Installation and Operational Instructions for ROBA®-ES Couplings Type 940. _ _ _ . _ Sizes 14 – 65 (B.9.6.EN)

Please read these Operational Instructions carefully and follow them accordingly!
Ignoring these Instructions may lead to malfunctions or to coupling failure, resulting in damage to other parts.

Contents:

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Safety and Guideline Signs

CAUTION

Danger of injury to personnel and damage to machines.

Please Observe!
Guidelines on important points.

Guidelines on explosion protection

Safety Regulations

These Installation and Operational Instructions (I + O) are part of the coupling delivery.
Please keep them handy and near to the coupling at all times.

It is forbidden to start initial operation of the product until you have ensured that all applicable EU directives and directives for the machine or system, into which the product has been installed, have been fulfilled.
At the time these Installation and Operational Instructions go to print, the ROBA®-ES couplings accord with the known technical specifications and are operationally safe at the time of delivery.

DANGER

- ❒ If the ROBA®-ES couplings are modified.
- ❒ The relevant standards for safety and / or installation conditions are ignored.

The ROBA®-ES coupling is permitted for use in areas where there is a danger of explosion.
For application in Ex-areas, please observe the special safety-related guidelines and directives on pages 12 and 13. The product must be especially marked for this area.
The product will only be marked if it is ordered especially for an Ex-area.

User-implemented Protective Measures

- ❒ Cover all moving parts to protect against seizure, dust or foreign body impact.

To prevent injury or damage, only professionals and specialists should work on the devices, following the relevant standards and directives. Please read the Installation and Operational Instructions carefully prior to installation and initial operation of the device.

These Safety Regulations are user hints only and may not be complete!

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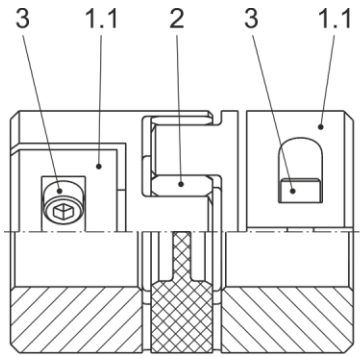
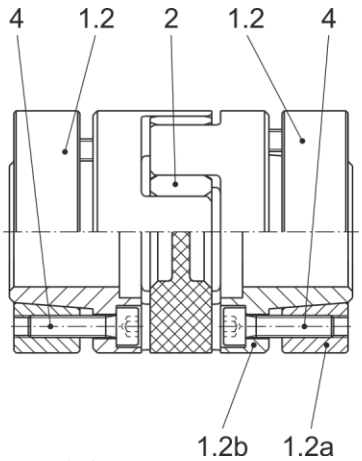
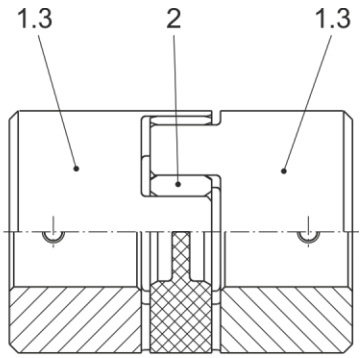


Type 940._00._
ROBA®-ES with clamping hubs
Fig. 1



Type 940._11._
ROBA®-ES with shrink disks
Fig. 2



Type 940._22._
ROBA®-ES with keyways
Fig. 3

Parts List (Only use *mayr* ® original parts)

1.1	Clamping hub	2	Elastomeric element	3	Clamping screw for clamping hub
1.2	Shrink disk hub assembly		98 Sh A (red)	4	Tensioning screw for shrink disk hub
1.2a	Shrink disk		92 Sh A (yellow)		
1.2b	Shrink disk hub		80 Sh A (blue)		
1.3	Hub with keyway		64 Sh D (green)		

Function - Application

ROBA®-ES stands for:
flexible (E), backlash-free (S) shaft coupling.
The device consists of two coupling hubs and a flexible, star-shaped intermediate ring (elastomeric element) Figs. 1 – 4.

ROBA®-ES couplings are conceived specially for backlash-free operation at comparatively high speeds.

ROBA®-ES couplings are mainly used in measurement and regulatory technology as well as in control and procedure technology.

ROBA®-ES couplings are shaft-shaft connections for flexible, backlash-free torque transmission in highly dynamic servo drives.

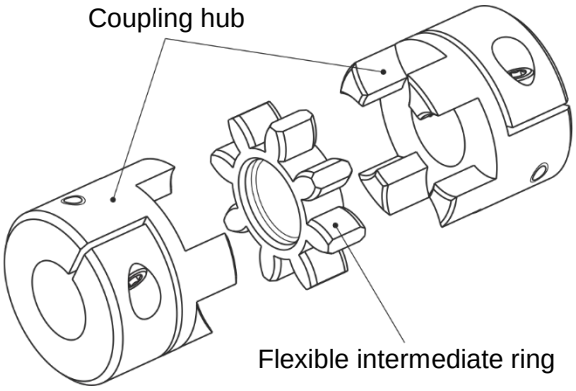


Fig. 4

State of Delivery

ROBA®-ES couplings are delivered manufacturer-assembled ready for installation (Please check state of delivery).
Depending on size or Type, ROBA®-ES coupling hubs are made of aluminium or steel.
The flexible, star-shaped intermediate ring (elastomeric element) is pressed into specially designed claws (Fig. 5) under light pre-tension.

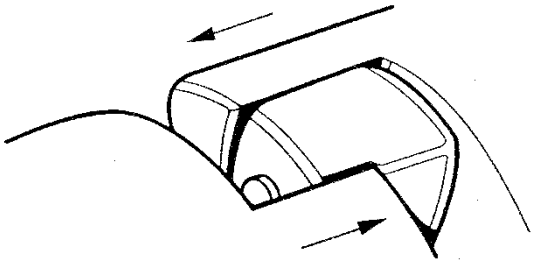


Fig. 5

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Table 1: Technical Data Type 940._22._ (Fig. 3)

Sizes	14	19	24	28	38	42	48	55	65
Minimum bore [mm]	6	6	8	10	12	14	20	20	38
Maximum bore [mm]	15	24	28	38	45	55	60	70	80
Maximum speed [rpm]	19000	14000	10600	8500	7100	6000	5600	5000	4600
Adjusting screw thread (see Fig. 10)	M4	M5	M5	M6	M8	M8	M8	M10	M10
Adjusting screw tightening torques [Nm]	1.5	2	2	4.1	8.5	8.5	8.5	20	20

Table 2: Technical Data for Type 940._00._ (Fig. 1)

Sizes	14	19	24	28	38	42	48	55	65
Minimum bore [mm]	6	10	15	19	20	28	35	40	45
Maximum bore [mm]	15	20	28	35	45	50	55	70	80
Maximum speed [rpm]	19000	14000	10600	8500	7100	6000	5600	5000	4600
Clamping screw thread	M3	M6	M6	M8	M8	M10	M12	M12	M14
Clamping screw tightening torques [Nm]	1.4	10	10	25	25	70	120	120	200

