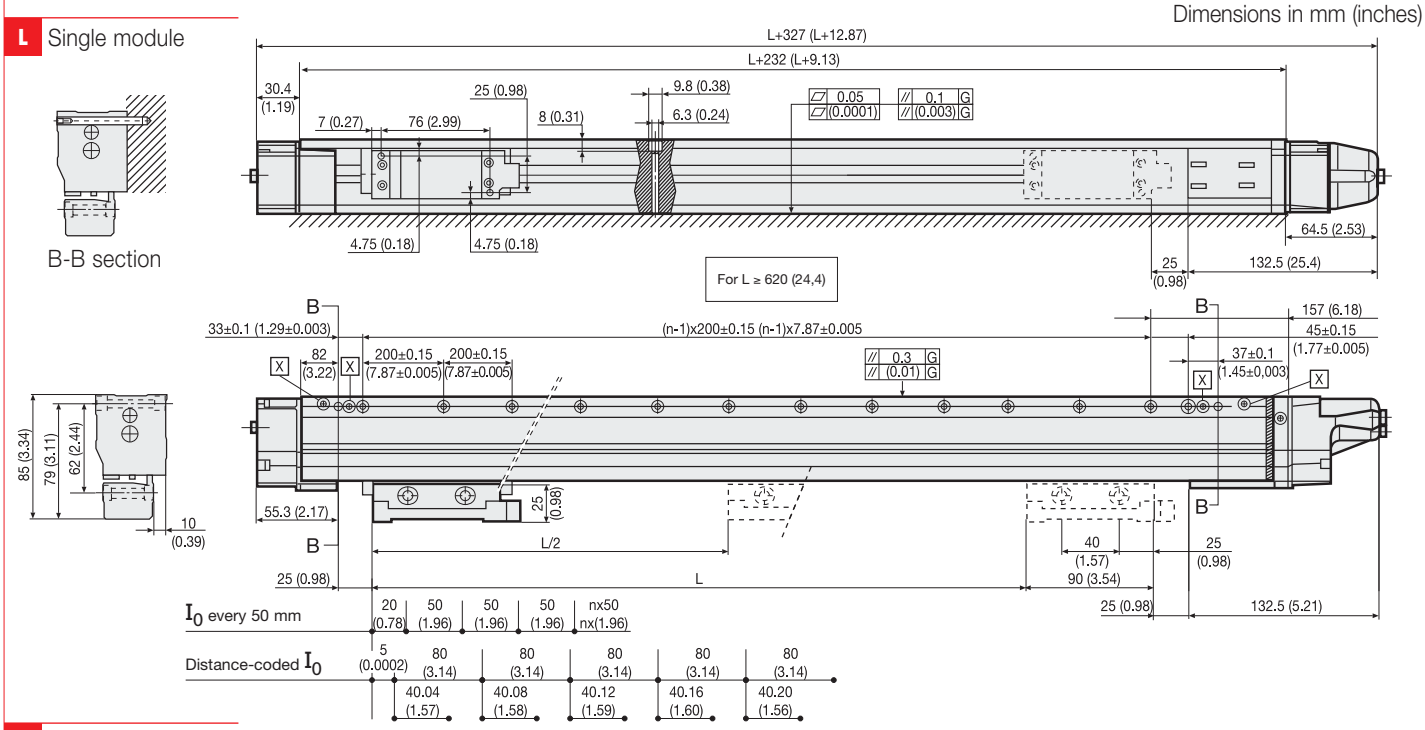
Measuring lengths in millimeters (inches)

- Measuring lengths from 440 mm to 30 m in 200 mm (7.87 inch) increments. Contact FAGOR for greater lengths.
- LA series absolute encoders, measuring lengths up to 20240 mm (403.15 inches); Contact FAGOR for greater lengths.

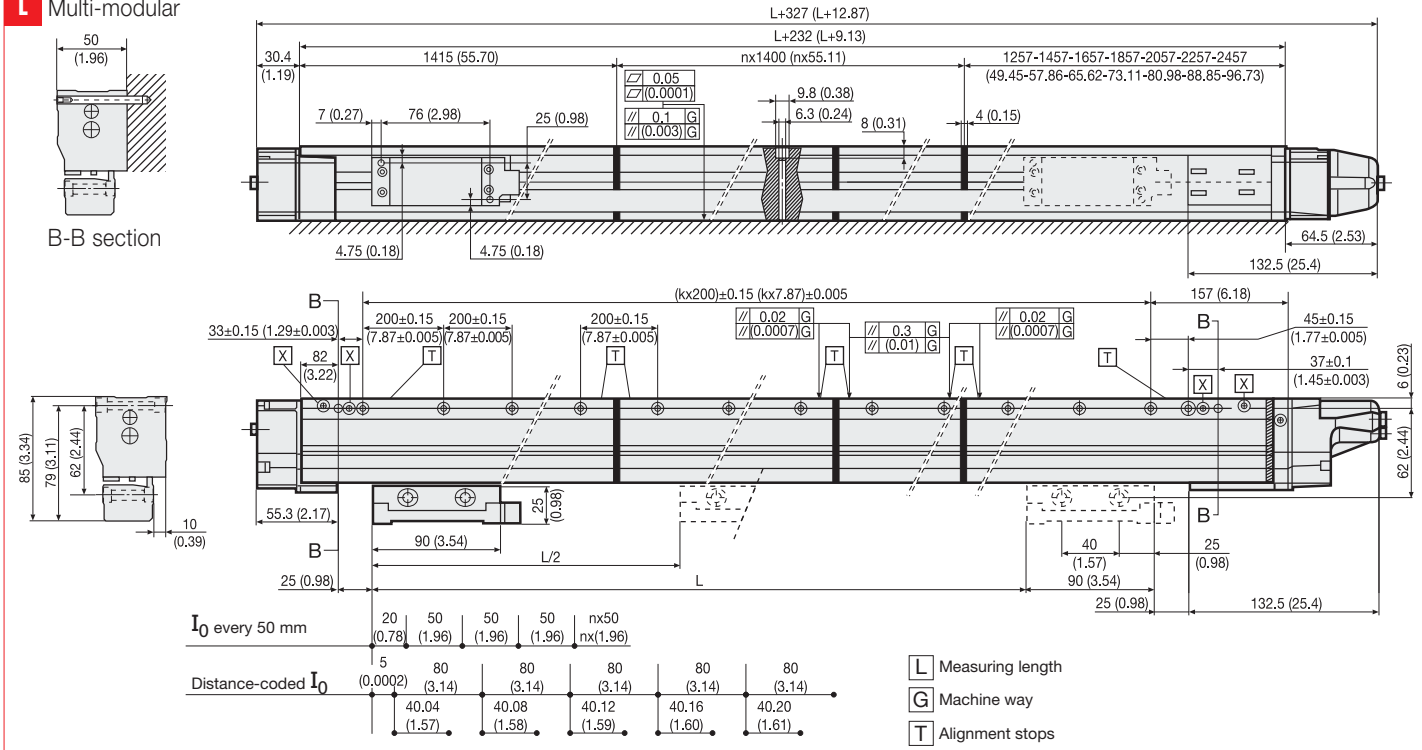
SPECIFIC CHARACTERISTICS						
	INCREMENTAL ENCODERS		ABSOLUTE ENCODERS			
	LX LOX	LP LOP	LA	LAF	LAM	LAP
Measuring resolution	1 µm (0.00004")	Up to 0,2 µm (0.000004")	0,1 µm (0.000004")	0,05 µm (0.000002")		
Output signals	TTL differential	1 Vpp	1 Vpp	–		
Incremental signal period	4 µm	40 µm	40 µm			
Limit frequency	600 Khz	120 Khz	≥ 130 kHz for 1 Vpp			
Maximum cable length	50 m (165 ft)	150 m (495 ft)	150 m (495 ft)			
Reference marks I_0	LX and LP: every 50 mm (1.97 inches) LOX and LOP: Distance-coded I_0		–			
USB connection	–	–	Through an RS-485-to-USB converter (optional)			
Supply voltage	5V ± 5%, 150 mA (without load)	5V ± 10%, <150 mA (without load)	5V ± 10%, 250 mA (without load)			

Dimensions in mm (inches)

L Single module



L Multi-modular



L Measuring length

G Machine way

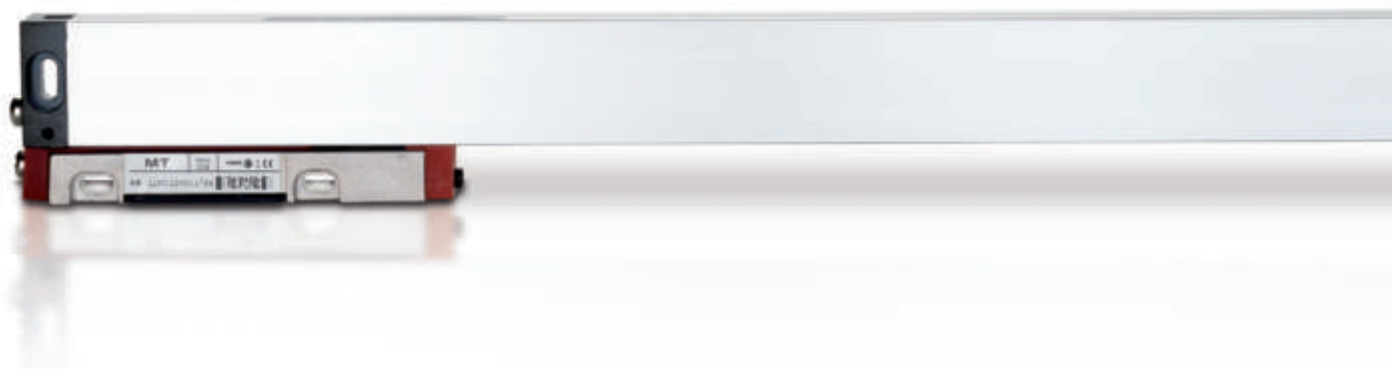
T Alignment stops

X Shipping screws. Do not remove until the linear encoder is completely mounted

Order identification

Example for an incremental encoder: LOP - 102		Example for an absolute encoder: LA - 102	
L	**Type of profile: for great measuring length**	**L**	**Type of profile: for great measuring length**
O	**Type of reference mark I_0** • Blank space: Incremental, one mark every 50 mm (1.97") • **O: Absolute distance-coded marks** • S: Selectable reference marks	**A**	**Letter identifying the absolute encoder**
P	Type of signal • X: 1 µm resolution differential TTL • Y: 0.5 µm resolution differential TTL • W: 0.1 µm resolution differential TTL • **P: 1 Vpp sinusoidal**	**F**	**Type of communications protocol** • **Blank space: SSI protocol (FAGOR, SIEMENS, etc.)** • F: FANUC (01 and 02) protocol • M: MITSUBISHI CNC (high speed serial interface) protocol • P: PANASONIC (Matsushita) protocol
102	Ordering length code. **In the example (102) = 10240 mm**	**102**	Ordering length code. **In the example (102) = 10240 mm**
A	• Blank space: Without air intake on the reader head • **A: With air intake on the reader head**	**A**	• Blank space: Without air intake on the reader head • **A: With air intake on the reader head**

M series



GENERAL CHARACTERISTICS	
Measurement	By means of a 20 µm-pitch (0.0008 inch) graduated glass
Maximum speed	60 m/min. (198 ft / min.)
Maximum vibration	3g
Moving thrust	<5N
Operating temperature	0º...50ºC
Storage temperature	-20º...70ºC
Weight	0.58 Kg + 0.6 Kg/m
Relative humidity	20...80%
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air in linear encoders
Reader head	With built-in connector (except MKT)

Designed for applications on machines of up to 1540 mm of measuring length and limited mounting space.

With reference marks every 50 mm or distance-coded and connector built into the reader head (except the MKT series whose reader head comes with a 3-meter cable).

