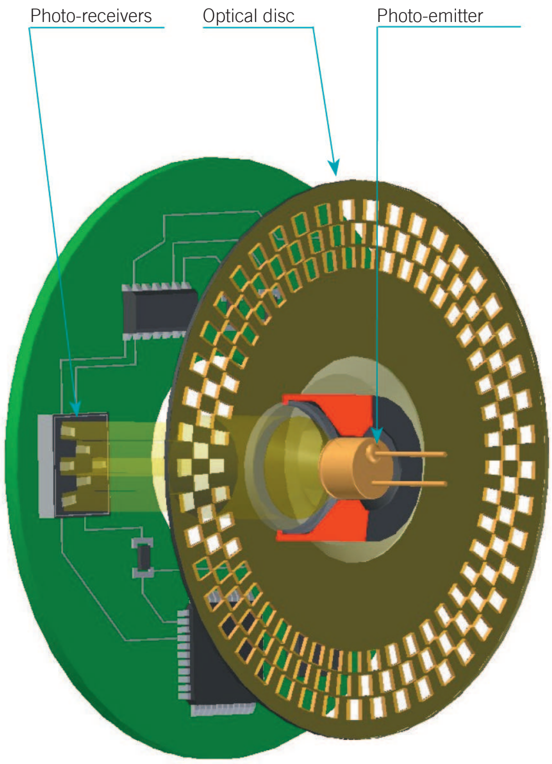
INCREMENTAL ENCODERS
GENERAL DESCRIPTION

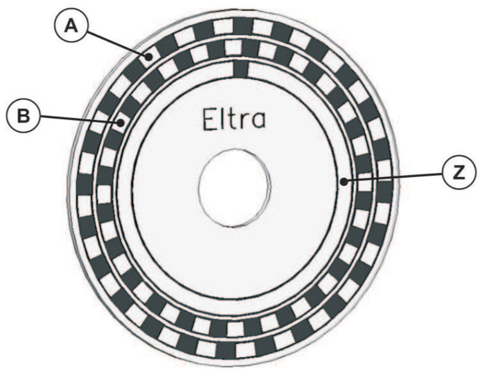
WORKING PRINCIPLE

An encoder is a rotary transducer that converts an angular movement into a series of electrical digital pulses. If associated to racks or endless screws, these generated pulses can be used to control angular or linear movements. During rotation, electrical signals can be elaborated by numerical controls (CNC), programmable logic controls (PLC), control systems, etc. Main applications of these transducers are: machinery, robots, motor feedback, measure and control devices. In Eltra encoders the angular movement transduction is based on the photoelectric scanning principle. The reading system is based on the rotation of a radial graduated disk formed by opaque windows and transparent ones alternated. The system is perpendicularly illuminated by an infrared light source. The light projects the disk image on the receivers surface which are covered by a grating called collimator having the same disk steps. The receivers trasduce the occurring light variations caused by the disk shifting and convert them into their corresponding electrical variations. Electrical signals, raised to generate squared pulses without any interference, must be electronically processed. The reading system is always carried out in differential modality, that is comparing different signals nearly identical but out of phase of 180 electrical degrees. That in order to increase quality and stability of output signals. The reading is performed comparing the difference between the two channels, to remove the noise known as “common mode”, because signals are overlapped in equal way on each wave.



INCREMENTAL ENCODER

The incremental encoder usually gives two types of squared waves out of phase of 90 electrical degrees. They are usually called channel A and B. The first channel gives information about the rotation speed while the second, basing on the state sequence produced by the two signals, provides the direction of rotation. A further signal, called Z or zero channel, is also available. It gives the absolute zero position of the encoder shaft. This signal is a squared pulse with phase and width centered on A channel.