Sizes	Preferred bores on clamping hubs and respective transmittable torques T_R [Nm] on clamping hubs frictional locking with shaft tolerance k6																	
	Ø 6	Ø 7	Ø 8	Ø 9	Ø 10	Ø 11	Ø 12	Ø 14	Ø 15	Ø 16	Ø 19	Ø 20	Ø 22	Ø 24	Ø 25	Ø 28	Ø 30	Ø 32	Ø 35
14	2.5	3.0	3.4	3.8	4.2	4.7	5.1	6.0	6.4	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	23	25	27	32	34	36	43	45	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	34	36	43	45	50	54	57	63	-	-	-
28	-	-	-	-	-	-	-	-	-	-	79	83	91	100	104	116	124	133	145
38	-	-	-	-	-	-	-	-	-	-	-	83	91	100	104	116	124	133	145
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	208	228	248	280
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	350
55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sizes	Ø 38	Ø 40	Ø 42	Ø 45	Ø 48	Ø 50	Ø 52	Ø 55	Ø 58	Ø 60	Ø 62	Ø 65	Ø 68	Ø 70	Ø 72	Ø 75	Ø 78	Ø 80
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	158	166	174	187	-	-	-	-	-	-	-	-	-	-	-	-	-	-
42	315	340	365	404	442	470	-	-	-	-	-	-	-	-	-	-	-	-
48	390	420	455	505	560	600	640	705	-	-	-	-	-	-	-	-	-	-
55	-	340	365	405	435	465	490	525	570	600	625	665	700	740	-	-	-	-
65	-	-	-	545	590	630	662	710	764	800	840	900	954	990	1032	1095	1158	1200

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Table 3: Technical Data for Types 940._11.P and 940._11.F (Fig. 2) - Steel Design

Sizes	14-32	19-37.5	19	24-50	24	28	38	42	48	55	65
Minimum bore [mm]	6	10	10	15	15	19	20	28	35	40	45
Maximum bore [mm]	14	16	20	24	28	38	45	50	60	70	75
Bore acc. DIN 69002 [mm]	14	16	19	24	25	35	-	-	-	-	-
Maximum speed [rpm]	28000	21000	21000	15500	15500	13200	10500	9000	8000	6300	5600
Tensioning screw thread	4 x M3	6 x M4	6 x M4	4 x M5	4 x M5	8 x M5	8 x M6	4 x M8	4 x M8	4 x M10	4 x M12
Tensioning screw tightening torques [Nm]	1.3	3.0	3.0	6.0	6.0	6.0	10	25	30	52	90

Sizes	Preferred bores on shrink disk hubs and respective transmittable torques T_R [Nm] on shrink disks frictional locking with shaft tolerance k6																	
	Ø 6	Ø 7	Ø 8	Ø 9	Ø 10	Ø 11	Ø 14	Ø 15	Ø 16	Ø 17	Ø 18	Ø 19	Ø 20	Ø 22	Ø 24	Ø 25	Ø 28	Ø 30
14-32	7	9	11	13	15	17	25	-	-	-	-	-	-	-	-	-	-	-
19-37,5	-	-	-	-	26	30	45	50	60	-	-	-	-	-	-	-	-	-
19	-	-	-	-	33	38	55	61	67	73	78	84	88	-	-	-	-	-
24-50	-	-	-	-	-	-	-	45	50	54	60	65	70	85	112	-	-	-
24	-	-	-	-	-	-	-	56	62	68	74	81	87	100	120	125	135	-
28	-	-	-	-	-	-	-	-	-	-	-	141	153	177	203	216	256	282
38	-	-	-	-	-	-	-	-	-	-	-	-	197	228	261	279	332	368
42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	300	350
48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sizes	Ø 32	Ø 35	Ø 38	Ø 40	Ø 42	Ø 45	Ø 48	Ø 50	Ø 52	Ø 55	Ø 58	Ø 60	Ø 62	Ø 65	Ø 68	Ø 70	Ø 72	Ø 75
14-32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19-37,5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24-50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28	308	343	373	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	405	460	513	547	577	617	-	-	-	-	-	-	-	-	-	-	-	-
42	400	500	600	680	730	790	850	880	-	-	-	-	-	-	-	-	-	-
48	-	450	500	600	720	850	1000	1180	1270	1353	1428	1471	-	-	-	-	-	-
55	-	-	-	723	814	946	1085	1187	1284	1436	1585	1682	1795	1943	2100	2207	-	-
65	-	-	-	-	-	1402	1596	1731	1873	2095	2308	2420	2570	2750	2989	3157	3306	3550

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Table 4: Technical Data for Type 940._11.A (Fig. 2) - Aluminium Design

Sizes	14	19	24	28	38
Minimum bore [mm]	6	10	15	19	20
Maximum bore [mm]	14	20	28	38	45
Maximum speed [rpm]	28000	21000	15500	13200	10500
Tensioning screw thread	4 x M3	6 x M4	4 x M5	8 x M5	8 x M6
Tensioning screw tightening torques [Nm]	1.3	3.0	6.0	6.0	10

Sizes	Preferred bores on shrink disk hubs and respective transmittable torques T_R [Nm] on shrink disks frictional locking with shaft tolerance k6																							
	ø 6	ø 7	ø 8	ø 9	ø 10	ø 11	ø 14	ø 15	ø 16	ø 17	ø 18	ø 19	ø 20	ø 22	ø 24	ø 25	ø 28	ø30	ø 32	ø 35	ø 38	ø 40	ø 42	ø 45
14	7	9	11	13	15	17	24	-	-	-	-	-			-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	33	38	55	61	67	73	78	84	88	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	56	62	68	74	81	87	100	120	125	135	-	-	-	-	-	-	-
28	-	-	-	-	-	-	-	-	-	-	-	141	153	177	203	216	256	282	308	343	373	-	-	-
38	-	-	-	-	-	-	-	-	-	-	-	-	197	228	261	279	332	368	405	460	513	547	577	617

Table 5: Torques

This concerns rated torques. For exact dimensioning, please observe the transmittable torques of the respective shaft-hub connections as well as the design calculation on pages 14 and 15.

Sizes	Torque Type 940._ _ _._							
	Elastomeric element hardness 80 Sh A (blue)		Elastomeric element hardness 92 Sh A (yellow)		Elastomeric element hardness 98 Sh A (red)		Elastomeric element hardness 64 Sh D (green)	
	T_{KN} [Nm]	$T_{K\,max}$ [Nm]	T_{KN} [Nm]	$T_{K\,max}$ [Nm]	T_{KN} [Nm]	$T_{K\,max}$ [Nm]	T_{KN} [Nm]	$T_{K\,max}$ [Nm]
14	4	8	8	16	13	26	16	32
19	5	10	10	20	17	34	21	42
24	17	34	35	70	60	120	75	150
28	46	92	95	190	160	320	200	400
38	95	190	190	380	325	650	405	810
42	125	250	265	530	450	900	560	1120
48	150	300	310	620	525	1050	655	1310
55	-	-	410	820	685	1370	825	1650
65	-	-	900	1800	1040	2080	1250	2500
Only available as Type 940._11.P								
14-32	4	8	8	16	13	26	16	32
19-37,5	4	8	8	16	14	28	17	34
24-50	12	24	25	50	43	86	54	108

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Table 6: Permitted Misalignment Values