Measuring lengths in millimeters (inches)

40 (1.63) (*) • 70 (2.85) (*) • 120 (4.7) • 140 (5.5) • 170 (6.7) • 220 (8.7) • 270 (10.6) • 320 (12.6) • 370 (14.6) • 420 (16.5) • 470 (18.5) • 520 (20.5) • 620 (24.4) • 720 (28.4) • 770 (30.3) • 820 (32.3) • 920 (36.2) • 1020 (40.2) • 1140 (45) • 1240 (48.8) • 1340 (52.7) • 1440 (56.7) • 1540 (60.6)

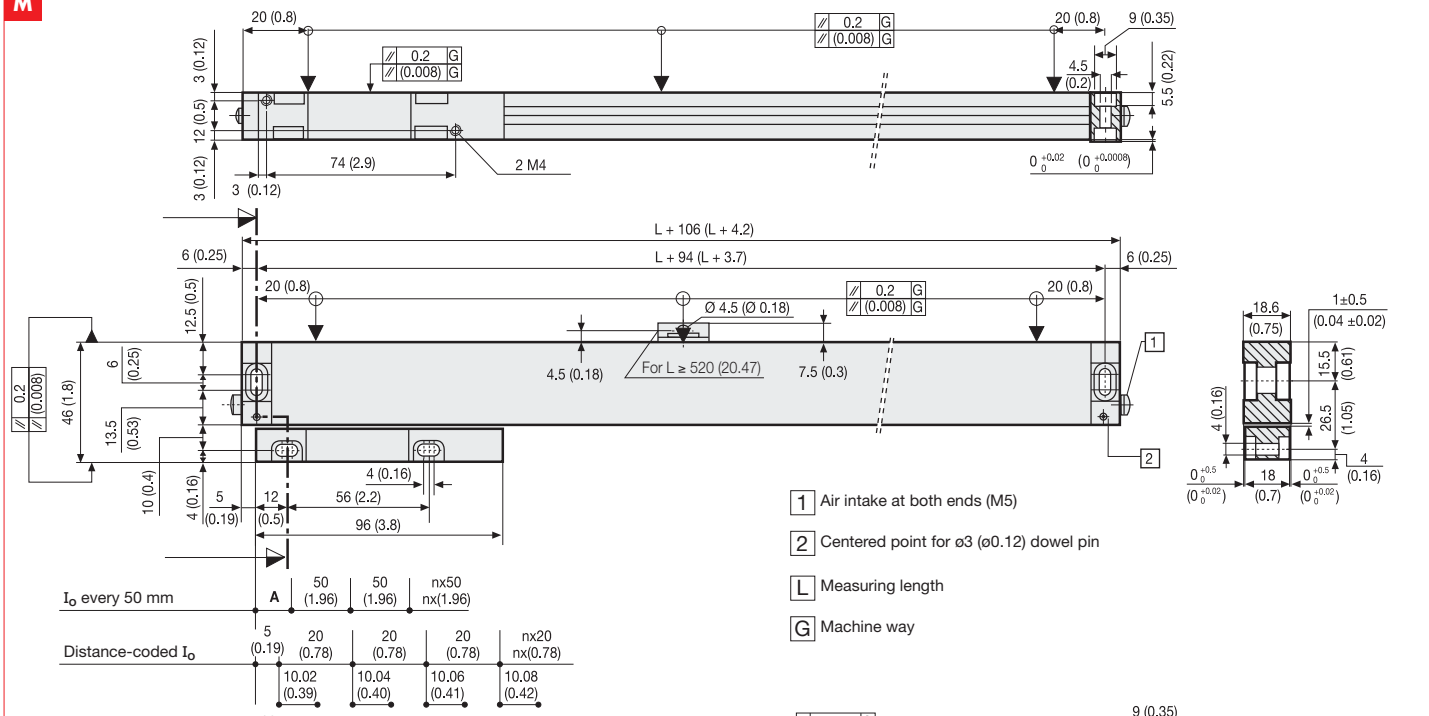
(*) On MT models

SPECIFIC CHARACTERISTICS						
	MT	**MTD**	**MKT**	**MX / MOX**	**MKX**	**MP / MOP**
Accuracy	± 10 µm (± 0.0004“)	±10 µm (± 0.0004”)	± 10 µm (± 0.0004“)	± 5 µm (± 0.0002“)	± 10 µm (± 0.0004“)	± 5 µm (± 0.0002“)
Resolution	5 µm (0.0002“)	5 µm (0.0002“)	5 µm (0.0002“)	1 µm (0.00004“)		Up to 0.1 µm (0.000004“)
Reference marks I_0	MKT and MKX: I_0 every 50 mm (1.97”) MT, MTD, MX, and MP: every 50 mm (1.97”) MOT, MOX and MOP: Distance-coded I_0					
Output signals	TTL	Differential TTL	TTL	Differential TTL		1 Vpp
T period of output signals	20 µm	20 µm	20 µm	4 µm		20 µm
Maximum cable length	20 m (66 ft)	50 m (166 ft)	20 m (66 ft)	50 m (166 ft)		150 m (66 ft)
Supply voltage	5V ± 5%, 150 mA (without load)					5V ± 10%, <150 mA (without load)

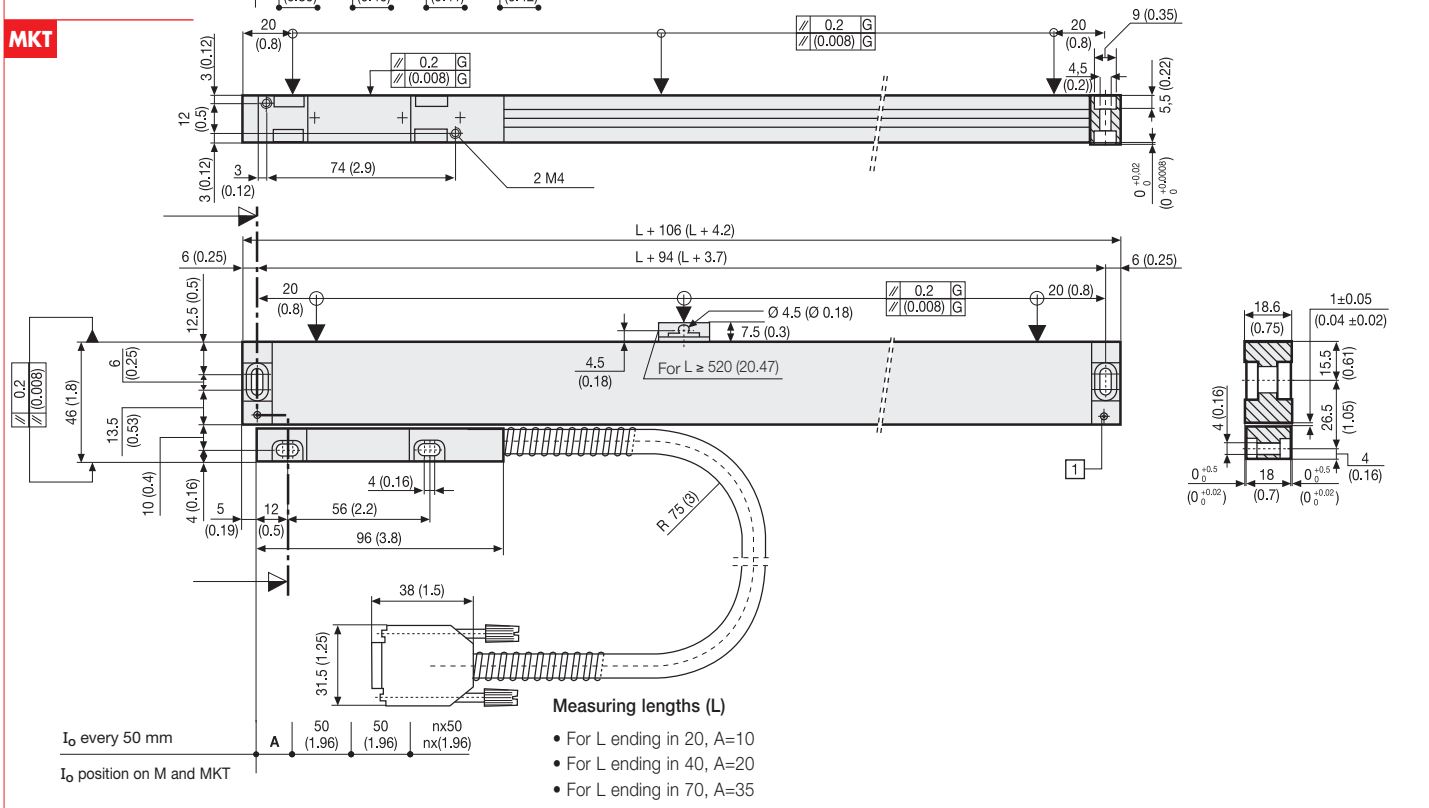
M series for **PRESS BRAKE** applications

Within the MTD series, FAGOR offers the "MTD-P-2R", linear encoder especially designed for press-brake applications. The linear encoder comes as an assembled set, a universal joint for reader head movement and an aluminum support that is mounted directly on to the machine.

M



MKT



Measuring lengths (L)

- For L ending in 20, A=10
- For L ending in 40, A=20
- For L ending in 70, A=35

Order identification			
Example for an incremental encoder: MOP - 425		**For press brakes: MTD - 170 - P-2R**	
M	**Type of profile: M for limited space**	**M**	**Type of profile: M for limited space**
O	**Type of reference mark I_o** • Blank space: Incremental, one mark every 50 mm (1.97") • **O: Absolute distance-coded marks**		
P	**Type of signal** • T: 5 µm resolution TTL • TD: 5 µm resolution differential TTL • X: 1 µm resolution differential TTL • **P: 1 Vpp sinusoidal**	**TD**	**Type of signal** • TD: 5 to 10 µm resolution differential TTL
42	Measuring length in cm. **In the example (42) = 42 cm = 420 mm**	**170**	Measuring length in cm. **In the example (170) = 170 cm = 170 mm**
5	**Accuracy of the linear encoder** • **5: ± 5 µm** • Blank space: ± 10 µm	**P-2R**	**Press brake**

C series

GENERAL CHARACTERISTICS	
Measurement	By means of a 20 µm-pitch (0.0008 inch) graduated glass.
Maximum speed	60 m/min.
Maximum vibration	3g
Moving thrust	<5N
Operating temperature	0º...50ºC
Storage temperature	-20º...70ºC
Weight	1.2 Kg + 2.50 Kg/m
Relative humidity	20...80%
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air in linear encoders
Reader head	With built-in connector

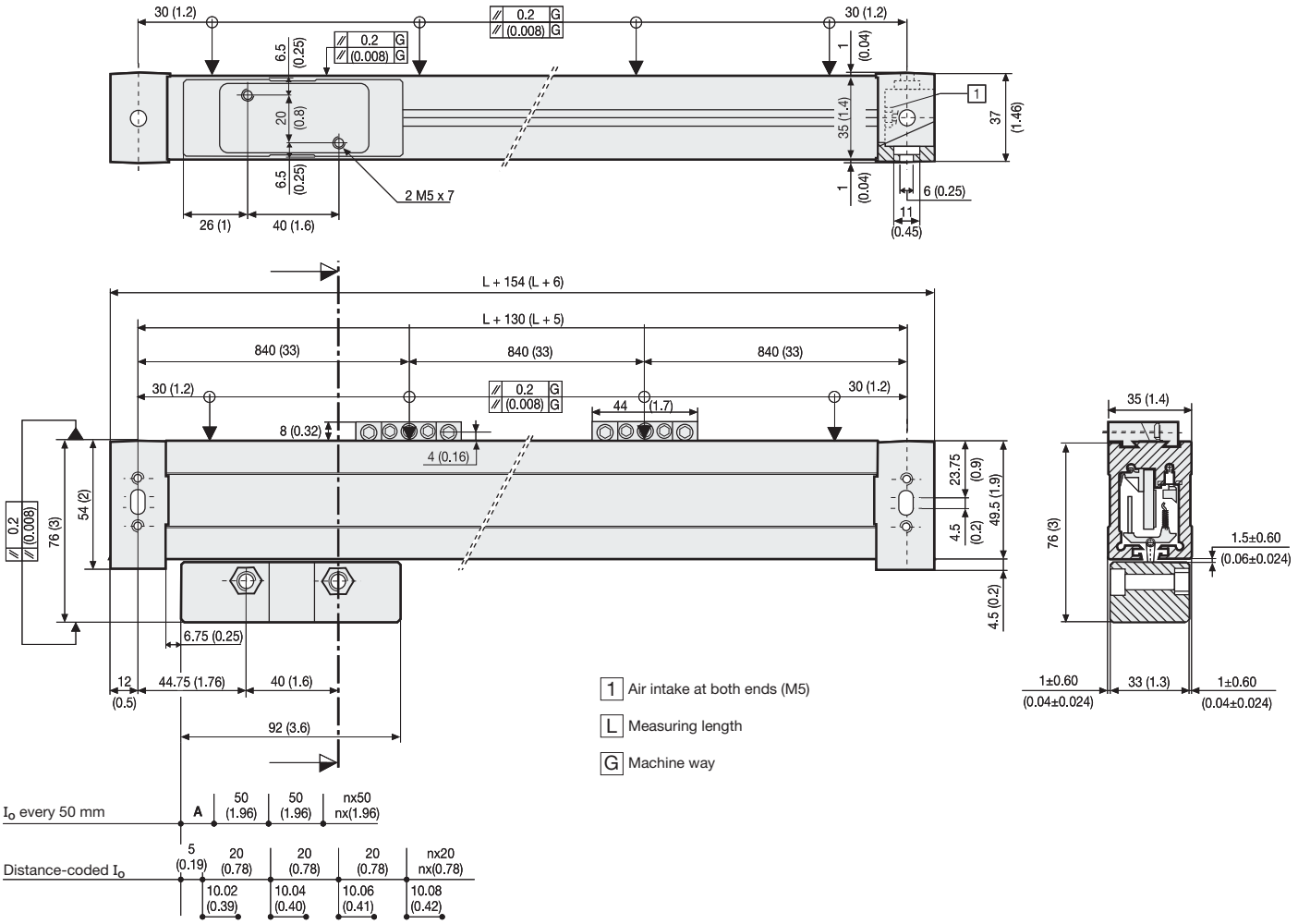
Designed for applications on standard machines of up to 3040 mm of measuring length. With reference marks every 50 mm or distance-coded and connector built into the reader head.

