DANA SPICER® NORDISKA KARDAN AB

Commercial Vehicles

General catalogue series

Cardan 2000 compact

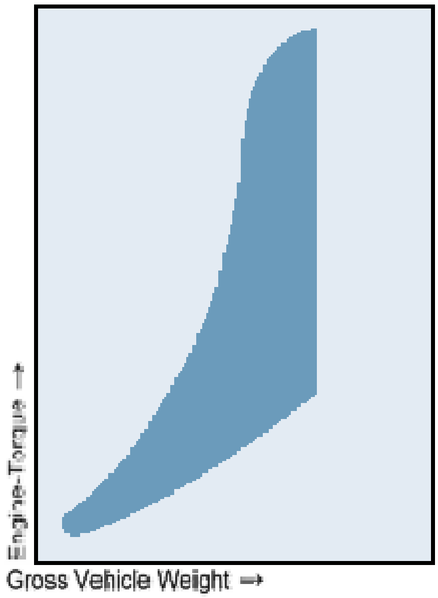
Today, our Cardan 2000 Compact line represents a largely standardized selection of universal shafts suitable for a wide variety of vehicles and models. In developing these products we were able to anticipate a number of important trends in the field of commercial vehicle design. Major features of the Cardan shaft include its high resistance to dynamic load variations, large deflection angles, uniform load distribution throughout the axial displacement range, low rotational diameter, low weight, and versatile flange connections. These features provide an ideal base for standardised drive train design and new power transmission concepts.

Index

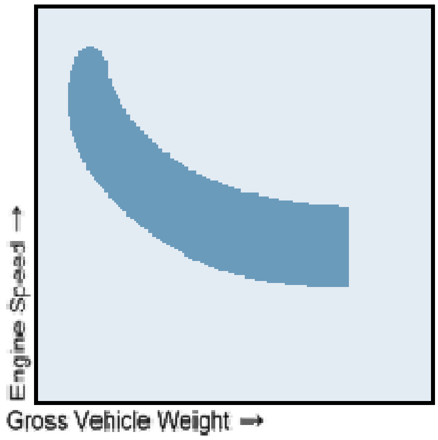
General trends in commercial vehicle development

The decisive factors determining developments in the commercial vehicles sector are

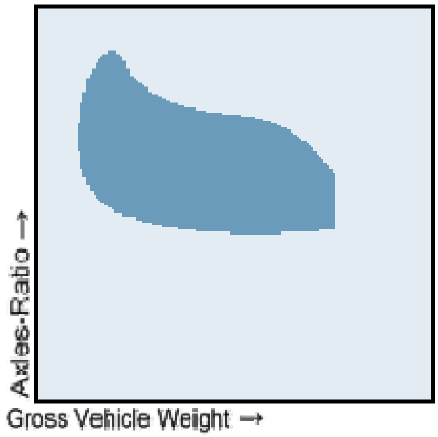
- Engine power
- Engine torque
- Engine speed
- Axle transmission ratios
- Weights
- Sound insulation
- Environmental protection



In all vehicle categories and weight classes engine power and torque are being increased. Engine speeds are reduced accordingly.

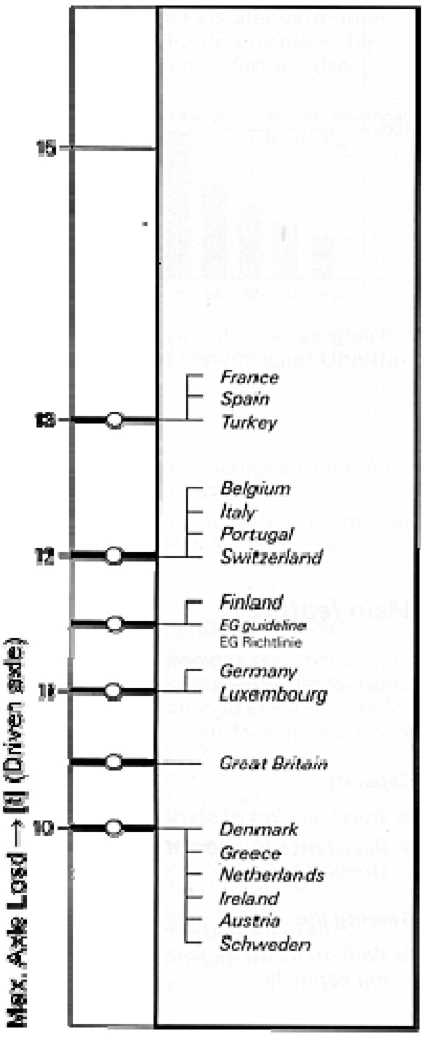


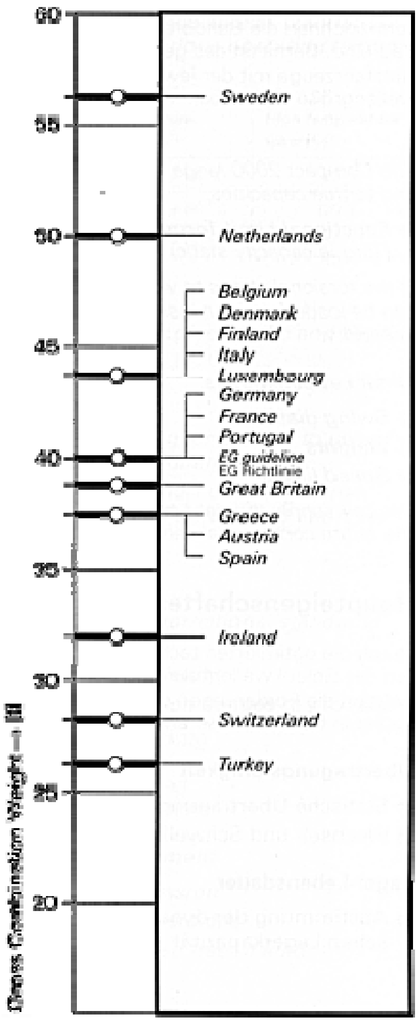
Since noise levels have to be lowered, fuel consumption reduced and efficiency optimized, the trend is towards slow-running engines and power trains with the lowest possible number of gear selections. Axle-ratios are also decreasing.