Sizes	Shaft Misalignments								
	Axial	Radial				Angular			
	ΔK_a 80/92/98 Sh A 64 Sh D [mm]	ΔK_r 80 Sh A [mm]	ΔK_r 92 Sh A [mm]	ΔK_r 98 Sh A [mm]	ΔK_r 64 Sh D [mm]	ΔK_w 80 Sh A [°]	ΔK_w 92 Sh A [°]	ΔK_w 98 Sh A [°]	ΔK_w 64 Sh D [°]
14	1.0	0.21	0.15	0.09	0.06	1.1	1.0	0.9	0.8
19	1.2	0.15	0.10	0.06	0.04	1.1	1.0	0.9	0.8
24	1.4	0.18	0.14	0.10	0.07	1.1	1.0	0.9	0.8
28	1.5	0.20	0.15	0.11	0.08	1.3	1.0	0.9	0.8
38	1.8	0.22	0.17	0.12	0.09	1.3	1.0	0.9	0.8
42	2.0	0.24	0.19	0.14	0.10	1.3	1.0	0.9	0.8
48	2.1	0.26	0.21	0.16	0.11	1.3	1.0	0.9	0.8
55	2.2	-	0.24	0.17	0.12	-	1.0	0.9	0.8
65	2.6	-	0.25	0.18	-	-	1.0	0.9	-
Only available as Type 940._11.P									
14-32	1.0	0.21	0.15	0.09	0.06	1.1	1.0	0.9	0.8
19-37,5	1.2	0.15	0.10	0.06	0.04	1.1	1.0	0.9	0.8
24-50	1.4	0.18	0.14	0.10	0.07	1.1	1.0	0.9	0.8

Table 7: Spring Rigidities

Sizes	Static torsional spring rigidity				Dynamic torsional spring rigidity				Static radial spring rigidity			
	$C_{T\,stat.}$ 80 Sh A [Nm/rad.]	$C_{T\,stat.}$ 92 Sh A [Nm/rad.]	$C_{T\,stat.}$ 98 Sh A [Nm/rad.]	$C_{T\,stat.}$ 64 Sh D [Nm/rad.]	$C_{T\,dyn.}$ 80 Sh A [Nm/rad.]	$C_{T\,dyn.}$ 92 Sh A [Nm/rad.]	$C_{T\,dyn.}$ 98 Sh A [Nm/rad.]	$C_{T\,dyn.}$ 64 Sh D [Nm/rad.]	C_r 80 Sh A [N/mm]	C_r 92 Sh A [N/mm]	C_r 98 Sh A [N/mm]	C_r 64 Sh D [N/mm]
14	50	80	120	230	120	240	300	730	180	300	470	960
19	350	820	900	1400	1050	1800	2200	4200	700	1200	2100	2700
24	820	2300	3700	4500	1300	4800	7600	10800	800	1900	2800	4200
28	1300	3800	4200	7000	2200	6800	10100	17200	950	2100	3500	4900
38	2000	5600	7400	9000	3400	11900	19900	30500	1300	2900	4800	5600
42	3500	9800	13800	15000	5950	20500	31100	64900	3400	4100	5400	6900
48	4300	12000	15100	28500	7300	22800	44900	102800	3750	4500	6200	8200
55	-	14200	20500	56300	-	25800	48200	117400	-	5680	8200	22500
65	-	19100	32800	90200	-	36200	67400	164000	-	7640	13120	36000
Only available as Type 940._11.P												
14-32	50	80	120	230	120	240	300	730	180	300	470	960
19-37,5	280	660	720	1120	840	1440	1760	3360	560	960	1680	2160
24-50	600	1700	2700	3300	1000	3600	5700	8100	600	1500	2100	3200

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Elastomeric Elements (2)

The elastomeric elements (2) are the central element of the ROBA®-ES-coupling. They define the application range as well as the shaft connection behaviour via the permitted torque, the rigidity, the damping and the misalignment values.

By using a unique polyurethane material and a special injection procedure, it is possible to achieve a high dimensional accuracy and evenness in the teeth of the elastomeric element (2). The elastomeric elements are available in different shore hardnesses (see Table 8).

The teeth of the elastomeric element (2) are chamfered at the sides. This makes blind assembly easier.

Agent Resistance – Elastomeric Elements (2)

The elastomeric elements (2) are very resistant against

- ❒ pure mineral oils (lubricating oils)
- ❒ anhydrous greases.

They have a similar resistance against fuels such as

- ❒ regular-grade petroleum
- ❒ diesel oil
- ❒ Kerosene.

Damage may occur after longer exposure to

- ❒ alcohols
- ❒ aromatic fuels (super/four star petrol).

The elastomeric element material used is resistant to hydrolysis. In contrast to other polyurethane materials, water (including sea water) causes, even after years of exposure, no particular changes to the mechanical characteristics. Hot water, however, reduces the mechanical strength.

For information on contact with special agents or radiation, please contact the manufacturers.

Temperature Resistance – Elastomeric Elements (2)

The ambient temperatures present during operation have a considerable effect on the torque, the rigidity or the damping behaviour of the coupling. The permitted temperature ranges according to Table 8 must be maintained.
The temperature influence must be taken into account during coupling dimensioning (pages 14 and 15).

General Installation Guidelines

As standard the bores of the coupling hubs are provided with a H7 tolerance on the designs with shrink disks or with keyways and with a F7 tolerance on the design with clamping hub. We recommend a k6* shaft tolerance. The shaft surface should be finely turned or ground (Ra = 0.8 µm).
In case of customer-side provided bores, please observe the shaft run-out tolerance 0.05 to "A" (see Fig. 6).
The bores or shafts **must not be oiled or greased** when installing the coupling with clamping hub (1.1) or shrink disk hub (1.2).
(* Please contact the manufacturer for other shaft tolerances.)

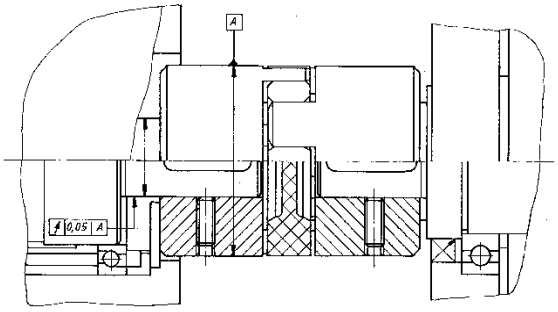

Fig. 6 ROBA®-ES with keyways

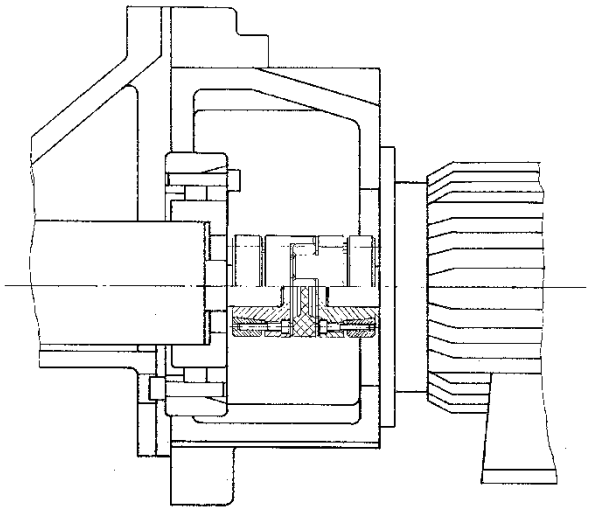

Fig. 7 ROBA®-ES with shrink disk hubs

Table 8: Elastomeric Element Hardnesses and Permitted Temperature Ranges

Elastomeric element hardness [Shore]	Colour	Permitted temperature range	
		Permanent temperature	Max. temporary temperature
80 Sh A	blue	-50 °C to +80 °C	-60 °C to +120 °C
92 Sh A	yellow	-40 °C to +90 °C	-50 °C to +120 °C
98 Sh A	red	-30 °C to +90 °C	-40 °C to +120 °C
64 Sh D	green	-30 °C to +100 °C	-40 °C to +140 °C

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Installation

Due to its optimum construction the ROBA®-ES coupling offers the possibility to connect the coupling axially after the hubs have been assembled onto the input or output shafts.
Any subsequent screwing together and special housings are not necessary
(see Installation Examples on pages 6, 7 and 11).

