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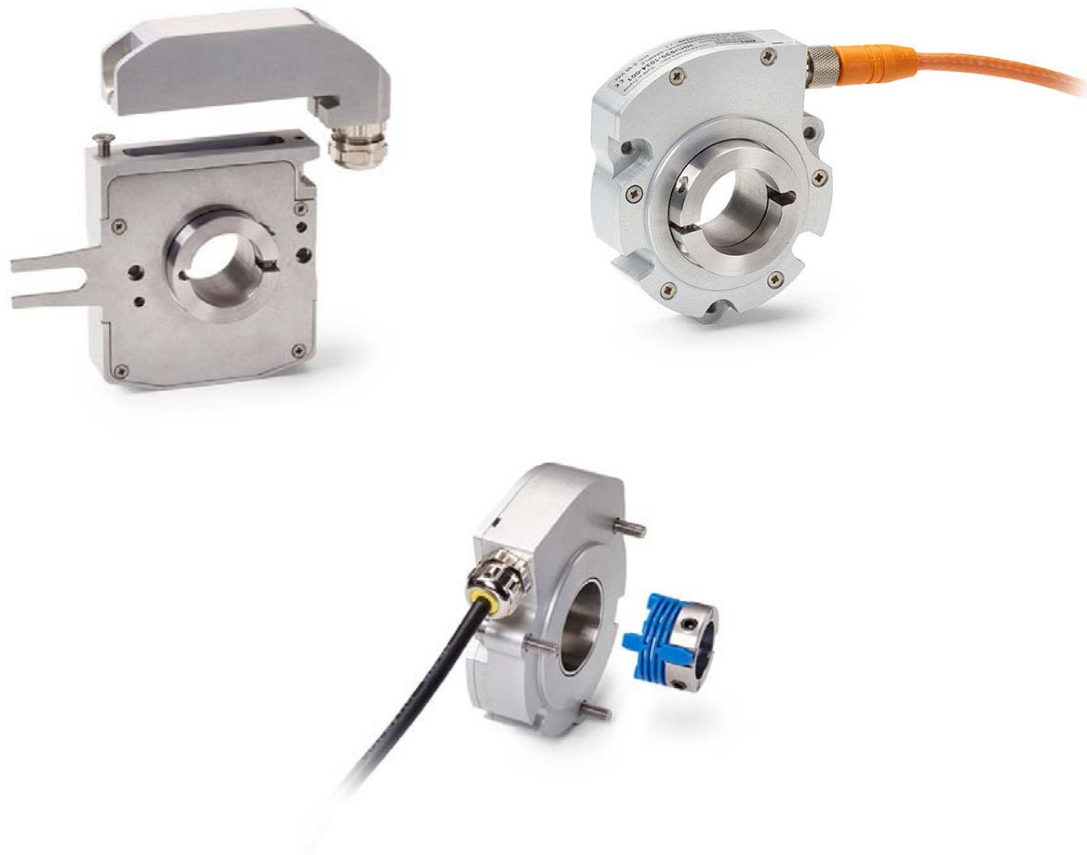
Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



# LP SERIES ENCODERS

## US User Manual – LP35



## IMPORTANT INFORMATION

- This manual contains important information regarding proper installation and operation of the LP35 encoder. Ensure that this manual and all other pertinent product documentation is available to all users of the product.
- Carefully read and observe all safety instructions contained in this manual and other documentation provided with your LP35 encoder.
- The specifications and data in this manual are subject to modifications without notice. See individual product specification sheets for additional information.
- All details provided are technical data which do not imply warranted performance. Products are warranted against defects in material and workmanship only. For more detailed warranty information please refer to section “7. Warranty”.
- Keep this manual for future reference.

Safety instructions are highlighted by safety alert symbols in the manual.

Depending on the seriousness of the hazard, the safety instructions are divided into two hazard categories.



### **WARNING**

**WARNING** indicates a potentially hazardous situation, which, if not avoided, can result in death, serious injury, or equipment damage.



### **CAUTION**

**CAUTION** indicates a recommendation, which, if not followed, may eventually result in death, serious injury, or equipment damage depending on the context.

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## 1. LP SERIES – TECHNICAL FEATURES

### 1.1. Range presentation

Typical model numbers – see individual product specifications for details of model number configuration.

1. LP35-S-Q29-02048-H8EP-28/V-SM12-T2
2. LP35-S-Q29-02048-H8EP-28/V-T-T4
3. LP35-S-Q28-01000-C20P-28/VR-T-T5

## 1.2. MECHANICAL SPECIFICATIONS

### 1.2.1. General

Installation of the encoder must be done in such a way to prevent excessive loads on the encoder bearings. Some parts of the installation are compliant (or flexible) by design to accomplish this. For the Thru Hollow shaft and Blind Hollow shaft, a flexible tether arm is used. See Tether Mounts on pages 11-13. The integrated coupling includes a flexible part which provides the necessary compliance. The Solid Shaft variation requires the use of a separate flexible shaft coupling. See pages 14-15 for details.

Note: Flexible coupling installation must be done so that the coupling device is not distorted or crushed and there is no contact between the driving shaft and encoder shaft. Ignoring this may result in premature failure of coupling or encoder bearings.



### CAUTION

Secure the fasteners (on flange, shaft, clamping rings, couplings...) by using a screw with the appropriate torque and lock the treads with Thread locker Loctite 243 or equivalent

In case of electrical leakage currents on the drive shaft, a common occurrence with the use of Variable Frequency Drives (VFD's) or industrial DC motors, use an insulated sleeve. Refer to section "2.2.5.3. *Sleeves*".

If possible, mount the encoder shaft horizontal or facing downward with the cable-glands or the connector facing downward.

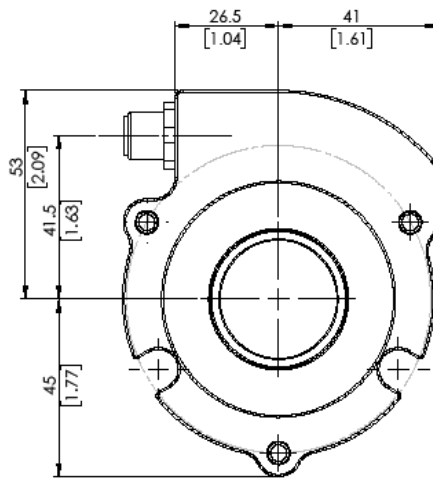
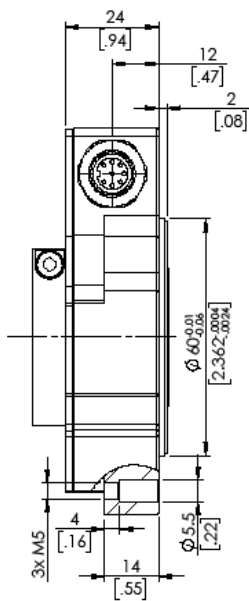
Mounting cautions and mechanical interface configurations are described in detail in the next sections.