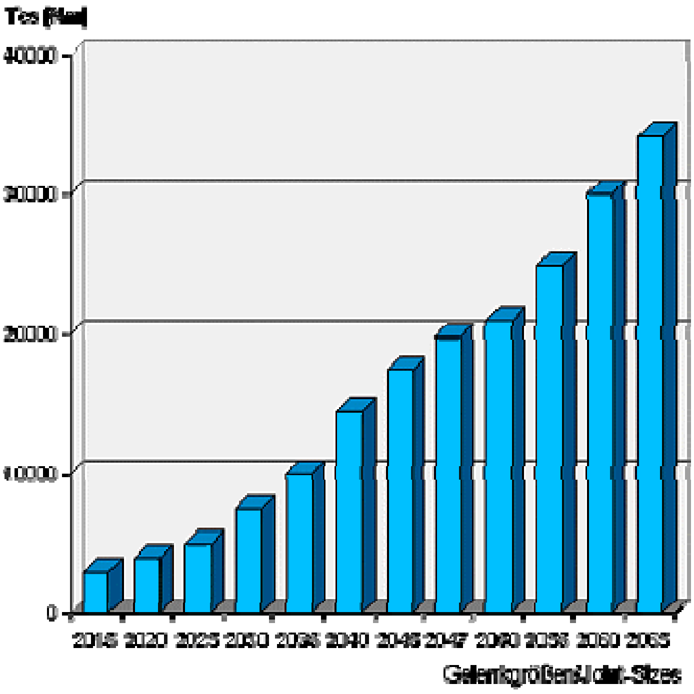
Over the recent years vehicle unladen weights have decreased across the board, permitting higher maximum pay loads. In addition, new legislation has permitted higher axle loads and higher total loads of tractor/trailer rigs.

Keeping pace with these trends, we have tailored the design and dimensioning of the new Compact 2000 cardan shaft series to the specific requirements of the market.





Product description



The Compact 2000 range is available in 12 sizes and torque capacities.

- Functional Limit Torque TCS
  (Torque capacity static)

is the torsional stress to which the cardan shaft can be loaded without
loss of operational capability.

Other key parameters:

- Swing diameter
- Weights
- Speed limits

We can supply the right cardan shaft size across the entire commercial vehicle spectrum.

Main features

Using optimizing engineering, the Compact 2000 cardan shaft series has been designed to meet the requirements of commercial vehicle manufactures such as:

Capacity
- Transmission of static torque
- Resistance to alternating and pulsating stresses

Bearing life
- Well matched dynamic and static loadbearing capacity

Dynamic behaviour
- Reduced mass moment of inertia
- Longer single-piece cardan shaft for given speed
- Reduced unbalance through lowered shaft weight
- Enhanced true running due to new centre bearing design
- Improved/repeatable balance due to accurate centering of cross-serration

Operating Temperature
- Cardan shafts are available as standard or special types for various operating temperature ranges:

Version	Temperature range	High temperature (shortly)
Standard	- 25 °C to + 60 °C	80 °C
High temp.	- 25 °C to + 80 °C	120 °C
Low temp.	- 50 °C to + 60 °C	80 °C

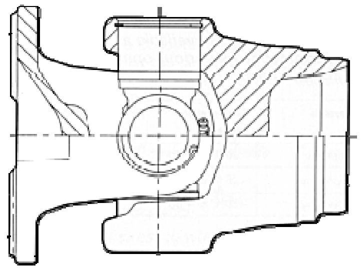
Weight
- Weight reduced for given static and dynamic torque

Short design
- Reduced installation length due to use of standardized components
- Expansion of the short coupling range through addition of particularly short versions

Logistics
- Conformity with international standards (ISO)
- Reduction of complexity
- Use of cross-serration flanges to provide
  - cost-efficient stocking
  - fewer bolts to fix
  - bolt fixing simplified
  - shorter assembly time

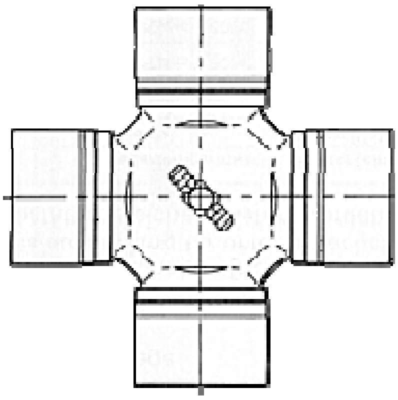
Protection of environment
- Reduced noise emission
- Maintenance-free versions
- application of grease free of lead

Cardan shaft in detail



Joints

- Optimized torsional strength
- System-matched rigidity

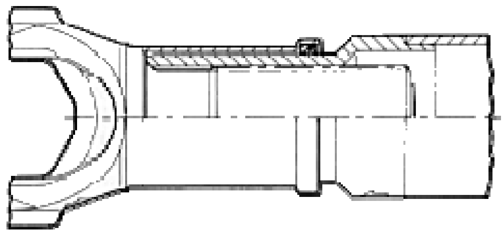


Unit pack - regreaseable

- High-performance unit pack with high fatigue strength and small rotational diameter
- Fibre-reinforced plastic thrust washer
- Highly effective sealing system

Unit pack - maintenance-free

- Structural dynamic characteristics and dimensions same as regreaseable type
- Newly developed sealing system using special grease
- Improved spider geometry

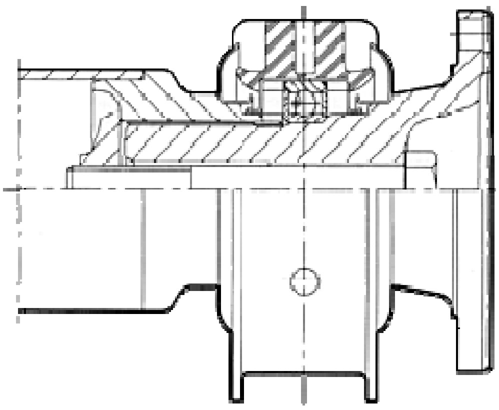


Sliding joint

- Refined involute profile guarantees optimised performance
- Functional isolation of torque transmission and centering features
- Plastic-coated muff

Centre bearing with elastic centre bearing assembly

Standard model

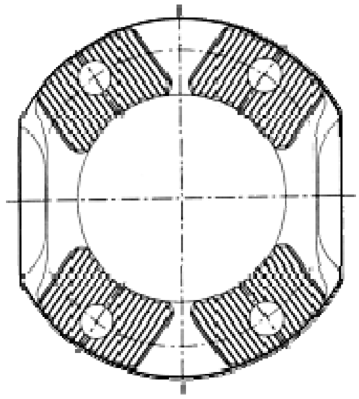


The bearing unit in the so-called reverse construction consists of the following component parts:

- Stub flange with bearing seat and flange connection on the same component. Advantage: small running tolerances from flange to bearing seat.
- Groove ball bearings with service-life grease packing and laterally arranged greasepacked labyrinth seals to keep out dirt and moisture.
- Rubber cushion for the functions:
  - *Damping and insulation (vibrations and noise). Different rigidities are available to facilitate optimal adjustment.*
  - *Cushioning axial movements.*
  - *Cushioning angular movements and positions.*
- Laterally arranged flingers, which prevent splash water from impinging directly on the bearing.
- Bolt connection with a long head bolt, whose longitudinal expansion provides a high level of security against loosening, in connection with an all-metal self-locking nut as an additional precaution against loss.
- Centre bearing bracket for mounting the rubber cushion and for fastening to the vehicle frame.