Measuring lengths in millimeters (inches)

220 (8,7) • 270 (10,6) • 320 (12,6) • 370 (14,6) • 420 (16,5) • 470 (18,5) • 520 (20,5) • 620 (24,4) • 720 (28,3) • 770 (30,3) • 820 (32,3) • 920 (36,2) • 1020 (40,2) • 1140 (45) • 1240 (48,8) • 1340 (52,8) • 1440 (56,7) • 1540 (60,6) • 1640 (64,6) • 1740 (68,5) • 1840 (72,4) • 1940 (76,4) • 2040 (80,3) • 2240 (88,2) • 2440 (96) • 2640 (104) • 2840 (112) • 3040 (120)

SPECIFIC CHARACTERISTICS			
	CT	CX	CP
Accuracy	± 10 µm (± 0.0004")	± 5 µm (± 0.0002")	± 5 µm (± 0.0002")
Resolution	5 µm (± 0.0002")	1 µm (± 0.00004")	Up to 0.1 µm (± 0.00004")
Reference marks I_0	Every 50 mm (1.97 inches)		
Output signals	TTL	Differential TTL	1Vpp
T period of output signals	20 µm	4 µm	20 µm
Maximum cable length	20 m (66 ft)	50 m (165 ft)	150 m (495 ft)
Supply voltage	5V ± 5%, 150 mA (without load)		5V ± 10%, <150 mA (without load)

Dimensions in mm (inches)



Measuring lengths (L)

- For L ending in 20, A=10
- For L ending in 40, A=20
- For L ending in 70, A=35

Order identification	
Example for an incremental encoder: COP - 425	
C	**Type of profile: C for regular space**
O	**Type of reference mark I_o** • Blank space: One I0 mark every 50 mm (1.97") • **O: Absolute distance-coded marks**
P	**Type of signal** • T: 5 µm resolution TTL • X: 1 µm resolution differential TTL • **P: 1 Vpp sinusoidal**
42	Measuring length in cm. **In the example (42) = 42 cm = 420 mm**
5	**Accuracy of the linear encoder** • **5: ± 5 µm** • Blank space: ± 10 µm

F series

GENERAL CHARACTERISTICS	
Measurement	By means of a 100 µm-pitch (0.0016 inch) graduated stainless steel tape
Steel tape accuracy	± 5 µm (± 0.0002 inch)
Maximum speed	120 m/min.
Maximum vibration	10g
Moving thrust	<5N
Operating temperature	0º...50ºC
Storage temperature	-20º...70ºC
Weight	1.5 Kg + 4 Kg/m
Relative humidity	20...80%
Protection	IP 53 (standard) IP 64 (DIN 40050) using pressurized air in linear encoders
Supply voltage	5V ± 5%, 100 mA
Reader head	With built-in connector

Designed for applications on machines from 440 mm to 30 m of measuring length.

With reference marks every 50 mm or distance-coded and connector built into the reader head.

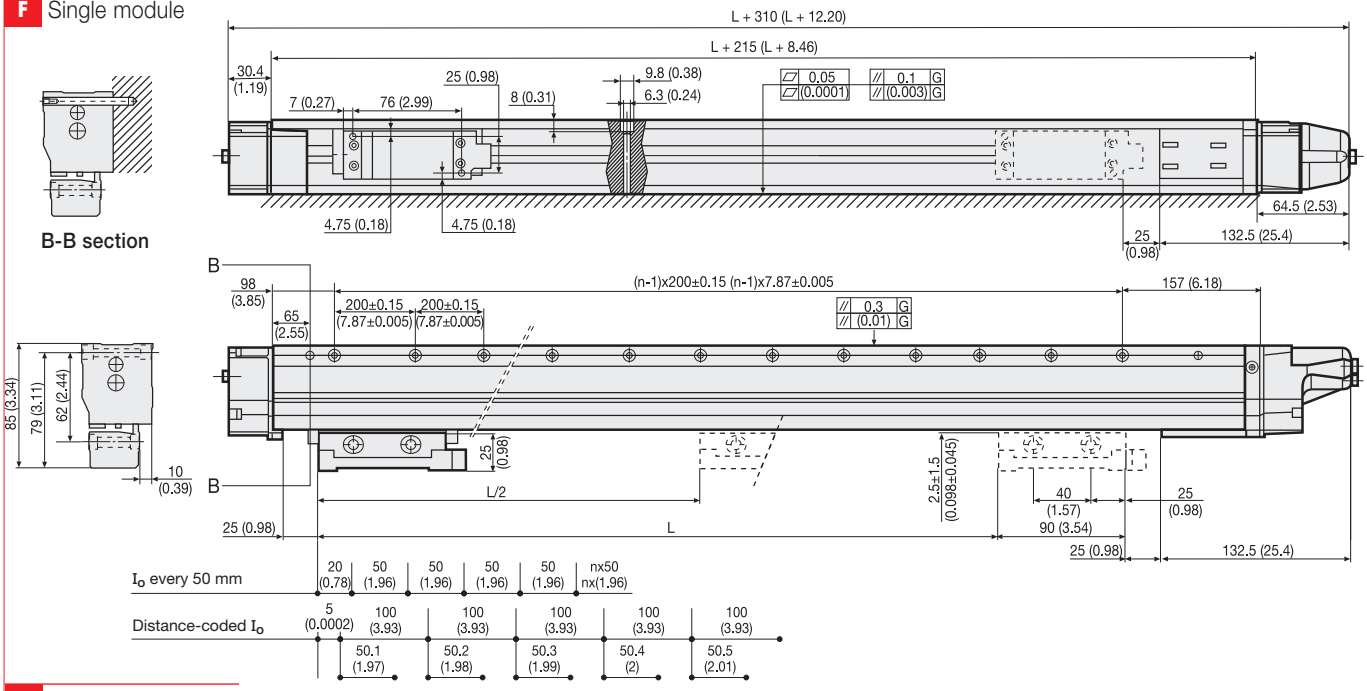
The steel tape graduation pitch is 0.1 mm. Measuring lengths over 4040 mm require the use of modules.

Measuring lengths in millimeters (inches)

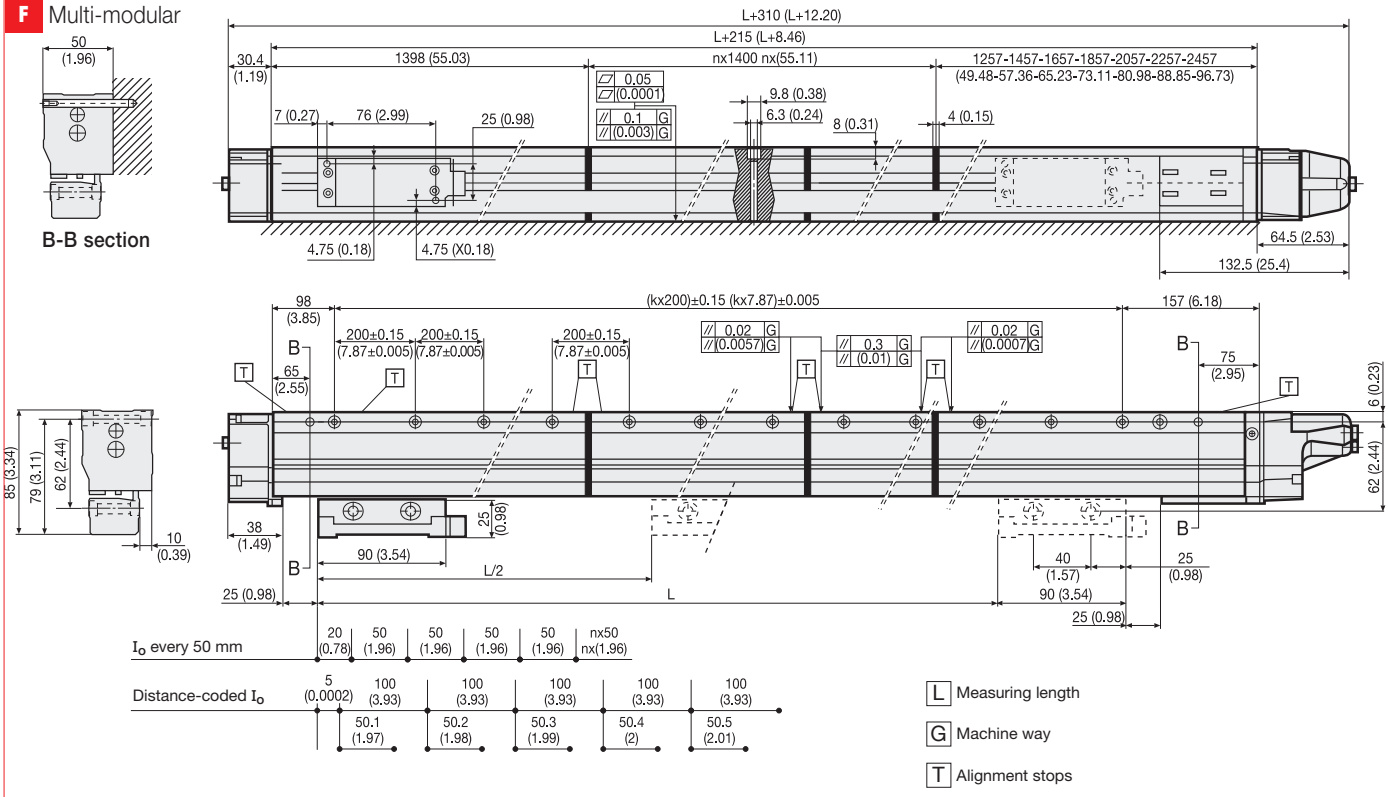
- Measuring lengths from 440 mm to 30240 mm in 200 mm (7.87 inch) increments.
- Contact FAGOR for greater lengths.

SPECIFIC CHARACTERISTICS			
	FT	**FX**	**FP**
Resolution	5 µm (0.0002")	Up to 1 µm (0.00004")	Up to 0,1 µm (0.000004")
Reference marks I_0	Every 50 mm (1.97 inches)		
Output signals	TTL	Differential TTL	1Vpp
T period of output signals	20 µm	4 µm	100 µm
Maximum cable length	20 m (66 ft)	50 m (165 ft)	150 m (495 ft)
Supply voltage	5V ± 5%, 150 mA (without load)		5V ± 10%, <150 mA (without load)

F Single module



F Multi-modular



Order identification	
Example: FX - 36	
F	**Type of profile** **F: For great lengths**
O	**Type of reference mark I_o** • **Blank space: One I0 mark every 50 mm (1.97")** • O: Absolute distance-coded marks
X	**Type of signal** • T: 5 or 10 µm resolution differential TTL • **X: 1 µm resolution differential TTL** • P: 1 Vpp sinusoidal
36	**Ordering length code** **In the example (36) = 3640 mm**

ANGULAR AND ROTARY **ENCODERS**

On FAGOR angular and rotary encoders, the graduated disk of the measuring system is directly attached to the shaft; they have their roller bearings and stator coupling that serve as guide and adjustment.

This coupling, besides minimizing static and dynamic deviations, compensates the axial movements of the shaft. Some of their advantages are that they're small, easy to mount and they can be ordered with a hollow shaft.

Angular encoders

FAGOR angular encoders provide high resolution and high quality solutions and may be used in applications such as indexers, rotary tables with NC positioning, angular metrology, aerials, telescopes, etc.

* Number of pulses: between 18000 and 360000
* Accuracy of ±5", ±4", ±2.5" and ± 2"
* Differential TTL square and 1 Vpp sinusoidal signals

Rotary encoders

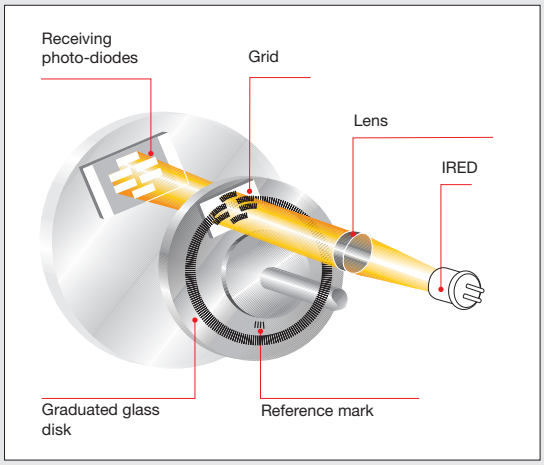
Rotary encoders are used as measurement sensors for rotary movements, angular speed and also on linear movements as part of mechanical devices like leadscrews. They are used on machine-tools, on woodworking, robots, handlers, etc.