1.2.2. Mechanical outlines

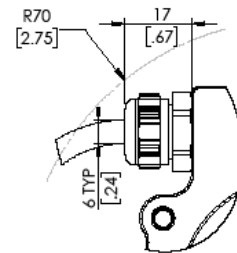
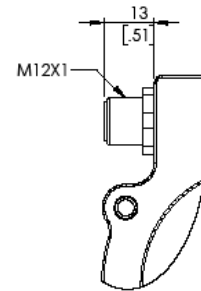
All dimensions are in millimeters [inches] and are for reference only. See individual specification sheets for more detailed product outlines.

1.2.2.1. Overall dimensions

Standard through Hollow shaft

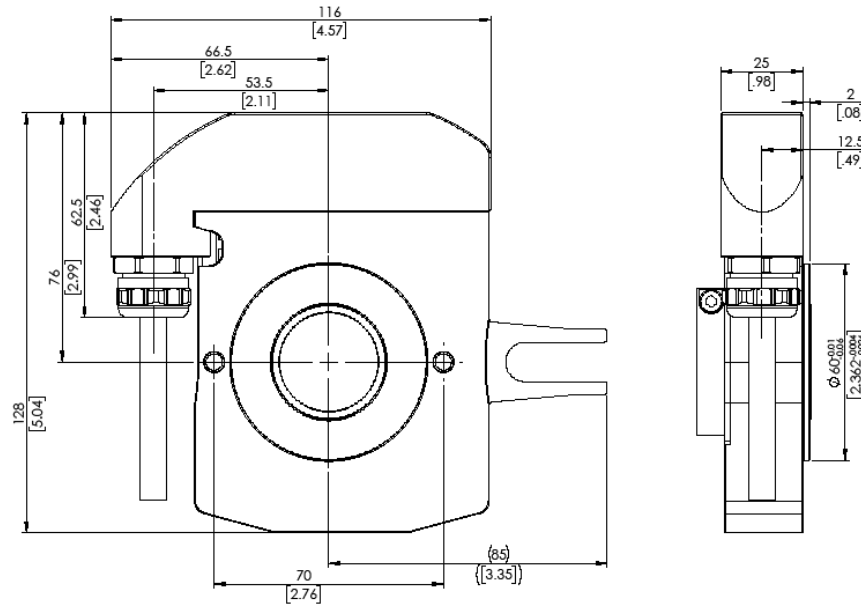


Connection dimensions





Terminal box through hollow shaft



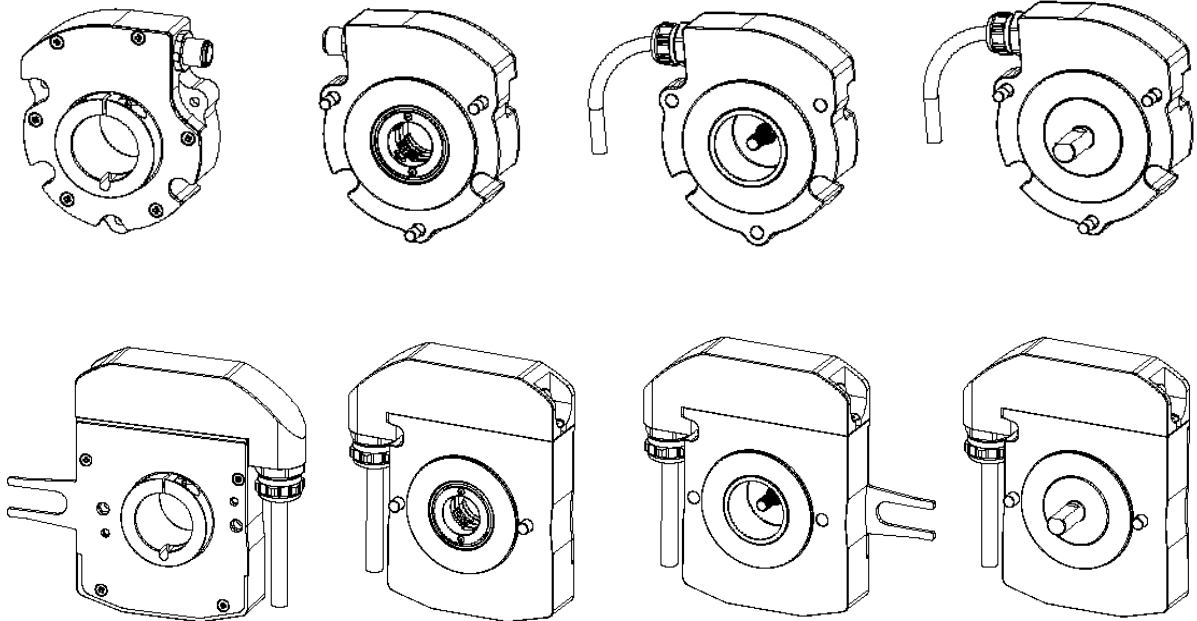
Standard shaft configurations

Through hollow shaft

Hollow shaft with integrated coupling

Blind Shaft

Solid shaft



Mechanical detailed outline drawings are available for each configuration on request.

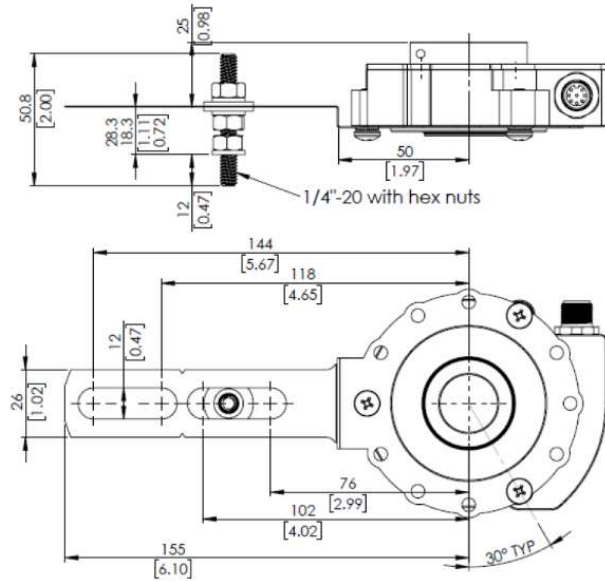
Mounting options

1.2.2.2. Flange and shaft configurations

Tether mounts									
Customer shaft dimensions and geometric tolerance	<table border="1"> <thead> <tr> <th>Speed (RPM)</th> <th>Permissible Runout (X mm)</th> </tr> </thead> <tbody> <tr> <td>&lt; 1000</td> <td>0,2 [0.008 in.]</td> </tr> <tr> <td>&lt; 3000</td> <td>0,1 [0.004 in.]</td> </tr> <tr> <td>&lt; 6000</td> <td>0,05 [0.002 in.]</td> </tr> </tbody> </table>	Speed (RPM)	Permissible Runout (X mm)	< 1000	0,2 [0.008 in.]	< 3000	0,1 [0.004 in.]	< 6000	0,05 [0.002 in.]
Speed (RPM)	Permissible Runout (X mm)								
< 1000	0,2 [0.008 in.]								
< 3000	0,1 [0.004 in.]								
< 6000	0,05 [0.002 in.]								
Standard Configuration	Terminal Box Configuration								
<p>Tether arm options – tether arm is installed by customer at any angle to best fit the application. (See 4.2.2)</p>									