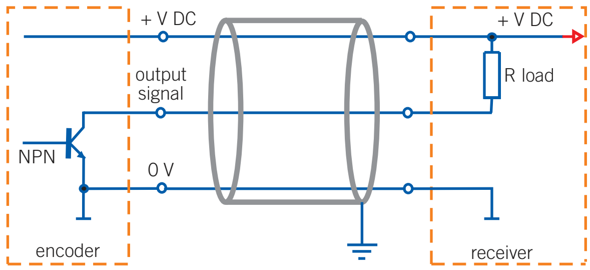


ISO 9001:2000

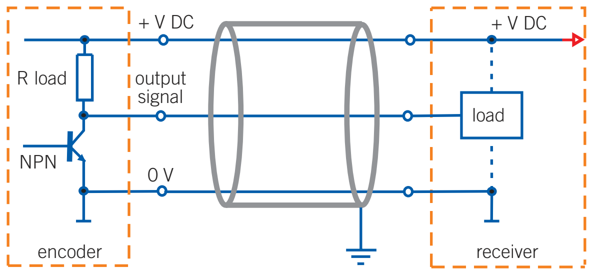
NPN and NPN open collector

It is composed of a NPN transistor and a pull-up resistor used to match the output voltage to the power supply when transistor is off. From the electrical point of view it is similar to TTL logic and so it is considered compatible. If used properly, it has low saturation levels at 0 V and null at + V DC. It is proportionally influenced by cable length, output frequency and load. So it is necessary to consider these specifications for a proper use.
The open collector variant is different for the absence of the pull-up resistor, which releases the transistor collector from the link to the encoder power supply, and allows to obtain signals with different voltage.

NPN OPEN COLLECTOR



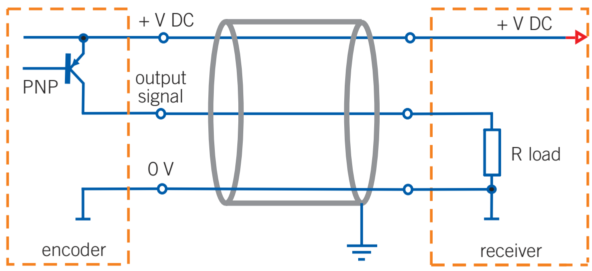
NPN



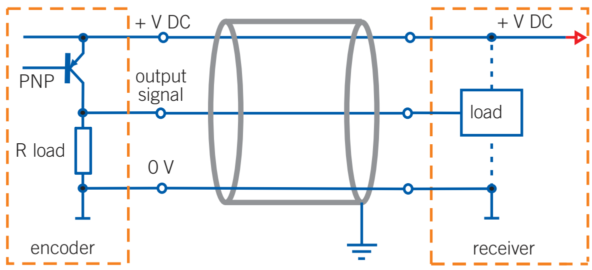
PNP and PNP open collector

Main features and limitations are the same as NPN electronics. Main difference is the transistor, that is PNP type and is linked to + V DC. The resistor, if present, is pull-down type and is placed between output and 0 V.

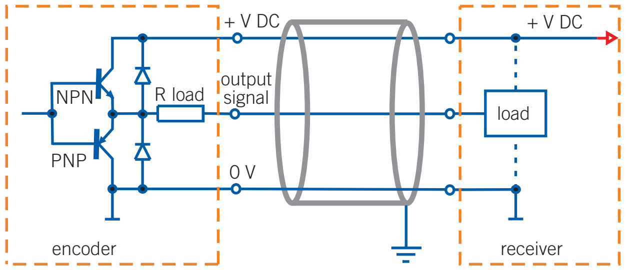
PNP OPEN COLLECTOR



PNP



PUSH-PULL

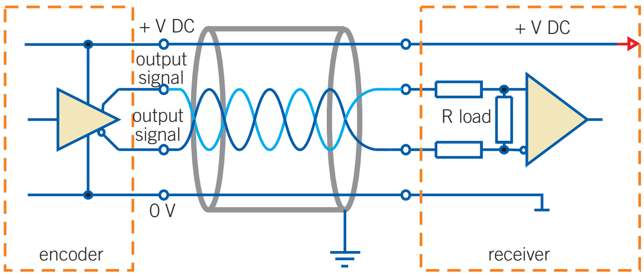


Push-pull

Electronics with high performances. NPN or PNP major limitations are caused by the resistor, that operates with a much higher impedance than a transistor. To overcome this issue, push-pull electronics uses a complementary transistor, so that the impedance is lower for commutations to + V DC and to 0 V.