ROBA®-ES couplings with steel hubs and steel shrink disks have been zinc phosphated manufacturer-side to form a basic corrosion protection. All other components are untreated. The hubs acc. DIN 69002 are blank and oiled. For both steel and aluminium hubs, the bores or shafts have to be degreased before installing the coupling Types:

with clamping hubs 940._00._

with shrink disk hubs 940._11._

Greasy or oily bores or shafts do not transmit the indicated transmittable torque T_R specified on order.

Installation of the Coupling Halves (Hubs)

Installation of the Coupling Clamping Hubs

Type 940._00._ (Fig. 8)

- ❒ Mount the coupling hubs (1.1) onto both shaft ends using a suitable device and bring them into the correct position.
- ❒ Tighten the tensioning screw (3) using a torque wrench evenly to the required torque acc. Table 2.

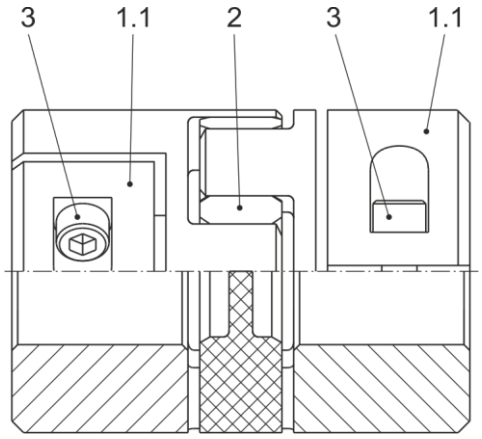

Fig. 8

Installation of the Coupling Hubs with Keyway

Type 940._22._ (Fig. 10)

In order to dimension the shaft-hub connection or to check the permitted contact pressure per unit area of the keyway, the calculation procedure acc. DIN 6892 usual in mechanical engineering is to be applied.

For calculation, please take the yield point as R_p 0.2 for aluminium 200 N/mm² and for steel 350 N/mm².

- ❒ Mount the coupling hubs (1.3) onto both shaft ends using a suitable device and bring them into the correct position.
- ❒ Secure the hubs (1.3) axially (see also Installation Example Fig. 6).
  Axial securement takes place via a set screw (adjusting screw / Fig. 10).
- ❒ The key must lie over the entire length of the hub.

Installation of the Coupling Shrink Disk Hubs

Type 940._11._ (Fig. 9)

- ❒ The contact surfaces of the cone shrink disk (1.2a) or the cone shrink disk hub (1.2b) are greased manufacturer-side.
- ❒ Mount the coupling hubs (1.2) onto both shaft ends using a suitable device and bring them into the correct position.
- ❒ Tighten the tensioning screws (4) lightly up to their limits.
- ❒ Tighten the tensioning screws stepwise (in 3 to max. 6 tightening sequences) and cross-wise evenly using a torque wrench to the required torque acc. Table 3 or 4 (dependent on Type).

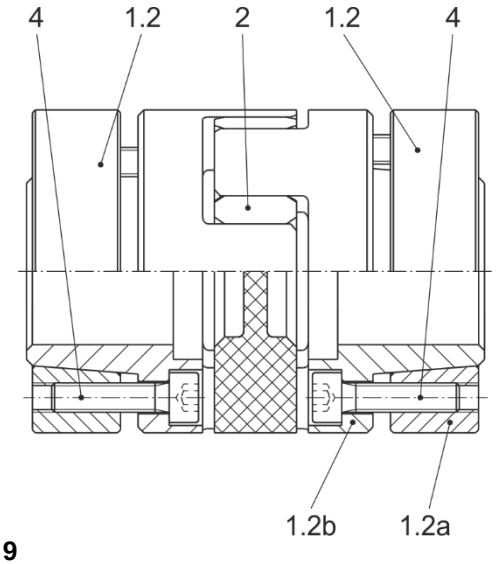

Fig. 9

For De-installation

- ❒ Loosen all tensioning screws (4) by several thread turns.
- ❒ Screw out the tensioning screws located next to the tapped extracting holes and screw them into the tapped extracting holes up to their limits.
- ❒ Tighten the tensioning screws (4) evenly and step-wise so that the shrink disk (1.2a) is loosened from the shrink disk hub (1.2b) (Fig.9).

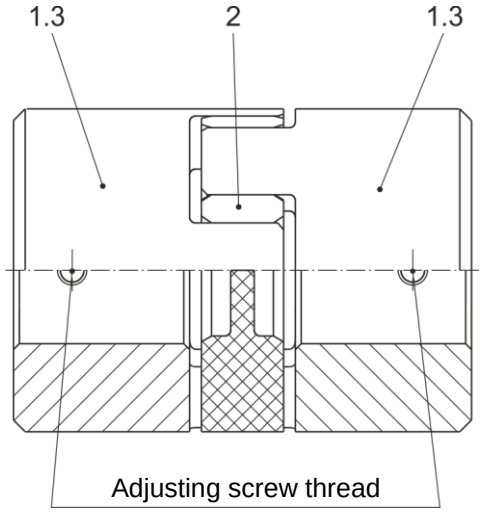

Fig. 10

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Joining Both Coupling Hubs

Due to the pre-tension on the flexible elastomeric element (2), an axial installation force is required when joining the coupling hubs (1.1-1.3) (Fig. 5).
The force required can be reduced by lightly greasing the elastomeric element.

Use PU-compatible lubricants (e. g. Vaseline or a multi-purpose grease based on mineral oil, NLGI Class 2, with a basic oil viscosity of approx. 200 mm²/s).

After joining both coupling hubs, no axial pressure must be placed on the elastomeric element (2).
Keep to distance dimension "E" acc. Fig. 11 and Table 9!