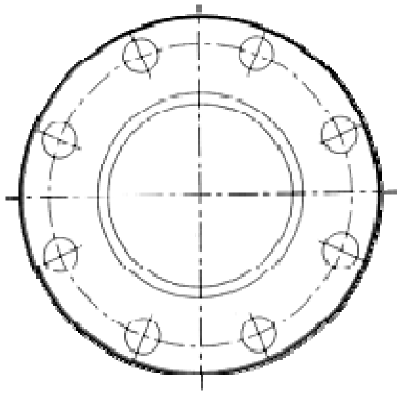
Variants of connections

Attaching cardan shafts to various transmissions and axle assemblies calls for different types of connections. The following flange types (ISO standard) are available:



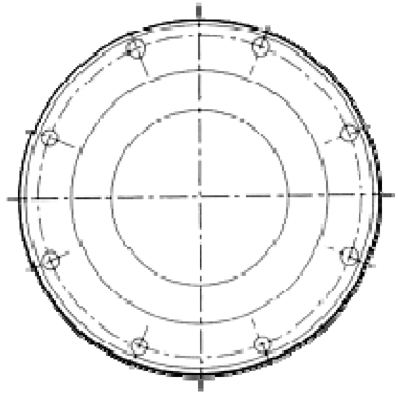
XS

- Positive engagement
  - XS (x-serration), corresponding to
    ISO 8667 for gearbox flanges
    ISO 12667 for propeller shaft flanges



DIN

- Friction type
  - to DIN, corresponding to ISO 7646
  - to SAE, corresponding to ISO 7647



SAE

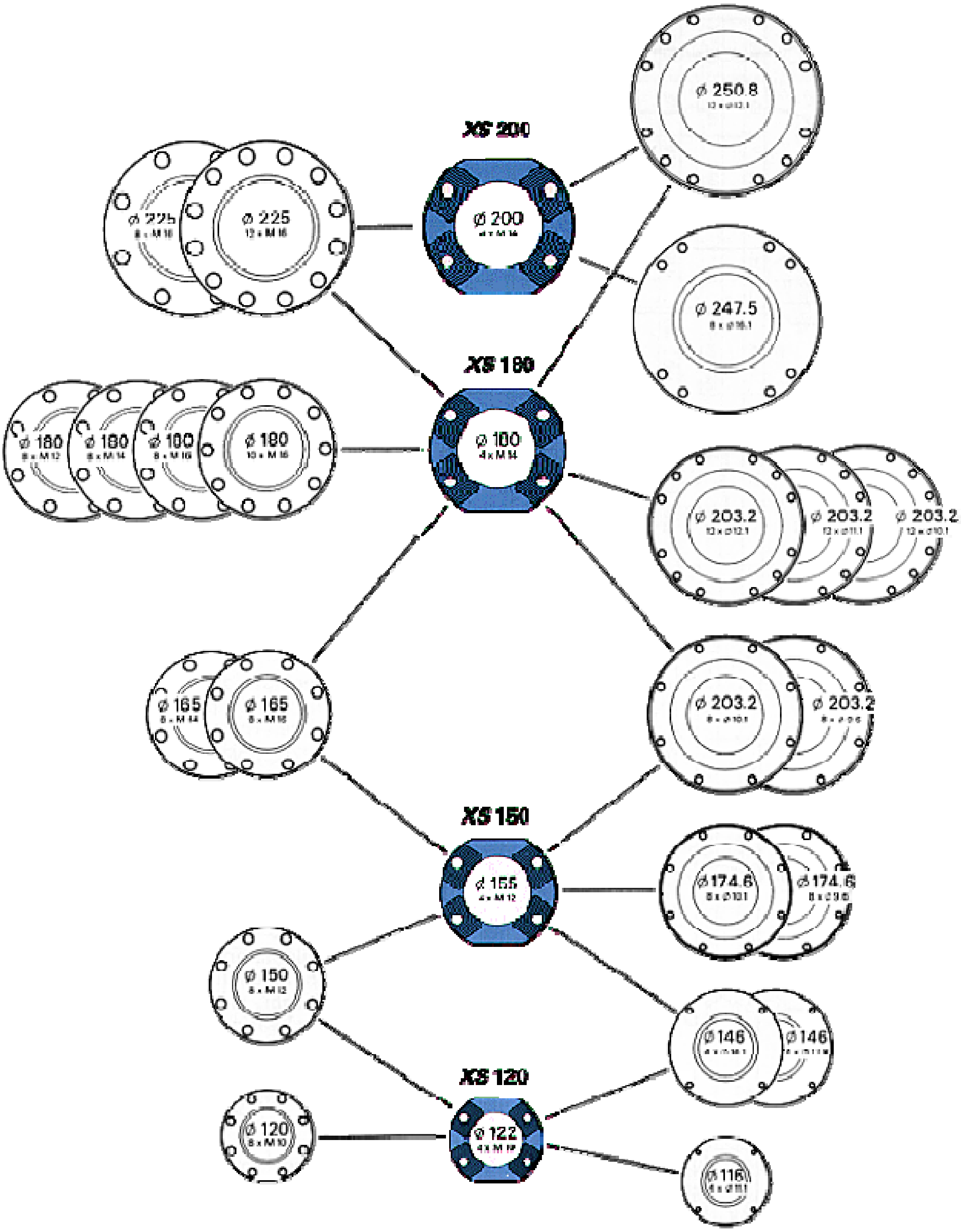
The **x-serration flange (XS)** is gaining ever wider acceptance on account of its technical and economical advantages and is set to become the preferred flange of the future.