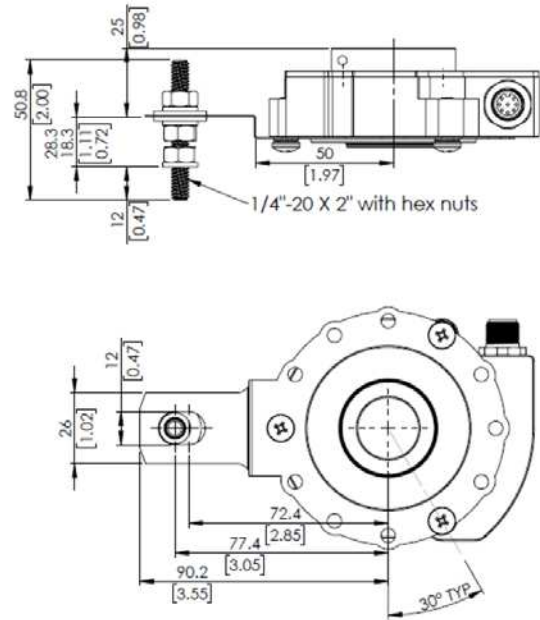
T2 – Long Tether arm with 1/4"-20 adj. hardware

P/N : M9445/053-02



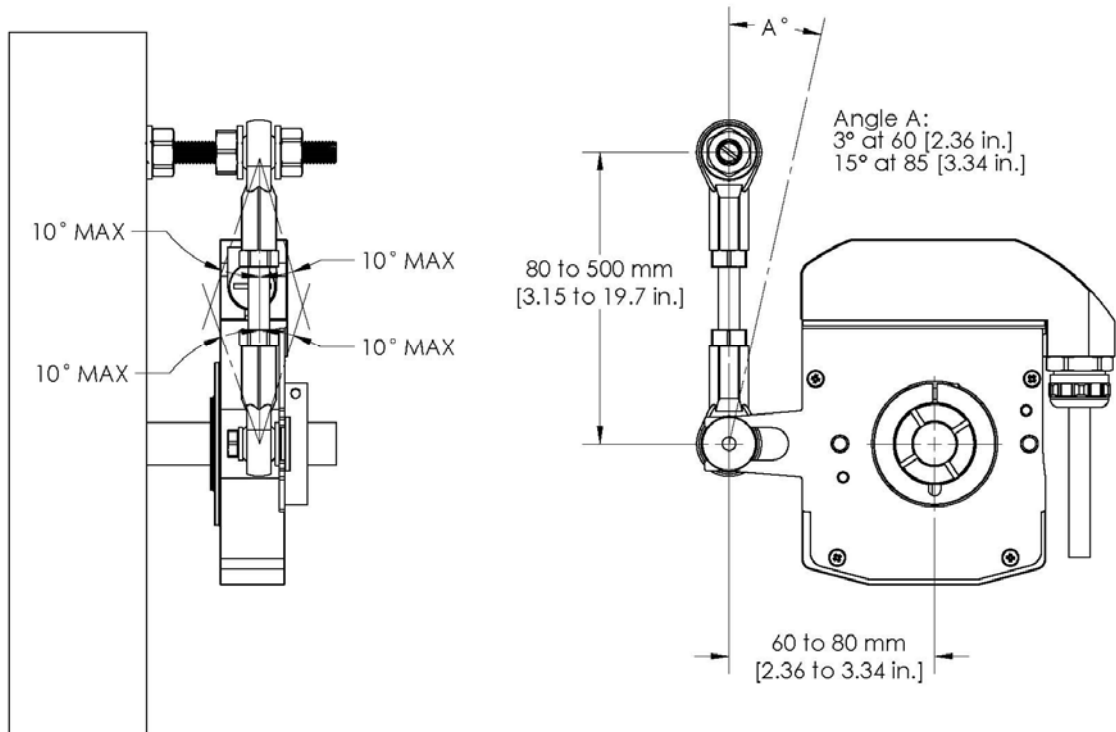
T3 – Short Tether arm (56C flange compatible) with 1/4"-20 adj. hardware

P/N : M9445/058-02



Permissible misalignments	
Axial	+/-2mm [0.08 in.]
Perpendicularity	+/-5°
Angular rigidity >200 N.m/rad [147 lbf*ft/rad]	

Ball end tether arm set for terminal box version  
P/N – M9230-04/xxx  
(xxx = length in mm) to be ordered separately