* Number of pulses: between 50 and 10000
* Accuracy of ± 1/10 of the pitch
* Differential TTL square and 1 Vpp sinusoidal signals

MEASURING PROCESS

Incremental angular and rotary encoders with graduated glass

FAGOR angular and rotary encoders operate by transmitting light through the graduated glass disks with a pitch determined by the number of lines per turn.

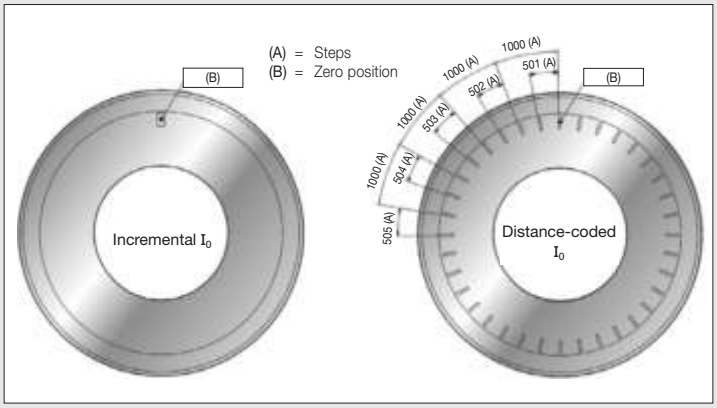


FAGOR angular and rotary encoders operate by transmitting light through the graduated glass disks

Reference signals on rotary feedback systems

FAGOR angular and rotary encoders have two types of reference marks:

- One signal per turn.
- Distance-coded reference marks throughout the whole circumference.



ANGULAR AND **ROTARY ENCODER** SELECTION GUIDE

Rotary encoders for general applications

- Encoders especially designed for:
  - Rotary movements
  - Angular speed
  - Linear movements through a leadscrew
- With a solid shaft or an incorporated flexible coupling (hollow shaft).
- With radial or axial cable exit.
- With differential TTL or 1 Vpp sinusoidal output signals

High Resolution Angular Encoders

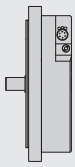
- Encoders especially designed for:
  - Rotary tables of machine-tools.
  - Swinging spindles.
  - Optical dividers.
  - Measuring devices.
- With a solid shaft or an incorporated flexible coupling (hollow shaft).
- With a connector built-into the encoder housing
- With differential TTL or 1 Vpp sinusoidal output signals

Reference marks (I_0)

- One reference mark per turn
- Distance-coded reference marks throughout the whole circumference.

Alarm signal

All angular encoders with differential TTL signal offer the alarm signal /AL.

Encoder type	Section	Pulses/turn	Type of axis	Accuracy	Output signal	Model
Rotary		From 50 to 5000	Solid shaft	± 1/10 of the pitch	TTL 5V	S
					1Vpp	SP
		From 50 to 3000	Hollow shaft	± 1/10 of the pitch	TTL 5V	H
		From 1000 to 3000	Hollow shaft	± 1/10 of the pitch	1Vpp	HP
		From 1024 to 10000	Hollow shaft	± 1/10 of the pitch	TTL 5V	HA
Angular		18000, 90000 & 180000	Solid shaft	± 5", ± 2" (arc-seconds)	TTL 5V	S-D 90 / SO-D 90
		18000	Solid shaft	± 5", ± 2" (arc-seconds)	1 Vpp	SP-D 90/SOP-D 90
		90000, 180000 & 360000	Solid shaft	± 2" (arc-seconds)	TTL5V	S-D170/SO-D170
		18000 & 36000	Solid shaft	± 2" (arc-seconds)	1 Vpp	SP-D170/SOP-D170
		90000-1024	Solid shaft	± 5" (arc-seconds)	TTL5V (Dual feedback)	S/SO 90000-1024-D90
		18000-1024	Solid shaft	± 5" (arc-seconds)	1 Vpp (Dual feedback)	SP/SOP 18000-1024-D90
		18000, 90000 & 180000	Hollow shaft	± 5", ± 2.5" (arc-seconds)	TTL 5V	H-D 90 / HO-D 90
		18000	Hollow shaft	± 5", ± 2.5" (arc-seconds)	1 Vpp	HP-D 90/HOP-D 90
		90000, 180000 & 360000	Hollow shaft	± 2" (arc-seconds)	TTL 5V	H-D 200 / HO-D 200
		From 18000 to 36000	Hollow shaft	± 2" (arc-seconds)	1 Vpp	HP-D 200/HOP-D 200

Order identification - Model SP-18000-1024 D90 (Dual feedback)
Example: SP- 18000-1024 - D-90

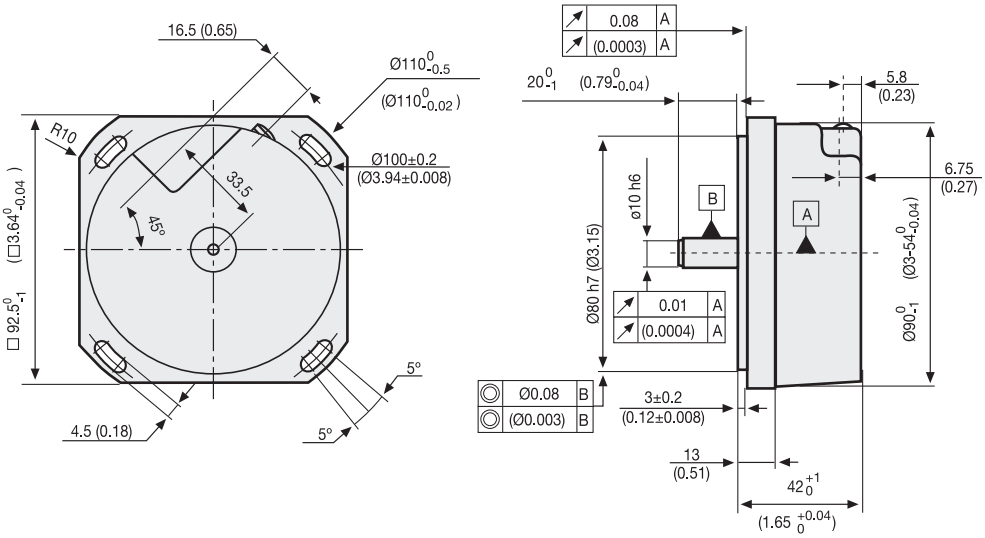
S	**Type of axis** On this model, always solid shaft
P	**Type of signal** • Blank space: TTL 5V • **1 Vpp (only on models of 18000 pulses/turn)**
18000	**Number of pulses/turn of the first feedback** • **18000: Only on 1 Vpp models** • 90000: Only on TTL model
1024	**Number of pulses/turn of the second feedback** • On this model, always 1024
D90	**Diameter** • On this model, always 90 mm (3.5 inches)

Order identification - Rest of models
Example: SOP - 18000 - D90

S	**Shaft** • **S: Solid Shaft** • H: Hollow Shaft
O	**Reference mark type I_o** • Blank: Incremental, a reference mark per turn • **O: Distance-coded reference mark**
P	**Type of signal** • Blank space: TTL 5V • **1 Vpp (only on models of 18000 pulses/turn)**
18000	**Number of pulses/turn of the first feedback** • **18000: Only on 1 Vpp models** • 90000: Only on TTL model
D90	**Diameter** • **D90: 90 mm (3.5 inches)** • D170: 170 mm (6.7 inches). Only solid shaft Encoders • D200: 200 mm (7.8 inches). Only hollow shaft Encoders

Model S... D90

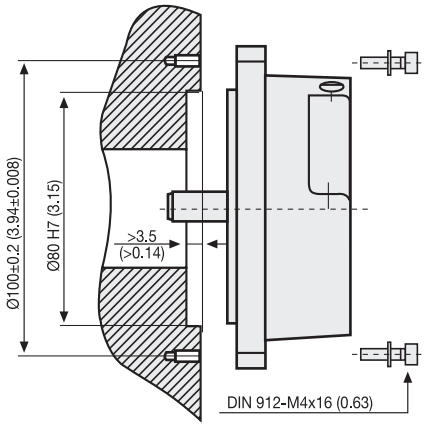
Dimensions in mm (inches)



SPECIFIC CHARACTERISTICS	S-....-D90
Measurement	By means of graduated glass disk
Accuracy	± 5" and ± 2" (*)
Number of pulses/turn	18000, 90000 & 180000
Vibration	100 m/seg² (55 ÷ 2000 Hz) IEC 60068-2-6
Shock	1000 m/s² (6 mseg) IEC 60068-2-27
Inertia	200 gr. cm²
Maximum speed	10000 RPM
Turning torque	≥ 0.01 Nm.
Shaft type	Solid
Load on the shaft:	Axial: 1 kg. Radial: 1 Kg.
Weight	0.8 Kg.
Ambient characteristics: **Running temperature** **Storage temperature**	 -20°...+70°C -30°...+80°C
Protection	IP 64 (DIN 40050) standard >IP 64 using pressurized air
Light source	IRED (InfraRed Emitting Diode)
Maximum frequency	180 kHz for 1 Vpp signal 1 MHz for TTL signal
Current under no load condition	Maximum 150 mA (TTL); 5V ±10% (1Vpp)
Supply voltage	5 V ± 5%
Reference signal I_0	One reference signal per encoder turn or distance-coded I_0
Output signals	Differential TTL (90000, 180000 & 360000 Imp./pulses/turn) 1Vpp (18000 Imp./pulses/turn)
Maximum cable length:	TTL signals: 50 m (164 ft) 1Vpp: 150 m (492 ft)

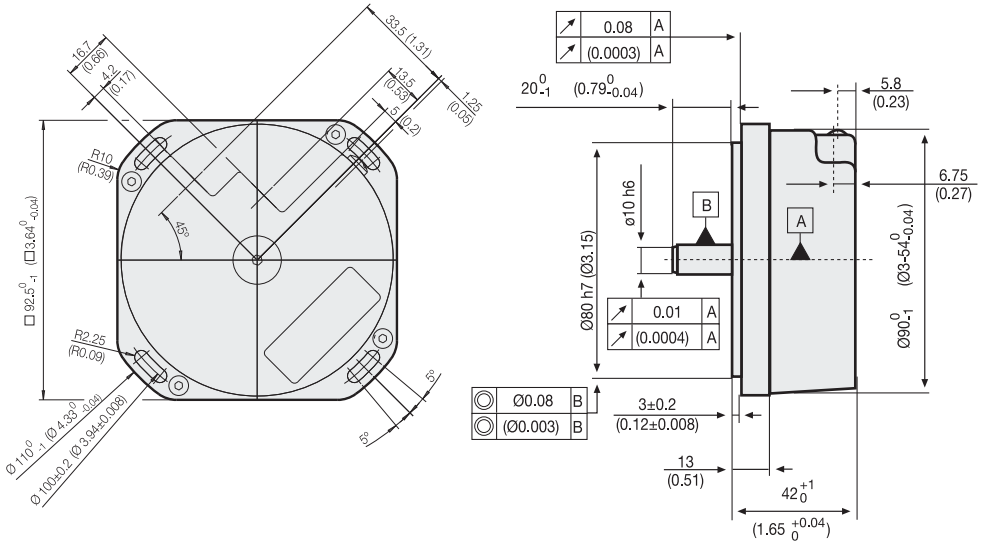
* For ± 2" accuracy, add 2 to the purchase order.
Example: S-....-D90 - 2

Mounting possibilities



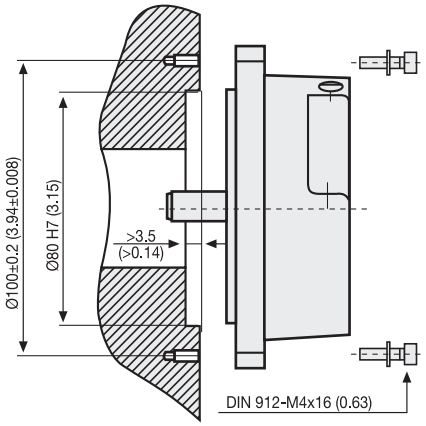
Model S...1024-D90

Dimensions in mm (inches)