The advantages are:

- Positive engagement of serrations
- Shorter time required for assembly
- Bolting simplified
- Fewer bolts
- Reduced stock complexity
- Clearly defined mounting position
- Use of self-locking nuts

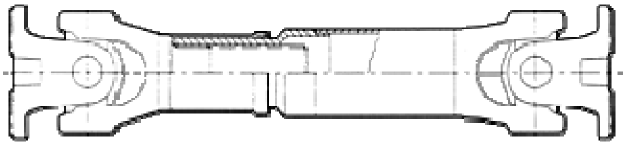
Number of flange variants

10 DIN-Flanges | 4 XS-Flanges ISO 12667 | 12 SAE-Flanges

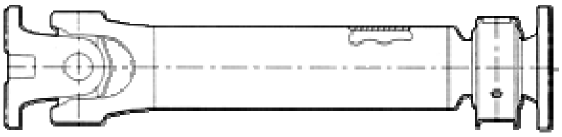


Cardan shaft variants and combinations

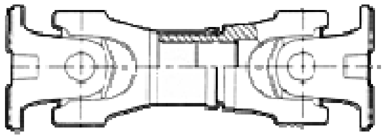
The main variants are:



Cardan shaft with length compensation
(fixed and slip)

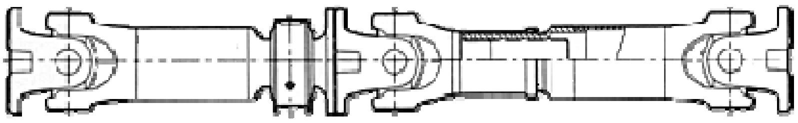


Cardan shaft without length compensation with midship
(fixed and mid)

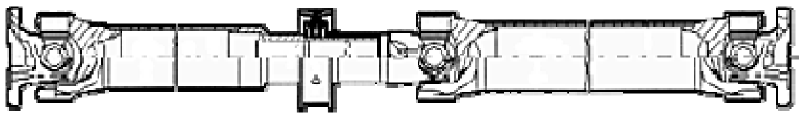


Short coupled cardan shaft with length compensation
variants with
sleeve yoke/sleeve muff

The design of the cardan shaft line may vary according to application, e.g.



Shaft assembly with fixed-length midship shaft and cardan shaft with length compensation



Shaft assembly with length compensation in midship bearing area

Additional variants on request.

Special variants- e.g.: maintenance free, higher/lower temperature, sound insulated construction etc. on request.

Product description

Survey of sizes

SPICER COMPACT 2000			2015	2020	2025	2030	2035			2040				2045		2047	2050	2055		2060	2065
Tcs		kNm	2,4	3,5	5,0	6,5	10,0			14,0				17,0		19,0	21,0	25,0		30,0	35,0
Connection	XS	-		120	120	120	120	-	-	150	-	150	-	180		180	180	180		180	180
	XS	-		-	-	-	-	150		-	180	-	180								
XS-Flange-Ø	A	mm		120	120	120	120	155	-	155	180	155	180	180		180	180	180		180	180
Connection	DIN	mm	100	120	120 150	120 150	-		150 180	-		180		180	-	180	180	-	180	180	180
Connection	SAE	Size	1300	1400	1500	1500 1600	1600			1700 1800				1800	-	1800	1800	1800	-	1800	1800
Joint angle	ß	°	25	25	25	25	25		35	25		44		25	44	25	25	25	35	25	25
Max. Rotations-Ø	K	mm	90	98	113	127	144			160				174		174	180	178		196	206
Length comp.	La	mm	60	70	100	110	110		180	110		180		110	180	110	110	110		110	110
Tube-Ø	D x s	mm	63,5 x2,4	76,2 x2,4	89 x2,4	90 x 3	100 x 3		85 x 5	120 x 3		100 x 4,5		120 x 4	110 x 5	120 x 5	120 x 5	120 x 6		130 x 6	142 x 6
Spline-Ø	W	mm	36	40	45	48	54			62				68		68	74	78		82	88

Explanations:

TCS Functional limit torque
La Sliding movement

Recommended connection (shaded)

Companion flanges:
- DIN: according to ISO 7646
- SAE: according to ISO 7647
- XS: Cross serration according to ISO 8667

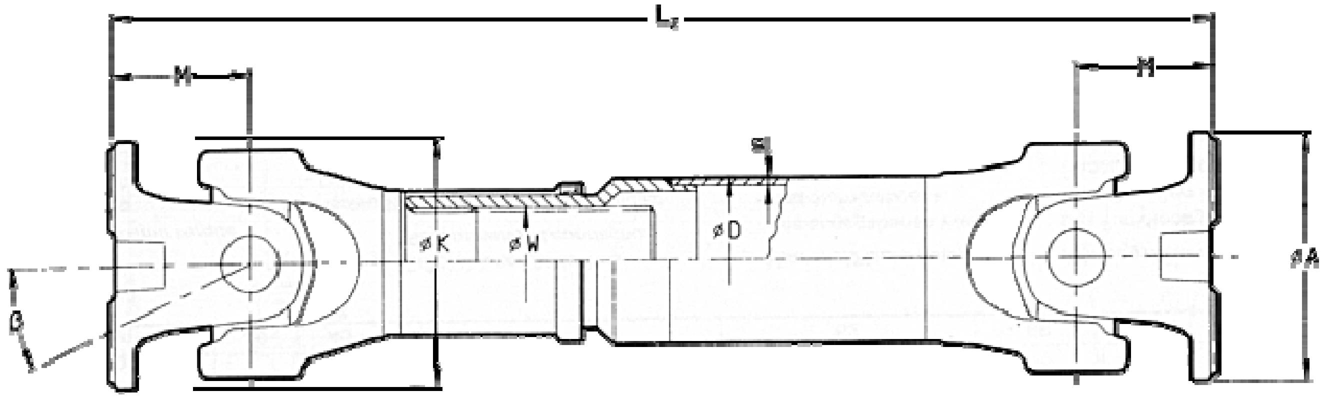
Propshaft flange yokes:
- XS: Cross serration according to ISO 12667

Please note:
All values given are nominal. Exact information should only be obtained from drawing.

Attention:
Not all DIN/SAE-flange-connection can transmit the function-limit-torque of the corresponding propshaft size by friction.

