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Imprint

CSN
Cardan Service Network

WiCHMANN

WiCHMANN – Industry catalogue

Your specialist for cardan shafts

Our oldest tradition is called:
Innovation.

WiCHMANN GmbH have committed themselves to unconditional customer orientation. Guaranteeing function of your cardan shaft drives is the task to which we have dedicated ourselves for over 30 years. This reflects our claim "Leistung, die bewegt". The meaning is "Power that keeps you moving". We have therefore created one of the most capable organisations in this field of manufacture and repair of cardan shafts for commercial vehicles and industrial plants with our Cardan Service Network (CSN). We are one of the most capable organisation on the field of manufacture and repair of cardan shafts for industrial plants and commercial vehicles. We posses one of the largest warehouse of machinable finish-worked components worldwide. Together with our component employees, we make an international contribution towards reducing breakdowns and machine downtimes to a minimum.

We create customer satisfaction via smooth communication routes, fast requirements analyses and secure problem solutions. All roads lead to the head office in Lotte.

Innovation

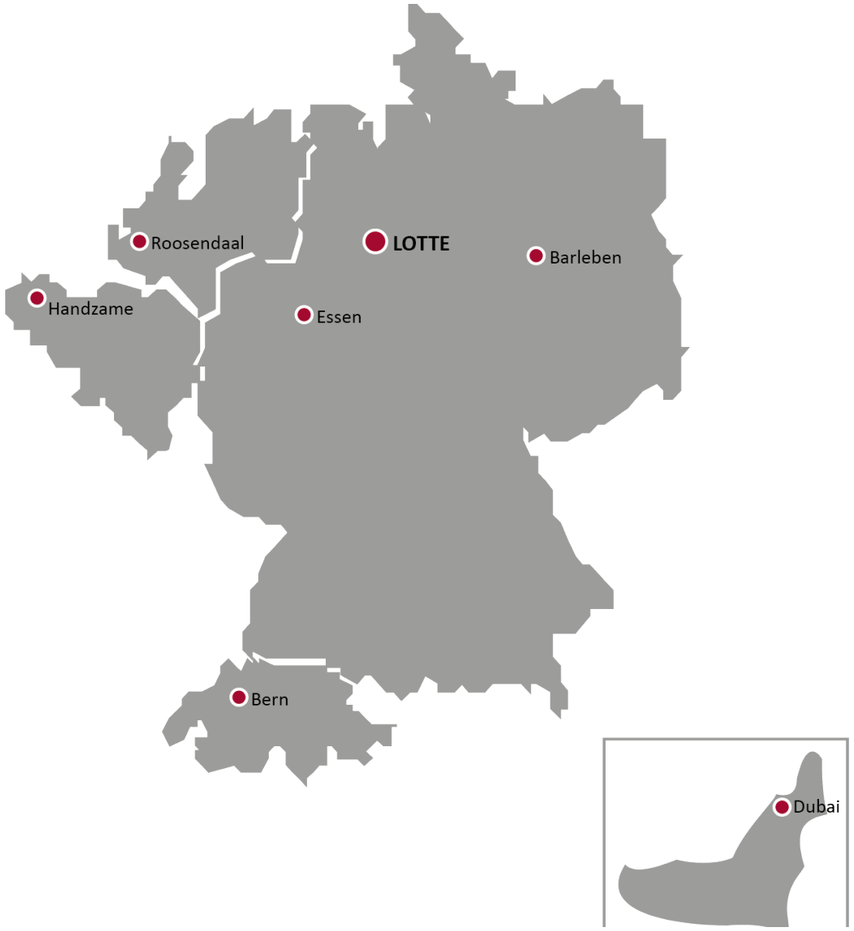



Brand of the WiCHMANN-Group
CSN

Cardan Service Network

Our Cardan Service Network (CSN) markets rebuilt cardan shafts, which we sell over our familiar network in the aftermarket. Here our unbeatable service and minimum delivery times ensure our competitive edge for rebuilt cardan shafts for commercial vehicles and industrial applications. Together with our domestic and foreign franchise partners, we guarantee the same first-class service and familiar high quality at all locations.

CSN
CARDAN SERVICE NETWORK



Content

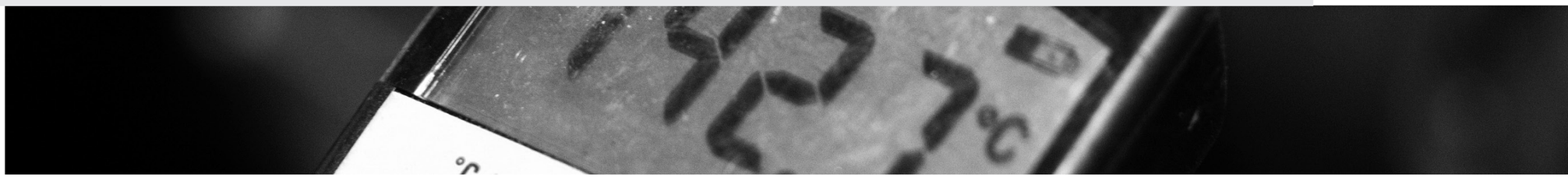
Quality „Made in Germany“

1. WiCHMANN – cardan shafts

Benefit from the excellent reliability, high service life and low operating costs of WiCHMANN – cardan shafts. We offer you a product range which is ideally graded in sizes from S to XXL+.

Especially in the heavy duty field from XL to XXL+, CSN cardan shafts are the right choice for difficult and severe requirements due to the following construction features:

Feature	Advantage	Customer benefit
Closed bearing yokes	· Maximum cross-sections for highest torques · Fewer high-maintenance components	· Longer service life · Higher productivity · Lower maintenance efforts
Maintenance-free U-joints	· Closed system · Innovative sealing system · No lubricant passages	· No loss of grease · No lack of maintenance · No maintenance costs · Longer service life · No machine down time
Perfected geometries	· Reduced notch stresses	· Higher torque capacity
Optimised spline	· Application-oriented splines and surfaces	· Reduced axial forces · Lower wear
Welding process certified according to DIN ISO 3834-2 and DIN EN 15085-2 CL1	· Guaranteed maximum weld seam quality · Central monitoring of welding process by qualified welding engineers	· High value weld seams
Competent consulting and service	· Decades of experience in all areas of application · Quick, trouble-free assistance/solutions	· Cost-effective cardan shaft selection · Higher plant availability
Optimal balancing	· Dynamic balancing in up to 4 planes	· Maximum running smoothness
Engineering of customised solutions	· Innovative, customer-specific construction of individual parts · Use of special materials	· Customised cardan shafts

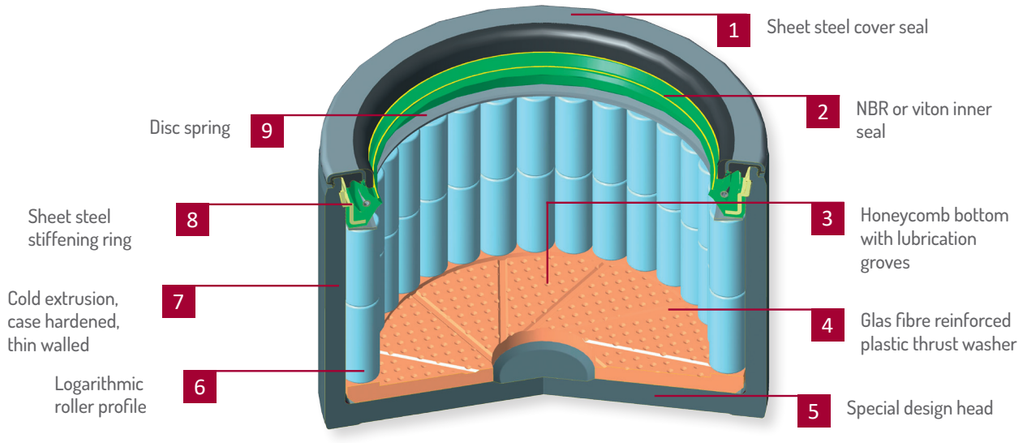


With WiCHMANN you stay flexible
2. Special solutions

2.1 Maintenance - free

Damages on cardan shafts can be traced back to wrong or deficient greasing. Our solution: an innovative U-Joint, which never has to be lubricated.