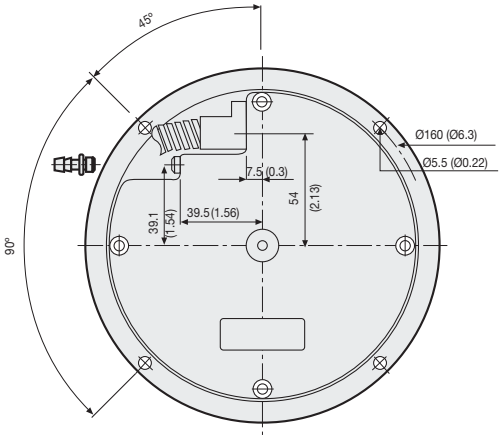
SPECIFIC CHARACTERISTICS	S... 1024-D90
Measurement	By means of graduated glass disk
Accuracy	± 5”
Number of pulses/turn	90000-1024 (Dual feedback)
Vibration	100 m/seg² (55 ÷ 2000 Hz) IEC 60068-2-6
Shock	1000 m/seg² (6 mseg) IEC 60068-2-27
Inertia	200 gr.cm²
Maximum speed	10000 RPM
Turning torque	0.01 Nm.
Type	Solid shaft
Load on the shaft:	Axial: 1 Kg. Radial: 1 Kg.
Weight	0.8 Kg.
Ambient characteristics: Running temperature Storage temperature	 -20°…+70°C -30°…+80°C
Protection	IP 64 (DIN 40050) standard >IP 64 using pressurized air
Light source	IRED (InfraRed Emitting Diode)
Maximum frequency	180 kHz for 1 Vpp signal 1 MHz for TTL signal
Maximum current without load	250 mA
Supply voltage	5 V ± 5%
Reference signal I_0	One reference signal per turn or distance-coded I_0
1st feedback output signals	Differential TTL (90000 pulses/turn) 1 Vpp (18000 pulses/turn)
2nd feedback output signals	Differential TTL (1024 pulses/turn)
Maximum cable length:	TTL signals: 50 m(164 ft) 1Vpp: 150 m (492 ft)

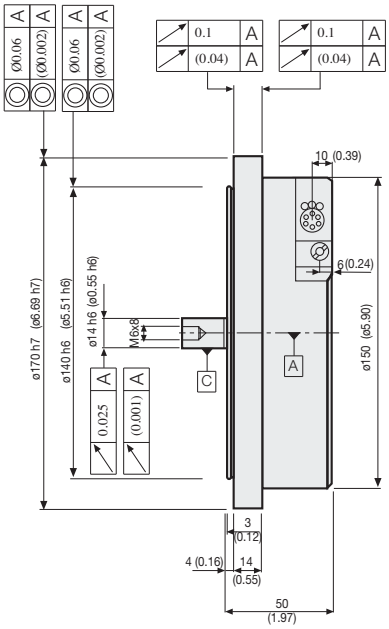
Mounting possibilities



Model S... D170

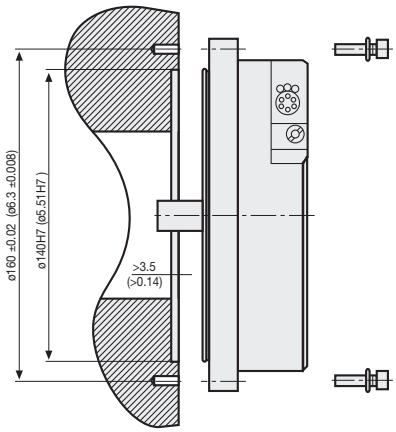
Dimensions in mm (inches)

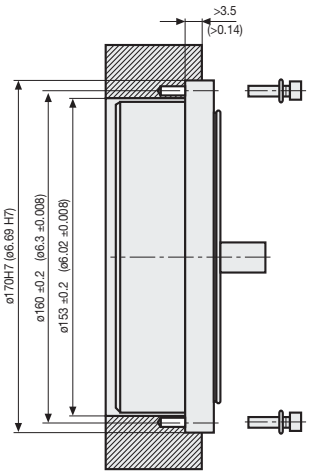




SPECIFIC CHARACTERISTICS	S-....-D170
Measurement	By means of graduated glass disk
Accuracy	± 2"
Number of pulses/turn	18000, 90000 & 180000
Vibration	100 m/seg² (55 ÷ 2000 Hz) IEC 60068-2-6
Shock	300 m/seg² (6 mseg) IEC 60068-2-27
Inertia	350 gr.cm²
Maximum speed	3000 RPM
Turning torque	0.01 Nm.
Type	Solid shaft
Load on the shaft:	Axial: 1 Kg. Radial: 1 Kg.
Weight	2.65 Kg.
Ambient characteristics: Running temperature Storage temperature	 0°…+50°C -30°…+80°C
Protection	IP 64 (DIN 40050) standard >IP 64 using pressurized air
Light source	IRED (InfraRed Emitting Diode)
Maximum frequency	180 kHz for 1 Vpp signal 1 MHz for TTL signal
Maximum current without load	250 mA
Supply voltage	5 V ± 5% (TTL); 5V ±10% (1Vpp)
Reference signal I_0	One reference signal per turn or distance-coded I_0
Output signals	Differential TTL (90000, 180000 & 360000 pulses/turn) 1Vpp (18000 pulses/turn)
Maximum cable length:	TTL signals: 50 m (164 ft) 1Vpp: 150 m (492 ft)

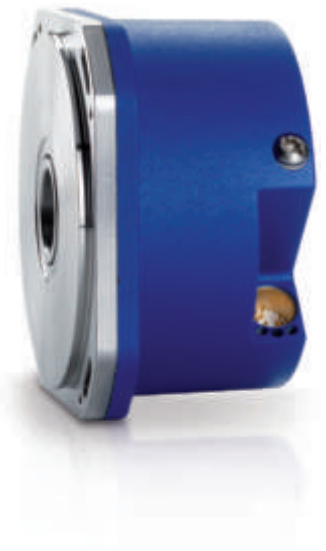
Mounting possibilities

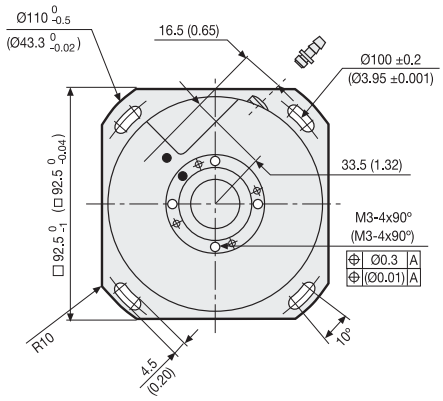


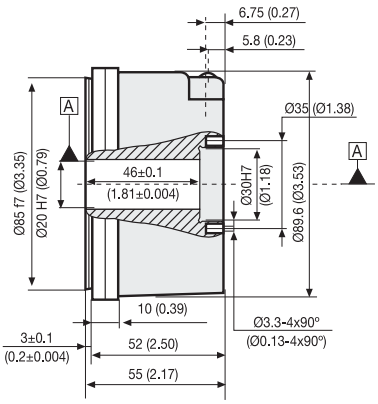


Model H... D90

Dimensions in mm (inches)



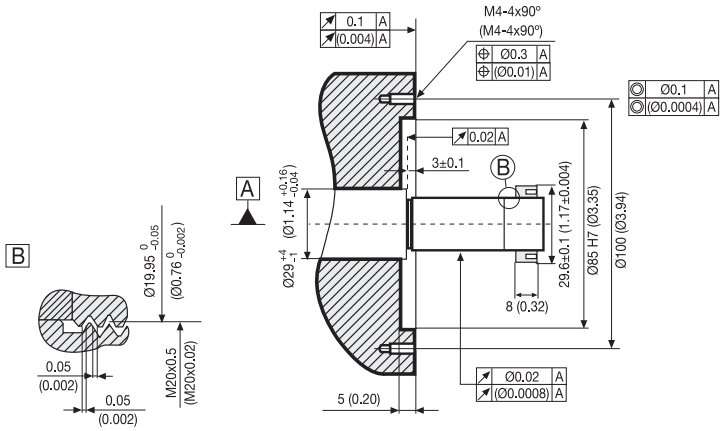


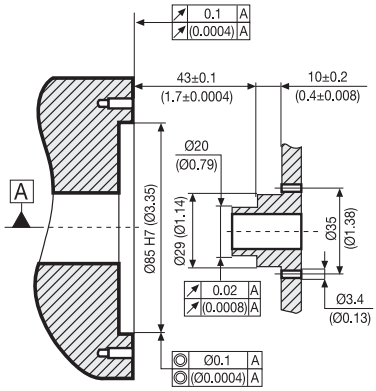


SPECIFIC CHARACTERISTICS	H-....-D90
Measurement	By means of graduated glass disk
Accuracy	± 5" and ± 2.5" (*)
Number of pulses/turn	18000, 90000 & 180000
Vibration	100 m/seg² (55 ÷ 2000 Hz) IEC 60068-2-6
Natural frequency	≥ 1000Hz
Shock	1000 m/seg² (6 mseg) IEC 60068-2-27
Inertia	730 gr.cm²
Maximum speed	3000 RPM
Turning torque	≥ 0.08 Nm.
Type	Hollow shaft
Load on the shaft:	–
Weight	1 Kg.
Ambient characteristics: Running temperature Storage temperature	 -20°...+70°C -30°...+80°C
Protection	IP 64 (DIN 40050) standard >IP 64 using pressurized air
Light source	IRED (InfraRed Emitting Diode)
Maximum frequency	180 kHz for 1 Vpp signal 1 MHz for TTL signal
Maximum current without load	150 mA
Supply voltage	5 V ± 5% (TTL); 5V ±10% (1Vpp)
Pulse generating electronics	Inside the encoder
Reference signal (I_0)	One reference signal per encoder turn or distance-coded I_0
Output signals	Differential TTL (90000 and 180000 pulses/turn) 1Vpp (18000 pulses/turn)
Maximum cable length:	TTL signals: 50 m (164 ft) 1Vpp: 150 m (492 ft)

* For ± 2.5" accuracy, add 2 to the purchase order.
Example: H-....-D90 - 2

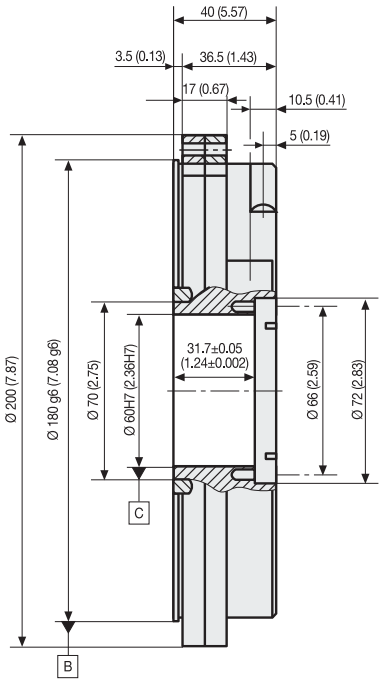
Mounting possibilities

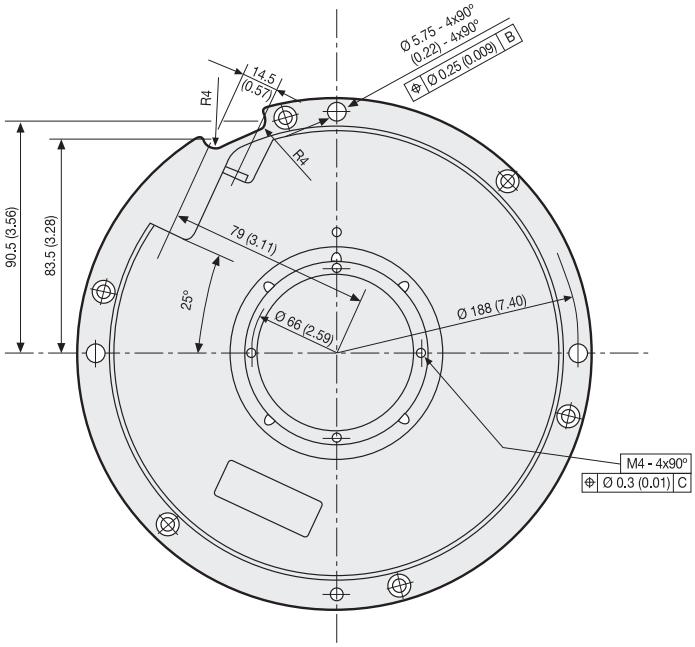




Model H... D200

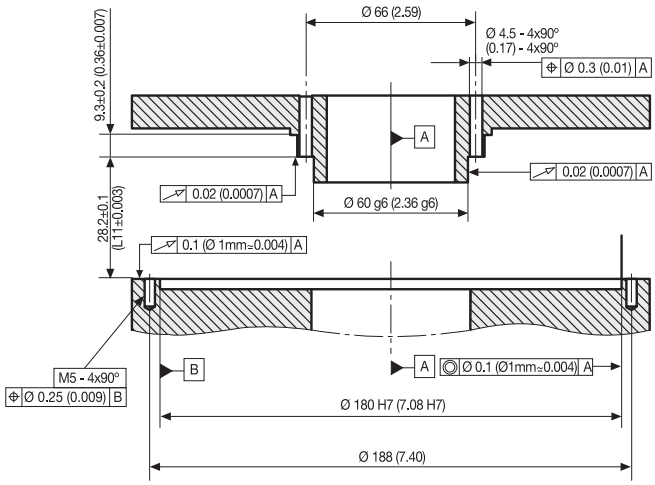
Dimensions in mm (inches)



