Linear and angular encoders for CNC Machines and High Accuracy Applications
Linear, angular and rotary encoders

Over 30 years of continuous evolution
Fagor Automation has been manufacturing high quality linear and rotary encoders using precision optical technology for more than 30 years. Over the years Fagor has created, developed and patented systems, components and technologies that allow us to offer best quality and features over the complete range of product utilizing innovative production methods. Hence making Fagor Automation the most efficient alternative in the world of feedback systems.

**Modern facilities and innovative processes**

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

**With state-of-the-art technology**

Fagor Automation’s commitment to this technology and quality is evident by creation of [Aotek](#) in 2002, a dedicated research center providing various technological breakthroughs. This investment has resulted in large number of patents and customized solutions in electrical, optical and mechanical fields.
Fagor Automation develops with maximum professionalism the three cornerstones in encoder design: optical design, electronic design and mechanical design that result in a state-of-the-art product.

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

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

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

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

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

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

Quality

Accuracy certificate

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

The quality of the measurement is mainly determined by:

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

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#### Linear

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<td>GA series</td>
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<td>SA series</td>
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<td>SVA series</td>
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#### Angular

<table>
<thead>
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<th>Series</th>
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<tbody>
<tr>
<td>HA-D200 series</td>
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<tr>
<td>HA-D90 series</td>
<td>25</td>
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<td>SA-D170 series</td>
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<td>SA-D90 series</td>
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<tr>
<td>Cables + extension cables</td>
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</table>

### Incremental Technology

<table>
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<tbody>
<tr>
<td>Technology</td>
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<td>Signals</td>
<td>34</td>
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<td>Range</td>
<td>36</td>
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</tbody>
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#### Linear

<table>
<thead>
<tr>
<th>Series</th>
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<tbody>
<tr>
<td>L series</td>
<td>38</td>
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<td>G series</td>
<td>40</td>
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<td>S series</td>
<td>42</td>
</tr>
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<td>SV series</td>
<td>44</td>
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</table>

#### Angular and rotary

<table>
<thead>
<tr>
<th>Series</th>
<th>Page</th>
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<tbody>
<tr>
<td>H-D200 series</td>
<td>46</td>
</tr>
<tr>
<td>H-D90 series</td>
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<tr>
<td>S-D170 series</td>
<td>48</td>
</tr>
<tr>
<td>S1024-D90 series</td>
<td>49</td>
</tr>
<tr>
<td>S-D90 series</td>
<td>50</td>
</tr>
<tr>
<td>H series</td>
<td>52</td>
</tr>
<tr>
<td>S series</td>
<td>52</td>
</tr>
<tr>
<td>Cables + extension cables</td>
<td>54</td>
</tr>
<tr>
<td>Accessories</td>
<td>56</td>
</tr>
</tbody>
</table>
The absolute measurement system is a direct digital measure of machine position. It is fast, accurate and does not require homing of the machine. The position value is available from the moment the machine is turned on and may be requested by the connected device (CNC) at any time.

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

Linear encoders

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

- **Graduated glass**: Linear encoders with a measuring length of up to 3,040 mm use optical transmission. The light from the LED goes through a graduated glass and a reticule before reaching the receiving photo diodes. The period of the generated electrical signals is the same as the graduation pitch.

- **Graduated steel**: Linear encoders with a measuring length over 3,040 mm use the autoimage principle by means of diffuse light reflected on the graduated steel tape. The reading system consists of one LED, as the light source of the linear encoder; a mesh that makes the image and a monolithic photo detector element in the plane of the image specially designed and patented by Fagor Automation.

Both measuring methods have two different etchings:

- **Incremental graduation**: Used to generate incremental signals that are counted inside the reader head. The incremental graduation also provides the 1 Vpp analog signals except in systems that only use digital signals.

- **Absolute graduation**: It is a unique binary code which is imprinted along the measuring length of encoder. Fagor encoders calculate the absolute position by reading the unique binary code using a high precision optical sensor.

Enclosed design

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

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

Angular encoders are used as angular movement sensors on machines that require high resolution and high accuracy. Fagor angular encoders reach 23 and 27-bit angular resolution equivalent to 8,388,608 and 134,217,728 positions respectively and accuracy levels of ± 5", ± 2.5", ± 2" and ± 1" depending on the model. In them, the graduated disk of the measuring system is attached directly to the shaft. They have bearings and couplings that serve as guide and adjustment. Couplings, besides minimizing the static and dynamic deviations, compensate for axial movements of the shaft providing easier mounting, smaller size and the possibility of hollow shafts.

Fagor Automation uses the graduated glass measuring method in their absolute angular and rotary encoders. The measurement is based on the pitch determined by the number of pulses/turn. Like graduated glass linear encoders, they are based on optical transmission.

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

Electrical output signals

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

ABSOLUTE signals

Transmission: SSI synchronous serial transfer via RS 485
Levels: EIA RS 485
Clock frequency: 100 kHz - 500 kHz
Max. bit (n): 32
T: 1 µs + 10 µs
t1: > 1 µs
t2: 20 µs - 35 µs
SSI: Binary
Parity: No

1 Vpp DIFFERENTIAL signals

Signals: A, /A, B, /B
Vpp: 1 V ±20%, ±40%

DC offset: 2.5 V ±0.5 V
Signal period: 20, 40 µs
Supply V: 5 V ±10%
Max. cable length: 100 meters
A, B centered: |V1 - V2| / 2 Vpp < 0.065
A&B relationship Vpp / Vpp: 0.8÷1.25
A&B phase shift: 90°±10°

2. Fagor FeeDat Serial Interface

These systems only use digital signals. The absolute encoder is connected via the SERCOS board.

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

Fagor FeeDat is an open communication protocol that is also used to communicate with other CNC system manufacturers.
SIEMENS® systems
They may be connected to Siemens® systems via:

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

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

DIFFERENTIAL signals
Signals A, /A, B, /B
Vpp 1 V +20%, -40%
Vpp 1 V +20%, -40%
DC offset 2.5 V ±0.5 V
Signal period 20, 40 µm
Supply V 5 V ±10%
Max. cable length 100 meters
A, B centered: |V1-V2| / 2 Vpp < 0.065
A&B relationship VApp / VBpp 0.8÷1.25
A&B phase shift 90°±10°

2. DRIVE-CLIQ® Interface
These systems only use digital signals. The absolute encoder is connected through a cable having the electronics integrated into the connector and it is connected to the “Solution Line” family without the need for intermediate modules.

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

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

PANASONIC® systems  Serial Communication
These systems only use digital signals. The absolute encoder is connected through the MINAS series drive.
As an example, here is the photo and characteristics of the Panasonic® MINAS A5L drive.
These systems use Analogue / Pulse signals.
- Systems can be connected to linear motors, shaft motors, DD motors
- Automatic drive/motor matching software available
- Vibration, resonance suppression filters available with setting done automatically / manually
- Drive range from 50 W to 15 kW at AC 100 V / 200 V / 400 V
- Safety Torque Off feature available


A B S O L U T E

Range

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

To do this, bear in mind the following considerations:

**Linear**

**Installation**
Consider the physical length of the installation and the space available for it.
These aspects are crucial to determine the type of linear encoder to use (type of profile).

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

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

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

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

**Compatibility**
The signal must be compatible with the control system.

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

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

**Angular**

**Installation**
This point considers the physical dimensions of the installation and the space available for it.
It is essential to determine its type of shaft: Hollow or solid.

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

### Linear

<table>
<thead>
<tr>
<th>Series</th>
<th>Section</th>
<th>Measuring lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td>LA</td>
<td>LA</td>
<td>440 mm to 50 m</td>
</tr>
<tr>
<td>GA</td>
<td>GA</td>
<td>140 mm to 3040 mm</td>
</tr>
<tr>
<td>SA</td>
<td>SA</td>
<td>70 mm to 1240 mm</td>
</tr>
<tr>
<td>SVA</td>
<td>SVA</td>
<td>70 mm to 2040 mm</td>
</tr>
</tbody>
</table>

### Angular

<table>
<thead>
<tr>
<th>Series</th>
<th>Section</th>
<th>Type of shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>HA-D200</td>
<td>Hollow shaft</td>
<td></td>
</tr>
<tr>
<td>HA-D90</td>
<td>Hollow shaft</td>
<td></td>
</tr>
<tr>
<td>SA-D170</td>
<td>Solid shaft</td>
<td></td>
</tr>
<tr>
<td>SA-D90</td>
<td>Solid shaft</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>Signals</td>
<td>Pitch Resolution up to</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>± 5 µm</td>
<td>SSI + 1 Vpp FAGOR / SIEMENS(<em>) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS(</em>)</td>
<td>0.1 µm</td>
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<td></td>
<td></td>
<td>1 µm</td>
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<td></td>
<td></td>
<td>0.01 µm</td>
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<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td>± 5 µm and ± 3 µm</td>
<td>SSI + 1 Vpp FAGOR / SIEMENS(<em>) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS(</em>)</td>
<td>0.1 µm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01 µm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td>± 5 µm and ± 3 µm</td>
<td>SSI + 1 Vpp FAGOR / SIEMENS(<em>) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS(</em>)</td>
<td>0.1 µm</td>
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<td></td>
<td></td>
<td>0.01 µm</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td>± 5 µm and ± 3 µm</td>
<td>SSI + 1 Vpp FAGOR / SIEMENS(<em>) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS(</em>)</td>
<td>0.1 µm</td>
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<tr>
<td></td>
<td></td>
<td>0.01 µm</td>
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</table>

### Angular Series

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Signals</th>
<th>Model</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 2° and ±1°</td>
<td>SSI + 1 Vpp FAGOR / SIEMENS(<em>) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS(</em>)</td>
<td>HA-D200 / HAS-D200</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HAF-D200 / HAM-D200 / HAP-D200 / HAD-D200</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>HAD-D200 + EC-PA-DQ</td>
<td></td>
</tr>
<tr>
<td>± 5° and ±2,5°</td>
<td>SSI + 1 Vpp FAGOR / SIEMENS(<em>) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS(</em>)</td>
<td>HA-D90 / HAS-D90</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HAF-D90 / HAM-D90 / HAP-D90 / HAD-D90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>HAD-D90 + EC-PA-DQ</td>
<td></td>
</tr>
<tr>
<td>± 2°</td>
<td>SSI + 1 Vpp FAGOR / SIEMENS(<em>) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS(</em>)</td>
<td>SA-D170 / SAS-D170</td>
<td>26</td>
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<tr>
<td></td>
<td></td>
<td>SAF-D170 / SAM-D170 / SAP-D170 / SAD-D170</td>
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<tr>
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<td>SAD-D170 + EC-PA-DQ</td>
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<tr>
<td>± 5° and ±2,5°</td>
<td>SSI + 1 Vpp FAGOR / SIEMENS(<em>) FANUC® / MITSUBISHI® / PANASONIC® / FAGOR SIEMENS(</em>)</td>
<td>SA-D90 / SAS-D90</td>
<td>27</td>
</tr>
<tr>
<td></td>
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<td>SAF-D90 / SAM-D90 / SAP-D90 / SAD-D90</td>
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<tr>
<td></td>
<td></td>
<td>SAD-D90 + EC-PA-DQ</td>
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</tbody>
</table>

* SIEMENS*: valid for family Solution Line.
Specially designed for high performance environment requiring speed and accuracy.