Feature	Customer benefit
Closed system	No re-lubrication
No loss of grease	Shorter downtimes
No penetration of water and dirt	Fewer failures



2.2 Length compensation – spline designs

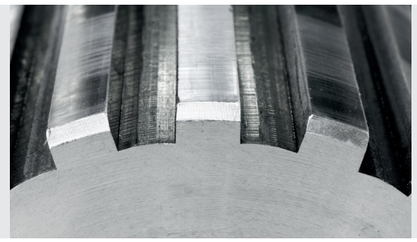
WiCHMANN offers 2 different spline types of length compensations. The involute profile is frequently used in small cardan shaft sizes. The parallel side spline is used in heavy duty shafts. On requirement we are able to offer this spline for other sizes.

Following advantages can be obtained:

Spline design	Advantage
SAE spline	· separated torque transmission and alignment · due to a large contact surface, you reach a lower surface pressure and axial forces. This leads to high friction resistance and service life
Involute spline	· optimal for smaller sizes, shortest delivery time and a good price performance

Confidence

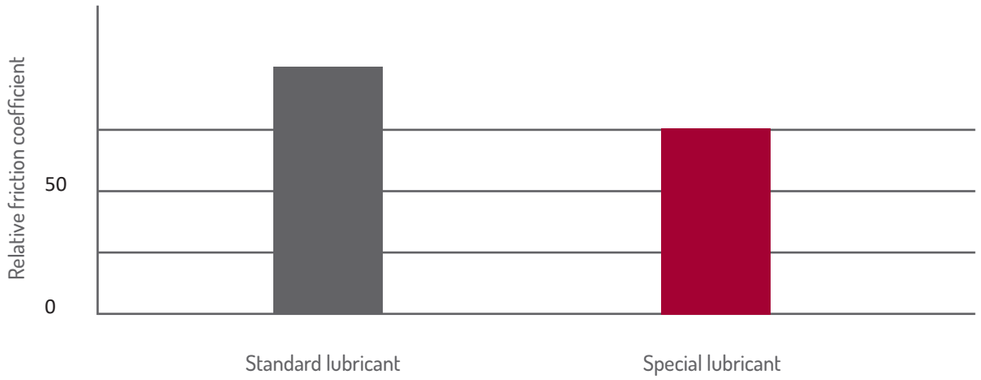
WiCHMANN



2.3 Lubricant

Cardan shafts for standard operating conditions are greased at our factory with a lubricant based on a lithium-complex saponification. For operation under heavy loads, as for example in rolling mill applications or in crusher drives, the use of a special lubricant with reaction-efficient additives is recommended. These form a anti-wear coating between the contact surfaces in case of high surface pressures and oscillatory movements in the U-joint. The service life can be considerably increased.

Though test bench experiments, accompanied by WiCHMANN, it was determined that the friction coefficient is thereby reduced by 25% for an axial displacement. This results in a significant reduction of the bearing loads of connected assemblies and a wearing of the tooth flanks. Both lubricants are compatible and mixable with each other.



2.4 WiCHMANN – services

WiCHMANN – services are available as a complete package or as single components:

1. Measurement and evaluation of all data related to operation and selection (power, speed, torque, etc.) for your cardan shaft
2. Design and construction of a cost-effective cardan shaft and corresponding connecting parts
3. On request: development and construction of spindle supports and joint hugger systems, as well as special constructions
4. Manufacture of the cardan shafts and connecting parts with continuous documentation and certificates/ references
5. Preparation of acceptance certificates of all major classification societies
6. Supervising of installation by qualified personnel
7. Training of operating and maintenance personnel on site or at a WiCHMANN location
8. Professional maintenance of the supplied drive elements
9. Cost-optimised repair service

Competence

Economical & fast.
3. Service concepts

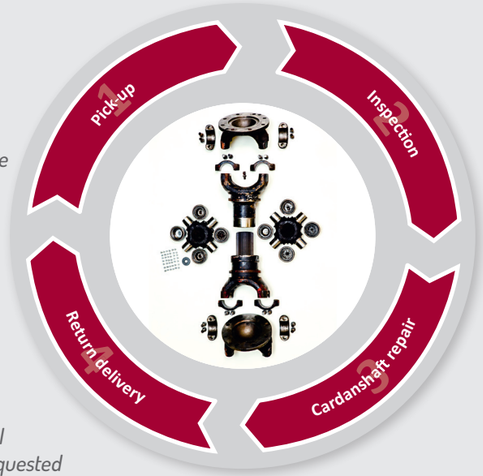
3.1 Repair service

Even with correct dimensioning and optimal maintenance, component failure in the U-joint is still possible after exceeding the bearing life, which can cause a considerable damage within the facility. For this reason, we recommend the preventive replacement of the relevant components. Component failure can also be caused by unpredicted overloading.

In order to guarantee professional workmanship, we recommend that the components be checked and repaired by our qualified personnel. The punctual renewal of defective components reduces maintenance costs.

1.

· *Coordinated pick-up service*



2. → **2a.** (optional)

· *Cleaning*
· *Visual inspection for deformations of all kinds*
· *Functional test*
· *Disassembly into all single parts*
· *Cleaning of all components*
· *Inspection of all individuals parts for reusability*
· *Radiographic examination of welding seams**
· *Inspection reports**
· *Proposal preparation*

✓ *Cleaning*
✓ *Visual inspection for deformations of all kinds*
✓ *Functional test*
\+ *Balancing process*

3.

· *Reassembly with replacement of defective components*
· *Converting to maintenance-free design**
· *Balancing*
· *Permanent marking*
· *Paintwork*
· *Lubrication*

4.

· *Quality control*
· *Creation of requested certificates & protocols**
· *Additional and permanent marking**
· *Delivery*
· *Special Packaging**
· *Guarantees on refurbished components*

** upon request of customer*

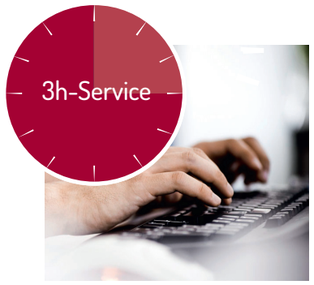
Service

3.2 3h – Service

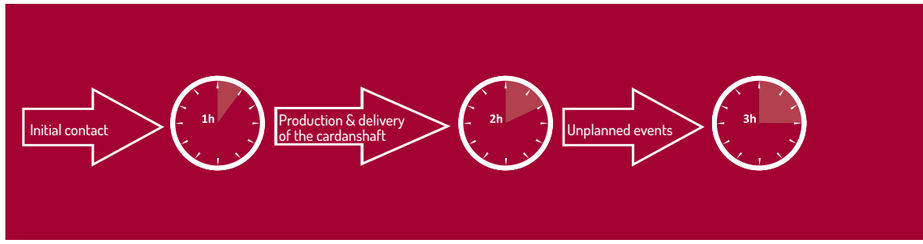
Cardan shafts up to size L which are used in the industrial sector, for example in steel mills or paper mills, can be supplied in a maximum of 3 hours if you are located in a WiCHMANN direct sales area. WiCHMANN can also process orders for larger sizes in an uncomplicated and fast manner, thus downtimes can be reduced to a minimum.

In order to keep the delivery time, the unique WiCHMANN machine system is used. This self-developed machine is able to make the following three steps in one stroke: pressing, welding, balancing. Benefit from the resulting short delivery times.