This solution increases frequency performances, allowing long links and optimal data transmission, even at high speed. Saturation levels are contained, but at times higher than in NPN and PNP electronics. Anyway push-pull electronics is indifferently applicable in place of NPN or PNP.

LINE DRIVER

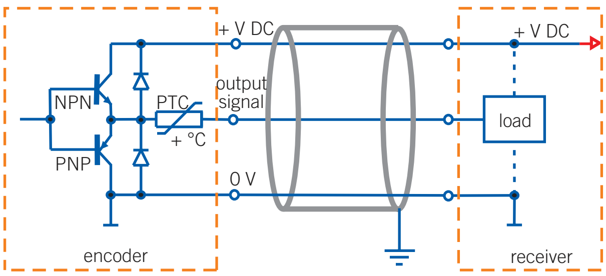


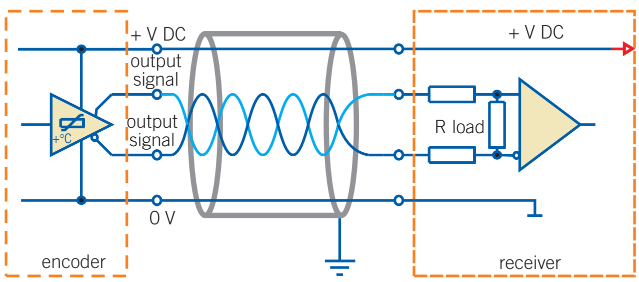
Line driver

Line driver is used when operating environments are particularly exposed to electrical disturbances or when the encoder is far from the receiver. Data transmission and reception uses 2 complementary channels, so disturbances are limited (they usually come from other cables or close machinery). These interferences are known as “common mode” noises because their generation is related to a common point (system ground).

In line driver electronics, transmitted and received signals operate in differential mode. In other words, the system works basing the communication on voltage differences between complementary channels. Therefore it is insensitive to “common mode” noises. This type of transmission is used in 5 V DC systems and it is also known as RS422 standard. It is available also with power supply up to 24 V DC on demand.

PROTECTIONS





Protections for outputs

Two different kinds of electronic protection against short circuits may be used: the passive one (using fuses, non-linear resistors, etc.) and the active one (using transistors). Eltra encoders can be equipped with both types of protection.

Passive protection

Passive solution is the cheapest one. It is used to avoid accidental short circuits, that rarely happen. The component which carries out the protection is called PTC. It is a resistor that, if passed through by a current exceeding the definite one, increases its resistance to limit current growing. The limitations of this kind of protection is the low reacting speed, that progressively stresses the components under protection. Therefore this protection is efficacious against a limited number of short circuits and it is available only for NPN, PNP, and push-pull electronics.

Active protection

This solution is based on a integrated circuit in the output stage that constantly controls the temperature reached by the element that must be protected. In this way protection is very effective and reacting speed is very high. Moreover it ensures a constant protection against recurrent and permanent short circuits, which makes it excellent for harsh environments. It is available only for line driver and push-pull electronics.