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

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

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

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>LA / LAS</th>
<th>LAF</th>
<th>LAM</th>
<th>LAP</th>
<th>LAD</th>
<th>LAD+ EC-PA-DQ</th>
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</thead>
<tbody>
<tr>
<td>Measurement</td>
<td>Incremental: By means of a 40 µm-pitch stainless steel tape</td>
<td></td>
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<tr>
<td></td>
<td>Absolute: Optical reading of sequential binary code</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Steel tape thermal expansion coefficient</td>
<td>εαtherm: 11 ppm/K approx.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring resolution</td>
<td>0.1 µm / 1 µm</td>
<td>0.01 µm</td>
<td>0.05 µm</td>
<td>0.01 µm</td>
<td>0.05 µm</td>
<td>0.01 µm</td>
</tr>
<tr>
<td>Output signals</td>
<td>1 Vpp</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Incremental signal period</td>
<td>40 µm</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Limit frequency</td>
<td>&lt; 50 kHz for 1 Vpp</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>100 m</td>
<td>30 m</td>
<td>30 m</td>
<td>30 m</td>
<td>30 m</td>
<td>100 m</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>5V ± 10%, 250 mA (without load)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Steel tape accuracy</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>120 m/min</td>
<td>180 m/min</td>
<td>120 m/min</td>
<td>120 m/min</td>
<td>180 m/min</td>
<td>120 m/min</td>
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<tr>
<td>Maximum vibration</td>
<td>10 g</td>
<td></td>
<td></td>
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<tr>
<td>Maximum shock</td>
<td>30 g (11 lbs) IEC 60668-2-27</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Maximum acceleration</td>
<td>10 g in the measuring direction</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Required moving force</td>
<td>&lt; 5 N</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Operating temperature</td>
<td>0 °C ... 50 °C</td>
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<td>Storage temperature</td>
<td>-20 °C ... 70 °C</td>
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<td></td>
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<tr>
<td>Weight</td>
<td>1.5 kg ± 4 kg/m</td>
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<tr>
<td>Relative humidity</td>
<td>20 ... 80%</td>
<td></td>
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<tr>
<td>Protection</td>
<td>IP 53 (standard)</td>
<td></td>
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<tr>
<td></td>
<td>IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders</td>
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</tr>
<tr>
<td>Reader head</td>
<td>With built-in connector</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Connection at both ends of the reader head</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Order identification

Example of Linear Encoder: LAF10-102-A

<table>
<thead>
<tr>
<th>L</th>
<th>A</th>
<th>F</th>
<th>10</th>
<th>102</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of profile for long space</td>
<td>Letter identifying the absolute encoder</td>
<td>Type of communications protocol:</td>
<td>Resolution:</td>
<td>Ordering length code:</td>
<td>Air intake on the reader head:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blank space: SSI protocol (FAGOR)</td>
<td>Blank space: 50 nm 50: 50 nm (*)</td>
<td>Blank space: Without air intake</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>D: FeeDat protocol (FAGOR)</td>
<td>10: 10 nm</td>
<td>Blank space: With air intake</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>S: SIEMENS® (SL) protocol</td>
<td>In the example (102) = 10240 mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>F: FANUC® (01 and 02) protocol</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M: MITSUBISHI® CNC protocol</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P: PANASONIC® (Matsushita) protocol</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) : identificador sólo para Protocolo FeeDat LAD50
A B S O L U T E
GA series
LINEAR

Specially designed for high performance environment requiring high speed and accuracy.
The TDMS™ mounting system ensures greater accuracy, higher repeatability and ability to withstand vibrations without compromising machine performance.

Measuring lengths in millimeters
140 • 240 • 340 • 440 • 540 • 640 • 740 • 840 • 940
1 040 • 1 140 • 1 240 • 1 340 • 1 440 • 1 540 • 1 640
1 740 • 1 840 • 2 040 • 2 240 • 2 440 • 2 640 • 2 840 • 3 040

Model description:
GA: Absolute linear encoders with SSI protocol for FAGOR and others.
GAS: Absolute linear encoders with SSI protocol for SIEMENS® (Solution Line).
GAF: Absolute linear encoders with FANUC® (01 and 02) protocol.
GAM: Absolute linear encoders with MITSUBISHI® CNC protocol.
GAP: Absolute linear encoders with PANASONIC® (Matsushita) protocol.
GAD: Absolute linear encoders with FeeDat protocol for FAGOR and others.
GAD + EC-PA-DQ: Linear and absolute encoders with DRIVE-CLIQ® protocol, for SIEMENS® (Solution Line).

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

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

<table>
<thead>
<tr>
<th>Type of profile for long space</th>
<th>Letter identifying the absolute encoder</th>
<th>Type of communications protocol:</th>
</tr>
</thead>
<tbody>
<tr>
<td>G</td>
<td>A</td>
<td>Blank space: SSI protocol (FAGOR)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D: FreeDat protocol (FAGOR)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S: SIE MENS® (SL) protocol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>F: FANUC® (01 and 02) protocol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M: MITSUBISHI® CNC protocol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P: PANASONIC® (Matsushita) protocol</td>
</tr>
</tbody>
</table>

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

(*): identificador sólo para Protocolo FeeDat GAD50
SA series
LINEAR

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

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

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

Characteristics

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

SA / SAS

Incremental: By means of a 20 µm-pitch stainless steel tape
Absolute: Optical reading of sequential binary code

SAF

SAM

SAM

SAP

SAP

SAD

SAD + EC-PA-DQ
**Order identification**

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

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

(*) identificador sólo para Protocolo FeeDat SAD50

---

**SA model**

Dimensions in mm

---

Example of Linear Encoder:

```
SAF10 - 420 - 5 - A
```

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

---

**SAF10**

Dimensions in mm

---

**SAF10**

Dimensions in mm

---

**SAF10**

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

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

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

**Model description:**
SA: Absolute linear encoders with SSI protocol for FAGOR and others.
SVAS: Absolute linear encoders with SSI protocol for SIEMENS® (Solution Line).
SVAF: Absolute linear encoders with FANUC® (01 and 02) protocol.
SVAM: Absolute linear encoders with MITSUBISHI® CNC protocol.
SVAP: Absolute linear encoders with PANASONIC® (Matsushita) protocol.
SVAD: Absolute linear encoders with FeeDat protocol for FAGOR and others.
SVAD + EC-PA-DQ: Linear and absolute encoders with DRIVE-CLiQ® protocol, for SIEMENS® (Solution Line).

**Characteristics**

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

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

<table>
<thead>
<tr>
<th>SV</th>
<th>A</th>
<th>F</th>
<th>10</th>
<th>420</th>
<th>5</th>
<th>B</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration mounting for up to 20 g</td>
<td>Letter identifying the absolute encoder</td>
<td>Type of communications protocol:</td>
<td>Resolution:</td>
<td>Measuring lengths in millimeters:</td>
<td>Accuracy of the linear encoder:</td>
<td>Linear encoder with mounting support:</td>
<td>Air intake on the reader head:</td>
</tr>
<tr>
<td>SV</td>
<td>B1</td>
<td>B2</td>
<td>B3</td>
<td>B4</td>
<td>70 - 520</td>
<td>570 - 920</td>
<td>1020 - 1340</td>
</tr>
</tbody>
</table>

(*) identificador sólo para Protocolo FeeDat SVAD50
HA-D200 series

General characteristics

<table>
<thead>
<tr>
<th>Measurement</th>
<th>By means of graduated glass disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>± 2&quot; and ± 1&quot; arc-seconds</td>
</tr>
<tr>
<td>Number of pulses/turn</td>
<td>27 bits (134,217,728 positions)</td>
</tr>
<tr>
<td>Number of pulses/turn</td>
<td>1 Vpp (32,768 pulses/turn)</td>
</tr>
<tr>
<td>Vibration</td>
<td>100 m/s² (65 ÷ 2000 Hz) IEC 60068-2-6</td>
</tr>
<tr>
<td>Natural frequency</td>
<td>≥ 1000 Hz</td>
</tr>
<tr>
<td>Shock</td>
<td>1,000 m/s² (6 gms) IEC 60068-2-27</td>
</tr>
<tr>
<td>Inertia</td>
<td>10,000 gr. cm²</td>
</tr>
<tr>
<td>Maximum mechanical speed</td>
<td>1,000 rpm</td>
</tr>
<tr>
<td>Maximum electrical speed</td>
<td>300 rpm (SSI Fagor, SSI Siemens®)</td>
</tr>
<tr>
<td>Turning torque</td>
<td>≤ 0.5 Nm</td>
</tr>
<tr>
<td>Weight</td>
<td>3.2 kg</td>
</tr>
<tr>
<td>Ambient characteristics:</td>
<td></td>
</tr>
<tr>
<td>Running temperature</td>
<td>0 °C...+50 °C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-30 °C...+80 °C</td>
</tr>
<tr>
<td>Protection</td>
<td>IP64 (DIN 40050) standard</td>
</tr>
<tr>
<td>Maximum frequency</td>
<td>180 kHz for 1 Vpp signal</td>
</tr>
<tr>
<td>Current under no load condition</td>
<td>Maximum 350 mA</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>5 V (3.6...5.25)</td>
</tr>
<tr>
<td>Output signals</td>
<td>1 Vpp (32,768 pulses/turn)</td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>100 m (SSI Fagor, FeeDat Fagor, SSI Siemens®)</td>
</tr>
<tr>
<td></td>
<td>30 m (DRIVE-CLiQ®, Siemens®, Fanuc®, Mitsubishi®, Panasonic®)</td>
</tr>
</tbody>
</table>

Order identification

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

<table>
<thead>
<tr>
<th>H</th>
<th>A</th>
<th>F</th>
<th>27</th>
<th>D200</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of shaft:</td>
<td>Letter identifying the absolute encoder</td>
<td>Type of communications protocol:</td>
<td>Absolute positions per turn:</td>
<td>Outside diameter:</td>
<td>Accuracy:</td>
</tr>
<tr>
<td>H: Hollow shaft</td>
<td></td>
<td>Blank space: SSI protocol (FAGOR)</td>
<td>27 bits (134,217,728 positions)</td>
<td>D200: 200 mm</td>
<td>± 2&quot; arc-seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D: FeeDat protocol (FAGOR)</td>
<td></td>
<td></td>
<td>± 1&quot; arc-seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S: SIEMENS® (SI) protocol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F: FANUC® (01 and 02) protocol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M: MITSUBISHI® CNC protocol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P: PANASONIC® (Matsushita) protocol</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
General characteristics

<table>
<thead>
<tr>
<th>Measurement</th>
<th>By means of graduated glass disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>± 5&quot; and ± 2.5&quot;</td>
</tr>
</tbody>
</table>
| Number of pulses/turn | 23 bits (8,388,608 positions)  
                                                                         27 bits (134,217,728 positions)  
                                                                         1 Vpp (16,384 pulses/turn)         |
| Vibration         | 100 m/sec² (55 – 2000 Hz) IEC 60068-2-6 |
| Natural frequency | ≥ 1,000 Hz                       |
| Shock             | 1,000 m/sec² (6 ms) IEC 60068-2-27 |
| Inertia           | 650 gr.cm²                       |
| Maximum mechanical speed | 3,000 rpm                   |
| Maximum electrical speed | 1,500 rpm                     |
| Turning torque    | ≤ 0.06 Nm                        |
| Weight            | 1 kg                             |
| Ambient characteristics: |                               |
| Running temperature | -20 °C...+70 °C (5"), 0 °C...+50 °C (2.5")   |
| Storage temperature | -30 °C...+80 °C                  |
| Protection        | IP64 (DIN 40050) standard       |
|                   | >IP64 with pressurized air at 0.8 ± 0.2 bar |
| Maximum frequency | 180 KHz for 1 Vpp signal         |
| Current under no load condition | Maximum 150 mA               |
| Supply voltage    | 5 V (3.6...5.25)                 |
| Output signals    | 1 Vpp (16,384 pulses/turn)      |
|                   | Differential TTL; EIA RS 485 / EIA RS 422 |
| Maximum cable length | 100 m (SSI FAGOR, FeeDat FAGOR, SSI Siemens®) |
|                   | 30 m (DRIVE-CLiQ®, Siemens®, Fanuc®, Mitsubishi®, Panasonic®) |

Order identification

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

<table>
<thead>
<tr>
<th>Type of shaft:</th>
<th>H: Hollow shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letter identifying the absolute encoder</td>
<td>A</td>
</tr>
<tr>
<td>Type of communications protocol:</td>
<td>F</td>
</tr>
<tr>
<td>Absolute positions per turn:</td>
<td>27</td>
</tr>
<tr>
<td>Outside diameter:</td>
<td>D90: 90 mm</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>± 5&quot; arc-seconds</td>
</tr>
<tr>
<td>Maximum frequency</td>
<td>180 KHz for 1 Vpp signal</td>
</tr>
<tr>
<td>Current under no load condition</td>
<td>Maximum 150 mA</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>5 V (3.6...5.25)</td>
</tr>
<tr>
<td>Output signals</td>
<td>1 Vpp (16,384 pulses/turn)</td>
</tr>
<tr>
<td>Differential TTL; EIA RS 485 / EIA RS 422</td>
<td></td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>100 m (SSI FAGOR, FeeDat FAGOR, SSI Siemens®)</td>
</tr>
<tr>
<td>30 m (DRIVE-CLiQ®, Siemens®, Fanuc®, Mitsubishi®, Panasonic®)</td>
<td></td>
</tr>
</tbody>
</table>