Emergency service 365 days / 24h



Contact



Functional principle of the WiCHMANN-3h-Service

3.3 Training service

To keep up with global competition, the constant further development of cardan shaft technology requires that one have a knowledge edge to recognise current trends and to develop further. The know-how gained in this area allows us to offer a kind of training and symposium and enables you to optimise process and costs.

We are glad to invite you on request to our WiCHMANN-training centre. We can also offer a training on-site at your company.

Possible subjects:

„Extension of service life through professional installation and maintenance of cardan shafts“.

„Correct failure diagnostics and repair of cardan shafts“.

Quality in black and white

4. Quality and certificates

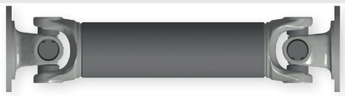
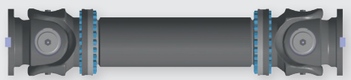
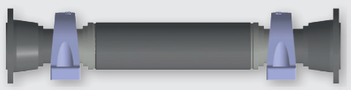
Our testing procedure, certificates and memberships show you that you have with WiCHMANN a reliable partner on your side:

Testing procedure	Short description
Spectral analysis	Quick detection of material composition
X-ray- and Ultrasonic test	For inner examination of the welding quality
Visual- and Crack test	For outer examination of the welding quality
Macrosection images	Check of the material structure
Hardness test	Test of surface hardness and penetration depth
Dimensional test	Registering the main dimensions
Paint thickness test	Control of thickness and composition of paint coatings

Certificate	Short description
ISO 9001 : 2008	Quality management standard
ISO 14001 : 2004	Environmental management standard
DIN EN 15085-2	Welding of rail vehicles and rail vehicle parts
DIN EN ISO 3834-2 CL1	Quality requirements for technical welding manufacturers
ATEX-Produktrichtlinie 94/9/EG	Operating safety regulation for explosive atmospheres
GHOST / TR-Certificate	Quality standard of the Russian Federation
DVS	German Association for Welding, Cutting and Allied Processes
VDMA	German Engineering Federation
GVA	Association of the German Car Parts Trade

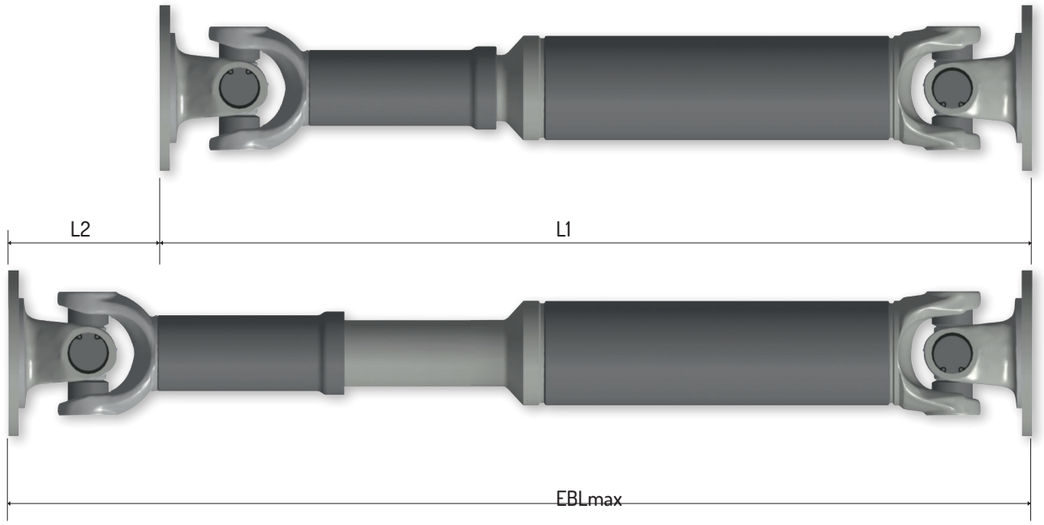
5. Cardan shaft designs

To provide the optimal shaft for the requested application, different sizes are the basis of an application-oriented dimensioning and calculation of your cardan shaft.

Design	Image	Description
100		Cardan shaft with length compensation
105		Cardan shaft with length compensation in double-flange design
110		Short couple shaft
130		Tube shaft without length compensation
135		Tube shaft without length compensation in double-flange design
160		Intermediate shaft
220		Intermediate tube shaft

6. Length definition

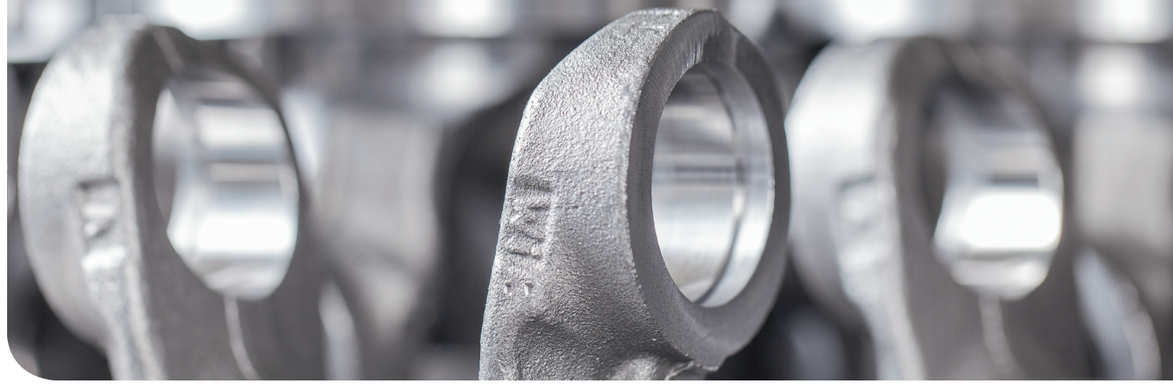
The working length EBL of your cardan shaft defines the distance between the drive and output units and the values of changes in length occurring during operation or at standstill. Cardan shafts without length compensation have a constant length L1 corresponding to the working length.



L1 = compressed length
L2 = maximum possible length compensation

EBLmax = maximum possible working length
Optimal working length = EBLopt. = L1 + ½ L2

WiCHMANN



One product – various opportunities
7. Cardan shaft sizes

Our cardan shaft range is oriented around individual demands of use and offers optimal properties and cost-effective designs for all applications, sizes and both standard and special constructions. Our range of products is as follows:

Size	Swing diameter [mm]	Bearing torque [Nm]	Areas of application	Feature
S	up to 76	up to 600	· General mechanical engineering · Paper machines · Test stands	· One-piece bearing yokes · Length compensation with involute spline · Flange yoke with DIN or SAE connection
M	100 - 144	1.400 - 6.000	· General mechanical engineering · Auxiliary drives · Construction machines · Test stands	· One-piece bearing yokes · Length compensation with involute spline · Flange yoke with DIN, SAE or cross-serrated connection · Maintenance-free U-joints
L	158 - 204	8.800 - 20.000	· General mechanical engineering · Rail vehicles · Utility vehicles · Test stands · Pumps · Paper machines · Rolling mill auxiliary drives	· One-piece bearing yokes · Length compensation with involute spline or straight flank spline (SAE) · Application-related spline coating · Flange yoke with DIN, SAE or cross-serrated connection, as well as with face key · Maintenance-free U-joints
XL	220 - 315	26.000 – 143.000	· General mechanical engineering · Rail vehicles · Test stands · Pumps · Paper machines · Cranes · Rolling mill drives	· One-piece bearing yokes · Length compensation with involute spline or straight flank spline (SAE) · Application-related spline coating · Flange yoke with DIN, face key or Hirth-serration · Maintenance-free U-joints
XXL	350 - 620	210.000 – 1.250.000	· General mechanical engineering · Test stands · Pumps · Paper machines · Cranes · Rolling mill drives	· One-piece bearing yokes · Length compensation with involute spline or straight flank spline (SAE) · Application-related spline coating · Flange yoke with DIN, face key or Hirth-serration · Double flange design
XXL+	from 680	from 1.950.000	· Heavy engineering · Rolling mill main drives	· One-piece bearing yokes · Length compensation with straight flank spline (SAE) · Application-related spline coating · Flange yoke with face key or Hirth-serration · Double flange design