Data Sheets Standard variants

Cardan shaft with length compensation



SPICER COMPACT 2000			2015	2020	2025	2030	2035		2040		2045		2047	2050	2055	2060	2065
Tcs		kNm	2,4	3,5	5,0	6,5	10,0		14,0		17,0		19,0	21,0	25,0	30,0	35,0
Connection		-	DIN 100	DIN 120	XS 120	XS 120	XS 150		XS 180		XS 180		XS 180	XS 180	XS 180	XS 180	XS 180
Flange-Ø	A	mm	100	120	120	120	120	155	155	180	180		180	180	180	180	180
Joint angle	ß	°	25	25	25	25	25	35	25	44	25	44	25	25	25	25	25
Max. Rotations-Ø	K	mm	90	98	113	127	144		160		174		174	180	178	196	206
	M	mm	48	54	60	63,5	75	88	82	102	87	108	87	85	92	100	105
	Lzmin	mm	346	379	438	475	542	667	546	693	579	729	579	576	616	635	676
	La	mm	60	70	100	110	110	180	110	180	110	180	110	110	110	110	110
Tube-Ø	D x s	mm	63,5x 2,4	76,2x 2,4	89x 2,4	90x 3	100x 3	85x 5	120x 3	100x4,5	120x 4	110x 5	120x 5	120x 5	120x 6	130x 6	142x 6
	GW	kg	8,0	11,2	15,0	18,0	23,7	27,0	33,3	38,8	43,0	46,0	43,0	46,4	51,7	60,5	70,6
	GR	kg	3,6	4,4	5,1	6,4	7,17	9,9	8,65	10,6	11,44	12,9	14,18	14,18	16,86	18,34	20,12
Spline-Ø	W	mm	36	40	45	48	54		62		68		68	74	78	82	88

Explanations:

TCS Functional limit torque
Lz Compressed length
La Sliding movement
GW Weight of 1 m-shaft
GR Weight of 1 m-tube

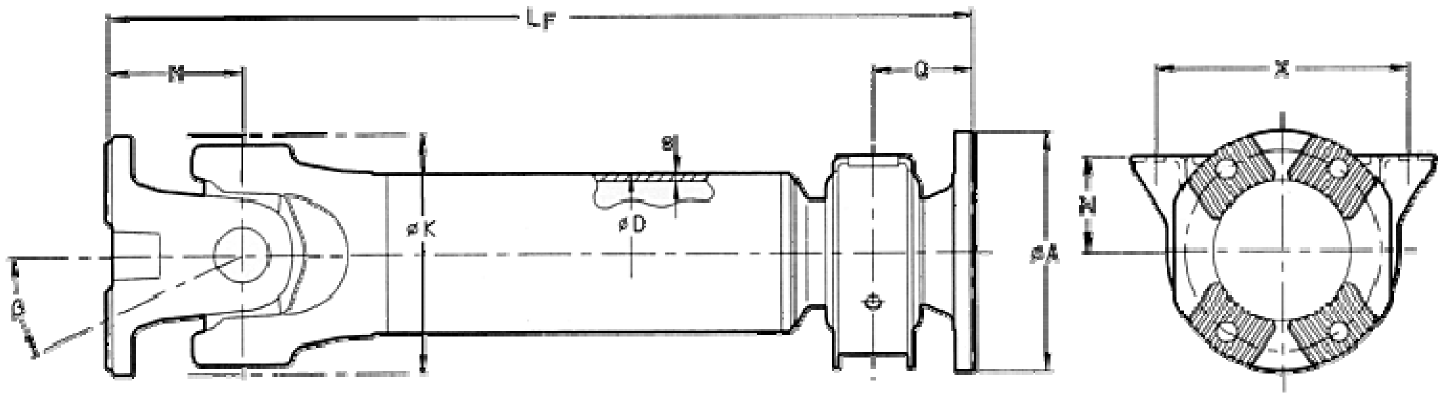
Recommended connection
Companion flanges:
- DIN: according to ISO 7646
- SAE: according to ISO 7647
- XS: Cross serration according to ISO 8667

Propshaft flange yokes:
- XS: Cross serration according to ISO 12667

Please note:
All values given are nominal. Exact information should only be obtained from drawing.

Attention:
Not all DIN/SAE-flange-connection can transmit the function-limit-torque of the corresponding propshaft size by friction.

Cardan shaft without length compensation with midship



SPICER COMPACT 2000			2015	2020	2025	2030	2035	2040	2045	2047	2050	2055	2060	2065
Tcs		kNm	2,4	3,5	5,0	6,5	10,0	14,0	17,0	19,0	21,0	25,0	30,0	35,0
Connection		-	DIN 100	DIN 120	XS 120	XS 120	XS 120	XS 180	XS 180	XS 180	XS 180	XS 180	XS 180	XS 180
Flange-Ø	A	mm	100	120	121	121	120	180	180	180	180	180	180	180
Joint angle	ß	°	25	25	25	25	25	25	25	25	25	25	25	25
Max. Rotations-Ø	K	mm	90	98	113	127	144	160	174	174	180	178	196	206
	M	mm	48	54	60	63,5	75	82	87	87	85	92	100	105
	LFmin	mm			262	308,5	312	344	357	357	350	419	435	451
Tube-Ø	D x s	mm	63,5 x2,4	76,2 x2,4	89 x2,4	90 x3	100 x3	120 x3	120 x4	120 x5	120 x5	120 x6	130 x6	142 x6
Joint overhang	Q	mm			70	73	73	80	80	80	80	107	107	107
Hole distance	X	mm	168,1	168,1	168,1	193,5	193,5	193,5	200	200	200	220	220	220
	N	mm	58	58	63	69	69	71,5	71,5	71,5	71,5	85,5	85,5	85,5
	GW	kg			13,1	15,4	18,8	28,5	32,0	32,0	33,5	42,0	46,5	53,0
	GR	kg	3,6	4,4	5,1	6,4	7,17	8,65	11,44	14,18	14,18	16,86	18,34	20,12

Explanations:

TCS Functional limit torque
LF Min. fixed length
GW Weight of 1 m-shaft
GR Weight of 1 m-tube

Information about center bearing
see Centre Bearings

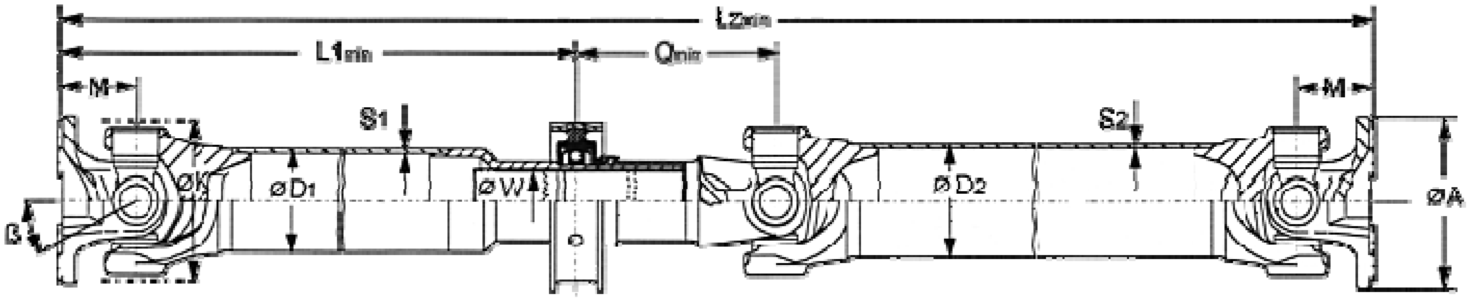
Recommended connection
Companion flanges:
- DIN: according to ISO 7646
- SAE: according to ISO 7647
- XS: Cross serration according to ISO 8667

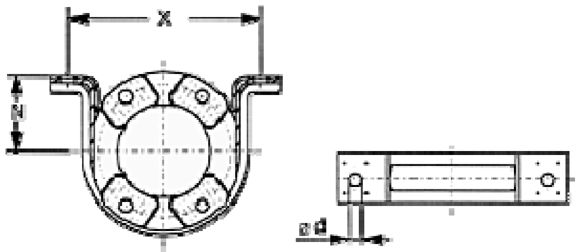
Propshaft flange yokes:
- XS: Cross serration according to ISO 12667

Please note:
All values given are nominal. Exact information should only be obtained from drawing.