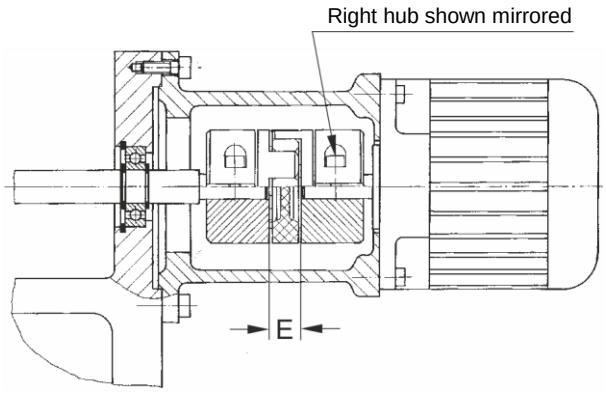

Fig. 11 ROBA®-ES with clamping hubs

Table 9:
Tightening Torques and Distance Dimension "E"

Sizes	Distance dimension "E" (Fig. 11)
14	13 mm
19	16 mm
24	18 mm
28	20 mm
38	24 mm
42	26 mm
48	28 mm
55	30 mm
65	35 mm

Shaft Misalignments

ROBA®-ES couplings compensate for radial, axial and angular shaft misalignments (Fig. 13) without losing their backlash-free function.
However, the permitted shaft misalignments indicated in Table 6 must not simultaneously reach their maximum value. If more than one kind of misalignment takes place simultaneously, they influence each other. This means that the permitted misalignment values are dependent on one another, see Fig. 12. The sum total of the actual misalignments in percent of the maximum value must not exceed 100 %.
The permitted misalignment values given in Table 6 refer to coupling operation at nominal torque, an ambient temperature of +30 °C and an operating speed of 1500 rpm. If the coupling is operated in other or more extreme operating conditions, please contact the manufacturers.

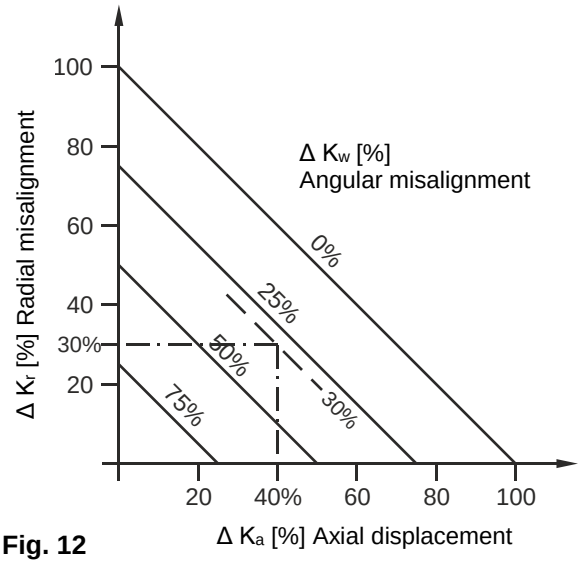

Fig. 12

Coupling Alignment

Exact alignment of the coupling increases the coupling service lifetime and reduces the load on the shaft bearings. We recommend alignment of the coupling using a dial gauge on drives operating at very high speeds. However, coupling alignment using a straight edge in two levels vertical to each other is usually sufficient.

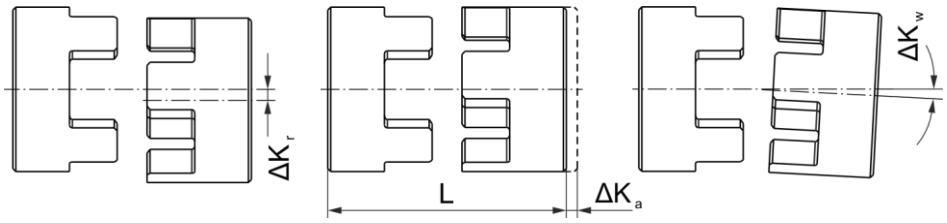

Fig. 13 Radial misalignment | Axial displacement | Angular misalignment

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Balancing

Key hubs (1.3) and clamping hubs (1.1):

Key hubs (1.3) and clamping hubs (1.1) rotate at maximum speed with a circumferential speed of 30 m/s. They are not balanced for standard delivery.

Shrink disk hubs (1.2):

Shrink disk hubs (steel and aluminium) (1.2) maintain balance quality G = 6.3 up to speed n_G (equals approx. 30 m/s) without needing to be balanced. Above this speed, we recommend balancing. The hubs are balanced individually. The diagram (Fig. 14) shows reference values. We recommend you use these values to balance the coupling components.
Smooth running of a machine or system is not only dependent on the balance quality of the coupling, but also on many parameters such as rigidity or distance to the adjacent bearing. Therefore there are no fixed rules in which conditions you have to balance.

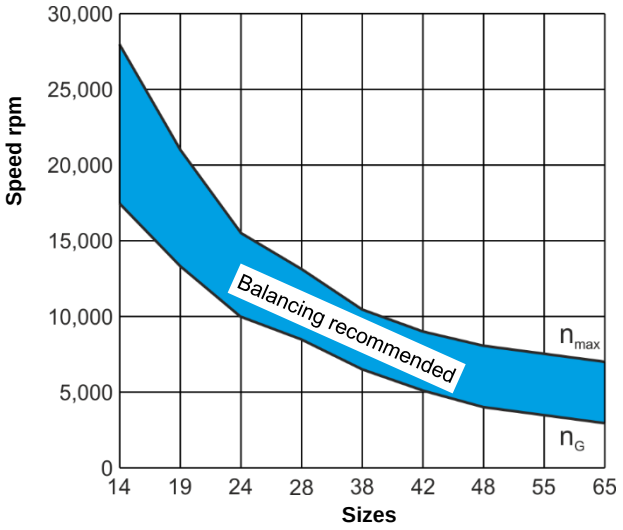

Fig. 14 **Diagram: Balancing the Shrink Disk Hubs**

Maintenance

The following maintenance and inspection intervals are to be maintained:

1.) Visual inspection. Inspection of the installation parameters (misalignment and tightening torques) and the coupling running behaviour **before initial operation.**

2.) Visual inspection, torsional backlash and elastomer wear, inspection of the misalignment and the tightening torques, coupling running behaviour
after 1000 h, at the latest after 3 months.

3.) If no irregularities or wear are found during the second maintenance and inspection interval, further inspection intervals can, with unchanged operating parameters, take place **after 4000 operating hours or after maximum 12 months.**

Elastomer wear limit:
No abraded particles are allowed on the elastomeric element (2), as the ROBA®-ES is a backlash-free coupling. The gap between two claws must be filled with the elastomer, with no room for backlash.
You should not be able to insert a feeler gauge with a thickness of 0.1 mm (Fig. 15).

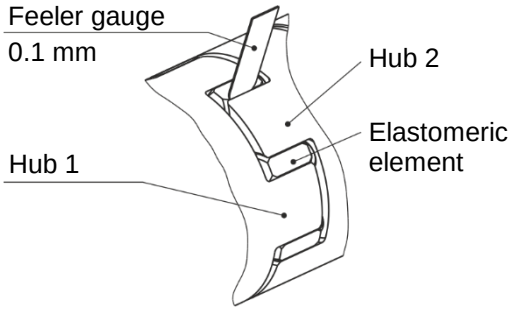

Fig. 15

If wear or damages are detected, the affected components must be replaced immediately and the cause of the malfunction must be determined.

Causes of malfunctions could be:

a.) Excessive misalignment
b.) Excessive load
(load alternations, start-up impacts, overload)
c.) Ambient influences

Wear or damage on the ROBA®-ES coupling manifest themselves as:

a.) Noise development
b.) Troubled running behaviour, vibration occurrences
c.) Formation of cracks on the components
d.) Warming
e.) Loosening of the components
f.) Friction tracks

CAUTION

Should any irregularities occur, the system must be stopped independently of imminent maintenance and inspection intervals, and the cause of the malfunction must be determined using the Malfunctions / Breakdowns Table.