8. Data sheets

L1 = compressed length, L2 = length compensation

Series		S	M				L				XL					XXL						XXL+			
Size		*07600*	*10000*	*11600*	*12600*	*14400*	*15800*	*17200*	*17800*	*20400*	*21500*	*21510*	*22580*	*25080*	*28580*	*31510*	*35000*	*39000*	*44000*	*49000*	*55000*	*62000*	*68000*	*75000*	*84000*
Bearing Torque Nm		600	1.400	3.000	5.300	6.000	8.800	12.500	17.000	20.000	26.000	29.000	45.000	70.000	100.000	143.000	210.000	300.000	500.000	700.000	1.000.000	1.250.000	1.950.000	2.650.000	3.900.000
Reversing Fatique Torque Nm		300	700	1.500	2.300	2.900	4.400	5.100	8.500	11.000	13.000	14.500	23.000	35.000	50.000	70.000	100.000	150.000	250.000	345.000	500.000	625.000	950.000	1.350.000	1.850.000
Joint Performance Factor Nm		220	660	990	1.780	2.070	2.400	3.500	4.600	6.800	8.050	8.350	12.050	18.650	26.200	28.140	40.300	56.800	81.500	112.000	154.000	210.000	320.000	750.000	2.230.000
Swing Diameter mm		76	100	116	126	144	158	172	178	204	220	220	225	250	285	315	350	390	440	490	550	620	680	750	840
100	L1 min	250	421	451	536	572	630	566	661	746	797	775	900	995	1.115	1.205	1.295	1.450	1.660	1.810	1.965	2.240			
	L2 min	40	110	110	110	110	180	110	110	110	150	140	110	140	140	140	150	170	190	190	240	250			
	tube size	50	50 / 76,2	70 / 90	90	100	100	120	120	140	144	150	160 / 170	180	200	219	245	273	325	351	402	445			
105	L1 min																						3.250	4.000	4.250
	L2 min																						250	250	250
	tube size																						559	609	660
110	L1 min	214	240	290	340	409	400	430	450	480	551	580	585	645	990	980	1.175	1.140	1.300	1.300	1.770	2.050			
	L2 min	15	15	30	40	45	35	40	40	40	50	40	40	40	50	100	50	80	70	50	55	55			
	L1 max	249	420	450	535	571	559	565	660	745	796	650	899	994	1.114	1.204	1.294	1.449	1.659	1.809	1.964	2.239			
	L2 max	40	110	110	110	110	110	110	110	110	150	110	140	140	140	140	150	170	190	190	240	250			
130	L1 min	190	218	278	309	369	355	400	353	440	506	538	615	680	760	890	950	1.040	1.250	1.360	1.480	1.690			
	tube size	50	50 / 76,2	70 / 90	90	100	120	120	120	140	144	150	160 / 170	180	200	215	245	273	324	355	406	445			
135	L1 min																						1.950	2.400	2.700
	tube size																						559	609	660
DIN *		75-6-6	90-4-8	100-6-8	120-8-10	150-8-12	150-8-12	180-8-14	180-8-14	180-8-14	225-8-16	225-8-16	225-8-16	250-8-18	285-8-20	315-8-22	350-10-22	390-10-24	435-10-27							
		90-4-8	100-6-8	120-8-8	150-8-12	180-8-14	180-8-14	180-8-16	180-8-16	180-8-16	250-8-18	250-8-18	250-8-18	285-8-20	315-8-22	350-10-22	390-10-24	435-10-27								
			100-8-8	120-8-10	180-8-10		180-8-16	180-10-16	180-10-16	180-10-16	285-8-20	285-8-20	285-8-20	315-8-22												
			120-8-8	150-8-10	180-8-14		180-10-16	225-8-16	225-8-16	225-8-16																
			120-8-10	150-8-12					250-8-18	250-8-18																
SAE *		87-4-8	87-4-8	119-4-11,1	146-4-12,7	174,8-8-9,6	174,8-8-9,6	203,2-8-9,6	203,2-8-9,6	203,2-12-11,1																
			96,8-4-9,6	149-4-12,7			203,2-8-9,6	203,2-12-11,1	203,2-12-11,1	244,5-8-16,1																
			119-4-11,1				203,2-12-11,1																			
Cross serration			100-4-8,5	122-4-11	122-4-11	122-4-11	150-4-13	150-4-13	150-4-13	180-4-15																
			122-4-11			150-4-13	180-4-15	180-4-15	180-4-15																	
DIN with face key											225-8-17 (32x9)	225-8-17 (32x9)	225-8-17 (32x9)	250-8-19 (40x12)	285-8-21 (40x15)	315-10-23 (40x15)	350-10-23 (50x16)	390-10-25 (70x18)	435-16-28 (80x20)	480-16-31 (90x22,5)	550-16-31 (100x22,5)	620-16-38 (100x25)				
												250-8-19 (40x12,5)	250-8-19 (40x12,5)	285-8-21 (40x15)	315-10-23 (40x15)	350-10-23 (50x16)	390-10-25 (70x18)	435-16-28 (80x20)	480-16-31 (90x22,5)	550-16-31 (100x22,5)	620-16-38 (100x25)				
													285-8-21 (40x15)													
Hirth-serration																	350-12-1116	390-12-1118	435-16-1118	480-16-1120	550-11-1122	620-6	680-24-33	750-24-33	840-24-38
																	390-12-1118	435-16-1118	480-16-1120	550-16-24	620-24-26	680-24-33			

Design

Connections

*At a purely frictionally engaged torque transmission there could be a reduction of the based nominal torque. Please contact our technical department in this case.

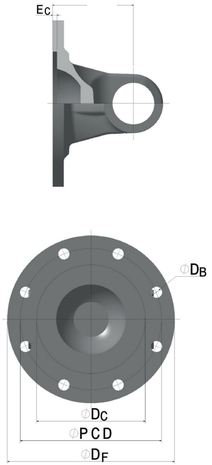
Notes

- Friction transfer of torque as well as special flange patterns can result in reduction of the torque output rating. (Applies only for Cardan shafts with smooth flanges; marked with *)
- Bolt sets in strength class 10.9 to DIN EN 898-1 are required to transfer the specified torque. Here it is necessary to observe the appropriate tightening torque depending on type of coating in compliance with VDI2230.
- In addition to the flange dimensions illustrated, special solutions are also available to meet customer specifications.
- Cardan shafts in series S, M and L are equipped with Rilsan coated length compensation. Moreover the special coatings used on the other series are also available.
- Our Development and Design Department will be pleased to provide support for questions regarding other possible versions.
- Subject to technical changes without prior notice.