Attention:
Please respect the information concerning the safety of central bolt. If necessary contact us.
Not all DIN/SAE- flange-connection can transmit the function-limit-torque of the corresponding propshaft size by friction.

Shaft assembly with length compensation in midship bearing area





SPICER COMPACT 2000			2015	2020	2025	2030	2035	2040	2045	2055
Tcs		kNm	2,4	3,5	5,0	6,5	10,0	14,0	17,0	25,0
Connection			SAE 1400	XS 120	XS 120	XS 120	XS 120	XS 150	XS 180	XS 180
Flange-Ø	A	mm	99	120	120	120	120	150	180	180
max. Joint angle	ß	°	25	25	25	25	25	25	25	25
Joint angle	ß	°	6	6	6	6	6	6	6	6
Max. Rotations-Ø	K	mm	90	98	113	127	144	160	174	178
	M	mm	43	54	60	63,5	75	82	87	92
	Lz min.	mm					807	874	913	892
	L1 min.	mm	262	276	313	347,5	347	372	385	382
	La	mm	90	90	100	110	80	80	80	80
Tube 1	D1 x S1	mm	76,2 x 1,64	76,2 x 2,4	89 x 2,4	90 x 3	85 x 5	100 x 4,5	110 x 5	120 x 6
Tube 2	D2 x S2	mm	76,2 x 1,64	76,2 x 2,4	89 x 2,4	90 x 3	100 x 3	120 x 3	120 x 4	120 x 6
Joint overhang	Q min.	mm	75	78	86	88	99	201	207	218
Hole distance	X	mm	168,1	168,1	168,3	193,5	220	220	220	220
	N	mm	58	58	62,8	69	85	85	85	85
Hole-Ø	d	mm	13,5	13,5	13	13	15	15	15	15
	GR1	kg					9,9	10,6	12,9	16,8
	GR2	kg					7,17	8,65	11,44	16,8
Spline-Ø	W	mm					54	62	68	78

Explanations:

TCS	Functional limit torque
Lz min.	Compressed length
L1 min.	Min. length
La	Length compensation
GR1	Weight of Tube 1 (Tubelength 1 m)
GR2	Weight of Tube 2 (Tubelength 1 m)

Recommended connection

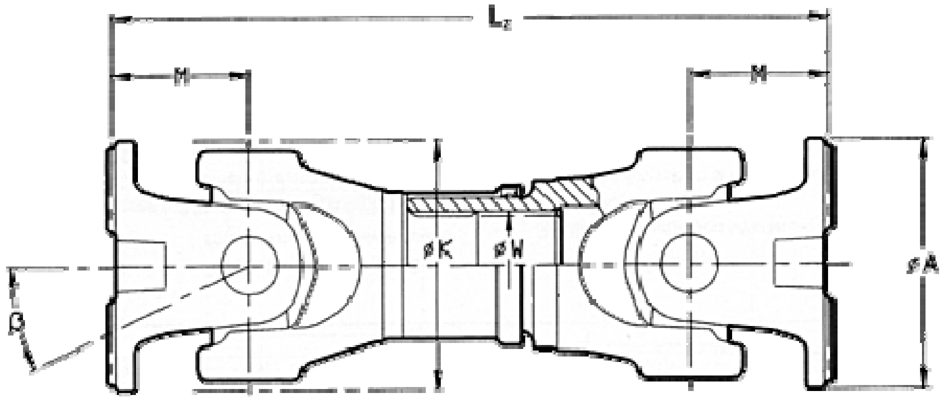
Companion flanges:
- DIN: according to ISO 7646
- SAE: according to ISO 7647
- XS: Cross serration according to ISO 8667

Propshaft flange yokes:
- XS: Cross serration according to ISO 12667

Please note:
All values given are nominal. Exact information should only be obtained from drawing.

Attention:
Not all DIN/SAE-flange-connection can transmit the function-limit-torque of the corresponding propshaft size by friction.

Short coupled cardan shaft with length compensation
Sleeve-Yoke-Design



SPICER COMPACT 2000			2015	2020	2025	2030	2035	2040	2045	2055	2065
Tcs		kNm	2,4	3,5	5,0	6,5	10,0	14,0	17,0	25,0	35,0
Connection		-	DIN 100	DIN 120	XS 120	XS 120	XS 120	XS 150	XS 180	XS 180	XS 180
Flange-Ø	A	mm	100	120	120	120	120	155	180	180	180
Joint angle	ß	°	25	25	25	25	25	25	25	25	25
Max. Rotations-Ø	K	mm	90	98	113	127	144	160	174	178	206
	M	mm	48	54	60	63,5	75	82	87	92	105
	Lz max.	mm	280	317	335	380	444	466	491	517	574
	La max.	mm	60	70	70	95	110	110	110	110	110
	GW max.	kg						25,1	33	41	
	Lz min.	mm	245	274	293	314	379	401	431	467	514
	La min.	mm	25	27	28	29	45	45	50	50	50
	GW min.	kg						22,5	30,1	38,2	
Spline-Ø	W	mm	36	40	45	48	54	62	68	78	88

Explanations:

TCS Functional limit torque
Lz max. Compressed length with max. length compression
La max. Max. length compensation
Lz min. Compressed length with min. length compression
La min. Min. length compensation
GW Weight of short coupled cardan shaft with Lc min. / Lc max.