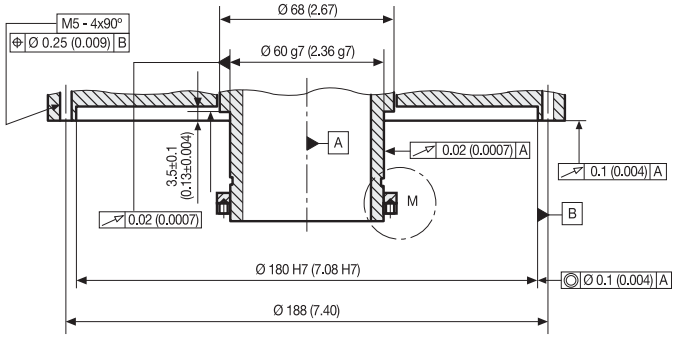


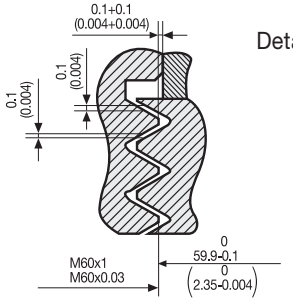
SPECIFIC CHARACTERISTICS	H-....-D200
Measurement	By means of graduated glass disk
Accuracy	± 2”
Number of pulses/turn	18000, 36000, 90000, 180000 & 360000
Vibration	100 m/seg² (55 ÷ 2000 Hz) IEC 60068-2-6
Natural frequency	≥ 1000 Hz
Shock	1000 m/seg² (6 mseg) IEC 60068-2-27
Inertia	10000 gr.cm²
Maximum speed	1000 RPM
Turning torque	≤ 0.5 Nm.
Type	Hollow shaft
Weight	3.2 Kg.
Ambient characteristics:	
Running temperature	0°…+50°C
Storage temperature	-30°…+80°C
Protection	IP 64 (DIN 40050) standard >IP 64 using pressurized air
Light source	IRED (InfraRed Emitting Diode)
Maximum frequency	180 kHz for 1 Vpp signal 1 MHz for TTL signal
Maximum current without load	150 mA
Supply voltage	5 V ± 5% (TTL); 5V ±10% (1Vpp)
Pulse generating electronics	Inside the encoder
Reference signal I_0	One reference signal per encoder turn or distance-coded I_0
Output signals	Differential TTL (90000, 180000 and 360000 pulses/turn) 1Vpp (18000 pulses/turn)
Maximum cable length:	TTL signals: 50 m (164 ft) 1Vpp: 150 m (492 ft)

Mounting possibilities



A Roller bearing





Detail M

ROTARY ENCODERS FOR GENERAL APPLICATIONS

SPECIFICATIONS	S	H / HA	HP	SP
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	12000 RPM			
Vibration	100 m/seg² (10 ÷ 2000 Hz.)			
Shock	300 m/seg² (11 mseg)			
Inertia	16 gr.cm²			
Turning torque	0.003 Nm. (30 grcm) max. at 20°C			
Type of axis	Solid shaft	Hollow shaft	Hollow shaft	Solid shaft
Maximum load on the shaft	Axial: 10 N Radial: 20 N	– –	– –	Axial: 10 N Radial: 20 N
Weight	0.3 kg.			
Ambient characteristics: Running temperature Storage temperature Relative humidity	 0°...70°C -30°...80°C 98% non-condensing			
Protection	IP 64 (DIN 40050). On S and SP models, optional IP 66			
Light source	IRED			
Maximum frequency	200 KHz		200 KHz	
Reference signal (I_0)	One reference signal per encoder turn			
Supply voltage	5 V ± 5% (TTL)		5 V ± 10% (1 Vpp)	
Consumption	70 mA typical, 100 mA max. (without load)			
Output signals	Differential TTL (5V)		1Vpp	
Maximum cable length	50 m (163 ft)		150 m (490 ft)	

Number of pulses/turn

S	SP	H	HP	HA
50	-	50	-	-
100	-	100	-	-
200	-	200	-	-
250	-	250	-	-
400	-	400	-	-
500	-	500	-	-
600	-	600	-	-
635	-	635	-	-
1000	1000	1000	1000	-
1024	1024	1024	1024	1024
1250	1250	1250	1250	1800
1270	1270	1270	1270	2000
1500	1500	1500	1500	2048
2000	2000	2000	2000	2500
2500	2500	2500	2500	3000
3000	3000	3000	3000	3600
-	3600	-	-	4000
-	4320	-	-	4096
5000	5000	-	-	5000
-	-	-	-	10000

Order identification - HA model
Example: HA - 22132 - 2500

HA	In all cases
1	Type of clamp • 1: Rear clamp • **2: Front clamp**
2	Size of hollow shaft (ØA) • 1: 10 mm • **2: 12 mm**
1	Output signals • **1: A, B, I_o plus their inverted**
3	Type of connection • 1: Radial cable (2 m) • 2: CONNEI 12 radial connector built into it • **3: Radial cable (1 m) with CONNEI 12 connector**
2	Supply voltage • 1: Push-Pull (11-30V) • **2: RS-422 (5V)**
2500	Number of pulses/turn

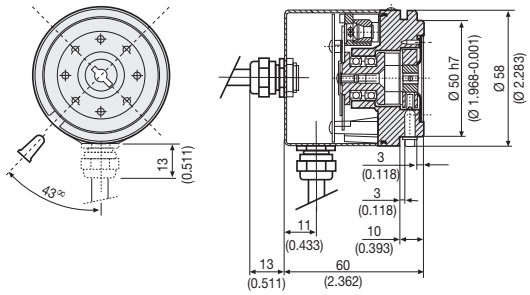
Order identification - models H, HP, S and SP
Example: S - 1024 - A - 12 - IP 66

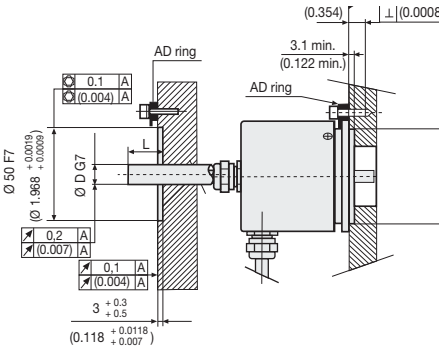
SP	Model • **S: Solid shaft, square signal (TTL or HTL)** • SP: Solid shaft, 1 Vpp sinusoidal signal • H: Hollow shaft, square signal (TTL or HTL) • HP: Hollow shaft, 1 Vpp sinusoidal signal
1024	Number of pulses/turn
C	Type of connector • **Blank space** • C: male-male connector in a CONNEI 12 housing • C5: 1 meter cable besides a male-male CONNEI 12 connector
A	Cable exit • R: Radial • **A: Axial** If not indicated, by default the cable exit is axial
12	Voltage • Blank space: Standard 5V supply • **12: Optional 12 V supply (only for HTL signal)**
IP 66	Protection •Blank space: Standard protection (IP 64) • **IP 66: Protection IP 66**

Dimensions in mm (inches)

Mounting possibilities

Models H, HP



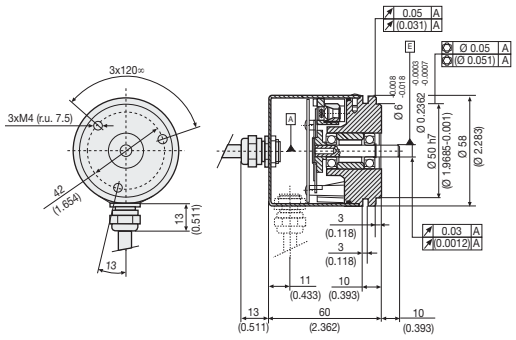


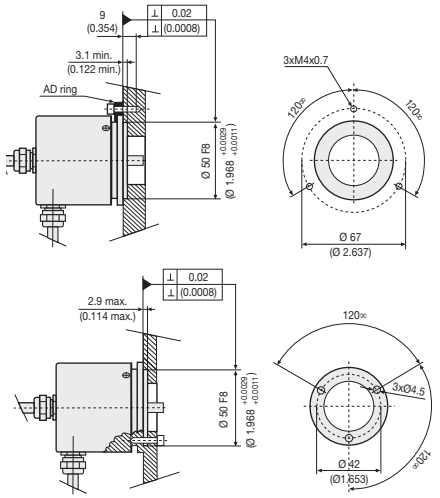
L: Min. 9 mm (0.36 inch), max. 16 mm (0.63 inch)

Ø D G7

mm	3	4	6	6.35	7	8	9.53	10
inches	(0.118)	(0.157)	(0.236)	(0.250)	(0.275)	(0.314)	(0.375)	(0.393)

Models S, SP

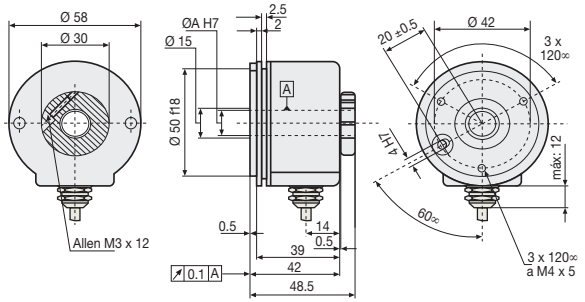


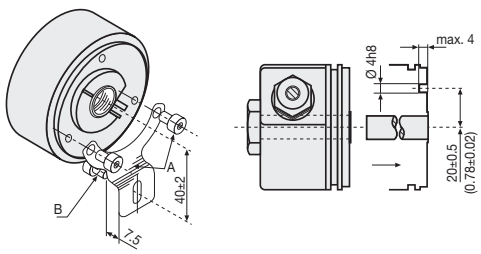


Signal	+5V Alim	0V Alim.	+5V Monitor	0V Monitor	A	/A	B	/B	I_O	/ I_O	GND
Color	Red	Black	Black	White	Blue	Pink	Green	Yellow	Grey	Brown	Shield

Model HA

With rear clamp (*)





(*) also available with front clamp

ACCESSORIES FOR **ANGULAR AND ROTARY ENCODERS**

High Resolution Angular

• 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. We at FAGOR recommend using our AA and AP couplings that have been designed for our encoders and provide that guarantee that other couplings cannot.

AA Model

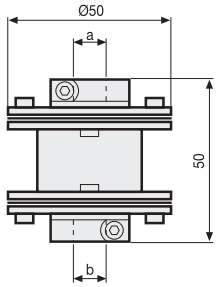
AP Model

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

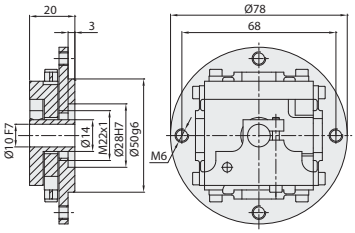
Model	a		b	
	mm	inches	mm	inches
AA 10/10	10	0.4	10	0.4
AA 10/14	10	0.4	14	0.6
AA 14/14	14	0.6	14	0.6

Dimensions

AA



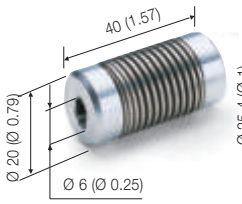
AP



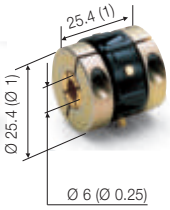
General purpose applications

• Couplings for solid-shaft encoders

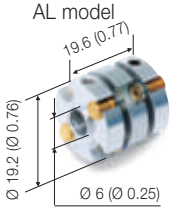
AF model



AC Model



AL model

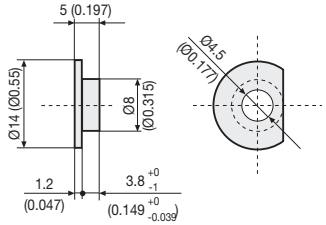


• Couplings for hollow-shaft encoders

Hollow-shaft encoders come with a standard 6-mm diameter (ø6) coupling.

These couplings are also available in the following diameters: ø3, ø4, ø6, ø7, ø8 y ø10 mm, 1/4" and 3/8".