8.2 Flange yoke types

8.2.1 DIN - ISO7646

D_F	D_C	E_C	PCD	D_B	N	A_2
75	42	2,2	62	6	6	60
90	47	2,5	74,5	8	4	90
100	57	3	84	8	6	60
120	75	3	101,5	8	8	45
120	75	3	101,5	10	8	45
150	90	3	130	12	8	45
180	110	3	155,5	14	8	45
180	110	3	155,5	16	10	36
210	140	5	185	13	10	36
225	140	5	196	16	8	45
250	140	6	218	18	8	45
285	175	7	245	20	8	45
315	175	7	280	22	8	45
350	220	7	310	22	10	36
390	250	8	345	24	10	36
435	280	10	385	27	10	36

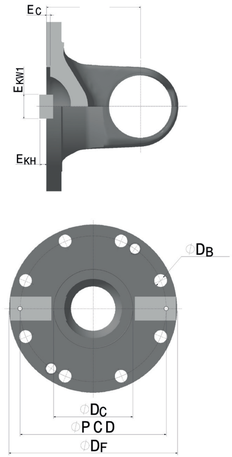


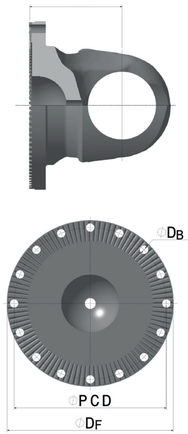
8.2.2 DIN with keyway

D_F	D_C	E_C	PCD	D_B	N	E_{KW1}	E_{KH}	A_2
225	105	5	196	17	8	32	9	45
250	105	6	218	19	8	40	12,5	45
285	125	7	245	21	8	40	15	45
315	130	8	280	23	10	40	15	30
350	155	8	310	23	10	50	16	30
390	170	8	345	25	10	70	18	30
435	190	12	385	28	16	80	20	20
480	205	12	425	31	16	90	22,5	20
550	250	12	492	31	16	100	22,5	20
620	380	12	555	38	16	100	25	20

8.2.3 Hirth-serration

D_F	PCD	D_B	N	Z	A_2
225	200	12	8	48	45
250	225	14	8	48	45
285	255	14	10	60	36
315	280	16	10	60	36
350	315	16	12	72	30
390	350	18	12	72	30
435	395	18	16	96	22,5
480	445	20	16	96	22,5
550	510	22	16	96	22,5
620	565	26	24	120	15



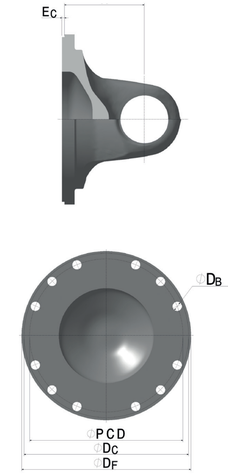


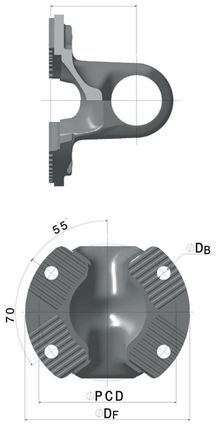
8.2.4 SAE - ISO 7647

D_F	D_C	E_C	PCD	D_B	N	A_2
87	57,15	1,5	69,87	8	4	100/80
96,8	60,32	1,5	79,37	9,5	4	100/80
119	69,85	1,5	95,27	11,1	4	100/80
149	95,25	1,5	120,65	12,7	4	100/80
174,8	168,22	3	155,57	3,6	8	45
203,2	196,82	3	184,15	9,6	8	45
203,2	196,82	3	184,15	11,1	12	22,5 (4x3)
247,7	177,8	3	209,5	16	8	45

8.2.5 Cross-serration - ISO 12667

D_F	PCD	D_B	N	A_2
100	84	8,5	4	110/70
122	100	11	4	110/70
150	130	13	4	110/70
180	150	15	4	110/70
200	165	15	4	110/70





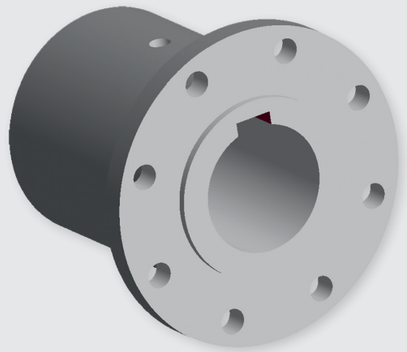
D_F Flange diameter [mm]
D_C Diameter centering [mm]
E_C Centering depth [mm]
PCD Pitch circle diameter [mm]
D_B Diameter Bore [mm]

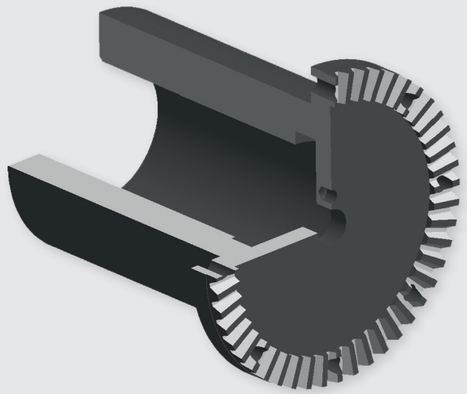
N No. of bores
A_2 Angle between Bores [o]
E_{KW1} Key width [mm]
E_{KH} Key height [mm]
Z No. of tooth

Special flanges available on request.

9. Connecting parts

In order to complete your requirement with regard to the application of cardan shafts, WiCHMANN offers a wide range of connecting parts. You can choose following products:





9.1 Companion flange DIN

The flange-side connection dimensions of the standard DIN companion flange correspond exactly to the dimensions of the cardan shaft size to which they are assigned.

These connecting parts can be connected as full body design or with an offset design, as well as with keyway, dual keyway, tangential keyway or shrink fit connection.

9.2 Companion flange with special connection

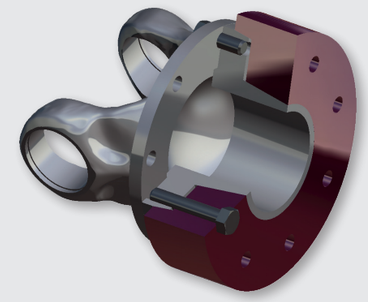
Special circumstances often make it necessary to design connections in such a way that higher torques can be transmitted. The connections are equipped with especially durable and wear-free properties, e.g. with face keys, dowel pin, Hirth-serration and dog-geared. Additional surface treatments are also possible, such as nickel- and chrome-plating.

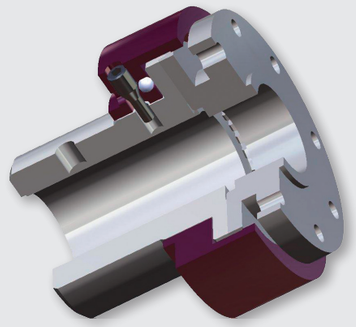
An individual, application-based selection of materials and precise manufacture are of fundamentally important to us.

9.3 Companion flange with locking disc

We offer companion flange with locking disc with a compact design for shaft/hub connections free from backlash and without fretting corrosion.

An advantage of this connecting part is that the keyway avoids a weakening of the shaft/hub.



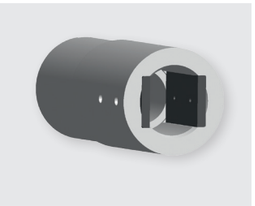


9.4 Quick-release coupling

Do you wish an innovative, cost-conscious combination of serial components and durable mechanics for frequently replaced connections?

Quick-release couplings offer a quick decoupling of both halves by loosening a single screw.

9.5 Roll end coupling box



Roll end coupling box are predominately used for roll-side connections of cardan shafts in rolling mill drives. This type of connection is a basic requirement for automatically roll change and guarantees a long service life due to its replaceable wear plates. The exact geometries and material pairings are individually adjusted to customer requirements by WiCHMANN.

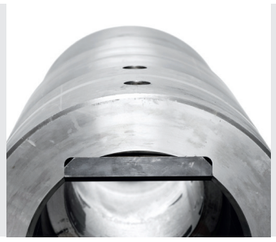
9.6 Flange bolts

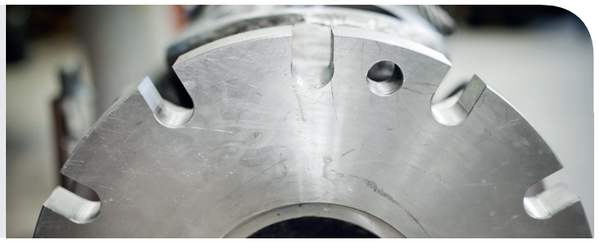
Suitable flange bolts in class 10.9 can be provided on request. Please refer to the assembly and maintenance instructions for the necessary guidelines and screw tightening torques. By request, we will send it to you.