Disposal

All steel components:
Steel scrap (Code No. 160117)

All aluminium components:
Non-ferrous metals (Code No. 160118)

Elastomer:
Plastic (Code No. 160119)

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Guidelines and Directives for Operation in Ex Areas Where There is a Danger of Explosion

Classification of Ex Areas Where There is a Danger of Explosion and Permitted Types

According to the described coupling combinations and if the measures and guidelines described in the Installation and Operational Instructions are observed, the ROBA®-ES is suitable for use in areas where there is a danger of explosion according to the category:

CE Ex II 2G c T4/T5/T6
–30° C≤Ta≤+80/60/45° C D110° C

Ex I M2 c –30° C≤Ta≤+80° C

Permitted Types: 940.022._ / 940.122._ / 940.522._ / 940.622._

For the dimensioning of the key connections, the permitted tensions common in machine construction must be considered. During initial operation, check whether the key is inserted correctly and whether the coupling is secured axially.

The couplings with frictional locking shaft-hub connections are in the standard design suitable for application in areas where there is a danger of explosion according to the category:

CE Ex II 3G c T4/T5/T6
–30° C≤Ta≤+80/60/45° C D110° C

Permitted Types: 940.000._ / 940.100._ / 940.500._ / 940.600._
940.011._ / 940.111._ / 940.511._ / 940.611._

Please observe the guidelines referring to the transmittable torques on clamping and shrink disk hubs in the currently valid ROBA®-ES catalogue.

For the bore diameters shown in Table 10, an additional keyway can be used in these designs for secure torque transmission. Furthermore, secure torque transmission is guaranteed if the respective customer-side application constellation is checked as to whether the torque transmission capability of the shaft-hub connection can be sufficiently guaranteed (at least 1.5 to the maximum torque on the system). This inspection must be repeated at regular intervals during maintenance work (see maintenance intervals).
In these conditions, coupling application is possible in the following areas:

CE Ex II 2G c T4/T5/T6
–30° C≤Ta≤+80/60/45° C D110° C

Table 10

Type	Bore [mm]	Sizes								
		14	19	24	28	38	42	48	55	65
940._00._	d_{min}	6	10	15	19	20	28	35	40	45
	d_{max}	15	20	28	35	45	45	55	70	80
940._11._	d_{min}	6	10	15	19	20	28	35	40	45
	d_{max}	12	18	22	32	36	42	52	58	63

Conditions to Observe in Ex Areas Where There is a Danger of Explosion

For malfunction-free coupling operation, it is necessary to keep to the coupling characteristic values (Technical Data) indicated on pages 3, 4 and 5 and in the catalogue.

Suitable coupling dimensioning is necessary for a malfunction-free and extremely low-wear operation, as described on pages 14 and 15.
Large shaft misalignments, in particular with high speeds and an alternating overall load configuration with high frequency, strain and heat up the elastomer material.
Unpermittedly high overall load configuration, unpermittedly high speeds and unpermitted shaft misalignments can destroy the coupling.

Attention: Danger of ignition

For suitable coupling dimensioning (see ROBA®-ES Coupling Dimensioning, pages 14 and 15), please observe the following points:

a.) Coupling nominal torque
b.) Coupling peak torque
c.) Max. speed
d.) Max. shaft misalignments
e.) Ambient temperatures
f.) Service factors

CAUTION

Operation outside of the indicated characteristic data is not permitted. There is a danger of coupling destruction and of ignition.

The number and type of start-up impacts must be taken into account according to the calculation basis (pages 14 and 15) during coupling dimensioning. Furthermore, elastomer heating may occur due to speed resonance. This must also be taken into account during coupling dimensioning. Changed operating parameters in the system require a renewed inspection of the coupling dimensioning. The maximum given ambient temperatures are to be kept to. The maximum surface temperature of the coupling changes in dependence of the ambient temperature, see coupling marking. Exceeding the permitted ambient temperature means a danger of elastomer destruction, or the maximum permitted surface temperature of the coupling is exceeded. With destroyed or heavily worn elastomer there is the danger that the metallic claws of the hubs hit each other.

Attention: Danger of ignition

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Guidelines and Directives for Operation in Ex Areas Where There is a Danger of Explosion

Electrical potential equalization on the coupling must be possible via the mounted shaft ends using the motor or gearbox.

All screws must be secured against loosening using a sealing lacquer, e.g. Loctite 243.

Hub combinations are only permitted in the same material combination, aluminium/aluminium or steel/steel.
Combinations steel/aluminium are not permitted.
The combination aluminium shrink disk hub and steel shrink disk does not represent any danger potential.

Despite technical coupling dimensioning, system-dependent vibration excitations may occur during operation, which might lead to resonances and therefore to destructions on the ROBA®-ES coupling. On critical applications, the total load profile of the system must be run through during initial operation in order to confirm the suitability of the coupling in the system.

Furthermore, coupling malfunctions must be expected if the Installation Guidelines are not observed. The data stated in these Installation and Operational Instructions must be observed.
All tightening torques must be observed.
After having reached the specified Maintenance and Inspection Intervals, the tightening torques must be inspected using a torque wrench. If the specified torques are not observed, component movements due to metal contact and therefore warming up and formation of sparks must be expected.
Constructional modifications of the coupling are not permitted.

Initial Operation

Steel hubs and steel shrink disks have been zinc phosphated manufacturer-side to form a basic corrosion protection. All other components are untreated.
The hubs acc. DIN 69002 are blank and oiled.

The ROBA®-ES coupling must be axially secured onto the input and output shaft. Correct securement must be checked before initial operation.
In the key design, please secure the locking set screw with sealing lacquer, e.g. Loctite 243.

Layers of dust on the coupling or operation in piles of dust is not permitted.

The rotating coupling components must be protected against contact and against foreign body impacts.
Please mount a suitable cover onto the coupling.
We recommend using a coupling cover made of rustproof steel.
The design must be arranged in such a way that no deformations occur by impacting parts which cause a rubbing of the cover at the coupling (danger of ignition).
The distance from the cover to the rotating components must be at least 5 mm.
The cover must be electrically conductible.
Covers made of aluminium are not permitted.

Maintenance and Inspection Intervals for Couplings in Ex Areas Where There is a Danger of Explosion

The following maintenance and inspection intervals are to be maintained:

4.) Visual inspection, inspection of the installation parameters (misalignment and tightening torques) and the coupling running behaviour **before initial operation.**

5.) Visual inspection, torsional backlash and elastomer wear, inspection of the misalignment and the tightening torques, coupling running behaviour **after 1000 h, at the latest after 3 months.**

6.) If no irregularities or wear are found during the second maintenance and inspection interval, further inspection intervals can, with unchanged operating parameters, take place **after 4000 operating hours or after maximum 12 months.**

Elastomer wear limit:
No abraded particles are allowed on the elastomeric element (2), as the ROBA®-ES is a backlash-free coupling. The gap between two claws must be filled with the elastomer, with no room for backlash. You should not be able to insert a feeler gauge with a thickness of 0.1 mm (Fig. 16).