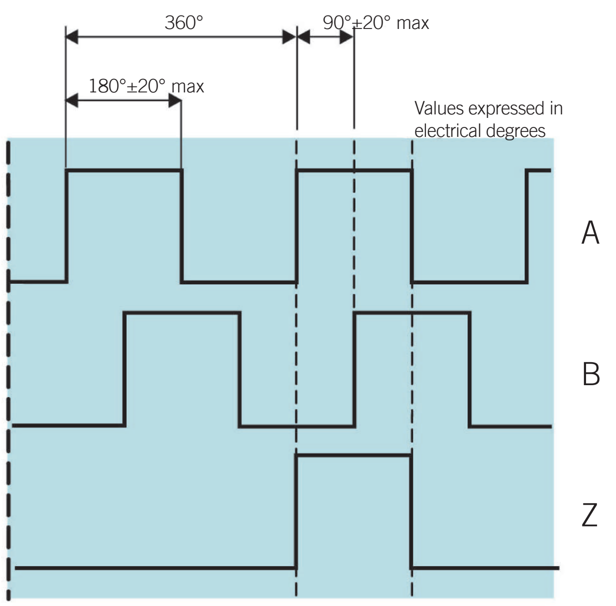
www.eltra.it e-mail: eltra@eltra.it
Via Monticello di Fara, 32 bis - 36040 - Sarego (VI) - ITALY - Tel. +39 0444 436489 - Fax. +39 0444 835335

The incremental encoder precision depends on mechanical and electrical factors. These errors could be: grating division, disk eccentricity, bearings eccentricity, electronic reading and optical inaccuracy. The measurement unit to define encoder precision is the electrical degree. It determinates the division of the impulse generated by the encoder: 360 electrical degrees correspond to the mechanical rotation of the shaft which is necessary to carry out a complete cycle. To know how many mechanical degrees correspond to 360 electrical degrees the following formula has to be applied:

$$\text{electrical } 360° = \frac{\text{mechanical } 360°}{\text{nr. pulses / turn}}$$

The encoder division error is given from the maximum shifting shown in the electrical degrees of two consecutive edges. This error exists in any encoder and is due to the above mentioned factors. For Eltra encoders this error is included in ±25 electrical degrees max. in whatever allowed condition, which corresponds to a shifting of ±7% from the nominal value. Regarding the 90 electrical degrees shifting between the two channels, it differs in ±35 electrical degrees max. It corresponds to ±10%.

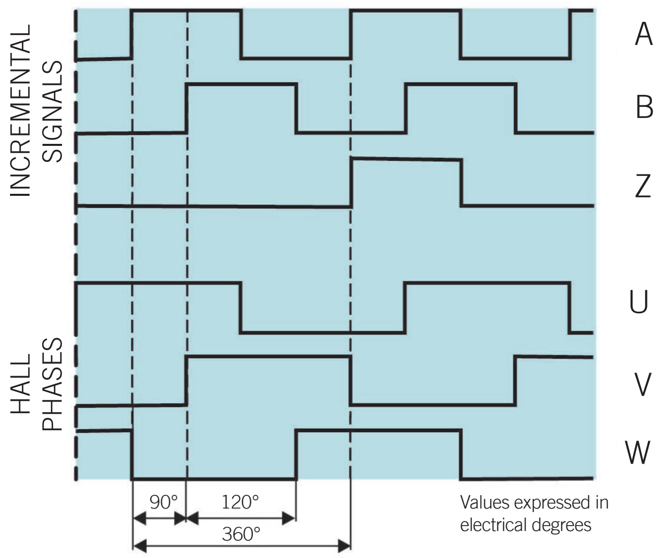
CLOCKWISE ROTATION DIRECTION



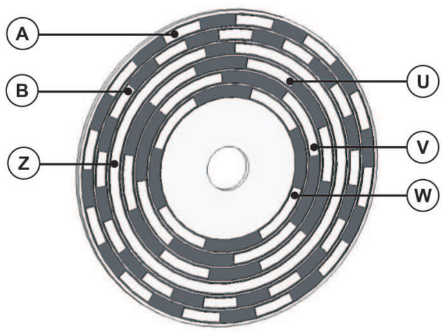
Graphic representation of A, B and Z incremental signals.