**Flange Mountings**

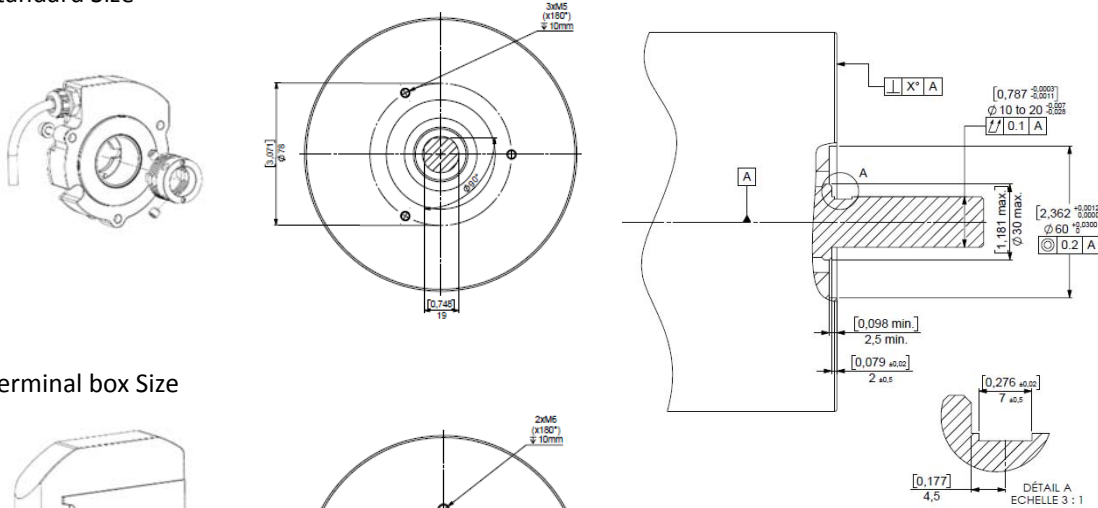
Integrated coupling



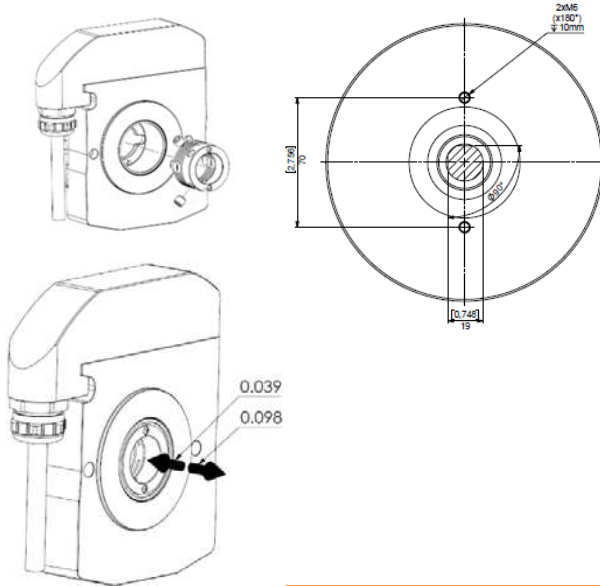
**CAUTION**

The mounting face must be rigid and aligned according the dimensions and geometry given on the drawing and table below.

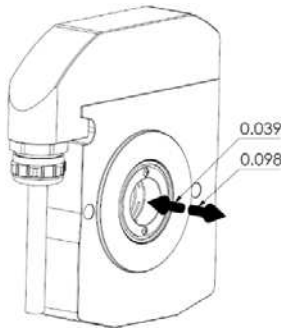
Standard Size



Terminal box Size

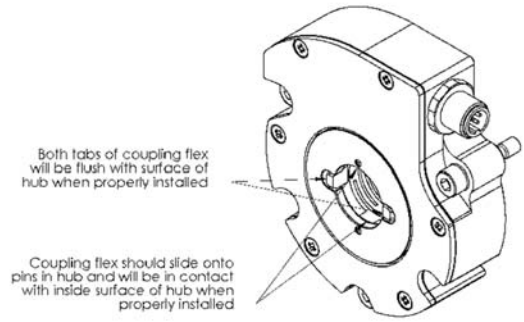


Shaft Diameter	Perpendicularity (X°)
Ø<0.7" (18mm)	+/- 1°
0.787" (Ø20mm)	+/- 0.25°



Axial Permissible misalignment  
(Standard and Terminal Box)

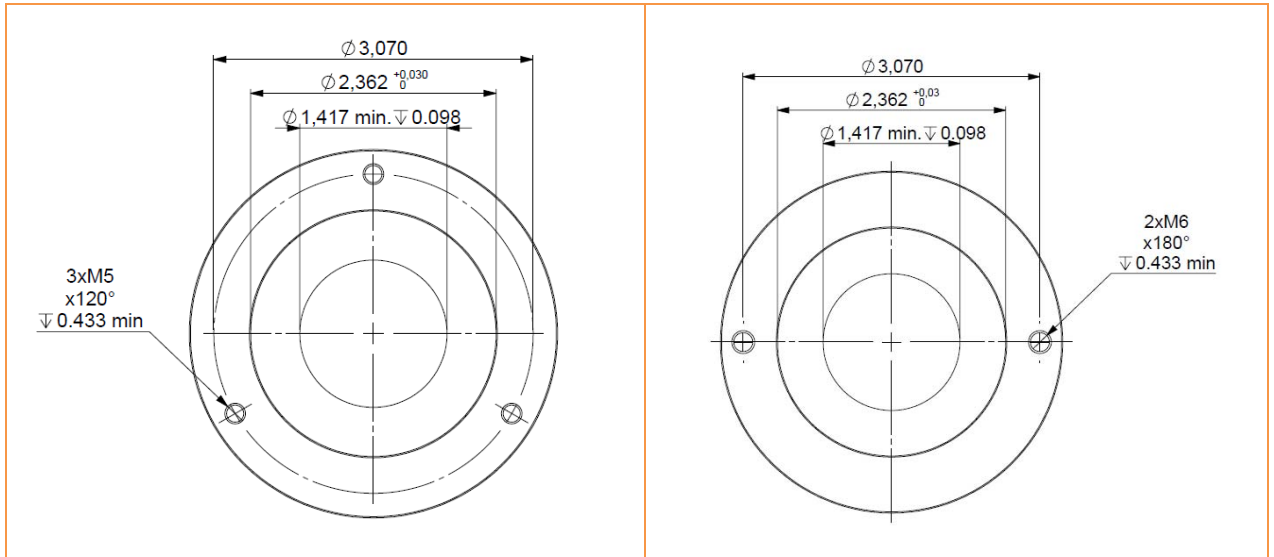
+1.0mm/-2.5mm [+0.039 in/-0.098 in]



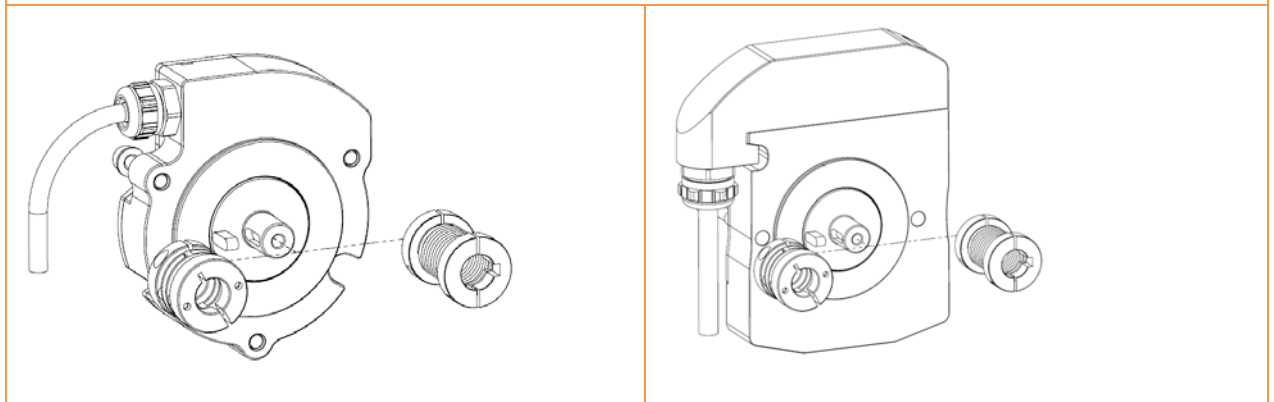
**Flange Mountings**

Solid shaft

Standard mounting hole pattern	Terminal box mounting hole pattern
--------------------------------	------------------------------------