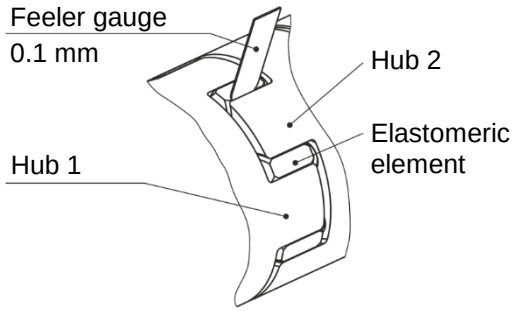

Fig. 16

If wear or damages are detected, the affected components must be replaced immediately and the cause of the malfunction must be determined.

Causes of malfunctions could be:

d.) Excessive misalignment
e.) Excessive load (load alternations, start-up impacts, overload)
f.) Ambient influences

Wear or damage on the ROBA®-ES coupling manifest themselves as:

g.) Noise development
h.) Troubled running behaviour, vibration occurrences
i.) Formation of cracks on the components
j.) Warming
k.) Loosening of the components
l.) Friction tracks

CAUTION

Should any irregularities occur, the system must be stopped independently of imminent maintenance and inspection intervals, and the cause of the malfunction must be determined using the Malfunctions / Breakdowns Table.

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ROBA®-ES Coupling Dimensioning

1. Approximate calculation of the coupling torque:

1.1. **T_N from the nominal power**

$$T_N = \frac{9550 \times P_{AN/LN}}{n}$$

1.2. **Dynamic torques T_S and T_W (5.1 and 5.2):**

Input-side excitation:

Peak torque: $T_S = T_{AS} \times \frac{J_L}{J_A + J_L} \times S_A$

Alternating torque: $T_W = T_{AW} \times \frac{J_L}{J_A + J_L} \times V_R$

Output-side excitation:

Peak torque: $T_S = T_{LS} \times \frac{J_A}{J_A + J_L} \times S_L$

Alternating torque: $T_W = T_{LW} \times \frac{J_A}{J_A + J_L} \times V_R$

2. Comparison of torques occurring in the coupling with the permitted torques

The coupling must be dimensioned so that the loads occurring do not exceed the permitted values in any operating condition.

2.1. **Load due to nominal torque**

$$T_{KN} \geq T_N \times S_\delta$$

2.2. **Load due to torque impacts (5.3)**

$$T_{K\,max} \geq T_S \times S_Z \times S_\delta + T_N \times S_\delta$$

2.3. **Load due to resonance passing through (5.4)**

$$T_{K\,max} \geq T_S \times S_Z \times S_\delta \times V_R + T_N \times S_\delta$$

2.4. **Load due to constantly alternating torque – cycle operation (5.5 and 5.6)**
Permitted alternating torque on coupling:

$$T_{KW} = 0.25 \times T_{KN} \text{ (for aluminium hubs)}$$

$$T_{KW} = 0.35 \times T_{KN} \text{ (for steel hubs)}$$

$$T_{KW} \geq T_W \times S_\delta \times S_f$$

3. Inspection of permitted misalignments

$$\Delta K_a \geq \Delta W_a \times S_\delta$$

$$\Delta K_r \geq \Delta W_r \times S_\delta \times S_n$$

$$\Delta K_w \geq \Delta W_w \times S_\delta \times S_n$$

If more than one kind of misalignment occurs at the same time, please observe Fig. 12 (page 10).

4. Frictional locking inspection on hub connection

$T_R > T_{max}$: T_{max} is the maximum torque occurring in the coupling.

Values for T_R are on pages 3, 4 and 5.

5. Explanations

5.1. The torque determination on the coupling is applicable if the shaft coupling in the system is the torsionally softest element, and therefore the system can be considered as a double-mass oscillator. If this is not the case, the calculation of the torque on the coupling requires a more detailed calculation procedure.

5.2. The impact factors S_A / S_L describe the impact progression. A rectangular progression of the peak torque is the heaviest impact (S_A/S_L = 2.0). A flat sinus progression of the peak torque is a light impact (S_A/S_L = 1.2).

5.3. T_S , the peak torque in the coupling, is the maximum torque on the coupling during the impact minus the system torque having an effect on the coupling during normal operation.

$T_S = T_{max,\,impact} - T_N$

5.4. If a drive is operated supercritically, meaning that the operating speed n lies above the resonance speed n_R , then resonance passing through causes particular loads.
If the resonance passes through quickly below the operating speed, only a few resonance peaks occur. The alternating torque in resonance can therefore be compared to the maximum torque on the coupling (see also 5.6).

5.5. S_f takes the frequency dependency of lifetime into account. The frequency dependency is first taken into account above 5 Hz.

5.6. On appreciable vibration excitation, the resonance must be moved out of the operating range by selecting a suitable torsional spring rigidity of the coupling.

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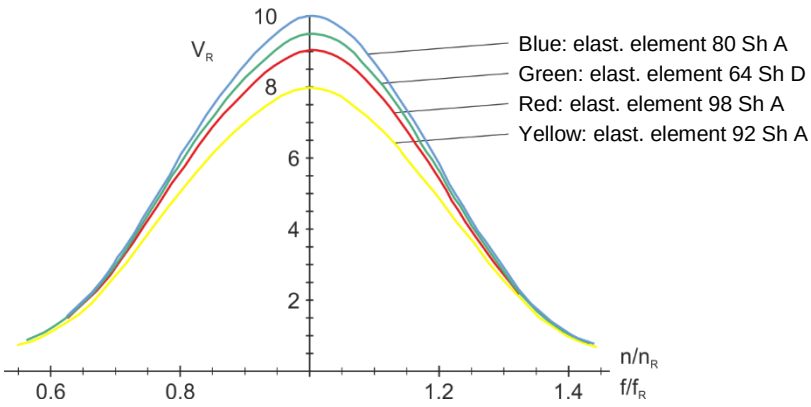
ROBA®-ES Coupling Dimensioning

Service Factors for Coupling Dimensioning

V_R = Resonance factor



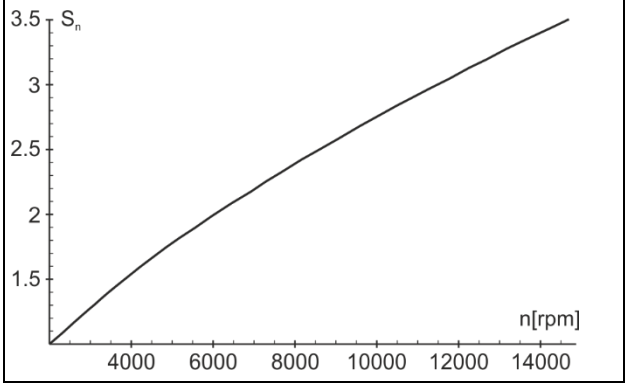
n_R = Resonance speed

$$n_R = \frac{30}{\pi} \sqrt{C_{T\,dyn.} \frac{J_A + J_L}{J_A \times J_L}}\ [rpm]$$

f_R = Resonance frequency

$$f_R = \frac{1}{2\pi} \sqrt{C_{T\,dyn.} \frac{J_A + J_L}{J_A \times J_L}}\ [rpm]$$

S_n = Speed factor



S_f = Frequency factor

F in Hz	≤ 5	> 5
S_f	1	$\sqrt{\frac{f}{5}}$

f shows the load alternation per second (Hz = s^{-1})