Dimensions in mm

Accuracy ± 2.5° ± 5°

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>D1</th>
<th>D2</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 2.5°</td>
<td>Ø 20 H6</td>
<td>Ø 20 H7</td>
</tr>
<tr>
<td>± 5°</td>
<td>Ø 30 H6</td>
<td>Ø 30 H7</td>
</tr>
</tbody>
</table>
### General characteristics

<table>
<thead>
<tr>
<th>Measurement</th>
<th>By means of graduated glass disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>± 2&quot;</td>
</tr>
<tr>
<td>Number of pulses/turn</td>
<td>23 bits (8,388,608 positions)</td>
</tr>
<tr>
<td></td>
<td>27 bits (134,217,728 positions)</td>
</tr>
<tr>
<td></td>
<td>1 Vpp (16,384 pulses/turn)</td>
</tr>
<tr>
<td>Vibration</td>
<td>100 m/sec² (65 = 2000 Hz) IEC 60068-2-6</td>
</tr>
<tr>
<td>Shock</td>
<td>1,000 m/sec² (6 ms) IEC-60068-2-27</td>
</tr>
<tr>
<td>Inertia</td>
<td>350 gr.cm²</td>
</tr>
<tr>
<td>Maximum mechanical speed</td>
<td>3,000 rpm</td>
</tr>
<tr>
<td>Maximum electrical speed</td>
<td>1,500 rpm</td>
</tr>
<tr>
<td>Turning torque</td>
<td>≤ 0.01 Nm</td>
</tr>
<tr>
<td>Load on the shaft</td>
<td>Axial: 1 kg</td>
</tr>
<tr>
<td></td>
<td>Radial: 1 kg</td>
</tr>
<tr>
<td>Weight</td>
<td>2.65 kg</td>
</tr>
<tr>
<td>Ambient characteristics:</td>
<td></td>
</tr>
<tr>
<td>Running temperature</td>
<td>0 °C...+50 °C</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-30 °C...+80 °C</td>
</tr>
<tr>
<td>Protection</td>
<td>IP64 (EN40050) standard</td>
</tr>
<tr>
<td></td>
<td>&gt;IP64 with pressured air at 0.8 ± 0.2 bar</td>
</tr>
<tr>
<td>Maximum frequency</td>
<td>180 kHz for 1 Vpp signal</td>
</tr>
<tr>
<td>Current under no load condition</td>
<td>Maximum 250 mA</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>5 V (3.6...5.25)</td>
</tr>
<tr>
<td>Signales de salida</td>
<td>1 Vpp (16,384 pulses/turn)</td>
</tr>
<tr>
<td></td>
<td>Differential TTL: EIA RS 485 / EIA RS 422</td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>100 m (SSI Fagor, FeeDat Fagor, SSI Siemens®)</td>
</tr>
<tr>
<td></td>
<td>30 m (DRMC CL/P®, Siemens®, Fanuc®, Mitsubishi®, Panasonic®)</td>
</tr>
</tbody>
</table>

### Order identification

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

<table>
<thead>
<tr>
<th>S</th>
<th>A</th>
<th>F</th>
<th>27</th>
<th>D170</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of shaft</td>
<td>Letter identifying the absolute encoder</td>
<td>Type of communications protocol:</td>
<td>Absolute positions per turn:</td>
<td>Outside diameter:</td>
<td>Accuracy:</td>
</tr>
<tr>
<td>S</td>
<td>Solid shaft</td>
<td>• Blank space: SSI protocol (FAGOR)</td>
<td>• 23 bits (8,388,608 positions)</td>
<td>D170: 170 mm</td>
<td>± 2° arc-seconds</td>
</tr>
<tr>
<td>D</td>
<td>Solid shaft</td>
<td>• S: SSI protocol (Siemens®) (SL) protocol</td>
<td>• 27 bits (134,217,728 positions)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>Solid shaft</td>
<td>• F: FANUC® (01 and 02) protocol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>Solid shaft</td>
<td>• M: MITSUBISHI® CNC protocol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Solid shaft</td>
<td>• P: PANASONIC® (Matsushita) protocol</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**General characteristics**

**Measurement**
- By means of graduated glass disk

**Accuracy**
- ± 5" and ± 2.5"

**Number of pulses/turn**
- 23 bits (8,388,608 positions)
- 27 bits (134,217,728 positions)
- 1 Vpp (16,384 pulses/turn)

**Vibration**
- 100 m/sec² (55 + 2000 Hz) [IEC 60068-2-6]

**Shock**
- 1000 m/sec²

**Inertia**
- 250 gr.cm²

**Maximum mechanical speed**
- 10,000 rpm

**Maximum electrical speed**
- 1500 rpm

**Turning torque**
- ≤ 0.01 Nm

**Load on the shaft**
- Axial: 1 kg
- Radial: 1 kg

**Weight**
- 0.8 kg

**Ambient characteristics:**
- Running temperature: -20 °C...+70 °C (5°), 0 °C...+50 °C (2.5°)
- Storage temperature: -30 °C...+80 °C

**Protection**
- IP64 (DIN 40050) standard
- >IP64 with pressurized air at 0.8 ± 0.2 bar

**Maximum frequency**
- 180 KHz for 1 Vpp signal

**Current under no load condition**
- Maximum 150 mA

**Supply voltage**
- 5 V (3.6...5.25)

**Signales de salida**
- 1 Vpp (16,384 pulses/turn)
- Differential TTL: EIA RS 485 / EIA RS 422

**Maximum cable length**
- 100 m (SSI Fagor, FeeDat Fagor, SSI Siemens®)
- 30 m (SERVE-CLQ®, Siemens®, Fanuc®, Mitsubishi®, Panasonic®)

---

**Order identification**

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

<table>
<thead>
<tr>
<th>S</th>
<th>A</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of shaft</td>
<td>Letter identifying the absolute encoder</td>
<td>Type of communications protocol:</td>
</tr>
<tr>
<td>• S: Solid shaft</td>
<td>• Blank space: SSI protocol (FAGOR)</td>
<td>• Blank space: ±5&quot; arc-seconds</td>
</tr>
<tr>
<td></td>
<td>• D: FeeDat protocol (FAGOR)</td>
<td>• 2: ±2&quot; arc-seconds</td>
</tr>
<tr>
<td></td>
<td>• S: SIEMENS® (SL) protocol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• F: FANUC® (01 and 02) protocol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• M: MITSUBISHI® (CNC) protocol</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• P: PANASONIC® (Matsushita) protocol</td>
<td></td>
</tr>
<tr>
<td><strong>Absolute positions per turn:</strong></td>
<td>23 bits (8,388,608 positions)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>27 bits (134,217,728 positions)</td>
<td></td>
</tr>
<tr>
<td><strong>Outside diameter:</strong></td>
<td>D90: 90 mm</td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy:</strong></td>
<td>Blank space: ±5&quot; arc-seconds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2: ±2&quot; arc-seconds</td>
<td></td>
</tr>
</tbody>
</table>
### SSI connection

#### UP TO 9 METERS

**Connector for direct connection to Fagor**

**EC...B-D**

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

**SUB D 15 HD connector (male Pin ▶)**

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

**Connector for direct connection to Siemens® SMC20**

**EC...B-S1**

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

**SUB D 25 connector (female Pin ▶)**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>A</td>
<td>Green</td>
</tr>
<tr>
<td>4</td>
<td>/A</td>
<td>Yellow</td>
</tr>
<tr>
<td>5</td>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>6</td>
<td>/B</td>
<td>Red</td>
</tr>
<tr>
<td>7</td>
<td>Data</td>
<td>Grey</td>
</tr>
<tr>
<td>8</td>
<td>/Data</td>
<td>Pink</td>
</tr>
<tr>
<td>9</td>
<td>Clock</td>
<td>Black</td>
</tr>
<tr>
<td>10</td>
<td>/Clock</td>
<td>Purple</td>
</tr>
<tr>
<td>11</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>12</td>
<td>+5 V</td>
<td>Light green</td>
</tr>
<tr>
<td>13</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>14</td>
<td>0 V</td>
<td>Orange</td>
</tr>
<tr>
<td>15</td>
<td>Ground</td>
<td>Internal shield</td>
</tr>
<tr>
<td>Housing</td>
<td>Ground</td>
<td>Internal shield</td>
</tr>
</tbody>
</table>

**Connector for direct connection to Siemens® SME25**

**EC...B-C9**

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

**CIRCULAR 17 connector (male Pin ▶)**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>A</td>
<td>Green</td>
</tr>
<tr>
<td>16</td>
<td>/A</td>
<td>Yellow</td>
</tr>
<tr>
<td>12</td>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>13</td>
<td>/B</td>
<td>Red</td>
</tr>
<tr>
<td>14</td>
<td>Data</td>
<td>Grey</td>
</tr>
<tr>
<td>17</td>
<td>/Data</td>
<td>Pink</td>
</tr>
<tr>
<td>8</td>
<td>Clock</td>
<td>Black</td>
</tr>
<tr>
<td>9</td>
<td>/Clock</td>
<td>Purple</td>
</tr>
<tr>
<td>17</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>1</td>
<td>+5 V</td>
<td>Light green</td>
</tr>
<tr>
<td>10</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>11</td>
<td>0 V</td>
<td>Orange</td>
</tr>
<tr>
<td>15</td>
<td>Ground</td>
<td>Internal shield</td>
</tr>
<tr>
<td>Housing</td>
<td>Ground</td>
<td>Internal shield</td>
</tr>
</tbody>
</table>
FROM 9 METERS ON

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

### EC-...B-C9

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

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

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

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

CIRCULAR 17 connector (female Pin ▶)
SUB D 25 HD connector (male Pin ◀)

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

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

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

CIRCULAR 17 connector (female Pin ▶)
CIRCULAR 17 connector (male Pin ◀)
direct connection cables

Connection to other CNC’s

**UP TO 9 METERS**

Connector for direct connection to FANUC®
**EC-...PA-FN**
*Lengths: 1, 3, 6 and 9 meters*

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Data</td>
<td>Green</td>
</tr>
<tr>
<td>2</td>
<td>/Data</td>
<td>Yellow</td>
</tr>
<tr>
<td>5</td>
<td>Request</td>
<td>Blue</td>
</tr>
<tr>
<td>6</td>
<td>/Request</td>
<td>Red</td>
</tr>
<tr>
<td>9</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>12</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>14</td>
<td>0 V</td>
<td>Pink</td>
</tr>
<tr>
<td>16</td>
<td>Ground</td>
<td>Shield</td>
</tr>
</tbody>
</table>

Connector for direct connection to MITSUBISHI®
**EC-...AM-MB**
*Lengths: 1, 3, 6 and 9 meters*

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>SD (MD)</td>
<td>Green</td>
</tr>
<tr>
<td>8</td>
<td>/SD (MD)</td>
<td>Yellow</td>
</tr>
<tr>
<td>3</td>
<td>RO (MR)</td>
<td>Grey</td>
</tr>
<tr>
<td>4</td>
<td>/RO (MR)</td>
<td>Pink</td>
</tr>
<tr>
<td>1</td>
<td>+5 V</td>
<td>Brown + purple</td>
</tr>
<tr>
<td>2</td>
<td>0 V</td>
<td>White + black + blue</td>
</tr>
<tr>
<td></td>
<td>Housing</td>
<td>Ground Shield</td>
</tr>
</tbody>
</table>

Connector for direct connection to Panasonic® MINAS A5
**EC-...PA-PN5**
*Lengths: 1, 3, 6 and 9 meters*