INCREMENTAL ENCODER WITH INTEGRATED COMMUTATION PHASES (HALL PHASES)

In addition to the above mentioned encoders, there are other encoders that integrate additional electrical output signals. These are incremental encoders with integrated commutation signals, used as motor feedback. These additional signals simulate the Hall phases that are usually present in brushless motors and are generally realized by magnetic sensors. In Eltra encoders these commutation signals are optically generated and presented as three squared waves, shifted by 120 electrical degrees. These signals will be used by the driver that controls the motor in order to generate correct voltage phases to determine right rotation. These commutation pulses can be repeated many times within one mechanical turn because they directly depend on the pole number in the related motor. So we have commutation phases for motors of 4. 6 or more poles.



Graphic representation of A, B and Z incremental signals with U, V and W Hall phases.



NPN / NPN open collector (TTL compatible) / push-pull

Function	5 wires	J connector 7 pins	M connector 7 pins	H connector 12 pins	V connector 9 pins	M12 connector 5 pins
+V DC	red	6	F	12	5	2
0 V	black	1	A	10	9	4
Signal A	green	3	C	5	1	3
Signal B	yellow	5	E	8	2	1
Signal Z	blue	4	D	3	3	5
⏚	shield	7	G	9	4	/

Line driver (without Z)

Function	8 wires	J connector 7 pins	M connector 7 pins	H connector 12 pins	V connector 9 pins	M12 connector 8 pins
+V DC	red	4	D	12	5	7
0 V	black	6	F	10	9	1
Signal A	green	1	A	5	1	6
Signal B	yellow	2	B	8	2	4
Signal A -	brown	3	C	6	6	5
Signal B -	orange	5	E	1	7	3
⏚	shield	7	G	9	4	/

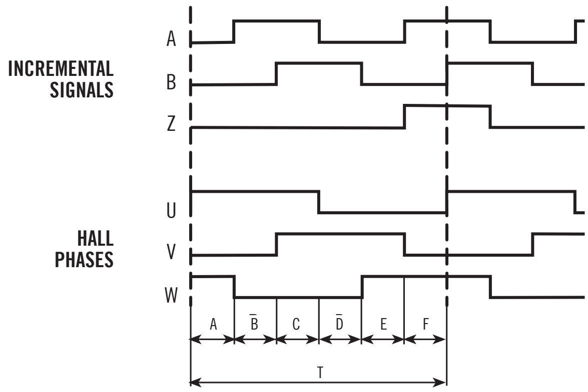
Line driver (with Z)

Function	8 wires	J connector 10 pins	M connector 10 pins	H connector 12 pins	V connector 9 pins	M12 connector 8 pins	MA connector 19 pins
+V DC	red	4	D	12	5	7	A
+V DC	red	5	E	12	5	7	A
0 V	black	6	F	10	9	1	C
Signal A	green	1	A	5	1	6	M
Signal B	yellow	2	B	8	2	4	P
Signal Z	blue	3	C	3	3	2	R
Signal A -	brown	7	G	6	6	5	N
Signal B -	orange	8	H	1	7	3	B
Signal Z -	white	9	I	4	8	8	L
⏚	shield	10	J	9	4	/	D

Line driver (with Hall phases)

Function	14 wires	MA connector 19 pins
+V DC	red	A
0 V	black	C
signal A	green	M
signal B	yellow	P
signal Z	blue	R
signal A -	brown	N
signal B -	orange	B
signal Z -	white	L
signal U	gray	H
signal V	purple	G
signal W	gray-pink	F
signal U -	red-blue	K
signal V -	white-green	V
signal W -	brown-green	U
⏚	shield	D