S_z = Start-up factor/impact frequency

S/h	0 – 100	101 – 200	201 – 400	401 – 800	801 – 1000
S_z	1	1.2	1.4	1.6	1.8

S_δ = Safety factor for temperature

T	-30 °C / +30 °C	+60 °C	+90 °C
S_δ	1	1.5	2

S_A or S_L = Impact factor

Impacts	S_A or S_L
Light impacts	1.2
Medium impacts	1.6
Heavy impacts	2.0

Terms

$P_{AN/LN}$	[kW]	Input-side/load-side power
T_R	[Nm]	Transmittable torque (frictional locking, Tables 2 – 4 on pages 3 – 5)
$T_{AS/AW}$	[Nm]	Excitational torque input side
$T_{LS/LW}$	[Nm]	Excitational torque load side
T_N	[Nm]	System torque
T_W	[Nm]	System alternating torque
T_S	[Nm]	Peak torque
T_{max}	[Nm]	Maximum torque in the coupling
T_{KN}	[Nm]	Permitted nominal torque
T_{Kmax}	[Nm]	Permitted maximum torque
T_{KW}	[Nm]	Permitted permanent alternating torque
J_A	[kgm^2]	Mass moment of inertia, input-side
J_L	[kgm^2]	Mass moment of inertia, load-side
ΔK_a	[mm]	Permitted axial displacement
ΔK_r	[mm]	Permitted radial misalignment
ΔK_w	[°]	Permitted angular misalignment
ΔW_a	[mm]	Axial shaft misalignment
ΔW_r	[mm]	Radial shaft misalignment
ΔW_w	[°]	Angular shaft misalignment
c_T	[Nm/rad]	Torsional spring rigidity
n	[rpm]	Nominal speed
n_R	[rpm]	Resonance speed
$S_{A/L}$	[-]	Impact factor input side /load side
S_n	[-]	Speed factor
S_Z	[-]	Start-up factor/impact frequency
S_δ	[-]	Temperature factor
S_f	[-]	Frequency factor
V_R	[-]	Resonance factor
f	[1/s]=[Hz]	Load factor
f_R	[Hz]	Resonance frequency

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Malfunctions / Breakdowns

Error	Possible Causes	Danger Guidelines for Ex Areas	Solutions
Changes in running noise and / or vibration occurrence	Incorrect alignment	Increased temperature on the elastomeric element surface; Danger of ignition due to hot surfaces	1) Set the system out of operation 2) Find / resolve the cause of incorrect alignment (e. g. loose foundation screws, motor securement breakage, heat expansion of system components, changes in the coupling installation dimension “E”) 3) Check the coupling for wear
	Wear on the elastomeric element, temporary torque transmission due to metal contact	Danger of ignition due to formation of sparks	1) Set the system out of operation 2) Dismantle the coupling and remove the remainders of the elastomeric element 3) Check the coupling parts and replace if damaged 4) Insert a new elastomeric element, install coupling components 5) Check the alignment and correct if necessary
	Tensioning and clamping screws or locking set screw for axial hub securement are loose	Danger of ignition due to hot surfaces and formation of sparks	1) Set the system out of operation 2) Check the coupling alignment 3) Tighten the tensioning and clamping screws for axial hub securement to the required torque or tighten the locking set screw and secure it against self-loosening using sealing lacquer 4) Check the coupling for wear
Cam breakage	Wear on the elastomeric element, torque transmission due to metal contact	Danger of ignition due to formation of sparks	1) Set the system out of operation 2) Replace the entire coupling 3) Check the alignment
	Cam breakage due to high impact energy / overload / excessively high shaft misalignments	Danger of ignition due to formation of sparks	1) Set the system out of operation 2) Replace the entire coupling 3) Check the alignment 4) Find the cause of overload
	Operating parameters are not appropriate for the coupling performance	Danger of ignition due to formation of sparks	1) Set the system out of operation 2) Check the operating parameters and select a suitable coupling (observe installation space) 3) Install a new coupling 4) Check the alignment
	Operational mistakes due to coupling characteristic data being exceeded	Danger of ignition due to formation of sparks	1) Set the system out of operation 2) Check coupling dimensioning 3) Replace the entire coupling 4) Check the alignment 5) Train and advise operating personnel
Premature wear on the elastomeric element	Incorrect alignment	Increased temperature on the elastomeric element surface; Danger of ignition due to hot surfaces	1) Set the system out of operation 2) Find / resolve the cause of incorrect alignment (e. g. loose foundation screws, motor securement breakage, heat expansion of system components, changes in the coupling installation dimension “E”) 3) Check the coupling for wear

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Malfunctions / Breakdowns

Error	Possible Causes	Danger Guidelines for Ex Areas	Solutions
Premature wear on the elastomeric element	e.g. contact with aggressive liquids / oils, ozone influences, excessively high ambient temperature etc., which lead to physical changes in the elastomeric element	Danger of ignition due to formation of sparks on metallic contact of the cams	1) Set the system out of operation 2) Dismantle the coupling and remove the remainders of the elastomeric element 3) Check the coupling parts and replace if damaged 4) Insert a new elastomeric element, install coupling components 5) Check the alignment and correct if necessary 6) Make sure that further physical changes to the elastomeric element can be ruled out
	The ambient or contact temperatures permitted for the elastomeric element are exceeded see Table 8	Danger of ignition due to formation of sparks on metallic contact of the cams	1) Set the system out of operation 2) Dismantle the coupling and remove the remainders of the elastomeric element 3) Check the coupling parts and replace if damaged 4) Insert a new elastomeric element, install coupling components 5) Check the alignment and correct if necessary 6) Check the ambient or contact temperature and regulate them (if necessary, use other elastomeric element materials)
Premature wear on the elastomeric element (material liquidation inside the elastomeric element toothing)	Drive vibrations	Danger of ignition due to formation of sparks on metallic contact of the cams	1) Set the system out of operation 2) Dismantle the coupling and remove the remainders of the elastomeric element 3) Check the coupling parts and replace if damaged 4) Insert a new elastomeric element, install coupling components 5) Check the alignment and correct if necessary 6) Find the cause of vibration (if necessary, use an elastomeric element with a lower or higher shore hardness)

Please Observe!
mayr® will take no responsibility or guarantee for replacement parts and accessories which have not been delivered by *mayr*®, or for damage resulting from the use of these products.

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Declaration of Conformity

According to the EC directive for the approximation of the laws and regulations for member states concerning devices and protective systems intended for use in areas where there is a danger of explosion (ATEX) 94/9/EC, we:

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hereby declare that the product described in these Installation and Operational Instructions

ROBA®-ES shaft coupling
Type 940._ _ _ X
Sizes 14, 19, 24, 28, 38, 42, 48, 55, 65

has been developed, constructed and produced by us in accordance with the EC directive named above.

Applied Standards, Regulations and Inspections (ASRI)

1 DIN EN 1127-1: 2011-10
Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concepts and methodology

2 DIN EN 13463-1: 2009-07
Non-electrical equipment intended for use in potentially explosive atmospheres - Part 1: Basic method and requirements

3 DIN EN 13463-5: 2011-10
Non-electrical equipment intended for use in potentially explosive atmospheres - Part 5: Protection by constructional safety “c”

Mauerstetten, December 10, 2015
Place / Date

Graduate Engineer (FH, University of Applied Science) Günther Klingler
(Managing Director ppa.)

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