At same sizes, for reasons related to flange yoke geometry, there is no guarantee that bolts can be inserted from Joint side. Please contact us for further information.

Please pay attention to the fact that friction lock flanges cannot be used without restrictions up to the characteristic torque values of the respective cardan shaft. An inspection and the use of form-locking flange connections may be necessary.

Flexibility





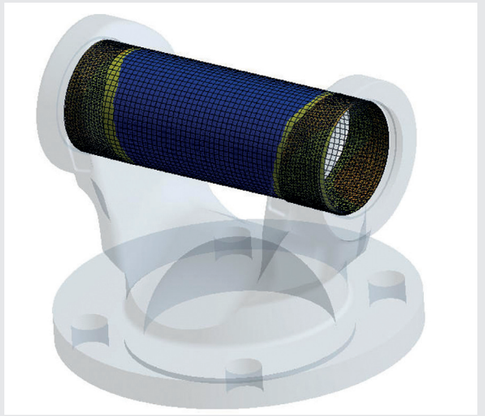
You can count on us!
10. Cardan shaft calculation

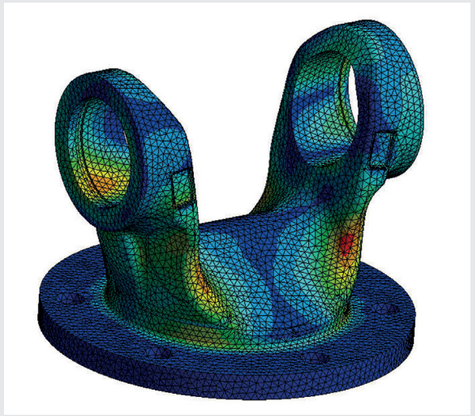
In the area of design and development our designers work at state-of-the-art 3D CAD and FEM workstations, which allow concurrent generation of detailed designs, calculations and drawings for technical communication.

The FEM program used allows linear as well as non-linear calculations of all types occurring in the area of Cardan shaft development and calculation. Moreover modal analyses and calculations of the torsional rigidity of components and shaft systems can also be performed concurrently.

Automatic, integrated evaluation of the calculation results in compliance with current FKM guidelines (FKM = Research Curatorium for Machine Construction) is available in the FEM program for reliable, static and dynamic assessment of the individual components.

Such studies and unequivocal strength verifications are essential for use of cardan shafts in controlled ranges or safety applications, thus providing an active contribution to operating safety.





The optimal selection of the right cardan shaft will be determined by WiCHMANN and is based both on the loading capacity of the materials and geometric used and on operating conditions such as impacts, deflection angle, soilings and mass moments of inertia.

To obtain the best possible lifecycle result, our aim is to balance savings on cost and weight on the one hand and the maximum transmissible torques and maximum bearing life times on the other.

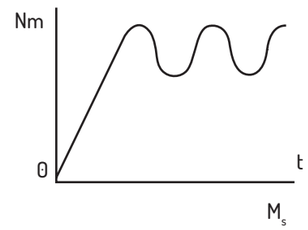
Due to the complexity of cardan shaft dimensioning, we recommend that you make use of the know-how of our experienced engineers.

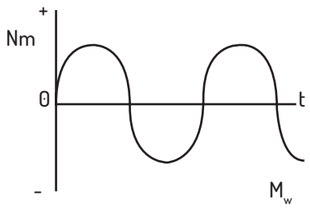
10.1 Cardan shaft selection based on component strength

$$M = \frac{9555 \cdot P}{n}$$

P	[kW]	Motor power
n	[min^{-1}]	Nominal speed
M	[N]	Nominal torque

10.2 Torque definition





1. Bearing torque M_l
Plastic deformations of the bearing raceways are possible if the bearing torque M_{max} is exceeded. It is admissible for extreme, rare instances of loading.

2. Pulsating fatigue torque M_s

At this torque, the cardan shaft remains fatigue-resistant under pulsating loads.

3. Reversing fatigue torque M_w

At this torque, the cardan shaft remains fatigue-resistant under reversing loads.

10.3 Loading factors

The optimal selection of the right cardan shaft will be determined by WiCHMANN and is based both on the loading capacity of the materials and geometric used and on operating conditions such as impacts, deflection angle, soilings and mass moments of inertia.

To obtain the best possible lifecycle result, our aim is to balance savings on cost and weight on the one hand and the maximum transmissible torques and maximum bearing life times on the other.

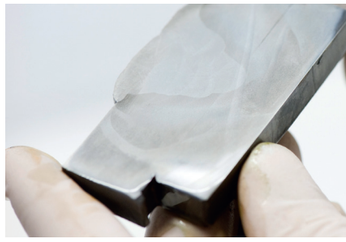
Due to the complexity of cardan shaft dimensioning, we recommend that you make use of the know-how of our experienced engineers.

Application	Shock load	Load factor K_1
Generators (cont. load) Centrifugal pumps Printing machines	light	1,1 – 1,5
Rod and bar mills Generators (non-cont. load) Rail vehicle primary drives	medium	1,5 – 2
Bending machines Presses Building machinery Roller tables Rail vehicle secondary drives	heavy	2 – 3
Reversing roller table Coiler drives Straightening machines Blooming stands	very heavy	3 – 6
Heavy main rolling mills Plate shears Breast roller drives	extreme	6 – 10

The following formula is used to estimate the peak torque: $M_{shock} = K_1 * M$.
The calculated peak torque must fulfil the following conditions:

$M_{shock} \leftarrow M_w$ for reversing fatigue loads

$M_{shock} \leftarrow M_s$ for pulsating fatigue loads



10.4 Cardan shaft selection based on bearing life

Whereas for torque-oriented applications, e.g. rolling mill drives, locomotive secondary drives and crane travel drives, the component strength is very important, bearing life has higher priority for pumps and paper machines. The bearing life is calculated using the formula below. Ideally, there should be a balanced relationship between components strength and bearing life.

ß	[°]	Working angle The following must be adhered to for a Z- or W-shaft arrangement ß = ß1 = ß2
$ß_1$	[°]	Total working angle Joint 1
$ß_2$	[°]	Total working angle Joint 2
$ß_{12}$	[°]	Remaining working angle of Joint 1 and Joint 2 Given a three-dimensional deflection, the resultant working angle can be calculated as follows: $ß_{12} = \arctan \sqrt{\tan^2 ß_1 + \tan^2 ß_2}$
L_h	[h]	Theoretical service life
G_l	[Nm]	Joint performance factor
K		Shock factor of the drive

Drive	Shock factor
Electric motor	1
Diesel engine	1,2

The theoretical, calculated bearing life, which is usually exceeded by a considerable margin in practice, is subject to the following factors. The base for bearing calculation is according DIN ISO 281:

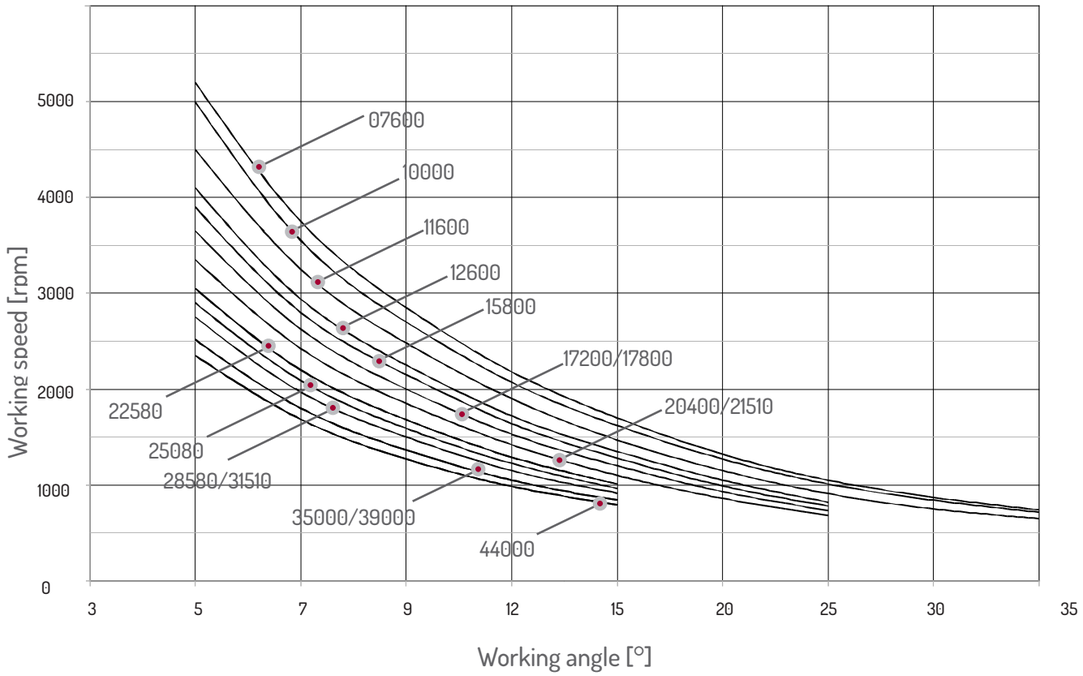
$$L_{hn} = \frac{1{,}5E + 07}{n_n \cdot \beta_n} \cdot \left(\frac{G_{lA}}{M_n \cdot K}\right)^{3{,}33} [h]$$

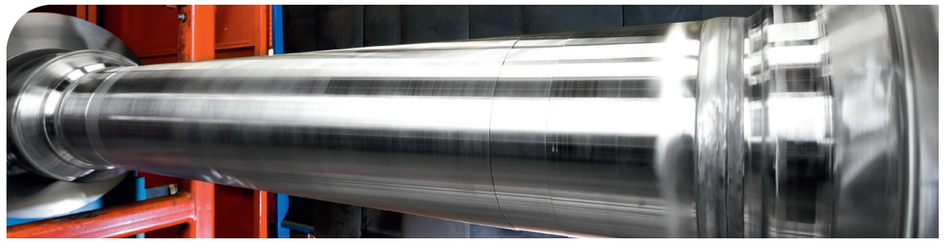
- *Quality of components*
- *Correct lubrication acc. to maintenance instructions*
- *Frequency and duration of overloads*
- *Intensity of overload*
- *Installation and operating conditions*

10.5 Determination of the maximum working speed

10.5.1 Maximum working speed as a function of the operating angle

In order to achieve the optimal running smoothness of a cardan shaft, certain mass acceleration torques may not be exceeded in the centre section. Exeedance over this value can lead to increased wear and noise.



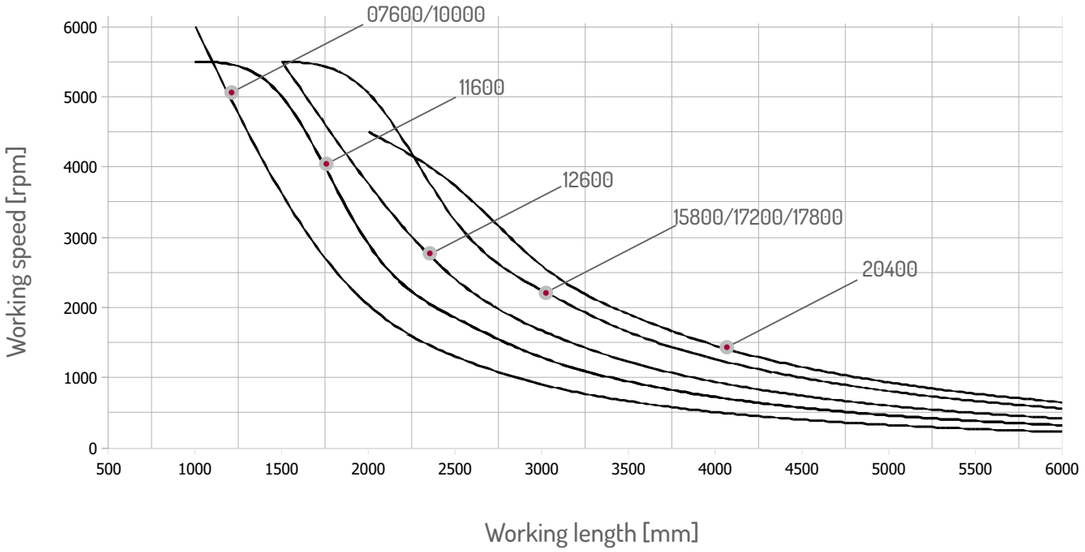


10.5.2 Maximum working speed related to the critical bending speed

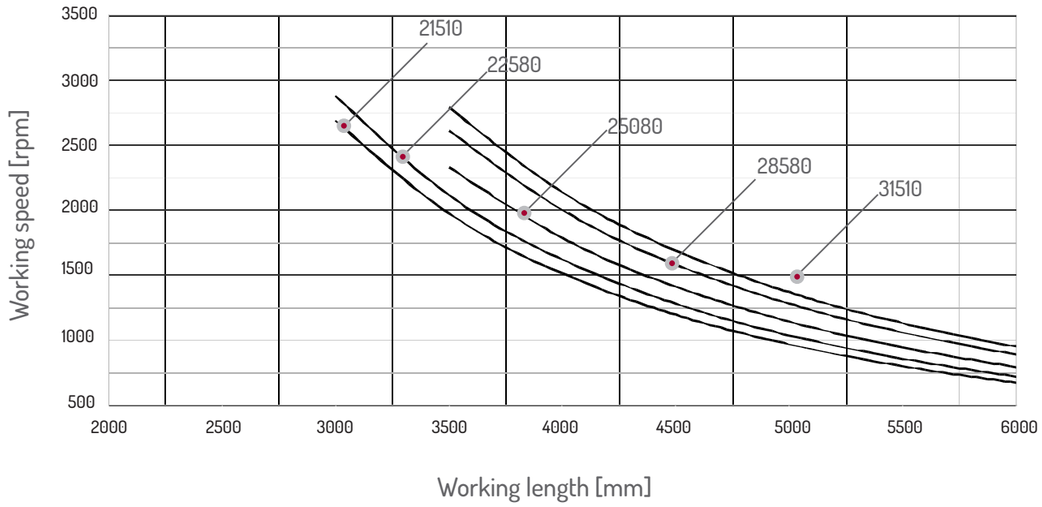
Through the special kinematics present in the middle section of the cardan shaft, inadmissible oscillations can be created which can damage or destroy the shaft.

For this reason, especially long and high-speed cardan shafts must be investigated with respect to their critical bending speed with the aid of the following diagrams. The diagrams contain values which are 20% reliable in comparison to the maximum theoretically achievable value.