Flexible shaft couplings are recommended




Mechanical figures

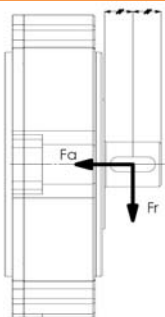
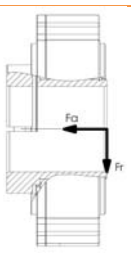
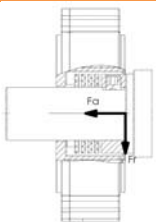
Parameter	Value
Material, Bearings, Maximum loads, Shaft inertia, Dynamic torque. Maximal speed (continuous & permissible) Encoder weight	This data may vary from one configuration to another one. Consequently, refer to the specific datasheets for detailed information.

Other important parameters are described in more detail in specific sections of this manual.

1.2.3. Bearing life

 **CAUTION**

Exceeding the values listed below drastically reduces the expected life time of the products. Avoid working at or near the load limits and consider the relation between misalignment and lifetime expectancy.

Scheme	Model	Axial/radial load (N) Pounds (Fa/Fr)	Continuous speed (rpm)	Bearing Life: L <sub>10h</sub> * (hours)
	Solid shaft	100 / 200 [22 / 44 lbf]  40 / 80 [9 / 18 lbf]	3 000  6 000	< 7200  < 8300
	Through hollow shaft	20 / 40 [4.5 / 9 lbf]	6 000	> 100 000
	Integrated coupling	10/20 [2.2 / 4.4 lbf] (max; load transmitted by the integrated coupling)	6 000	> 100 000

\* According to ISO 281: 1990, L<sub>10</sub>, Values are calculated based on the complete temperature range of the encoders.

#### 1.2.4. Accessories

##### 1.2.4.1. Tethers

Tethers are designed to provide a high degree of angular stability while at the same time allowing compensation for the driving shaft runout and dimensional errors as well as any normal axial shaft movement.

The complete mounting set for tethers including all fasteners are described in the section “1.2.2.2 Flange and shaft configurations”

##### 1.2.4.2. Isolation Sleeve

The use of Variable Frequency Drives (VFD's) or industrial DC motors often results in induced currents on the driving shaft which can damage the encoder bearings.

For through hollow shaft encoders:

Use an insulated sleeve to prevent these currents from damaging the encoder bearings and reducing their service life. They are included in the Encoder P/N for all shaft diameters smaller than 30mm.

Ordering code, when bought separately:

P/N: 9418/H20 for 20 mm shaft

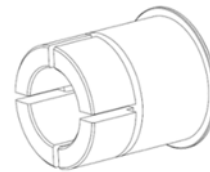
P/N: 9418/HE8 for 1" shaft

P/N: 9418/HE7 for 7/8" shaft

P/N: 9418/HE6 for 3/4" shaft

P/N: 9418/HE5 for 5/8" shaft

Reduction sleeve insulation: 2.5 kV



For integrated coupling encoders:

The integrated coupling device is insulated by design to prevent leakage currents from damaging the encoder bearings and reducing their service life.

Insulation using integrated coupling is 1 kV for a 20mm shaft.



### CAUTION

Exceeding the misalignment and dimensional values listed in the section “1.2.2.2” drastically reduce the insulation capability of the products.



1.2.4.3. Cable-connector assemblies

For reliability reasons, we recommend to use BEI sensors qualified cables or M12 cable-connector assemblies.

Cable type (refer 2.1.Range presentation for description)	Jacket material	Temperature range (Static/dynamic)	Smallest bending radius (static use)	Smallest bending radius (dynamic use)	Order format
SGXXX (1)	PVC	-40°+80°C	30mm	90mm	Ex: SG120; 120 = 120''
STEXXX (2)	Silicone	-40°+100°C	60mm	60mm	Ex: STE005; 005 = .5m
SQPXXX (1)	PUR	-40°+80°C	30mm	90mm	Ex: SQP020; 020 = 2 m

(1) UL listed: -20°C +80°C

(2) Advised cable for mobile application, in extreme temperature from -40°C to +100°C

M12 cable assembly	Customized	Connector	Cable type	Wiring	Length
		<b>9416/111</b> M12 – 8 poles mating connector with terminals	<b>8230/005</b> <b>8230/165</b> <b>8230/200</b>	<b>GM</b> (compatible with M12 connector)	<b>XXX</b> From 0,5m (code: 005) to 25m (code: 250) by 0,1m steps
P/N example :9416/111-8230/200-GM-005					
M12 Over-molded		<b>8230/362</b>	PVC Jacket	GM	<b>2 m</b>
		<b>8230/356</b>			<b>5 m</b>
		<b>8230/365</b>			<b>10 m</b>

BEI Sensors is not responsible for cable-connector assemblies not supplied by the company.

### 1.3. INCREMENTAL ENCODER ELECTRICAL SPECIFICATIONS

#### 1.3.1. Power supply

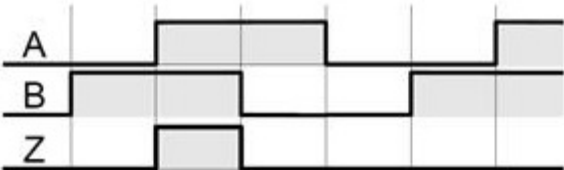
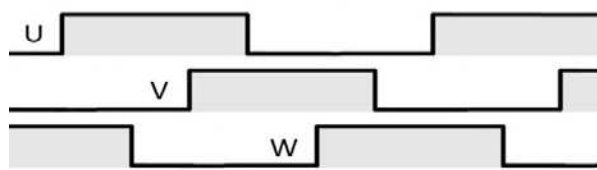
	28/5	28/V	28/VR
<b>Supply voltage +V:</b>	4.75-30VDC	5-30VDC	11-30VDC
<b>Ripples:</b>	250mV max.		
<b>Consumption without load:</b>	75mA max.		100mA max.
<b>Consumption with load:</b>	200mA max.	200mA max.	250mA max.
<b>Output current:</b>	40mA max by pair		60mA max by pair
<b>Min/Max load:</b>	100 ohms – 240 ohms	at 11V: 275 ohms – 3k ohms at 24V: 600 ohms – 3k ohms at 30V: 750 ohms – 3k ohms	
<b>Supply type:</b>	Power supply according to SELV/PELV with a maximum 60VDC fault.		