AD washer



Characteristics of the recommended couplings

Specifications \ Models	For general purpose applications			For high resolution	
	AF	AC	AL	AA 10/10 AA 10/14 AA 14/14	AP 10
Maximum radial misalignment permitted (λ)	2 mm	1 mm	0.2 mm	0.3 mm	0.3 mm
Maximum angular misalignment permitted (α)	8º	5º	4º	0.5º	0.5º
Maximum axial misalignment permitted (δ)	± 1.5 mm	–	± 0.2 mm	0.2 mm	0.2 mm
Kinematic transfer error	–	–	–	± 2" if λ <0.1 mm and α 0.09º	± 3" if λ <0.1 mm and α <0.09º
Maximum torque that may be transmitted	2 Nm	1.7 Nm	0.9 Nm	0.2 Nm	0.5 Nm
Torsion rigidity	1.7 Nm/rad.	50 Nm/rad.	150 Nm/rad.	1500 Nm/rad.	1400 Nm/rad.
Maximum rotating speed		12000 RPM		10000 RPM	1000 RPM
Weight	–	–	–	93 gr.	128 gr.
Inertia	–	–	–	$20x10^{-8}$ Kgm²	$100x10^{-8}$ Kgm²

CABLES AND EXTENSION CABLES TO CONNECT FAGOR ENCODERS TO CONTROLLERS

FAGOR encoder products should be connected to subsequent electronics using the recommended cables shown below. FAGOR shall not be held responsible for any problems caused by using other cables.

Fagor Automation also provides other cables and extension cables for connecting encoders to electronic equipment.

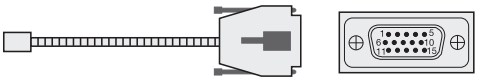
Contact the FAGOR center nearest you for other possibilities.

All cables are available with or without protective armour. Armour is provided as standard. To order cables without protective armour add an "N" to the order code.

Important: Vacant pins or wires must not be used

CABLES FOR DIRECT CONNECTION OF FAGOR INCREMENTAL ENCODERS TO FAGOR SYSTEMS

EC...P-D cable Cable for direct connection with FAGOR controllers
1, 3, 4, 6, 8, 9, 10 and 12 meters long

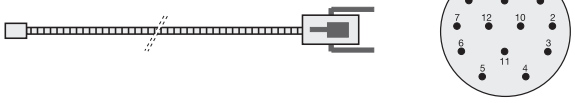


PIN	1	2	3	4	5	6	9	11	15	Chassis
SIGNAL	A	/A	B	/B	I_0	$/I_0$	+5V	0V	Ground	Ground
COLOR	Green	Yellow	Blue	Red	Grey	Pink	Brown	White	Shield	Shield

Extension cables for connecting FAGOR incremental linear encoders to FAGOR controllers

Cable lengths over 12 meters require the use of extension cables; in those cases, an **EC-...A-C1** cable (FAGOR recommends a length between 1 and 3 m) must be combined with the **XC-C2-...D** extension cable (available in 5, 10, 15, 20 and 25 m).

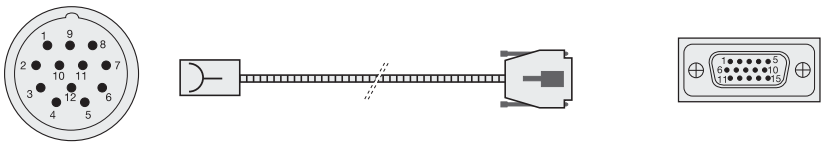
EC...A...C1 cable Cable to be used in combination with extension cables
Available in 1 and 3 meters
(Contact FAGOR for other lengths)



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

XC...C2...D extension cable

Available in 5, 10, 15, 20 and 25 meters

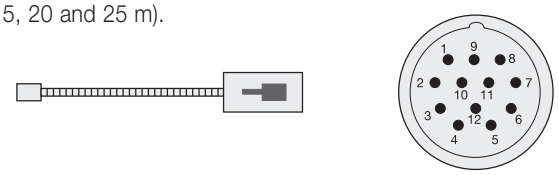


EXTENSION CABLE XC – C2 -...- D (4x2x0.14 + 4x0.5); Φ = 8 mm²												
	12-pin CIRCULAR female connector					SUB D 15 HD male connector						
PIN	5	6	8	1	3	4	7	12	2	10	11	Housing
PIN	1	2	3	4	5	6	7	9	9	11	11	Housing
SIGNAL	A	/A	B	/B	I_0	$/I_0$	Alarm	5V	+5V sensor	0V	0V sensor	Ground
COLOR	Brown	Green	Grey	Pink	Red	Black	Purple	Brown/Green	Blue	White/Green	White	Shield

Extension cables for connecting FAGOR incremental angular encoders to FAGOR controllers

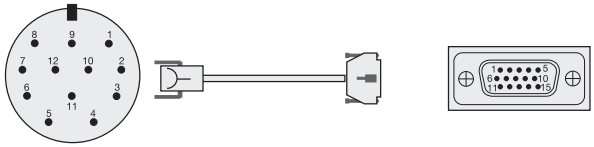
Cable lengths over 12 meters require the use of extension cables; in those cases, an **EC-...A-C5** cable (FAGOR recommends a length between 1 and 3 m) must be combined with the **XC-C4-...D** extension cable (available in 5, 10, 15, 20 and 25 m).

EC...A...C5 cable Cable to be used in combination with extension cables
Available in 1 and 3 meters
(Contact FAGOR for other lengths)



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

XC...C4...D extension cable Available in 5, 10, 15, 20 and 25 meters



EXTENSION CABLE XC – C4 -...- D (4x2x0.14 + 4x0.5); Φ = 8 mm²												
	CONNEI 12 female connector					SUB D 15 HD male connector						
PIN	5	6	8	1	3	4	7	12	2	10	11	Housing
PIN	1	2	3	4	5	6	7	9	9	11	11	Housing
SIGNAL	A	/A	B	/B	I_0	$/I_0$	Alarm	5V	+5V sensor	0V	0V sensor	Ground
COLOR	Brown	Green	Grey	Pink	Red	Black	Purple	Brown/Green	Blue	White/Green	White	Shield

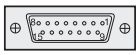
CABLES FOR CONNECTING FAGOR INCREMENTAL ENCODERS TO OTHER CONTROLLERS

Besides being able to connect to FAGOR controllers, FAGOR incremental encoders may also be connected to most popular controllers on the market; here is a list of specific cables and extension cables for that type of connection.

EC...C...FN1 cable For direct connection to FANUC controllers (second feedback)
Available in 1, 3, 6, 9 and 12 meters

HONDA/HIROSE female connector													
PIN ⟩—	1	2	3	4	5	6	9	12	14	18	20	16	Housing
SIGNAL	A	/A	B	/B	I_0	$/I_0$	+5V	0V	0V sensor	+5V	+5V sensor	Internal shield	Internal shield
COLOR	Green	Yellow	Blue	Red	Grey	Pink	Brown	White				Internal shield	External shield

EC...AS...H cable For direct connection to SIEMENS, HEIDENHAIN, SELCA and other controllers.
Available in 1, 3, 6, 9 and 12 meters



SUB D 15 female connector											
PIN —⟨	1	9	2	11	3	4	6	7	10	12	Housing
SIGNAL	+5V	+5V sensor	0V	0V sensor	A	/A	B	/B	I_0	$/I_0$	Ground
COLOR	Brown	Purple	White	Black	Green	Yellow	Blue	Red	Grey	Pink	Shield

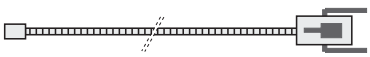
EC...AS...O cable Without a connector at one end; for other applications
1, 3, 6, 9, 12, 15 and 20 meters long

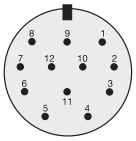
5x2x0.14 cable with sensor; Φ = 6 mm²											
SIGNAL	+5V	+5V sensor	0V	0V sensor	A	/A	B	/B	I_0	$/I_0$	Ground
COLOR	Brown	Purple	White	Black	Green	Yellow	Blue	Red	Grey	Pink	Shield

Extension cables for connecting FAGOR incremental encoders to other controllers

Cable lengths over 12 meters require the use of extension cables; in those cases, an **EC-...A-C1** cable (FAGOR recommends a length between 1 and 3 m) must be combined with the **XC-C2-...H** extension cable (available in 5, 10, 15, 20 and 25 m).

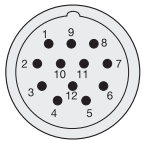
EC...A...C1 cable Cable to be used in combination with extension cables
Available in 1 and 3 meters
(Contact FAGOR for other lengths)

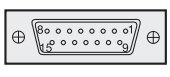




PIN —■	5	6	8	1	3	4	7	10	11	12	2	Chassis
SIGNAL	A	/A	B	/B	I_0	$/I_0$	/Alarm	0V	0V sensor	+5V	+5V sensor	Ground
COLOR	Green	Yellow	Blue	Red	Grey	Pink	Purple	White		Brown		Shield

XC...C2...H extension cable For direct connection to SIEMENS, HEIDENHAIN and other controllers.
Available in 5, 10, 15, 20 and 25 meters





EXTENSION CABLE XC – C2 -...- H (4x2x0.14 + 4x0.5) Φ = 8 mm²											
	12-pin CIRCULAR female connector					SUB D 15 HD male connector					
PIN ⟩—	5	6	8	1	3	4	12	2	10	11	Housing
PIN —■	3	4	6	7	10	12	1	9	2	11	Housing
SIGNAL	A	/A	B	/B	I_0	$/I_0$	+5V	+5V sensor	0V	0V sensor	Ground
COLOR	Brown	Green	Grey	Pink	Red	Black	Brown/Green	Blue	White/Green	White	Shield

CABLES FOR DIRECT CONNECTION OF FAGOR ABSOLUTE LINEAR ENCODERS TO FAGOR CONTROLLERS

EC...B...D cable For direct connection with FAGOR controllers
Available in 1, 3, 6 and 9 meters

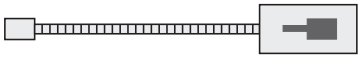
SUB D 15 HD connector														
PIN	1	2	3	4	5	6	7	8	9	10	11	12	15	14
SIGNAL	A	/A	B	/B	DATA	/DATA	CLOCK	/CLOCK	+5V	+5V sensor	0V	0V sensor	Internal shield	External shield
COLOR	Green	Yellow	Blue	Red	Grey	Pink	Black	Purple	Brown	Light green	White	Orange	Internal shield	Shield

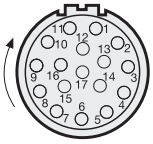
Extension cables for connecting FAGOR absolute linear encoders to FAGOR controllers

Cable lengths over 9 meters require the use of extension cables; in those cases, an **EC-...B - C9** cable (FAGOR recommends a length between 1 and 3 m) must be combined with the XC-C8-...F - D extension cable (available in 5, 10, 15, 20 and 25 m).

If with the available lengths of the **XC-C8-...F-D** extension cable (up to 25 meters) it is not possible to reach the desired total length, one must use the sum of the **EC...B...C9** cable + the necessary intermediate extension cables **XC-C8-...F-C9** + a final extension cable **XC-C8-...F-D** until the required length is reached.