Signal configuration



POLES	A / B / C / D / E / F	T
4	30° ±1,5°	180°
6	20° ±1,5°	120°
8	15° ±1,5°	90°

Connectors

Connector type	Ref. code
J 7 pins cable mount straight plug (female)	PLS-20-7 (PLT® Apex)
J 10 pins cable mount straight plug (female)	SCC6A16-10S (Sam Woo Electronics)
M 7 pins cable mount straight plug (female)	MS3106-16S-1 (Amphenol®)
M 10 pins cable mount straight plug (female)	MS3106-18-1 (Amphenol®)
H 12 pins cable mount straight plug (female)	-
V 9 pins	D-Subminiature DE-9
M 12 5 pins	-
M 12 8 pins	-
MA 19 pins cable mount straight plug (female)	MS3116-14-19S (Amphenol®)

Precautions against electrostatic discharges

Be sure the metallic case of the connector is connected to the ground through a ring fixed to the screw of the connector itself. (Fig. 1)

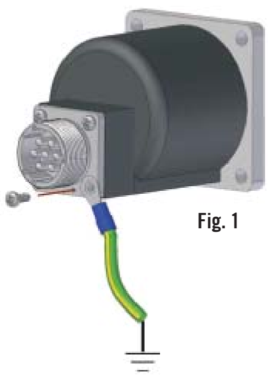


Fig. 1

Connect the cable shield to the ground and to the connector case. (Fig. 2)

Fig. 2

Proper installation of cables

· Make sure cable shield is connected to the ground and avoid connecting it to the power ground (0 V).

· Keep the encoder cable (signal cable) sufficiently far from power lines.

· Choose the cable according to installation requirements.

· Lay the cable avoiding spirals.

Further informations

· Custom cables, extensions and connectors are available on demand.

· Testing on 100% of the production.

· Anti-vibration wiring system.

· **Contact us for further informations.**

INSTALLATION AND OPERATION PRECAUTIONS

INSTALLATION AND OPERATION PRECAUTIONS

The encoder must be used with respect to its specifications. Encoder is a pulse generator and not a safety device.

Assembling and installing personnel must be qualified and carefully follow instructions of technical manual.

Don't expose the device to stress or impacts in order to ensure the correct working otherwise the warranty expires.

Make sure that the mechanical coupling of the encoder shaft is designed with the appropriate elastic couplings, especially in the case of accentuated axial or radial movements.

Make sure that the enviroment of use is free of corrosive agents (acids, etc.) or substances that are not compatible with the device.

Check the ground connection of the device if it is not possible to provide additional external connection.

Before putting it in operation, verify the voltage range applicable to the device and protect it from exceeding the stated technical specifications.

Connect power supply and signals cables in order to avoid capacitive or inductive interferences that may cause malfunction of the device.

Cable wiring must be carried out in a POWER-OFF condition.

For safety reason, we strongly recommend to avoid any mechanical or electrical modification. In that case, they will void the warranty.

MAIN PRODUCT WARRANTY TERMS

Replacements or repairs whether under the warranty or at the customer's expense must be performed in the service department of Eltra Srl or by explicitly authorized personnel. Before sending material for repairing, you must obtain an RMA number from our sales office. During the repair process in our service department, Eltra srl will be authorized to remove all parts that the customer added to the product. Any malfunction due to a failure to observe these usage and installation precautions will lead to the warranty voiding. Repairs will not extend the product warranty. We also exclude compensation for any type of damage or injury due to the use, or suspension of use, of the tranducer. Note: for additional information, refer to the sale terms on our website, www.eltra.it, or call our office.

PRECISION ELASTIC COUPLINGS

ISO 9001:2000

Main features

Eltra accurate elastic couplings are essential parts for the transmission of rotatory motion to the encoder shaft. Couplings are aluminium alloy made and are composed by a cylindrical body on which there is a helical groove that determines:

· Torsional rigidity
· Ability to compensate for slight shaft misalignments
· Ability to absorb small axial shifts of the shaft

Eltra elastic couplings have also a perfect balancing of the rotating body. They don't have critical points subject to breaking and they are completely frictionless. Moreover they perfectly transmit the rotatory motion, even in case of axial misalignment. Our couplings do not require any type of maintenance.
The internal drain allows the coupling between the shafts with distances from a minimum of 0.5 mm to a maximum of 6.12 mm (see "F" quota).
Elastic coupling can be supplied with different coupling diameters. E.G.: d1 = 8 mm, d2 = 10 mm. In this case the ordering code should be: G25A8/10.