Recommended connection
Companion flanges:
- DIN: according to ISO 7646
- SAE: according to ISO 7647
- XS: Cross serration according to ISO 8667

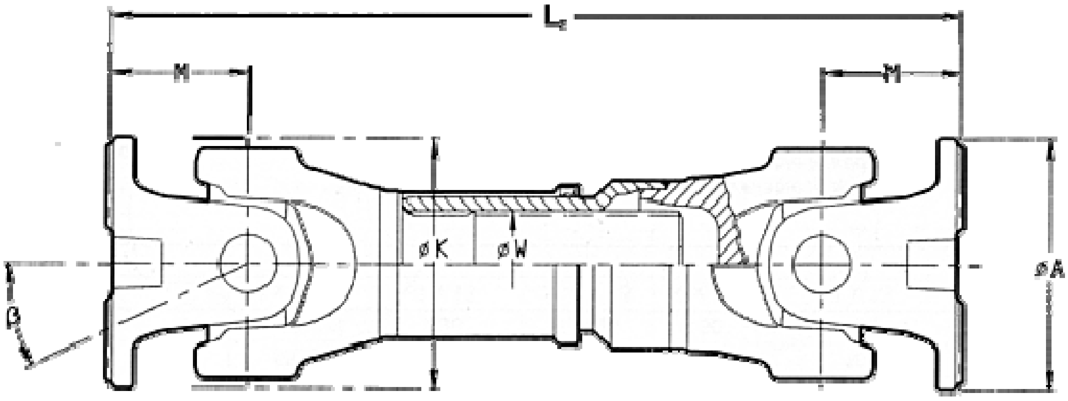
Propshaft flange yokes:
- XS: Cross serration according to ISO 12667

Please note:
All values given are nominal. Exact information should only be obtained from drawing.

Attention:
Not all DIN/SAE-flange-connection can transmit the function-limit-torque of the corresponding propshaft size by friction.

Short coupled cardan shaft with length compensation

Sleeve-Muff-Design



SPICER COMPACT 2000			2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065
Tcs		kNm	2,4	3,5	5,0	6,5	10,0	14,0	17,0	21,0,	25,0	30,0	35,0
Connection		-	DIN 100	DIN 120	XS 120	XS 120	XS 120	XS 150	XS 180	XS 180	XS 180	XS 180	XS 180
Flange-Ø	A	mm	100	120	120	120	120	155	180	180	180	180	180
Joint angle	ß	°	25	25	25	25	25	25	25	25	25	25	25
Max. Rotations-Ø	K	mm	90	98	113	127	144	160	174	180	178	196	206
	M	mm	48	54	60	63,5	75	82	87	85	92	100	105
	Lz max.	mm	348	381	405	436	510	505	541	531	571	590	631
	La max.	mm	90	100	100	110	110	110	110	110	100	110	110
	GWmax.	kg					20,9	26,4	35,3	39,5	43	50,8	61,1
	Lz min.	mm	296	322	341	362	470	465	501	491	531	550	591
	La min.	mm	38	41	36	36	70	70	70	70	70	70	70
	GWmin.	kg					19,3	24,8	33,3	37,1	40,2	48,4	57,9
Spline-Ø	W	mm	36	40	45	48	54	62	68	74	78	82	88

Explanations:

TCS Functional limit torque
Lz max. Compressed length with max. length compensation
La max. Max. length compensation
Lz min. Compressed length with min. length compression
La min. Min. length compensation
GW Weight of short coupled cardan shaft with Lc min. / Lc max.

Recommended connection
Companion flanges:
- DIN: according to ISO 7646
- SAE: according to ISO 7647
- XS: Cross serration according to ISO 8667

Propshaft flange yokes:
- XS: Cross serration according to ISO 12667

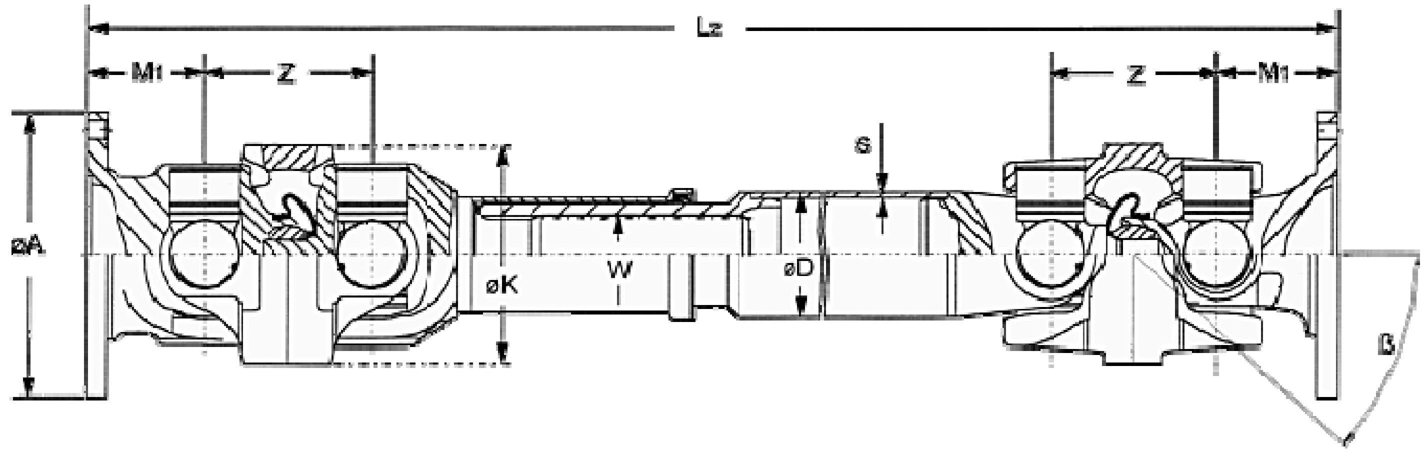
Please note:
All values given are nominal. Exact information should only be obtained from drawing.

Attention:
Not all DIN/SAE-flange-connection can transmit the function-limit-torque of the corresponding propshaft size by friction.