Sizes S - L



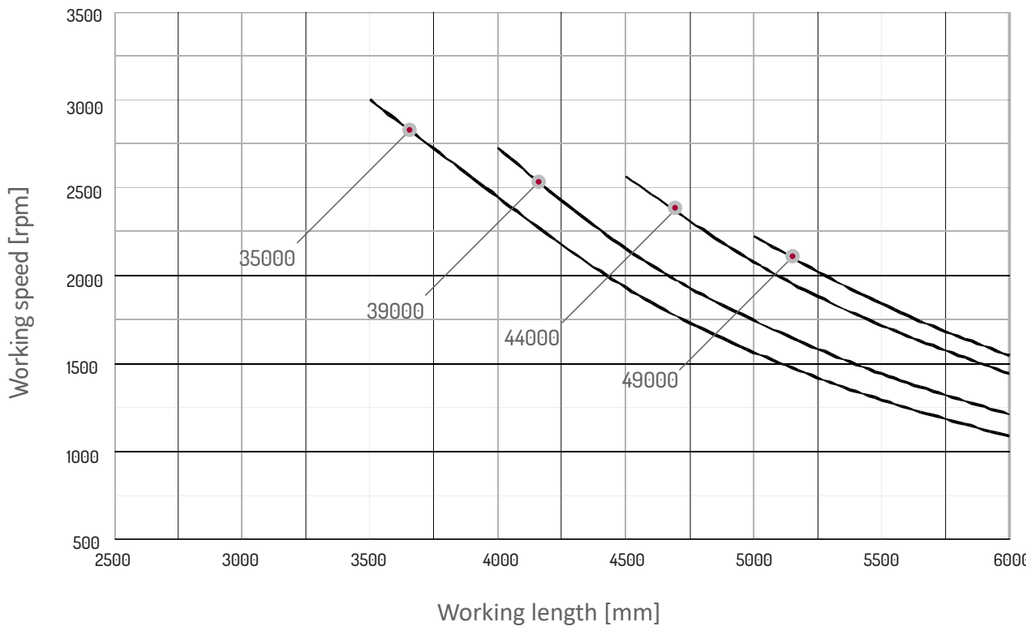
Size XL



Know-how

WiCHMANN

Size XXL

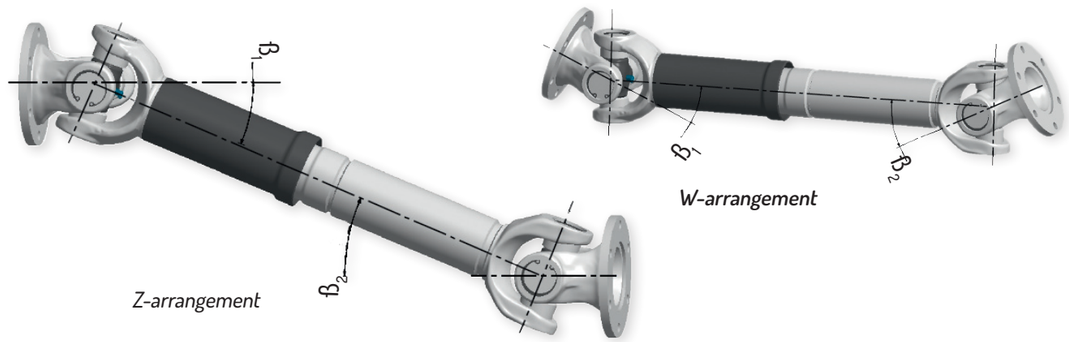


10.6 Universal joint kinematics

A single U-Joint causes a "Cardan error" as a result of different angular velocities in the drive and output shaft. For reaching a perfect balance of the irregular movement between the drive and output shaft we recommend a Z- or W-arrangement of a cardan shaft.

Following conditions must be observed:

Speed range	Maximum deflection angle difference $\beta_1=\beta_2$
Low speeds	3°
High speeds	1,5°



Dynamic

As a result of internal quality demands, the residual imbalance achieved in balancing processes for Wichmann cardan shafts lies 35 % below the maximum value defined in DIN ISO 1940-1.

10.7 Balancing grades

The balancing refers to the weight counterbalancing of eccentrically running masses of the cardan shaft and guarantees a quit running. WiCHMANN - cardan shafts are dynamically balanced starting from workingus speeds of > 300 rpm.

Due to the following conditions, the WiCHMANN - cardan shafts are balanced individually to customers application:

Feature	Advantage	Customer benefit
Balancing quality	Prevention of vibrations	· Low bearing stresses in con nected assemblies · Quiet operation of the cardan shaft
Balancing machine CSP	Balancing in up to 4 planes	Balancing cardan shaft lines as a unit
Factory-side reduction of residu-al imbalance	Reduction of the maximum residual imbalance as per standard to 65%	Highly precise balancing results
Use of premium components	Highest continous quality standard of all used components	Longer working life

An excerpt from the Standard DIN ISO 1940-1 recommends the following balancing grades for cardan shaft applications:

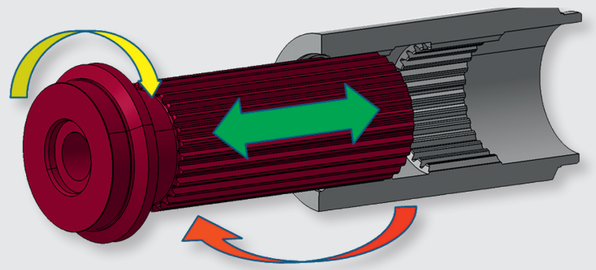
Balancing grade	General examples
G 40	Automobile wheels, rims, cardan shafts, crank drives of passenger cars, trucks, locomotive engines, flexibly mounted and high-speed crank drives
G 16	Drive shafts (propeller shafts, cardan shafts) with special requirements, rigid-ly mounted crank drives with special requirements
G 6,3	Paper and printing machine rolls, general mechanical engineering applications, flywheels, centrifugal pumps
G 2,5	Gas and steam turbines, computer drives, machine-tool drives

10.8 Calculation of axial force

When the length compensation is moved under the influence of torque, the resultant friction causes an axial force to be generated between the tooth flanks in the spline. This friction force F_{ax} can be calculated as follows:

$$F_{ax} = 2 \cdot M_1 \cdot \mu \cdot \left(\frac{1}{d_t} + \frac{\sin x}{L_ü} \right) [N]$$

$L_ü$	[mm]	Profile coverage
F_{ax}	[N]	Axial friction force
μ		Friction coefficient μ = 0.11 for steel/steel splines μ = 0.07 rilsan-coated splines
M	[Nmm]	Nominal torque
d_t	[m]	Pitch cycle diameter of the spline
ß	[°]	Working angle



An additional axial force can arises as a result of the pressure build-up from greasing in the length compensation.

Your satisfaction is our incentive.

11. Supplementary products

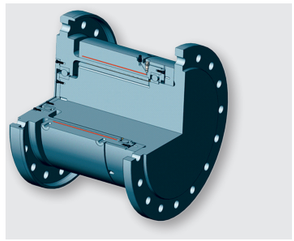
To complete our range of products following services can be offered together with our partners:

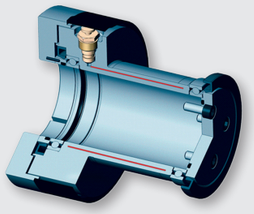
11.1 Torque measurement

Service	Customer benefit
Temporary or permanent measurement of all important operating parameters, such as torques or vibrations, for diverse load spectrums.	Optimised component dimensioning Process optimisation Preventive maintenance Research on damage causes

11.2 Cardan shaft alignment

Service	Customer benefit
Laser-supported alignment for installing cardan shaft and inspection of the installation situation.	Reduced vibrations Minimized energy requirements due to lower friction Increase in service life





Synergy

11.3 Hydraulic overload coupling

Service	Customer benefit
Use of a hydraulic torque limiter as additional component or as a replacement for a conventional mechanical overload coupling to interrupt the power flow within millisecond and protect connected assemblies from damage.	Adjustable load spectrum Constant release torque Almost temperature independence Compact design Power transmission without backlash No material fatigue No component damage Fast restarts Low downtime costs Minimal maintenance costs

11.4 Spindle support, hugger systems and special constructions

Service	Customer benefit
Our product range covers innovative solutions for customised drives from single part drawings to project management and assembly supervision.	Reduced wear Reduced labour intensity Savings on lubrication and energy Optimised workflows with low maintenance costs.