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Data</td>
<td>Green</td>
</tr>
<tr>
<td>4</td>
<td>/Data</td>
<td>Yellow</td>
</tr>
<tr>
<td>1</td>
<td>+5 V</td>
<td>Brown and grey</td>
</tr>
<tr>
<td>2</td>
<td>0 V</td>
<td>White and pink</td>
</tr>
<tr>
<td></td>
<td>Housing</td>
<td>Ground Shield</td>
</tr>
</tbody>
</table>

Connector for connection with extension cable (M12 H-RJ45) to Siemens® Sinamics/Sinumerik
**EC-...PA-DQ**
*Lengths: 1, 3, 6 and 9 meters*

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>RXP</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>RXN</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>TXN</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>TXP</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Vcc (24 V)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0 V</td>
<td></td>
</tr>
</tbody>
</table>

**FROM 9 METERS ON**
To Fanuc®: **EC-...B-C9 cable + XC-CB...FN extension cable**
To Mitsubishi®: **EC-...B-C9-F cable + XC-CB...MB extension cable**
To Panasonic® MINAS A5: **EC-...B-C9 cable + XC-CB...A-PN5 extension cable**
To Siemens®: **EC-...PA-DQ cable + (M12 H-RJ45) extension cable**

**EC-...B-C9**
*Lengths: 1 and 3 meters* (consult Fagor Automation for others)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Data</td>
<td>Grey</td>
</tr>
<tr>
<td>17</td>
<td>/Data</td>
<td>Pink</td>
</tr>
<tr>
<td>8</td>
<td>Request</td>
<td>Black</td>
</tr>
<tr>
<td>9</td>
<td>/Request</td>
<td>Purple</td>
</tr>
<tr>
<td>7</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>1</td>
<td>+5 V</td>
<td>Light green</td>
</tr>
<tr>
<td>10</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>4</td>
<td>0 V</td>
<td>Orange</td>
</tr>
<tr>
<td></td>
<td>Housing</td>
<td>Ground Shield</td>
</tr>
</tbody>
</table>

**EC-...B-C9-F**
*Lengths: 1 and 3 m with Ferrite* (consult Fagor Automation for others)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Data</td>
<td>Grey</td>
</tr>
<tr>
<td>17</td>
<td>/Data</td>
<td>Pink</td>
</tr>
<tr>
<td>8</td>
<td>Request</td>
<td>Black</td>
</tr>
<tr>
<td>9</td>
<td>/Request</td>
<td>Purple</td>
</tr>
<tr>
<td>7</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>1</td>
<td>+5 V</td>
<td>Light green</td>
</tr>
<tr>
<td>10</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>4</td>
<td>0 V</td>
<td>Orange</td>
</tr>
<tr>
<td></td>
<td>Housing</td>
<td>Ground Shield</td>
</tr>
</tbody>
</table>
**XC-C8... FN extension cable**
*Lengths: 5, 10, 15, 20 and 25 meters*

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

<table>
<thead>
<tr>
<th>Pin</th>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>1</td>
<td>Data</td>
<td>Grey</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>D/Date</td>
<td>Pink</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>Request</td>
<td>Purple</td>
</tr>
<tr>
<td>9</td>
<td>6</td>
<td>/Request</td>
<td>Yellow</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>+5 V</td>
<td>Brown/Green</td>
</tr>
<tr>
<td>1</td>
<td>18-20</td>
<td>0 V</td>
<td>White/Green</td>
</tr>
<tr>
<td>10</td>
<td>12</td>
<td>O V</td>
<td>White</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>O V sensor</td>
<td>White</td>
</tr>
</tbody>
</table>

Housing 16
Ground
Shield

**XC-C8... MB extension cable**
*Lengths: 5, 10, 15, 20 and 25 meters*

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

<table>
<thead>
<tr>
<th>Pin</th>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>7</td>
<td>SD (MD)</td>
<td>Purple</td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>/SD (MD)</td>
<td>Yellow</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>RQ (MR)</td>
<td>Grey</td>
</tr>
<tr>
<td>17</td>
<td>4</td>
<td>/RQ (MR)</td>
<td>Pink</td>
</tr>
<tr>
<td>1</td>
<td>−</td>
<td>+5 V sensor</td>
<td>Blue</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>GND</td>
<td>White/Green</td>
</tr>
<tr>
<td>4</td>
<td>−</td>
<td>0 V sensor</td>
<td>White</td>
</tr>
</tbody>
</table>

Housing
Ground
Shield

**XC-C8...A-PN5 extension cable**
*Lengths: 5, 10, 15, 20 and 25 meters*

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

<table>
<thead>
<tr>
<th>Pin</th>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>3</td>
<td>Data</td>
<td>Grey</td>
</tr>
<tr>
<td>17</td>
<td>4</td>
<td>D/Date</td>
<td>Pink</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>+5 V</td>
<td>Brown+Black</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>+5 V sensor</td>
<td>Green+Yellow</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>GND</td>
<td>White+Purple</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>GND sensor</td>
<td>Blue+Red</td>
</tr>
</tbody>
</table>

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

Measuring Methods
Fagor Automation uses two measuring methods in their incremental encoders:

- **Graduated glass**: Linear encoders with a measuring length of up to 3040 mm use optical transmission. The light from the LED goes through a graduated glass and a reticule before reaching the receiving photo diodes. The period of the generated electrical signals is the same as the graduation pitch.

- **Graduated steel**: Linear encoders over 3040 mm measuring length use graduated steel tape and image captured through diffused light as a measuring principle. The reading system consists of an LED as a light source, a mesh to make the image and a monolithic photo detector element in the plane of the image specially designed and patented by Fagor Automation.

Types of incremental encoders

- **Linear encoder**: Ideal for milling, grinding, lathe and boring mill applications requiring federates of up to 120 m/min and vibrations of up to 20 g.

- **Angular encoder**: Used as an angular movement sensor on machines/devices requiring high resolution and accuracy. Fagor Angular encoders offer from 18,000 to 360,000 pulses/turn and accuracy levels of ± 5", ± 2.5" and ± 2" depending on the model.

- **Rotary encoder**: Used as a measuring sensor for rotary movements, angular speeds and also linear movement when connected to a mechanical device like ball screw. They are also used on various types of machine tools and robotic applications.

Enclosed design
The robust aluminum profile encasing the graduated glass provides the primary protection. The sealing lips provides protection against contaminants and liquids as the reader head travels along the profile. The reader head movement along the graduated glass provides a perfectly balanced system accurately capturing the machine movement. The reader head travels on precision bearings with minimum contact with the profile hence minimizing the friction. The optional air inlet at both ends of the encoder and at the reader head provides increased protection levels against contaminants and liquids.
Reference signals ($I_0$)

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

Fagor Automation encoders have three types of reference marks $I_0$:

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

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

### Characteristics

<table>
<thead>
<tr>
<th>Signal</th>
<th>A, /A, B, /B, I₀, /I₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal level</td>
<td>V_H ≥ 2.5V, I_H = 20 mA</td>
</tr>
<tr>
<td></td>
<td>V_L ≤ 0.5V, I_L = 20 mA</td>
</tr>
<tr>
<td></td>
<td>With 1 m cable</td>
</tr>
<tr>
<td>90° reference signal (I₀)</td>
<td>Synchronized with A and B</td>
</tr>
<tr>
<td>Switching time</td>
<td>t+/t- &lt; 30 ns</td>
</tr>
<tr>
<td></td>
<td>With 1 m cable</td>
</tr>
<tr>
<td>Supply voltage and consumption</td>
<td>5 V ± 5%, 100 mA</td>
</tr>
<tr>
<td>T period</td>
<td>4, 2, 0.4, 0.2 µm</td>
</tr>
<tr>
<td>Max. cable length</td>
<td>50 meters</td>
</tr>
<tr>
<td>Load impedance</td>
<td>Zo = 120 Ω between differential</td>
</tr>
</tbody>
</table>

### Voltage drop across cable

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

\[
L_{\text{max}} = \frac{(VCC - 4.5) \times 500}{(Z_{\text{CABLE}}/\text{km}) \times I_{\text{MAX}}}
\]

**Example**

- Vcc = 5V, IMAX = 0.2 Amp (With 120 Ω load)
- Z (1 mm²) = 16.6 Ω/Km \((L_{\text{max}} = 75 \text{ m})\)
- Z (0.5 mm²) = 32 Ω/Km \((L_{\text{max}} = 39 \text{ m})\)
- Z (0.25 mm²) = 66 Ω/Km \((L_{\text{max}} = 19 \text{ m})\)
- Z (0.14 mm²) = 132 Ω/Km \((L_{\text{max}} = 9 \text{ m})\)
They are complementary sinusoidal signals whose differential value is 1 Vpp centered on Vcc. This characteristic together with a line termination of 120 Ω, twisted pair, and an overall shield provide greater immunity to electromagnetic noise caused by their environment.

### Characteristics

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals</td>
<td>A, /A, B, /B, I₀, /I₀</td>
</tr>
<tr>
<td>Vpp</td>
<td>1 V ± 20%, -40%</td>
</tr>
<tr>
<td>Vpp</td>
<td>1 V ± 20%, -40%</td>
</tr>
<tr>
<td>DC offset</td>
<td>2.5 V ± 0.5 V</td>
</tr>
<tr>
<td>Signal period</td>
<td>20 µm, 40 µm</td>
</tr>
<tr>
<td>Supply V</td>
<td>5 V ± 10%</td>
</tr>
<tr>
<td>Max. cable length</td>
<td>150 meters</td>
</tr>
<tr>
<td>A, B centered:</td>
<td></td>
</tr>
<tr>
<td>A&amp;B relationship: Vpp / Vpp</td>
<td>0.8 ÷ 1.25</td>
</tr>
<tr>
<td>A&amp;B phase shift:</td>
<td>90° ± 10°</td>
</tr>
<tr>
<td>I₀ amplitude: V₀</td>
<td>0.2 ÷ 0.8 V</td>
</tr>
<tr>
<td>I₀ width: L + R</td>
<td>I₀ min: 180°</td>
</tr>
<tr>
<td></td>
<td>I₀ typ: 360°</td>
</tr>
<tr>
<td></td>
<td>I₀ max: 540°</td>
</tr>
<tr>
<td>I₀ synchronism: L, R</td>
<td>180° ± 90°</td>
</tr>
</tbody>
</table>

### Voltage drop across cable

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

\[
L_{\text{max}} = \frac{(V_{\text{CC}} - 4.5) \times 500}{Z_{\text{CABLE}} \times I_{\text{MAX}}} 
\]

**Example**

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

### 1 Vpp signal damping due to the cable section

Besides attenuation due to signal frequency, there is another signal attenuation caused by the section of the cable connected to the encoder.
Analyze the application to make sure that the proper encoder will be selected for the machine.

To do this, bear in mind the following considerations:

**Linear**

**Installation**
Consider the physical length of the installation and the space available for it. These aspects are crucial to determine the type of linear encoder to use (type of profile).

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

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

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

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

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

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

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

**Angular**

**Installation**
This point considers the physical dimensions of the installation and the space available for it. It is essential to determine its type of shaft: Hollow or solid.

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

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

**Rotary**

**Installation**
This point considers the physical dimensions of the installation and the space available for it. It is essential to determine its type of shaft: Hollow or solid.