EC...B...C9 cable Cable to be used in combination with extension cables
Available in 1 and 3 meters
(Contact FAGOR for other lengths)

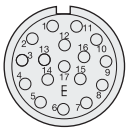


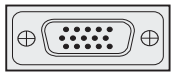


Circular 17 male connector														
PIN	7	1	10	4	15	16	12	13	14	17	8	9	11	Housing
SIGNAL	+5V	+5V sensor	0V	0V sensor	A	/A	B	/B	DATA	/DATA	CLOCK	/CLOCK	Ground	Ground
COLOR	Brown	Light green	White	Orange	Green	Yellow	Blue	Red	Grey	Pink	Black	Purple	Internal shield	Internal shield

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

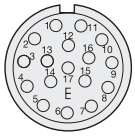
Available in 5, 10, 15, 20 and 25 meters

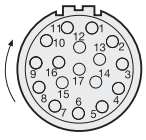




EXTENSION CABLE XC – C8 -...F- D ((4x0,14)+2x4x0.14+4x0.5); with double shield Φ = 10 mm^2														
	Circular 17 female connector					SUB D 15 HD male connector								
PIN	15	16	12	13	14	17	8	9	7	1	10	4	11	Housing
PIN	1	2	3	4	5	6	7	8	9	10	11	12	15	Housing
SIGNAL	A	/A	B	/B	DATA	/DATA	CLOCK	/CLOCK	+5V	+5V sensor	0V	0V sensor	Ground	Ground
COLOR	Green-Black	Yellow-Black	Blue-Black	Red-Black	Grey	Pink	Purple	Yellow	Brown-Green	Blue	White-Green	White	Internal shield	Shield

XC...C8...F- C9 extension cable Intermediate extension cable
Available in 5, 10, 15, 20 and 25 meters





EXTENSION CABLE XC – C8 -...F- C9 ((4x0,14)+2x4x0,14+4x0,5 mm^2); Φ = 10 mm^2														
	17-pin Circular female connector					17-pin Circular male connector								
PIN	15	16	12	13	14	17	8	9	7	1	10	4	11	Housing
PIN	15	16	12	13	14	17	8	9	7	1	10	4	11	Housing
COLOR	Green-Black	Yellow-Black	Blue-Black	Red-Black	Grey	Pink	Purple	Yellow	Brown-Green	Blue	White-Green	White	Internal shield	External shield

CABLES FOR DIRECT CONNECTION OF FAGOR ABSOLUTE LINEAR ENCODERS TO OTHER CONTROLLERS

CONNECTION WITH FANUC

EC...PA...FN cable For direct connection to FANUC absolute controllers (second feedback)
Available in 1, 3, 6 and 9 meters

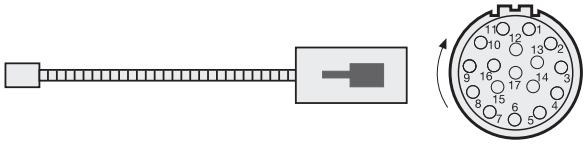
HONDA/HIROSE type female connector									
PIN	9	18-20	12	14	1	2	5	6	16
SIGNAL	+5V	+5V sensor	0V	0V sensor	DATA	/DATA	REQUEST	/REQUEST	Ground
COLOR	Brown	Grey	White	Pink	Green	Yellow	Blue	Red	

Cables with extension cables for connecting with FANUC

Cable lengths over 9 meters require the use of extension cables; in those cases, an **EC-...B - C9** cable (FAGOR recommends a length between 1 and 3 m) must be combined with the **XC-C8- ..FN** extension cable (available in 5, 10, 15, 20 and 25 m).

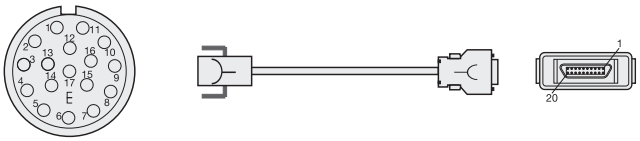
If with the available lengths of the **XC-C8-...FN** extension cable (up to 25 meters) it is not possible to reach the desired total length, one must use the sum of the **EC...B...C9** cable + the necessary intermediate extension cables **XC-C8-...F-C9** + a final extension cable **XC-C8-...FN** until the required length is reached.

EC...B...C9 cable Cable to be used in combination with extension cables.
Available in 1 and 3 meters (contact FAGOR for other lengths))



Circular 17 male connector										
PIN	7	1	10	4	14	17	8	9	11	Housing
SIGNAL	+5V	+5V sensor	0V	0V sensor	DATA	/DATA	REQUEST	/REQUEST	Ground	Ground
COLOR	Brown	Light green	White	Orange	Grey	Pink	Black	Purple	Internal shield	Internal shield

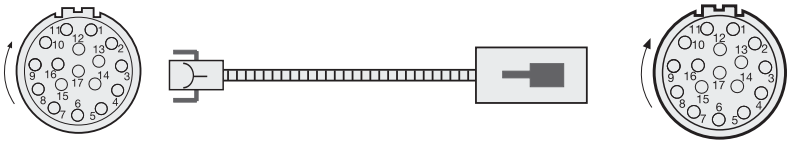
XC...C8...FN extension cable For direct connection to FANUC controllers.
Available in 5, 10, 15, 20 and 25 meters



((4x0.09) + 4x0.09 + 4x0.14) cable with double shield								
	Circular 17 female connector					20-pin HONDA/HIROSE rectangular female connector		
PIN	1	4	7	8	9	10	14	17	Housing
PIN	18-20	14	9	5	6	12	1	2	16
SIGNAL	+5V sensor	0V sensor	+5V	REQUEST	/REQUEST	0V	DATA	/DATA	Shield
COLOR	Blue	White	Brown-Green	Purple	Yellow	White-Green	Grey	Pink	Black wire

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

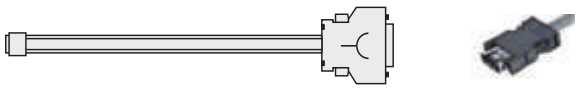
Intermediate extension cable
Available in 5, 10, 15, 20 and 25 meters



EXTENSION CABLE XC – C8 -...F- C9 (4x2x0,14mm²+4x0,5 mm²+4x0.14mm²)														
	17-pin Circular female connector					17-pin Circular male connector								
PIN	15	16	12	13	14	17	8	9	7	1	10	4	11	Housing
PIN	15	16	12	13	14	17	8	9	7	1	10	4	11	Housing
COLOR	Green-Black	Yellow-Black	Blue-Black	Red-Black	Grey	Pink	Purple	Yellow	Brown-Green	Blue	White-Green	White	Internal shield	External shield

CONNECTION WITH MITSUBISHI CNC

EC...AM...MB Cable For direct connection to MITSUBISHI absolute controllers (Half Duplex applications). Available in 1, 3, 6 and 9 meters.



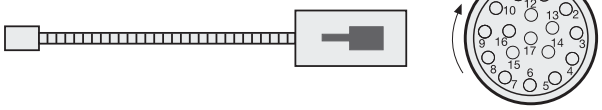
10-pin MOLEX/3M type female connector							
PIN	1	2	7	8	3	4	Housing
SIGNAL	+5V	0V	DATA	/DATA	REQUEST	/REQUEST	Ground
COLOR	Brown	White	Green	Yellow	Grey	Purple	Shield

Cables with extension cables for connecting with MITSUBISHI CNC

Cable lengths over 9 meters require the use of extension cables; in those cases, an EC-...B - C9 cable (FAGOR recommends a length between 1 and 3 m) must be combined with the XC-C8- ..F-MB extension cable (available in 5, 10, 15, 20 and 25 m).

If with the available lengths of the XC-C8-...FN extension cable (up to 25 meters) it is not possible to reach the desired total length, one must use the sum of the EC...B...C9 cable + the necessary intermediate extension cables XC-C8-...F-C9 + a final extension cable XC-C8-...F-MB until the required length is reached.

EC...B...C9 Cable Cable to be used in combination with extension cables. Available in 1 and 3 meters. (contact FAGOR for other lengths).



Circular 17 male connector										
PIN	7	1	10	4	14	17	8	9	11	Housing
SIGNAL	+5V	+5V sensor	0V	0V sensor	DATA	/DATA	REQUEST	/REQUEST	Ground	Ground
COLOR	Brown	Light green	White	Orange	Grey	Pink	Black	Purple	Shield	Shield

XC...C8...F-MB extension cable For direct connection to MITSUBISHI CNC. Available in 5, 10, 15, 20 and 25 meters.

XC – C8 -...F-MB (4x2x0,14+4x0,5) Extension cable with double shield									
	Circular 17 female connector					10-pin MOLEX/3M rectangular female connector			
PIN	7	1	10	4	14	17	8	9	Housing
PIN	1	-	2	-	7	8	3	4	Housing
SIGNAL	+5V	+5V sensor	0V	0V sensor	DATA	/DATA	REQUEST	/REQUEST	Ground
COLOR	Brown-Green	Blue	White-Green	White	Grey	Pink	Purple	Yellow	Shield

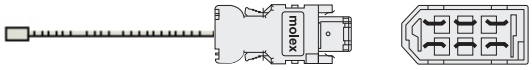
XC...C8...F- C9 extension cable Intermediate extension cable. Available in 5, 10, 15, 20 and 25 meters.

XC – C8 -...F- C9 (4x2x0,14mm2+4x0,5 mm2+4x0.14mm2) EXTENSION CABLE										
	Circular 17 female connector					17-pin Circular male connector				
PIN	14	17	8	9	7	1	10	4	11	Housing
PIN	14	17	8	9	7	1	10	4	11	Housing
COLOR	Grey	Pink	Purple	Yellow	Brown-Green	Blue	White-Green	White	Shield	Shield

CONNECTION WITH PANASONIC (Matsushita)

EC...PA...PN cable For direct connection to PANASONIC (Matsushita) absolute controllers
Available in 1, 3, 6 and 9 meters

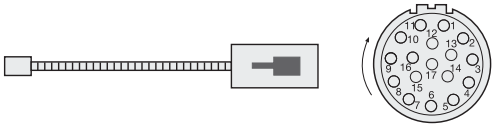
MOLEX type connector					
PIN	1	2	5	6	Housing
SIGNAL	+5V	0V	DATA	/DATA	Shield
COLOR	Brown-Grey	White-Pink	Green	Yellow	Shield



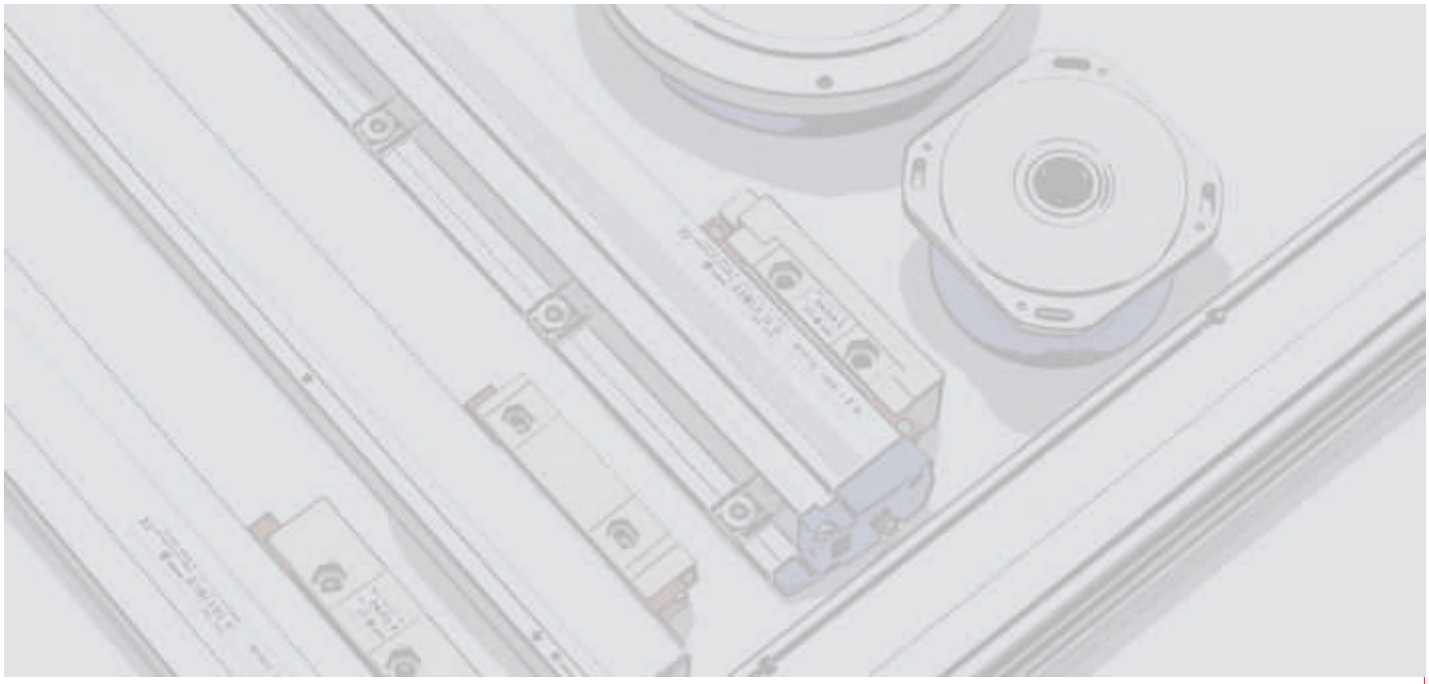
CONNECTION WITH SIEMENS, SELCA and others (see references)

The **EC-...B...C9** cable is supplied for connecting to SIEMENS, SELCA and other controllers; this cable ends on a 17-pin circular male connector with outside threading.
For greater lengths, extension cables supplied by the manufacturers of these controllers must be used.

EC...B...C9 cable For direct connection to SIEMENS, SELCA and other absolute controllers.
Available in 1, 3, 6 and 9 meters



Circular 17 male connector								
PIN	7	1	10	4	14	17	11	Housing
SIGNAL	+5V	+5V sensor	0V	0V sensor	DATA	/DATA	Ground	Ground
COLOR	Brown	Light green	White	Orange	Grey	Pink	Internal shield	Internal shield



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