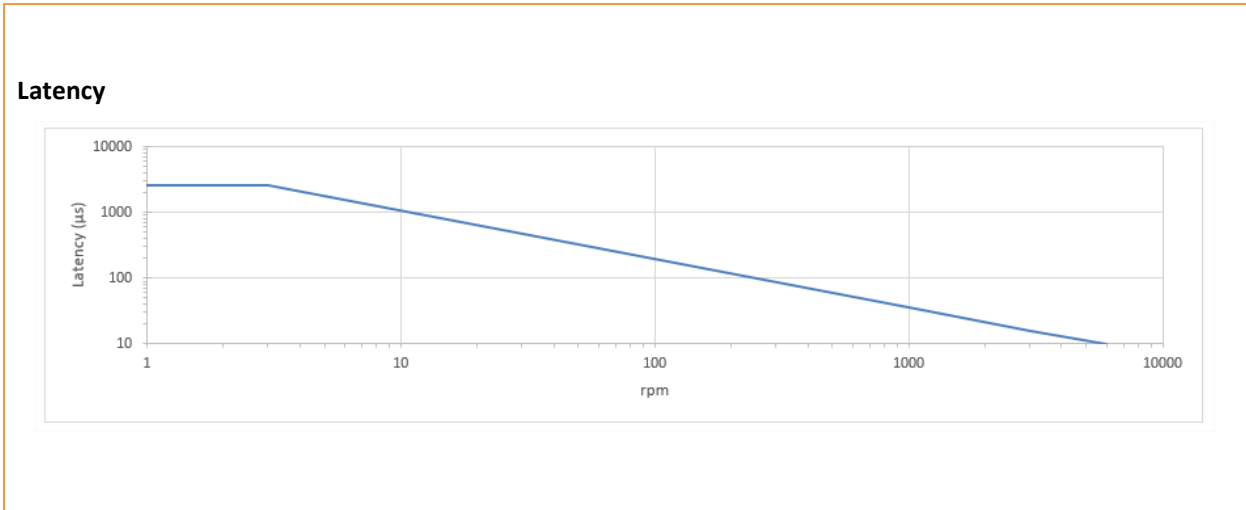
#### 1.3.2. Electrical protection

	28V/5	28V/V	28/VR
<b>Polarity inversion:</b>	Yes (without time limit)		
<b>Short circuit (when properly powered):</b>	To 0V = yes To +V = no To other signals = yes	To 0V = yes To +V = yes To other signals = yes	To 0V = yes To +V = yes To other signals = yes
<b>Overvoltage:</b>	Exceeding the nominal supply voltage range may definitely damage the encoder		Up to 60VDC
<b>Surges/transients:</b>	Yes		

For further details on electrical immunity, refer to “2.4.4. EMC section”.

#### 1.3.3. Output signals

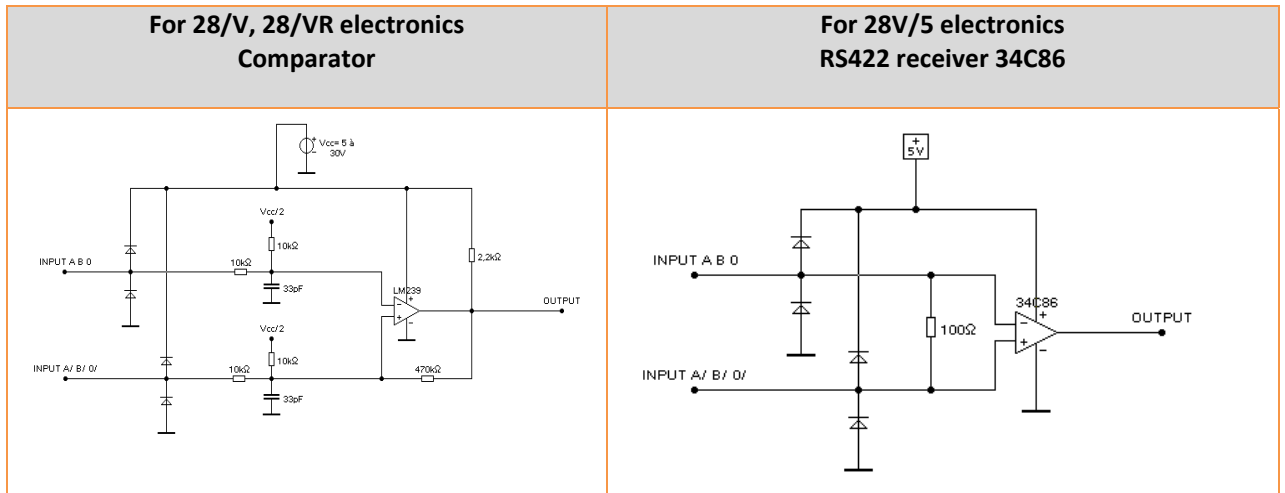
Incremental signals	Commutation tracks signals (contact factory)
<p>Two signals A and B, phased by 90°, indicates the speed, relative count, and rotation direction. One ¼ cycle wide Z pulse per turn is provided.</p>  <p>Inverted signals A/, B/, and Z/ are also present but have been omitted for clarity.</p>	<p>Three channels U V W, phased by 120°, giving the position of the motor rotor.</p>  <p>Inverted signals U/, V/, and W/ are also present but have been omitted for clarity.</p>



Output specifications (typical data):

<b>Phasing tolerance</b>	90° +/-45°	
<b>Duty cycle</b>	50% +/-25%	
<b>Output signal frequency</b>	300kHz max. depending on cable length. Refer "4.1.2. General Electrical and wiring precautions" section for further details.	
<b>Jitter (average)</b>	1024 : < 8%	2048 : < 16%
	4096 : < 30%	10000 : < 45%

1.3.4. Recommended receiver circuitry



1.4. ABSOLUTE ENCODER ELECTRICAL SPECIFICATIONS

1.4.1. Power supply

	28/SI – 28/SR
Supply voltage +V:	5-30VDC
Ripples:	250mV max.
Consumption without load:	75mA max.
Consumption with load:	150mA max.
Output current:	10 mA max by Data pair
Min max load:	100 ohms – 240 ohms
Supply type:	Power supply according to SELV/PELV with a maximum 60VDC fault.