---

### Linear Range

<table>
<thead>
<tr>
<th>Series</th>
<th>Section</th>
<th>Measuring lengths</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long</td>
<td><img src="image1.png" alt="Diagram" /></td>
<td>400 mm to 60 m</td>
</tr>
<tr>
<td><strong>G</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wide</td>
<td><img src="image2.png" alt="Diagram" /></td>
<td>140 mm to 3,040 mm</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced</td>
<td><img src="image3.png" alt="Diagram" /></td>
<td>70 mm to 1,240 mm</td>
</tr>
<tr>
<td><strong>SV</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduced</td>
<td><img src="image4.png" alt="Diagram" /></td>
<td>70 mm to 2,040 mm</td>
</tr>
</tbody>
</table>

### Angular Range

<table>
<thead>
<tr>
<th>Series</th>
<th>Section</th>
<th>Type of shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-D200</td>
<td><img src="image5.png" alt="Diagram" /></td>
<td>Hollow shaft</td>
</tr>
<tr>
<td>H-D90</td>
<td><img src="image6.png" alt="Diagram" /></td>
<td>Hollow shaft</td>
</tr>
<tr>
<td>S-D170</td>
<td><img src="image7.png" alt="Diagram" /></td>
<td>Solid shaft</td>
</tr>
<tr>
<td>S-1024-D90</td>
<td><img src="image8.png" alt="Diagram" /></td>
<td>Solid shaft</td>
</tr>
<tr>
<td>S-D90</td>
<td><img src="image9.png" alt="Diagram" /></td>
<td>Solid shaft</td>
</tr>
</tbody>
</table>

### Rotary Range

<table>
<thead>
<tr>
<th>Series</th>
<th>Section</th>
<th>Type of shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td><img src="image10.png" alt="Diagram" /></td>
<td>Hollow shaft</td>
</tr>
<tr>
<td>S</td>
<td><img src="image11.png" alt="Diagram" /></td>
<td>Solid shaft</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Signals</td>
<td>Pitch Resolution up to</td>
</tr>
<tr>
<td>----------</td>
<td>---------</td>
<td>------------------------</td>
</tr>
<tr>
<td>± 5 µm</td>
<td>LVpp</td>
<td>0.1 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>1 µm</td>
</tr>
<tr>
<td>± 5 µm and ± 3 µm</td>
<td>LVpp</td>
<td>0.1 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>1 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>0.5 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>0.1 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>0.05 µm</td>
</tr>
<tr>
<td>± 5 µm and ± 3 µm</td>
<td>LVpp</td>
<td>0.1 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>1 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>0.5 µm</td>
</tr>
<tr>
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<td>TTL</td>
<td>0.1 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>0.05 µm</td>
</tr>
<tr>
<td>± 5 µm and ± 3 µm</td>
<td>LVpp</td>
<td>0.1 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>1 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>0.5 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>0.1 µm</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>0.05 µm</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Signals</th>
<th>Model</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 2&quot; (arc-seconds)</td>
<td>LVpp</td>
<td>HP-D200 / HOP-D200</td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>H-D200 / HO-D200</td>
<td></td>
</tr>
<tr>
<td>± 5&quot;, ± 2,5&quot; (arc-seconds)</td>
<td>LVpp</td>
<td>HP-D90 / HOP-D90</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>H-D90 / HO-D90</td>
<td></td>
</tr>
<tr>
<td>± 2&quot; (arc-seconds)</td>
<td>LVpp</td>
<td>SP-D170 / SOP-D170</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>S-D170 / SO-D170</td>
<td></td>
</tr>
<tr>
<td>± 5&quot; (arc-seconds)</td>
<td>LVpp (dual feedback)</td>
<td>SP/SOP 18000-1024-D90</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>TTL (dual feedback)</td>
<td>S/SO 18000-1024-D90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>S/SO 90000-1024-D90</td>
<td></td>
</tr>
<tr>
<td>± 5&quot;, ± 2,5&quot; (arc-seconds)</td>
<td>LVpp</td>
<td>SP-D90 / SOP-D90</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>S-D90 / SO-D90</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Signals</th>
<th>Model</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>± 1/10 of the pitch</td>
<td>LVpp</td>
<td>HP</td>
<td>52 and 53</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>H / HA</td>
<td></td>
</tr>
<tr>
<td>± 1/10 of the pitch</td>
<td>LVpp</td>
<td>SP</td>
<td>52 and 53</td>
</tr>
<tr>
<td></td>
<td>TTL</td>
<td>S</td>
<td></td>
</tr>
</tbody>
</table>
Specially designed for high performance environment requiring speed and accuracy.

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

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

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

### Characteristics

<table>
<thead>
<tr>
<th></th>
<th>LX</th>
<th>LP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td>By means of a 40 µm-pitch stainless steel tape</td>
<td></td>
</tr>
<tr>
<td>Steel tape thermal expansion coefficient</td>
<td>αtherm: 11 ppm/K aprox.</td>
<td>Up to 0.1 µm</td>
</tr>
<tr>
<td>Measuring resolution</td>
<td>1 µm</td>
<td>Up to 0.1 µm</td>
</tr>
<tr>
<td>Output signals</td>
<td>TTL differential</td>
<td>1 Vpp</td>
</tr>
<tr>
<td>Incremental signal period</td>
<td>4 µm</td>
<td>40 µm</td>
</tr>
<tr>
<td>Limit frequency</td>
<td>500 kHz</td>
<td>50 kHz</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>120 m/min</td>
<td>120 m/min</td>
</tr>
<tr>
<td>Minimum distance between flanks</td>
<td>0.5 microseconds</td>
<td>–</td>
</tr>
<tr>
<td>Reference marks I0</td>
<td>LX and LP: every 50 mm</td>
<td></td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>50 m</td>
<td>150 m</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>5 V ± 10%, &lt; 150 mA (without load)</td>
<td></td>
</tr>
<tr>
<td>Accuracy of shaft</td>
<td>± 5 µm/µm</td>
<td>± 5 µm/µm</td>
</tr>
<tr>
<td>Maximum vibration</td>
<td>10 g (55 ... 2000 Hz) IEC 60068-2-6</td>
<td></td>
</tr>
<tr>
<td>Maximum shock</td>
<td>30 g (11 ms) IEC 60068-2-27</td>
<td></td>
</tr>
<tr>
<td>Maximum acceleration</td>
<td>10 g in the measuring direction</td>
<td></td>
</tr>
<tr>
<td>Required moving force</td>
<td>&lt; 5 N</td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>0 °C ... 50 °C</td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20 °C ... 70 °C</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>1.50 kg + 4 kg/m</td>
<td></td>
</tr>
<tr>
<td>Relative humidity</td>
<td>20 ... 80%</td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>IP 53 (standard)</td>
<td>IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders</td>
</tr>
<tr>
<td>Reader head</td>
<td>With built-in connector</td>
<td>Connection at both ends of the reader head</td>
</tr>
</tbody>
</table>
Order identification

Example of Linear Encoder LOP - 102 - A

<table>
<thead>
<tr>
<th>L</th>
<th>O</th>
<th>P</th>
<th>102</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of profile for long space</td>
<td>Type of reference mark L:</td>
<td>Type of signal:</td>
<td>Ordering length code:</td>
<td>Air intake on the reader head:</td>
</tr>
<tr>
<td></td>
<td>• Blank space: Incremental, one mark every 50 mm</td>
<td>• X: 1 µm resolution differential TTL&lt;br&gt;• P: 1 Vpp sinusoidal</td>
<td>In the example (102) = 10-240 mm</td>
<td>• Blank space: Without air intake&lt;br&gt;• A: With air intake</td>
</tr>
</tbody>
</table>
Specially designed for high performance environment requiring high speed and accuracy.

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

## Characteristics

<table>
<thead>
<tr>
<th>GX</th>
<th>GY</th>
<th>GW</th>
<th>GZ</th>
<th>GP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>By means of a 20 µm-pitch graduated glass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Glass thermal expansion coefficient</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\alpha_{\text{therm}}$: 8 ppm/K aprox.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Measuring resolution</strong></td>
<td>1 µm</td>
<td>0.5 µm</td>
<td>0.1 µm</td>
<td>0.05 µm</td>
</tr>
<tr>
<td><strong>Output signals</strong></td>
<td>TTL differential</td>
<td>TTL differential</td>
<td>TTL differential</td>
<td>TTL differential</td>
</tr>
<tr>
<td><strong>Incremental signal period</strong></td>
<td>4 µs</td>
<td>2 µs</td>
<td>4 µs</td>
<td>0.2 µs</td>
</tr>
<tr>
<td><strong>Limit frequency</strong></td>
<td>500 kHz</td>
<td>1 MHz</td>
<td>1.5 MHz</td>
<td>500 kHz</td>
</tr>
<tr>
<td><strong>Maximum speed</strong></td>
<td>120 m/min</td>
<td>120 m/min</td>
<td>36 m/min</td>
<td>6 m/min (*)</td>
</tr>
<tr>
<td><strong>Minimum distance between flanks</strong></td>
<td>0.5 microseconds</td>
<td>0.25 microseconds</td>
<td>0.1 microseconds</td>
<td>0.3 microseconds</td>
</tr>
<tr>
<td><strong>Reference marks</strong> $I_0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GX, GY, GW, GZ and GP: every 50 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GOX, GOY, GOW, GOZ and GOP: distance-coded $I_0$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GSX, GSY, GSW, GSZ and GSP: selectable $I_0$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum cable length</strong></td>
<td>50 m</td>
<td>50 m</td>
<td>50 m</td>
<td>50 m</td>
</tr>
<tr>
<td><strong>Supply voltage</strong></td>
<td>5 V ± 10%, &lt; 150 mA (without load)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
</tr>
<tr>
<td></td>
<td>± 3 µm/m</td>
<td>± 3 µm/m</td>
<td>± 3 µm/m</td>
<td>± 3 µm/m</td>
</tr>
<tr>
<td><strong>Maximum vibration</strong></td>
<td>20 g (55 ... 2000 Hz) IEC 60068-2-6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum shock</strong></td>
<td>30 g (11 ms) IEC 60068-2-27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum acceleration</strong></td>
<td>10 g in the measuring direction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Required moving force</strong></td>
<td>&lt; 5 N</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operating temperature</strong></td>
<td>0 °C ... 50 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Storage temperature</strong></td>
<td>-20 °C ... 70 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>0.25 kg + 2.25 kg/m</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Relative humidity</strong></td>
<td>20 ... 80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Protection</strong></td>
<td>IP 53 (standard)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reader</strong></td>
<td>With built-in connector</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connection at both ends of the reader head</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*): contact FAGOR for higher speed.
**Order identification**

Example of Linear Encoder: GDX - 1640 - 5 - A

<table>
<thead>
<tr>
<th>G</th>
<th>O</th>
<th>X</th>
<th>1640</th>
<th>5</th>
<th>A</th>
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<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Type of profile for wide space</strong></td>
<td><strong>Type of reference mark I_s</strong></td>
<td><strong>Type of signal:</strong></td>
<td><strong>Measuring lengths in millimeters:</strong></td>
<td><strong>Accuracy of the linear encoder:</strong></td>
<td><strong>Air Intake on the reader head:</strong></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>G</td>
<td>O</td>
<td>X</td>
<td>1640</td>
<td>5</td>
<td>A</td>
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<tr>
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<td></td>
</tr>
<tr>
<td>Non-distance coded</td>
<td>Blank space: Incremental, one mark every 50 mm</td>
<td>X: 1 µm resolution differential TTL</td>
<td>In the example (1640) = 1640 mm</td>
<td>± 5 µm</td>
<td>Blank space: Without air intake</td>
</tr>
<tr>
<td>Distance coded</td>
<td>G: Distance-coded marks</td>
<td>Y: 0.5 µm resolution differential TTL</td>
<td></td>
<td>± 3 µm</td>
<td>A: With air intake</td>
</tr>
<tr>
<td></td>
<td>S: Selectable reference marks</td>
<td>W: 0.1 µm resolution differential TTL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Z: 0.05 µm resolution differential TTL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>P: 1 Vpp sinusoidal</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Specially designed for high performance environment requiring high speed and accuracy. Ideal for limited mounting spaces.