Ordering code

G 25 A 6 / 8

accurate elastic coupling **G**

Coupling size
- (see table) 16
- (see table) 20
- (see table) 25
- (see table) 30

Shaft fixing type
- shaft fixing with grub screw A

Hole diameter "d1"
- ø 6 mm 6
- ø 8 mm 8
- ø 9.52 mm (3/8") 9
- ø 10 mm 10

Hole diameter "d2"
- ø 6 mm 6
- ø 8 mm 8
- ø 9.52 mm (3/8") 9
- ø 10 mm 10

don't indicate if d1 is equal to d2

Standard couplings

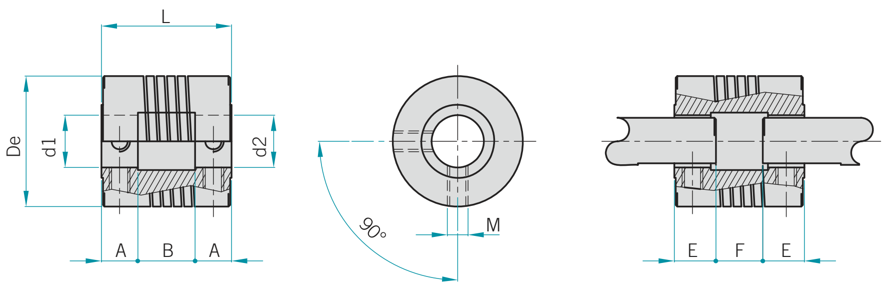
Type of material:
aluminium UNI 9002/5

For custom holes (d1-d2) please contact our offices.

Ordering code	ø De (mm)	L (mm)	ø d1 = d2 (mm)	A (mm)	B (mm)	M (mm)	E (mm)	F (mm)	Torque (Nm)
G 13 A 4	13.7	22 $^{+0.1}_{-0.1}$	4 H7 $^{+0.012}_{0}$	6	8	M3	7	6	0.25
G 20 A 6	20	20 $^{+0.1}_{-0.1}$	6 H7 $^{+0.012}_{0}$	6	8	M3	8	6	0.25
G 25 A 8	25	25 $^{+0.1}_{-0.1}$	8 H7 $^{+0.015}_{0}$	7	11	M4	8	9	0.4
G 25 A 9	25	25 $^{+0.1}_{-0.1}$	9.52 H7 $^{+0.015}_{0}$	7	11	M4	8	9	0.4
G 25 A 10	25	25 $^{+0.1}_{-0.1}$	10 H7 $^{+0.015}_{0}$	7	11	M4	8	9	0.4
G 30 A 10	25	30 $^{+0.1}_{-0.1}$	10 H7 $^{+0.015}_{0}$	8	14	M4	9	12	0.4

For a proper installation it is recommended to insert shafts in the coupling observing "E" quota.