1.4.2. Electrical protection

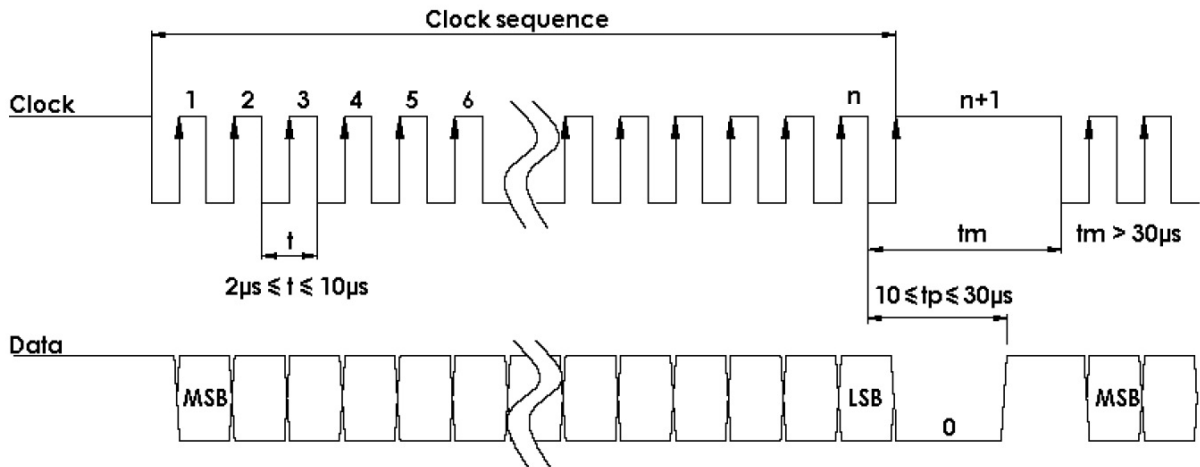
	28/SI	28/SR
<b>Polarity inversion:</b>	Yes	Yes
<b>Short circuit when properly powered:</b>	To 0V = yes To +V = no To other signals = yes	To 0V = yes To +V = yes To other signals = yes
<b>Overvoltage:</b>	Exceeding the nominal supply voltage range may definitely damage the encoder.	Exceeding the nominal supply voltage range may definitely damage the encoder.
<b>Surges/transients:</b>	Yes	Yes

For further details on electrical immunity, refer to “2.4.4. EMC section”.

1.4.3. SSI Output signals

**SSI**

For the transmission of one position value of a rotary encoder, a specific number (n) of clock signals (one clock sequence) must be sent to the clock input of the rotary encoder where n = number of bits to be transferred. The data doesn't change during the transmission of a position value. With the following rising edge transition of the clock signal the serial transmission begins with the most significant bit (MSB). With each following rising edge transition of the clock signal, the next lower significant bit is placed on the serial output data line. After the least significant bit (LSB) is shifted out, the last rising edge transition of the clock signal switches the data line to low, signaling transmission end.



**Latency**

See “1.3.2. Output signals – Latency”

**MAXIMUM FREQUENCY**

A delay due to cable capacitance must be taken into consideration for the outward signal (CLOCK) and the return (DATA). It must always be less than a transmission period, otherwise the word cannot be properly reconstructed. A limit on the transmission frequency, depending on the cable length is shown in the table, below. The table shows the approximate maximum length of cable allowed as a function of the clock frequency (this is dependent on the cable).

Length of cable	Frequency
< 50 m	< 400 kHz
< 90 m	< 300 kHz
< 150 m	< 200 kHz
< 350 m	< 100 kHz

**CABLE CHARACTERISTICS ACCORDING TO RS422 STANDARDS**

Capacitance :

< 60 pF/m between conductors of a same pair

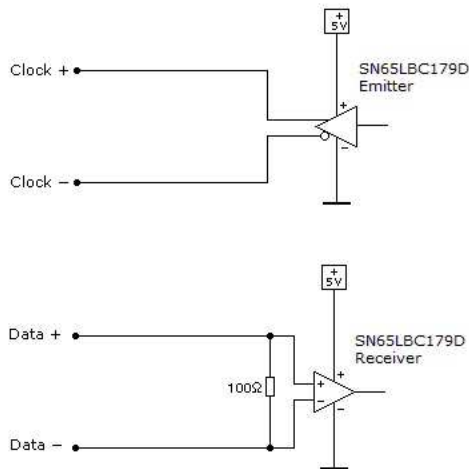
< 120 pF/m between a conductor and others connected to the ground

SSI drivers support high transmission rates and long line lengths.

One twisted pair line for the data and one twisted pair line for the shift clock are necessary.

BEI Sensors preferred reference cable for long length = SQPXXX. Ex: SQP500 = 50 m cable

**1.4.4. Recommended receiver circuitry**




**1.5. ENVIRONMENTAL SPECIFICATIONS**

**1.5.1. Ingress protection**

Refer to the Datasheets for the IP rating in each product configuration.

**1.5.1. Operating temperatures**



**CAUTION**

Overheating of the encoder could cause irreversible mechanical damage leading to a potential loss of seal. Any encoder which has been subjected to temperatures outside its rated specifications may be damaged.

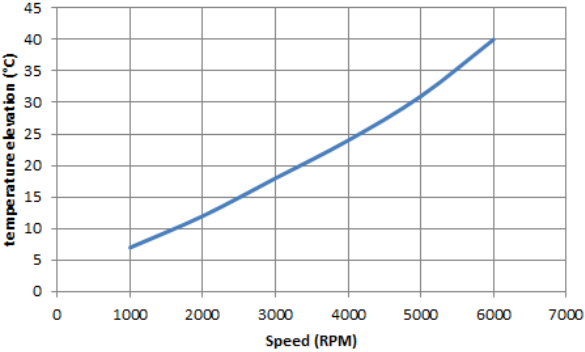
Maximum working temperature range is **from -40°C to +100°C**. This temperature range corresponds to the housing surface temperature. The de-rating parameters listed below must be considered when estimating the maximum permissible ambient temperature range in any application.

**CAUTION**

For UL listed products the temperature range is limited to -40°C to +85°C housing surface temperature.

**CAUTION**

Operating within admissible ambient temperature is dependent on cable parameters listed in the section “4.1.2.General Electrical and wiring precautions” and the table below

De-rating parameters	Value
Power supply*	Typically, the higher the supplied voltage, the more the power dissipation of the input stage will be.
Electrical loads*	The lower the output impedance, the hotter the output driver stage will be. However, never exceed the highest value of output load given in the documentation.
Mechanical loads*	Mechanical heating is influenced by the load on the bearing block.
Application power dissipation*	Encoder’s surface temperature is dependent on the configuration of the area around the device: heat transmission with other parts (frame, shaft, radiator...), to the air (air flow)/liquid/dust.
Encoder speed	<p>The temperature given on the following charts is to be added to the ambient temperature. The total must never exceed the maximum T°C given by the datasheet.</p>  <p>These temperature elevations are typical values which should be considered as indications only.</p>

\* For further information on de-rating parameters, please contact the factory.