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

**Characteristics**

<table>
<thead>
<tr>
<th></th>
<th>SX</th>
<th>SY</th>
<th>SW</th>
<th>SZ</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measurement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass thermal expansion coefficient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring resolution</td>
<td>1 µm</td>
<td>0.5 µm</td>
<td>0.1 µm</td>
<td>0.05 µm</td>
<td>Up to 0.1 µm</td>
</tr>
<tr>
<td>Output signals</td>
<td>TTL differential</td>
<td>TTL differential</td>
<td>TTL differential</td>
<td>TTL differential</td>
<td>1 Vpp</td>
</tr>
<tr>
<td>Incremental signal period</td>
<td>4 µm</td>
<td>2 µm</td>
<td>0.4 µm</td>
<td>0.2 µm</td>
<td>20 µm</td>
</tr>
<tr>
<td>Limit frequency</td>
<td>500 KHz</td>
<td>1 MHz</td>
<td>1.5 MHz</td>
<td>500 KHz</td>
<td>100 KHz</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>120 m/min</td>
<td>120 m/min</td>
<td>36 m/min</td>
<td>6 m/min (*)</td>
<td>120 m/min</td>
</tr>
<tr>
<td>Minimum distance between flanks</td>
<td>0.5 microseconds</td>
<td>0.25 microseconds</td>
<td>0.1 microseconds</td>
<td>0.3 microseconds</td>
<td>–</td>
</tr>
<tr>
<td>Reference marks I₀</td>
<td>SX, SY, SW, SZ and SP: every 50 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>50 m</td>
<td>50 m</td>
<td>50 m</td>
<td>50 m</td>
<td>150 m</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>5 V ± 10%, &lt; 150 mA (without load)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
<td>± 5 µm/m</td>
</tr>
<tr>
<td>Maximum vibration</td>
<td>10 g without mounting plate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum shock</td>
<td>30 g (11 ms) IEC 60068-2-27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum acceleration</td>
<td>10 g in the measuring direction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required moving force</td>
<td>&lt; 4 N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>0 ºC … 50 ºC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20 ºC … 70 ºC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>0.20 kg + 0.50 kg/m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative humidity</td>
<td>20 … 80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>IP 53 (standard)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reader</td>
<td>IP 64 (DIN 40058) using pressurized air at 0.8 ± 0.2 bar in linear encoders</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) : contact FAGOR for higher speed.
**Order identification**

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

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

**Dimensions in mm**

- 0.1 \( \times \) 
- 0.03 

**Measuring lengths in millimeters:**

- In the example (420) = 420 mm
Specially designed for high performance environments requiring high speed and accuracy and the need to withstand higher vibrations.

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

### Measuring lengths in millimeters

<table>
<thead>
<tr>
<th>Lengths</th>
<th>SVX</th>
<th>SVY</th>
<th>SVW</th>
<th>SVZ</th>
<th>SVP</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>120</td>
<td>170</td>
<td>220</td>
<td>270</td>
<td>320</td>
</tr>
<tr>
<td>370</td>
<td>420</td>
<td>470</td>
<td>520</td>
<td>570</td>
<td>620</td>
</tr>
<tr>
<td>670</td>
<td>720</td>
<td>770</td>
<td>820</td>
<td>870</td>
<td>920</td>
</tr>
<tr>
<td>970</td>
<td>1020</td>
<td>1070</td>
<td>1120</td>
<td>1180</td>
<td>1240</td>
</tr>
<tr>
<td>1340</td>
<td>1440</td>
<td>1540</td>
<td>1640</td>
<td>1740</td>
<td>1840</td>
</tr>
<tr>
<td>2040</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>SVX</th>
<th>SVY</th>
<th>SVW</th>
<th>SVZ</th>
<th>SVP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass thermal expansion coefficient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measuring resolution</td>
<td>1 µm</td>
<td>0.5 µm</td>
<td>0.1 µm</td>
<td>0.05 µm</td>
<td>Up to 0.1 µm</td>
</tr>
<tr>
<td>Output signals</td>
<td>TTL differential</td>
<td>TTL differential</td>
<td>TTL differential</td>
<td>TTL differential</td>
<td>1 Vpp</td>
</tr>
<tr>
<td>Incremental signal period</td>
<td>4 µm</td>
<td>2 µm</td>
<td>0.4 µm</td>
<td>0.2 µm</td>
<td>20 µm</td>
</tr>
<tr>
<td>Limit frequency</td>
<td>500 KHz</td>
<td>1 MHz</td>
<td>1,5 MHz</td>
<td>500 KHz</td>
<td>100 KHz</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>120 m/min</td>
<td>120 m/min</td>
<td>36 m/min</td>
<td>6 m/min (*)</td>
<td>120 m/min</td>
</tr>
<tr>
<td>Minimum distance between flanks</td>
<td>0.5 microseconds</td>
<td>0.25 microseconds</td>
<td>0.1 microseconds</td>
<td>0.3 microseconds</td>
<td>–</td>
</tr>
<tr>
<td>Reference marks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>50 m</td>
<td>50 m</td>
<td>50 m</td>
<td>50 m</td>
<td>150 m</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>5 V ± 10%, &lt; 150 mA (without load)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>± 5 µm/m</td>
<td>± 3 µm/m</td>
<td>± 5 µm/m</td>
<td>± 3 µm/m</td>
<td>± 5 µm/m</td>
</tr>
<tr>
<td>Maximum vibration</td>
<td>20 g with mounting plate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum shock</td>
<td>30 g (11 ms) IEC 60068-2-27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum acceleration</td>
<td>10 g in the measuring direction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Required moving force</td>
<td>&lt; 4 N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>0 ºC... 50 ºC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20 ºC... 70 ºC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>0.25 kg + 1.35 kg/m</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative humidity</td>
<td>20 ... 80%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>IP 53 (standard)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reader</td>
<td>IP 64 (DIN 40050) using pressurized air at 0.8 ± 0.2 bar in linear encoders</td>
<td>With built-in connector</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(*) : contact FAGOR for higher speed.
### Order identification

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

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

**Type of profile**

- SV: Vibration mounting for up to 20 g

**Type of reference mark**

- Blank space: Incremental, one mark every 50 mm
- D: Distance-coded marks
- S: Selectable reference marks

**Type of signal**

- X: 1 μm resolution differential TTL
- Y: 0.5 μm resolution differential TTL
- W: 0.1 μm resolution differential TTL
- Z: 0.05 μm resolution differential TTL
- P: 1 Vpp sinusoidal

**Measuring lengths in millimeters**

- In the example (420) = 420 mm

**Precision del encoder lineal**

- 5: ± 5 μm
- 3: ± 3 μm

**Linear encoder built-in support**

- B: With built-in support for vibration up to 20 g

**Air intake on the reader head**

- Blank space: Without air intake
- A: With air intake
H-D200 series

General characteristics

Measurement: By means of graduated glass disk
Accuracy: ± 2"
Number of pulses/turn: 18,000, 36,000, 90,000, 180,000 and 360,000
Vibration: 100 m/s² (0.05...2000 Hz) IEC 60068-2-6
Natural frequency: ≥ 1000 Hz
Shock: 1000 m/s² (8 ms) IEC 60068-2-27
Inertia: 10,000 g·cm²
Maximum mechanical speed: 1,000 rpm

<table>
<thead>
<tr>
<th>Maximum electrical speed</th>
<th>1 Vpp</th>
<th>TTL</th>
</tr>
</thead>
<tbody>
<tr>
<td>18,000</td>
<td>&lt; 1,000 min⁻¹</td>
<td>&lt; 600 min⁻¹</td>
</tr>
<tr>
<td>36,000</td>
<td>&lt; 1,000 min⁻¹</td>
<td>&lt; 300 min⁻¹</td>
</tr>
<tr>
<td>90,000</td>
<td>&lt; 666 min⁻¹</td>
<td></td>
</tr>
<tr>
<td>180,000</td>
<td>&lt; 333 min⁻¹</td>
<td></td>
</tr>
<tr>
<td>360,000</td>
<td>&lt; 166 min⁻¹</td>
<td></td>
</tr>
</tbody>
</table>

Turning torque: ≤ 0.5 Nm
Weight: 3.2 kg

Ambient characteristics:
- Running temperature: 0 °C...+50 °C
- Storage temperature: -30 °C...+80 °C

Protection:
P64 (IEC 60529) standard
>P64 with pressurized air at 0.8 ± 0.2 bar

Maximum frequency:
- 180 kHz for 1 Vpp signal
- 1 MHz for TTL signal

Supply voltage:
- 5 V ± 5% (TTL), 5 V ± 10% (1 Vpp)

Reference signal \( I_0 \):
- One reference signal per encoder turn or distance-coded \( I_0 \)

Output signals:
- TTL differential (18,000, 36,000, 90,000, 180,000 and 360,000 Pulses/turn)
- 1 Vpp (18,000 and 36,000 Pulses/turn)
- Signals TTL: 50 m
- Signals 1 Vpp: 150 m

Order identification

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

<table>
<thead>
<tr>
<th>H</th>
<th>O</th>
<th>18000</th>
<th>D200</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>H: Hollow shaft</td>
<td>Type of reference mark ( I_0 ): Blank space: Incremental, one per revolution, Distance-coded marks</td>
<td>Type of signal: Blank space: Differential TTL, P: 1 Vpp sinusoidal</td>
<td>Number of pulses/turn of the first feedback: 18,000: on 1 Vpp and TTL models, 36,000: on 1 Vpp and TTL models, 90,000: only on TTL models, 180,000: only on TTL models, 360,000: only on TTL models</td>
<td>Diameter: D200: 200 mm</td>
</tr>
</tbody>
</table>
General characteristics

**Measurement**
- By means of graduated glass disk

**Accuracy**
- ± 5° and ± 2.5°

**Number of pulses/turn**
- 18 000, 90 000 and 180 000

**Vibration**
- 100 m/sec² (55 + 2 000 Hz) IEC 60068-2-6

**Natural frequency**
- ≥ 1 000 Hz

**Shock**
- 1 000 m/sec² (6 ms) IEC 60068-2-27

**Inertia**
- 650 gr/cm²

**Maximum mechanical speed**
- 3 000 rpm

**Maximum electrical speed**

<table>
<thead>
<tr>
<th>Pulses</th>
<th>TTL</th>
<th>1 Vpp</th>
</tr>
</thead>
<tbody>
<tr>
<td>18000</td>
<td>&lt; 3000 min⁻¹</td>
<td>&lt; 600 min⁻¹</td>
</tr>
<tr>
<td>90000</td>
<td>&lt; 666 min⁻¹</td>
<td></td>
</tr>
<tr>
<td>180000</td>
<td>&lt; 333 min⁻¹</td>
<td></td>
</tr>
</tbody>
</table>

**Turning torque**
- ≤ 0.08 Nm

**Weight**
- 1 kg

**Ambient characteristics:**
- **Running temperature**
  - -20 °C…+70 °C
  - -30 °C…+80 °C

**Protection**
- IP64 (DIN 40050) standard
- >IP64 with pressurized air at 0.8 ± 0.2 bar

**Maximum frequency**
- 180 KHz for 1 Vpp signal
- 2 MHz for TTL signal

**Consumption without load**
- Maximum 150 mA

**Supply voltage**
- 5 V ± 5% (TTL); 5 V ± 10% (1 Vpp)

**Reference signal I₀**
- One reference signal per encoder turn or distance-coded I₀

**Output signals**
- ⊗ TTL differential
- 1 Vpp (18 000 Pulses/turn)
- 1 Vpp (18 000 Pulses/turn)

**Maximum cable length**
- Signals TTL: 50 m
- 1 Vpp: 150 m

Order identification

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

<table>
<thead>
<tr>
<th>H</th>
<th>O</th>
<th>P</th>
<th>18000</th>
<th>D90</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of shaft:</td>
<td>Type of reference mark I₀:</td>
<td>Type of signal:</td>
<td>Number of pulses/turn of the first feedback:</td>
<td>Diameter:</td>
<td>Accuracy:</td>
</tr>
<tr>
<td>• H: Hollow shaft</td>
<td>• Blank space: Incremental, one per revolution</td>
<td>• Blank space: Differential TTL</td>
<td>• 18 000: On 1 Vpp and TTL models</td>
<td>• D90: 90 mm</td>
<td>• Blank space: ±5° arc-seconds</td>
</tr>
<tr>
<td></td>
<td>• O: Distance-coded marks</td>
<td>• P: 1 Vpp sinusoidal</td>
<td>• 90 000: Only on TTL models</td>
<td></td>
<td>• ±2.5° arc-seconds</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• 180 000: Only on TTL models</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
General characteristics

Measurement
By means of graduated glass disk

Accuracy
± 2”

Number of pulses/turn
18 000, 90 000 and 180 000

Vibration
100 m/sec² (65 – 2000 Hz) EC 60068-2-6

Natural frequency
300 m/sec² (~6 m) EC 60068-2-27

Inertia
350 gr/cm²

Maximum mechanical speed
3 000 rpm

Type of shaft:
• S: Solid shaft

Type of reference mark
I

• Blank space: Incremental, one per revolution
• G: Distance-coded marks

Type of signal:
• Blank space: Differential TTL
• P: 1 Vpp sinusoidal

Number of pulses/turn of the first feedback:
• 18 000: on 1 Vpp and TTL models
• 90 000: only on TTL models
• 180 000: only on TTL models