Mechanical dimensions



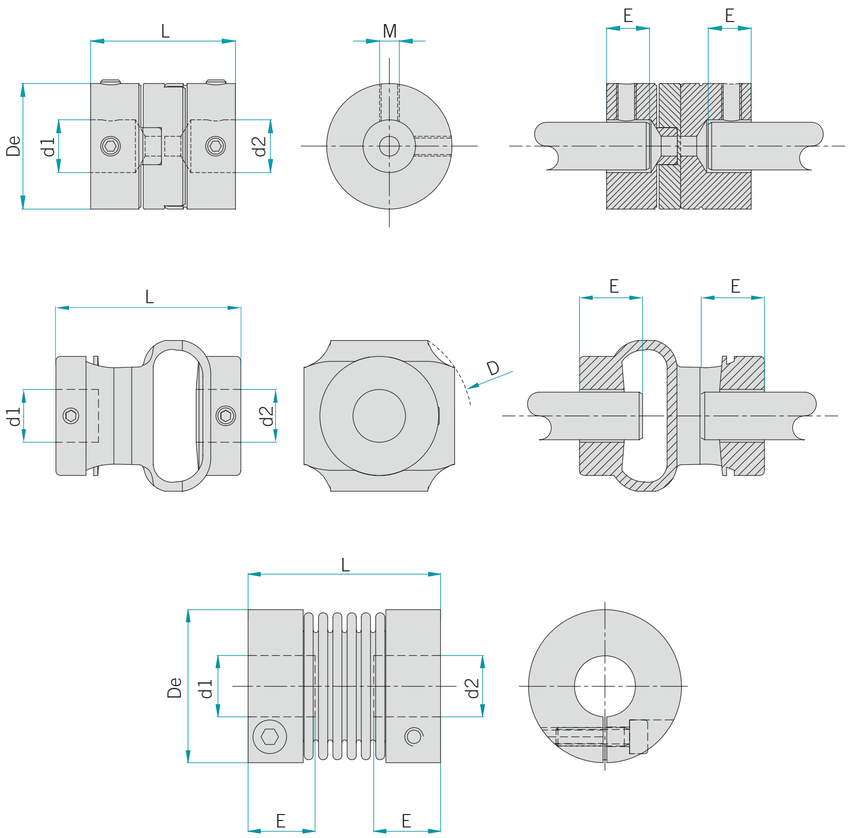
Special couplings

Ordering code	ø De (mm)	L (mm)	ø d1 = d2 (mm)	M	E (mm)	Torque (Nm)
GS 02 A 6	19.1	22 $^{+0.1}_{-0.1}$	6 H7 $^{+0.012}_{0}$	M3	6.3	0.9
GS 10 A 8	19.1	22 $^{+0.1}_{-0.1}$	8 H7 $^{+0.015}_{0}$	M3	6.3	0.9
GS 16 A 10	19.1	22 $^{+0.1}_{-0.1}$	10 H7 $^{+0.015}_{0}$	M3	6.3	0.9
GS 32 A 6	19.1	28 $^{+0.1}_{-0.1}$	6 H7 $^{+0.012}_{-0}$	M3	8	0.35
GS 01 A 8	19.1	28 $^{+0.1}_{-0.1}$	8 H7 $^{+0.015}_{-0}$	M3	8	0.35
GS 11 A 10	19.1	28 $^{+0.1}_{-0.1}$	10 H7 $^{+0.015}_{-0}$	M3	8	0.35
GS 15 A 10	19.1	47 $^{+0.1}_{-0.1}$	10 H7 $^{+0.015}_{-0}$	M4	12.6	1.4
GS 23 A 12	19.1	47 $^{+0.1}_{-0.1}$	12 H7 $^{+0.018}_{-0}$	M4	12.6	1.4
GS 29 A 6	25	32 $^{+0.1}_{-0.1}$	6 H7 $^{+0.012}_{-0}$	M3	10	3
GS 24 A 8	25	32 $^{+0.1}_{-0.1}$	8 H7 $^{+0.015}_{-0}$	M3	10	3
GS 25 A 10	25	32 $^{+0.1}_{-0.1}$	10 H7 $^{+0.015}_{-0}$	M3	10	3

For a proper installation it is recommended to insert shafts in the coupling observing “E” quota.

Eltra also manufactures a special coupling series designed specifically for critical and heavy uses. Some special couplings available on stock are listed in the table above. Different couplings are available on demand.

Mechanical dimensions



www.eltra.it e-mail: eltra@eltra.it
Via Monticello di Fara, 32 bis - 36040 - Sarego (VI) - ITALY - Tel. +39 0444 436489 - Fax. +39 0444 835335