**1.5.2. Chemical protection**

All housings have been submitted to salt spray test – EN 60068-2-11 / Part 2, Test type Ka – 168 hours according to their respective datasheet.  
 Aluminum parts are protected by clear anodization.  
 All shafts are AISI 303 stainless steel.  
 Connectors and cable glands are in nickel-plated brass or stainless steel.  
 Rotary seals and O-rings are in Nitrile. Detailed specifications are available on request.  
 Several cable jacket materials are available (PVC, PUR or Silicone). Environmental specifications are available on request.

**1.5.3. EMC**

The complete encoder range is compliant with EMC as follows:

**1.5.3.1. Emission:**

According to general standard **EN 61000-6-4**

Phenomenon	Basic standard	Level
Radiated emission	EN 5016-2-3	Test from 30MHz to 1GHz, 3m distant antenna

**1.5.3.2. Immunity:**

According to general standard **EN 61000-6-2**

The increased levels are in accordance with the IEC 62061 (2005).

Port	Phenomenon	Basic standard	Increased value for additional tests for SRECS performance
<b>Enclosure</b>	Electrostatic discharge (ESD)	IEC 61000-4-2	6kV/8kV contact/air discharge
	Electromagnetic (EM) field	IEC 61000-4-3	20V/m (80MHz – 1GHz) 6V/m (1.4GHz – 2GHz) 3V/m (2GHz – 2.7GHz)
	Rated power frequency magnetic field	IEC 61000-4-8	30A/m
<b>VDC Power</b>	Burst	IEC 61000-4-4	4kV
	Surge	IEC 61000-4-5	1kV line-to-line 4kV line-to-ground
	Conducted RF	IEC 61000-4-6	10V at frequencies given
<b>I/O signals / Control lines</b>	Burst	IEC 61000-4-4	2kV for lines >3m
	Surge	IEC 61000-4-5	2kV line-to-ground
	Conducted RF	IEC 61000-4-6	10V at frequencies given
<b>Functional earth</b>	Burst	IEC 61000-4-4	2kV

To fully comply with the EMC performance test done, the encoder body and the cable shield must be grounded to earth or 0V.

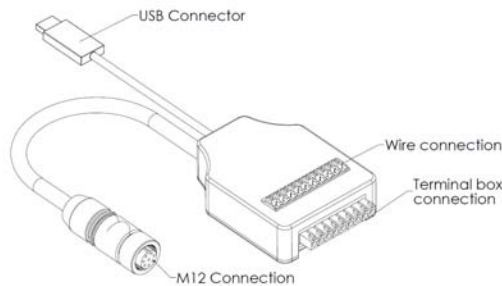


## 1.6 HAZARDOUS AREA PRODUCT

This user Manual contains general installation instructions and operation details usable for most applications. For LP35 products used in hazardous areas, you must also refer to the indicated product specification sheets for important warnings, installation and operation details related to the specific protection method. They contain very important information and special conditions for safe use vital to the safe operation of the product in a hazardous environment.

Protection method	Encoder model	Document reference
Intrinsic safety	LP35-HX (HH_9_/_/E4,E6,E8/)	02152-001
	LP35-HX_T (HH_B_/_/E4,E6,E8/)	
Explosion proof	LP35-HC (HH_X/..._ & AH_X...)	02162-001
	Control Drawing & Declaration	2000/040
Non-sparking	LP35-HN (HH_9_/_/E5,E7,E9/)	02164-001
	LP35-HN_T (HH_B_/_/E5,E7,E9/)	
	LP35-HN-X (AH_9_/_/E5,E7,E9/)	
	LP35-HN-Z_T (AH_B_/_/E5,E7,E9/)	
	Control Drawing & UL-EU declaration	2000/013


## 2. ENCODER PROGRAMMING TOOL




Download the software and drivers on BEI Sensors website [www.beisensors.com](http://www.beisensors.com)  
 Prior to using the software programming tool, additional USB drivers may be needed.  
 OS requirements: Windows XP or higher.

***For more detailed instructions on programming refer to the Programmable LP Series specification sheet.***

### 3. CERTIFICATIONS

UL Mark : Certified by	Assessment number
UL International France S.A. Espace Technologique, Bâtiment Explorer Route de l'Orme F-91190 SAINT-AUBIN France T:: +33 1 60 19 88 00 F:: +33 1 60 19 88 80	 <b>LISTED</b> Proc. Cont. Eq. <b>E477663</b>

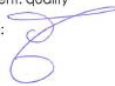
CE marking :




## EC DECLARATION OF CONFORMITY

We, BEI Sensors, declare that the products listed below meet the requirements of the EC Directives indicated with respect to design and manufacturing. This declaration becomes invalid in the case of any modification to the product not authorized by BEI Sensors.

Range:	LP series Encoders
Products:	HHU9/AHU9xx-xxxx-xxx, HHUB/AHUBxx-xxxx-xxx, HHK9/AHK9xx-xxxx-xxx, HHKB/AHKBxx-xxxx-xxx, HHA9/AHA9xx-xxxx-xxx, HHAB/AHABxx-xxxx-xxx, HHM9/AHM9xx-xxxx-xxx, HHMB/AHMBxx-xxxx-xxx,
Directives	EC Directive EMC 2004/108/EC EC Directive Low Voltage 2006/95/EC
Applied harmonized standards, especially:	EN 61000-6-4:2007/A1:2011 EN 61000-6-2:2005/AC:2005
Technical specifications	Product Datasheet User Manual

Company stamp:  <div style="text-align: center;"> <b>BEI SENSORS SAS</b>                      9, rue de Copernique                      Espace Européen de l'Entreprise - Schiltigheim                      BP 70044+ • F 67013 STRASBOURG Cedex                      Tél. : +33 (0)3 81 20 60 80 Fax: +33 (0)3 88 20 67 8                 </div>	Date: October 17 <sup>th</sup> , 2015 Name: Matuszewski Ludivine Department: quality Signature: 
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BEI SENSORS Siège social : 9, rue de Copernique - Espace Européen de l'Entreprise - F-67300 Schiltigheim - France  
 Tél. : +33 (0)3 88 20 60 80 • Fax : +33 (0)3 88 20 67 87 • Mail : info@beisensors.com • www.beisensors.com  
 Société par actions enregistrée au capital de 300 000 € I.S.R. - RCS Strasbourg B 419 890 729  
 Code NAF 2651 B - N° SIRET TVA FR 25 419 890 729