Dimensions in mm

Order identification

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

<table>
<thead>
<tr>
<th>S</th>
<th>O</th>
<th>P</th>
<th>18000</th>
<th>D170</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of shaft:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• S: Solid shaft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of reference mark I₂</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Blank space: Incremental, one per revolution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• G: Distance-coded marks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of signal:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Blank space: Differential TTL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• P: 1 Vpp sinusoidal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of pulses/turn of the first feedback:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 18 000: on 1 Vpp and TTL models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 90 000: only on TTL models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 180 000: only on TTL models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diameter:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• D170: 170 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• 2: ±2” arc-seconds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## General characteristics

<table>
<thead>
<tr>
<th>Measurement</th>
<th>By means of graduated glass disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>± 5°</td>
</tr>
<tr>
<td>Number of pulses/turn</td>
<td>90 000-1024 / 18 000-1024</td>
</tr>
<tr>
<td>Vibration</td>
<td>100 m/sec² (55 + 2000 Hz) IEC 60068-2-6</td>
</tr>
<tr>
<td>Shock</td>
<td>1 000 m/sec² (6 ms) IEC 60068-2-27</td>
</tr>
<tr>
<td>Inertia</td>
<td>240 gr/cm²</td>
</tr>
<tr>
<td>Maximum mechanical speed</td>
<td>10 000 rpm</td>
</tr>
<tr>
<td>Dimensions in mm</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum electrical speed</th>
<th>Pulses</th>
<th>TTL</th>
<th>1 vpp</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 000/90 000</td>
<td>&lt; 3 000 min⁻¹</td>
<td>&lt; 600 min⁻¹</td>
<td></td>
</tr>
</tbody>
</table>

| Turning torque | ≤ 0.01 Nm |
| Load on the shaft | Axial: 1 kg Radial: 1 kg |
| Weight          | 0.8 kg    |

| Ambient characteristics: | |
| Running temperature    | -20 °C…+70 °C |
| Storage temperature    | -30 °C…+80 °C |

| Protection | IP64 (DIN 40050) standard |
|           | >IP64 with pressurized air at 0.8 ± 0.2 bar |

| Maximum frequency | 180 kHz for 1 vpp signal |
|                   | 1 MHz for TTL signal    |

| Consumption without load | Maximum 250 mA |
| Supply voltage | 5 V ± 5% (TTL); 5V ±10% (1 Vpp) |

| Reference signal | One reference signal per encoder turn or distance-coded I₀ |
| Output signals 1st Feedback | TTL differential (18 000 and 90 000 Pulses/turn) |
|                       | 1 Vpp (18 000 Pulses/turn) |
| Output signals 2nd Feedback | TTL differential (1 024 Pulses/turn) |
|                         | 1 Vpp (1 024 Pulses/turn) |
| Maximum cable length | Signals TTL: 50 m |
|                       | 1 Vpp: 150 m |

## Order identification

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

<table>
<thead>
<tr>
<th>S</th>
<th>O</th>
<th>P</th>
<th>18000-1024</th>
<th>D90</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of shaft:</td>
<td>• S: Solid shaft</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Type of reference mark I₀: | • Blank space: Incremental, one per revolution  
|                          | • O: Distance-coded marks |
| Type of signal: | • Blank space: Differential TTL  
|                  | • P: 1 Vpp sinusoidal |
| Number of pulses/turn: | • 18 000-1024: On 1 Vpp and TTL models  
|                          | • 90 000-1024: Only on TTL models |
| Diameter: | • D90: 90 mm |
### General characteristics

<table>
<thead>
<tr>
<th>Measurement</th>
<th>By means of graduated glass disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>± 5° and ± 2.5°</td>
</tr>
<tr>
<td>Number of pulses/turn</td>
<td>18,000, 90,000 and 180,000</td>
</tr>
<tr>
<td>Vibration</td>
<td>100 m/sec² (65 - 2000 Hz) IEC 60068-2-6</td>
</tr>
<tr>
<td>Shock</td>
<td>1,000 m/sec² (6 ms) IEC 60068-2-27</td>
</tr>
<tr>
<td>Inertia</td>
<td>240 gr/cm²</td>
</tr>
<tr>
<td>Maximum mechanical speed</td>
<td>10,000 rpm</td>
</tr>
<tr>
<td>Maximum electrical speed</td>
<td>Pulses: 18,000, 90,000, 180,000</td>
</tr>
<tr>
<td>Turning torque</td>
<td>≤ 0.01 Nm</td>
</tr>
<tr>
<td>Load on the shaft</td>
<td>Axial: 1 kg Radial: 1 kg</td>
</tr>
<tr>
<td>Weight</td>
<td>0.8 kg</td>
</tr>
<tr>
<td>Ambient characteristics:</td>
<td></td>
</tr>
<tr>
<td>Running temperature</td>
<td>-20 °C...+70 °C (5°), 0 °C...+50 °C (2.5°)</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-30 °C...+80 °C</td>
</tr>
<tr>
<td>Protection</td>
<td>IP64 (DIN 40050) standard &gt;IP64 with pressurized air at 0.8 ± 0.2 bar</td>
</tr>
<tr>
<td>Maximum frequency</td>
<td>180 kHz for 1 Vpp signal 1 MHz for TTL signal</td>
</tr>
<tr>
<td>Consumption without load</td>
<td>Maximum 150 mA</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>5 V ± 5% (TTL); 5 V ± 10% (1 Vpp)</td>
</tr>
<tr>
<td>Reference signal I₀</td>
<td>One reference signal per encoder turn or distance-coded I₀</td>
</tr>
<tr>
<td>Output signals</td>
<td>TTL differential (18,000, 90,000 and 180,000 Pulses/turn) 1 Vpp (18,000 Pulses/turn)</td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>Signals TTL: 50 m 1 Vpp: 150 m</td>
</tr>
</tbody>
</table>

### Order identification

#### Example of Angular Encoder: SOP - 18000 - D90-2

<table>
<thead>
<tr>
<th>S</th>
<th>O</th>
<th>P</th>
<th>18000</th>
<th>D90</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of shaft:</td>
<td>• S: Solid shaft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Type of reference mark I₀: | • Blank space: Incremental, one per revolution  
• Ø: Distance-coded marks |
| Type of signal: | • Blank space: Differential TTL  
• P: 1 Vpp sinusoidal |
| Number of pulses/turn of the first feedback | 18,000: On 1 Vpp and TTL models  
90,000: Only on TTL models  
180,000: Only on TTL models |
| Diameter: | • D90: 90 mm |
| Accuracy: | • Blank space: ± 5° arc-seconds  
• 2: ± 2.5° arc-seconds |
# Incremental

## H, S series ROTARY

<table>
<thead>
<tr>
<th>General characteristics</th>
<th>S</th>
<th>SP</th>
<th>H</th>
<th>HP</th>
<th>HA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td>Up to 625 pulses/turn: By means of perforated metallic disk From 625 pulses/turn on: By means of graduated glass disk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>± 1/10 of the pitch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum speed</td>
<td>12 000 rpm</td>
<td>6 000 rpm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration</td>
<td>100 m/sec (10 ÷ 2000 Hz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shock</td>
<td>300 m/sec² (11 m/sec)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inertia</td>
<td>16 gr/cm²</td>
<td>30 gr/cm²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turning torque</td>
<td>0.003 Nm (30 gr/cm) max. at 20 °C</td>
<td>0.02 Nm (200 gr/cm)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of shaft</td>
<td>Solid shaft</td>
<td>Hollow shaft</td>
<td>Hollow shaft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum load on the shaft</td>
<td>Axial: 10 N Radial: 20 N</td>
<td>–</td>
<td>Axial: 40 N Radial: 60 N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>0.3 kg</td>
<td>0.5 kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient characteristics:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running temperature</td>
<td>0 °C...+70 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-30 °C...+80 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative humidity</td>
<td>98% non-condensing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>IP 64 (DIN 40050), On S and SP models: Optional IP 66</td>
<td>IP 65</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light source</td>
<td>IRED (InfraRed Emitting Diode)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum frequency</td>
<td>200 KHz</td>
<td>300 KHz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference signal I₀</td>
<td>One reference signal per encoder turn</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply voltage</td>
<td>5 V ± 5% (TTL)</td>
<td>5 V ± 10% (TTL)</td>
<td>5 V ± 5% (TTL)</td>
<td>5 V ± 10% (1 Vpp)</td>
<td>5 V ± 5% (TTL)</td>
</tr>
<tr>
<td>Consumption</td>
<td>70 mA typical, 100 mA max. (without load)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output signals</td>
<td>TTL differential</td>
<td>– 1 Vpp</td>
<td>TTL differential</td>
<td>– 1 Vpp</td>
<td>TTL differential</td>
</tr>
<tr>
<td>Maximum cable length</td>
<td>50 m</td>
<td>150 m</td>
<td>50 m</td>
<td>150 m</td>
<td>50 m</td>
</tr>
</tbody>
</table>

## Number of pulses/turn

<table>
<thead>
<tr>
<th>S</th>
<th>SP</th>
<th>H</th>
<th>HP</th>
<th>HA</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>–</td>
<td>100</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>200</td>
<td>–</td>
<td>200</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>250</td>
<td>–</td>
<td>250</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>400</td>
<td>–</td>
<td>400</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>500</td>
<td>–</td>
<td>500</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>600</td>
<td>–</td>
<td>600</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>635</td>
<td>–</td>
<td>635</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>1 000</td>
<td>1 000</td>
<td>1 000</td>
<td>1 000</td>
<td>–</td>
</tr>
<tr>
<td>1 024</td>
<td>1 024</td>
<td>1 024</td>
<td>1 024</td>
<td>1 024</td>
</tr>
<tr>
<td>1 250</td>
<td>1 250</td>
<td>1 250</td>
<td>1 250</td>
<td>1 800</td>
</tr>
<tr>
<td>1 270</td>
<td>1 270</td>
<td>1 270</td>
<td>1 270</td>
<td>2 000</td>
</tr>
<tr>
<td>1 500</td>
<td>1 500</td>
<td>1 500</td>
<td>1 500</td>
<td>2 048</td>
</tr>
<tr>
<td>2 000</td>
<td>2 000</td>
<td>2 000</td>
<td>2 000</td>
<td>2 500</td>
</tr>
<tr>
<td>2 500</td>
<td>2 500</td>
<td>2 500</td>
<td>2 500</td>
<td>3 000</td>
</tr>
<tr>
<td>3 000</td>
<td>3 000</td>
<td>3 000</td>
<td>3 000</td>
<td>3 600</td>
</tr>
<tr>
<td>–</td>
<td>3 600</td>
<td>–</td>
<td>–</td>
<td>4 000</td>
</tr>
<tr>
<td>–</td>
<td>4 320</td>
<td>–</td>
<td>–</td>
<td>4 096</td>
</tr>
<tr>
<td>5 000</td>
<td>5 000</td>
<td>–</td>
<td>–</td>
<td>5 000</td>
</tr>
<tr>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>10 000</td>
</tr>
</tbody>
</table>
**Order identification - models H, HP, S and SP**

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

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

**Order identification - HA model**

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

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

**Dimensions in mm**

---

**S, SP model**

**H, HP model**

**HA model**
Connection to FAGOR CNC

**UP TO 12 METERS**

**EC...P-D**
Lengths: 1, 3, 6 and 9 meters

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Green</td>
</tr>
<tr>
<td>2</td>
<td>/A</td>
<td>Yellow</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>4</td>
<td>/B</td>
<td>Red</td>
</tr>
<tr>
<td>5</td>
<td>I₀</td>
<td>Grey</td>
</tr>
<tr>
<td>6</td>
<td>/I₀</td>
<td>Pink</td>
</tr>
<tr>
<td>7</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>9</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>15</td>
<td>Ground</td>
<td>Shield</td>
</tr>
</tbody>
</table>

**FROM 12 METERS ON**
EC...A-C1 cable + XC-C2...D extension cable

**EC...A-C1**
Lengths: 1 and 3 meters

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>A</td>
<td>Green</td>
</tr>
<tr>
<td>6</td>
<td>/A</td>
<td>Yellow</td>
</tr>
<tr>
<td>8</td>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>1</td>
<td>/B</td>
<td>Red</td>
</tr>
<tr>
<td>3</td>
<td>I₀</td>
<td>Grey</td>
</tr>
<tr>
<td>4</td>
<td>/I₀</td>
<td>Pink</td>
</tr>
<tr>
<td>12</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>10</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>11</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>Housing</td>
<td>Ground</td>
<td>Shield</td>
</tr>
</tbody>
</table>

**XC-C2...D extension cable**
Lengths: 5, 10, 15, 20 and 25 meters

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>A</td>
<td>Brown</td>
</tr>
<tr>
<td>6</td>
<td>/A</td>
<td>Green</td>
</tr>
<tr>
<td>8</td>
<td>B</td>
<td>Grey</td>
</tr>
<tr>
<td>1</td>
<td>/B</td>
<td>Pink</td>
</tr>
<tr>
<td>3</td>
<td>I₀</td>
<td>Red</td>
</tr>
<tr>
<td>4</td>
<td>/I₀</td>
<td>Black</td>
</tr>
<tr>
<td>12</td>
<td>5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>2</td>
<td>+5 V</td>
<td>Blue</td>
</tr>
<tr>
<td>10</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>11</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>Housing</td>
<td>Housing</td>
<td>Ground</td>
</tr>
</tbody>
</table>
Connection to other CNC’s

UP TO 12 METERS
For direct connection to FANUC® (second feedback)

EC-...C-FN1
Lengths: 1, 3, 6 and 9 meters

HONDA / HIROSE connector (female Pin)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Green</td>
</tr>
<tr>
<td>2</td>
<td>/A</td>
<td>Yellow</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>4</td>
<td>/B</td>
<td>Red</td>
</tr>
<tr>
<td>5</td>
<td>I0</td>
<td>Grey</td>
</tr>
<tr>
<td>6</td>
<td>/I0</td>
<td>Pink</td>
</tr>
<tr>
<td>9</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>12</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>14</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>16</td>
<td>Ground</td>
<td>Shield</td>
</tr>
</tbody>
</table>

Housing

FROM 12 METERS ON
EC-...C-C1 extension cable + XC-C2... FN1 extension cable
EC-...A-C1 extension cable + XC-C2... H extension cable

XC-C2... FN1 extension cable
Lengths: 5, 10, 15, 20 and 25 meters

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

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
<td>/A</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>B</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>/B</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>I0</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>/I0</td>
</tr>
<tr>
<td>12</td>
<td>9</td>
<td>+5 V</td>
</tr>
<tr>
<td>18-20</td>
<td>9</td>
<td>+5 V</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>GND</td>
</tr>
<tr>
<td>11</td>
<td>14</td>
<td>GND</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>Ground</td>
</tr>
</tbody>
</table>

Housing

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

EC-...AS-H
Lengths: 1, 3, 6, 9 and 12 meters

SUB D 15 HD connector (female Pin)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>A</td>
<td>Green</td>
</tr>
<tr>
<td>4</td>
<td>/A</td>
<td>Yellow</td>
</tr>
<tr>
<td>6</td>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>7</td>
<td>/B</td>
<td>Red</td>
</tr>
<tr>
<td>10</td>
<td>I0</td>
<td>Grey</td>
</tr>
<tr>
<td>12</td>
<td>/I0</td>
<td>Pink</td>
</tr>
<tr>
<td>1</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>9</td>
<td>+5 V</td>
<td>Purple</td>
</tr>
<tr>
<td>2</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>11</td>
<td>0 V</td>
<td>Black</td>
</tr>
</tbody>
</table>

Housing

Without a connector at one end; for other applications.

EC-...AS-O
Lengths: 1, 3, 6, 9 and 12 meters

HONDA / HIROSE connector (female Pin)

<table>
<thead>
<tr>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Green</td>
</tr>
<tr>
<td>/A</td>
<td>Yellow</td>
</tr>
<tr>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>/B</td>
<td>Red</td>
</tr>
<tr>
<td>I0</td>
<td>Grey</td>
</tr>
<tr>
<td>/I0</td>
<td>Pink</td>
</tr>
<tr>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>+5 V</td>
<td>Purple</td>
</tr>
<tr>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>0 V</td>
<td>Black</td>
</tr>
</tbody>
</table>

Ground

Connection to other CNC’s

UP TO 12 METERS
For direct connection to FANUC® (second feedback)

EC-...C-FN1
Lengths: 1, 3, 6 and 9 meters

HONDA / HIROSE connector (female Pin)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Green</td>
</tr>
<tr>
<td>2</td>
<td>/A</td>
<td>Yellow</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>4</td>
<td>/B</td>
<td>Red</td>
</tr>
<tr>
<td>5</td>
<td>I0</td>
<td>Grey</td>
</tr>
<tr>
<td>6</td>
<td>/I0</td>
<td>Pink</td>
</tr>
<tr>
<td>9</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>12</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>14</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>16</td>
<td>Ground</td>
<td>Shield</td>
</tr>
</tbody>
</table>

Housing

FROM 12 METERS ON
EC-...C-C1 extension cable + XC-C2... FN1 extension cable
EC-...A-C1 extension cable + XC-C2... H extension cable

XC-C2... FN1 extension cable
Lengths: 5, 10, 15, 20 and 25 meters

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

<table>
<thead>
<tr>
<th>Pin</th>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3</td>
<td>A</td>
<td>Brown</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>/A</td>
<td>Green</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>B</td>
<td>Grey</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>/B</td>
<td>Pink</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>I0</td>
<td>Red</td>
</tr>
<tr>
<td>4</td>
<td>12</td>
<td>/I0</td>
<td>Black</td>
</tr>
<tr>
<td>12</td>
<td>9</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>18-20</td>
<td>9</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>GND</td>
<td>White</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>0 V</td>
<td>White</td>
</tr>
</tbody>
</table>

Housing

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

EC-...AS-H
Lengths: 1, 3, 6, 9 and 12 meters

SUB D 15 HD connector (female Pin)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>A</td>
<td>Green</td>
</tr>
<tr>
<td>4</td>
<td>/A</td>
<td>Yellow</td>
</tr>
<tr>
<td>6</td>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>7</td>
<td>/B</td>
<td>Red</td>
</tr>
<tr>
<td>10</td>
<td>I0</td>
<td>Grey</td>
</tr>
<tr>
<td>12</td>
<td>/I0</td>
<td>Pink</td>
</tr>
<tr>
<td>1</td>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>9</td>
<td>+5 V</td>
<td>Purple</td>
</tr>
<tr>
<td>2</td>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>11</td>
<td>0 V</td>
<td>Black</td>
</tr>
</tbody>
</table>

Housing

Without a connector at one end; for other applications.

EC-...AS-O
Lengths: 1, 3, 6, 9 and 12 meters

HONDA / HIROSE connector (female Pin)

<table>
<thead>
<tr>
<th>Signal</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Green</td>
</tr>
<tr>
<td>/A</td>
<td>Yellow</td>
</tr>
<tr>
<td>B</td>
<td>Blue</td>
</tr>
<tr>
<td>/B</td>
<td>Red</td>
</tr>
<tr>
<td>I0</td>
<td>Grey</td>
</tr>
<tr>
<td>/I0</td>
<td>Pink</td>
</tr>
<tr>
<td>+5 V</td>
<td>Brown</td>
</tr>
<tr>
<td>+5 V</td>
<td>Purple</td>
</tr>
<tr>
<td>0 V</td>
<td>White</td>
</tr>
<tr>
<td>0 V</td>
<td>Black</td>
</tr>
</tbody>
</table>

Ground

Connection to other CNC’s
Angular encoders

Couplings for solid-shaft encoders

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

AA Model

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

<table>
<thead>
<tr>
<th>Model</th>
<th>a (mm)</th>
<th>b (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA 10/10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>AA 10/14</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>AA 14/14</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

Specific characteristics

<table>
<thead>
<tr>
<th></th>
<th>AA 10/10</th>
<th>AA 10/14</th>
<th>AA 14/14</th>
<th>AP 10</th>
<th>AP 14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum radial misalignment permitted</td>
<td>0.3 mm</td>
<td>0.3 mm</td>
<td>0.3 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum angular misalignment permitted</td>
<td>0.5°</td>
<td>0.5°</td>
<td>0.2°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum axial misalignment permitted</td>
<td>0.2 mm</td>
<td>0.2 mm</td>
<td>0.1 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kinematic transfer error</td>
<td>± 2° if λ ≤ 0.1 mm and α ≤ 0.09°</td>
<td>± 3° if λ ≤ 0.1 mm and α ≤ 0.09°</td>
<td>± 2° if λ ≤ 0.1 mm and α ≤ 0.09°</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum torque that may be transmitted</td>
<td>0.2 Nm</td>
<td>0.5 Nm</td>
<td>0.5 Nm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torsion rigidity</td>
<td>1 500 Nm/rad.</td>
<td>1 400 Nm/rad.</td>
<td>6 000 Nm/rad.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum rotating speed</td>
<td>10 000 rpm</td>
<td>1 000 rpm</td>
<td>1 000 rpm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>93 gr</td>
<td>128 gr</td>
<td>222 gr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inertia</td>
<td>20 x 10^4 kg/m²</td>
<td>100 x 10^4 kg/m²</td>
<td>200 x 10^4 kg/m²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Specific characteristics**

<table>
<thead>
<tr>
<th></th>
<th>AF</th>
<th>AC</th>
<th>AL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum radial misalignment permitted</td>
<td>2 mm</td>
<td>1 mm</td>
<td>0.2 mm</td>
</tr>
<tr>
<td>Maximum angular misalignment permitted</td>
<td>8º</td>
<td>5º</td>
<td>4º</td>
</tr>
<tr>
<td>Maximum axial misalignment permitted</td>
<td>± 1.5 mm</td>
<td>—</td>
<td>± 0.2 mm</td>
</tr>
<tr>
<td>Maximum torque that may be transmitted</td>
<td>2 Nm</td>
<td>1.7 Nm</td>
<td>0.9 Nm</td>
</tr>
<tr>
<td>Torsion rigidity</td>
<td>1.7 Nm/rad.</td>
<td>50 Nm/rad.</td>
<td>150 Nm/rad.</td>
</tr>
<tr>
<td>Maximum rotating speed</td>
<td>12 000 rpm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**AH coupling caps**

**Rotary encoders: coupling caps (hollow shaft)**

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

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

**AD-M washer**

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

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

- **AI-400 filter**
  The air coming from an compressed air supply must be treated and filtered in the AI-400 unit which consists of:
  - Filtering and pressure regulating group.
  - Fast inlets and joints for 4 measuring systems.
  - A plastic tube 25 m long with an inside diameter of 4 mm and outside diameter of 6 mm.

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

<table>
<thead>
<tr>
<th>AI-500 filter MODELS</th>
</tr>
</thead>
<tbody>
<tr>
<td>For 2 axes:</td>
</tr>
<tr>
<td>For 4 axes:</td>
</tr>
<tr>
<td>For 6 axes:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technical Characteristics</th>
<th>Filters AI-400 / AI-500</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard</td>
</tr>
<tr>
<td>Maximum input pressure</td>
<td>10.5 kg/cm²</td>
</tr>
<tr>
<td>Maximum operating temperature</td>
<td>52 °C</td>
</tr>
<tr>
<td>Output pressure of the unit</td>
<td>1 kg/cm²</td>
</tr>
<tr>
<td>Consumption per measuring system</td>
<td>10 l/min.</td>
</tr>
<tr>
<td>Safety</td>
<td>Micro-filter saturation alarm</td>
</tr>
</tbody>
</table>

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

Fagor Automation linear feedback systems require the following air conditions:
- Class 1 - Maximum particle 0.12 µ
- Class 4 (7 bars) - Dew point 3 ºC
- Class 1 - Maximum oil concentration: 0.01 mg/m³.

**Safety switch**

It consists of a pressostat capable of activating an alarm switch when the pressure gets below 0.66 kg/cm².

**Technical data:**

The switching pressure may be adjusted between 0.3 and 1.5 kg/cm².
- Load: 4 A.
- Voltage: 250 V approx.
- Protection: IP65.
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