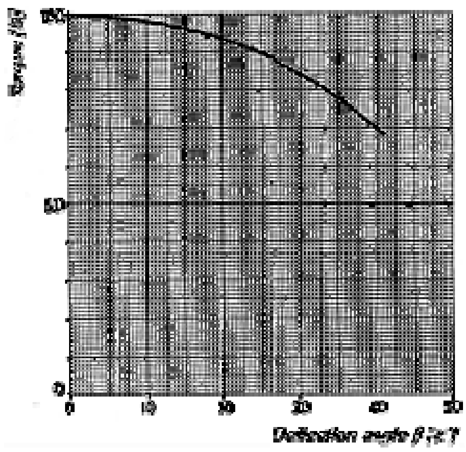
DANA SPICER® NORDISKA KARDAN AB

Data sheets Version 0.06

Cardan shaft with length compensation and centred double joint on both sides



SPICER COMPACT 2000			2030		587.20			587.35
Max. permissible speed	n		4500		4500			3800
TCS		kNm	-	6,5	-	8,3	8,3	17,0
TFR		kNm	-	-	7,4	-	-	-
Connection		-	-	DIN 150	DIN 150	XS 150	DIN 165	DIN 180
Flange-Ø	A	mm	-	150	150	150	165	180
Joint angle	ß	°	42		20 / 42			20 / 42
Rotations-Ø	K	mm	140		150			180
	M_1	mm	-	70	75	78	-	90
	Lz min	mm	700		820			930
	La	mm	110		110			110
	Z	mm	102		115			140
Tube-Ø	D x s	mm	90 x 3		85 x 5			100 x 6
	GW	kg	-		42,1			66,7
	GR	kg	6,43		9,9			13,9
Spline-Ø	W	mm	48		55			75



Transmission capacity dependent on deflection angle

Explanations:

TCS Functional limit torque
TFR Friction torque
Lz min. Compressed length
La Sliding movement
GW Weight of 1 m-shaft
GR Weight of 1 m-tube

Recommended connection

Companion flanges:
- DIN: according to ISO 7646
- SAE: according to ISO 7647
- XS: Cross serration according to ISO 8667

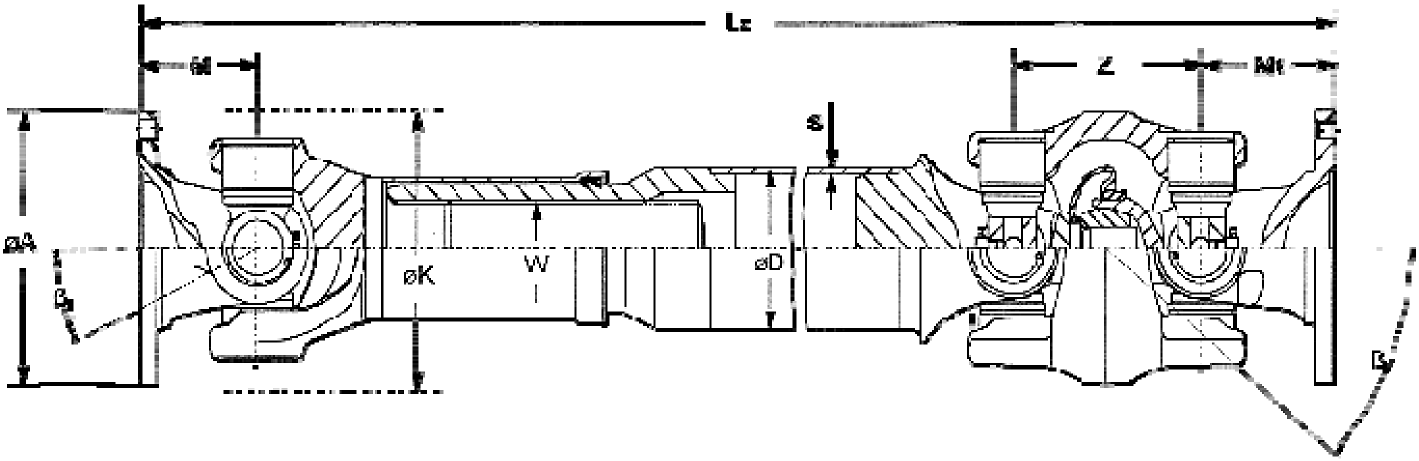
Propshaft flange yokes:
- XS: Cross serration according to ISO 12667

Please note:
All values given are nominal. Exact information should only be obtained from drawing.

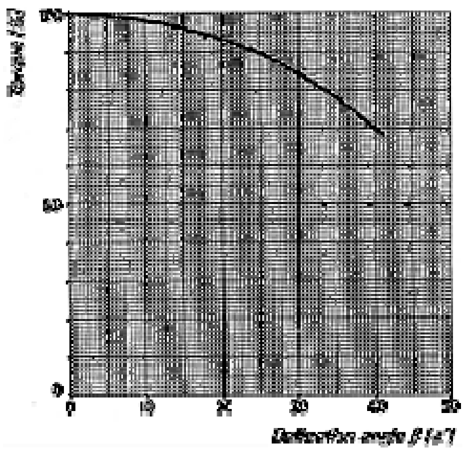
Attention:
Not all DIN/SAE-flange-connection can transmit the function-limit-torque of the corresponding propshaft size by friction.

Data sheets Version 0.08

Cardan shaft with length compensation and centered double joint on one side



SPICER COMPACT 2000			2030		587.20			587.35
Max. permissible speed	n		4500		4500			3800
TCS		kNm	-	6,5	-	8,3	8,3	17,0
TFR		kNm	-	-	7,4	-	-	-
Connection		-	-	DIN 150	DIN 150	XS 150	DIN 165	DIN 180
Flange-Ø	A	mm	-	150	150	150	165	180
Joint angle	ß	°	42		20 / 42			20 / 42
Joint angle	ß1	°	25		35			35
Rotations-Ø	K	mm	140		150			180
	M	mm	-	63,5	75	75	86	100
	M_1	mm	-	70	75	78	-	90
	Lz min	mm	600		705			820
	La	mm	110		110			110
	Z	mm	102		115			140
Tube-Ø	D x s	mm	90 x 3		85 x 5			100 x 6
	GW	kg	-		34,5			66,9
	GR	kg	6,43		9,9			13,9
Spline-Ø	W	mm	48		55			75



Transmission capacity dependent on deflection angle

Explanations:

TCS Functional limit torque
TFR Friction torque
Lz min. Compressed length
La Sliding movement
GW Weight of 1 m-shaft
GR Weight of 1 m-tube

Recommended connection

Companion flanges:
- DIN: according to ISO 7646
- SAE: according to ISO 7647
- XS: Cross serration according to ISO 8667

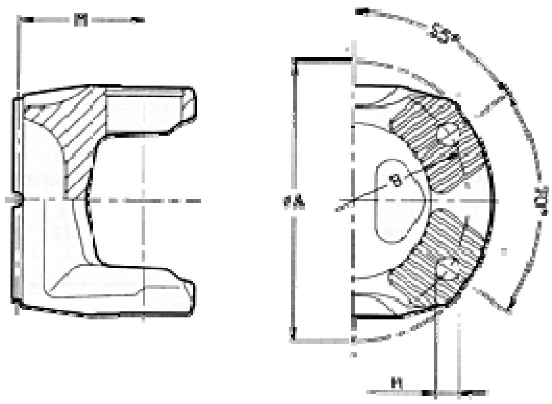
Propshaft flange yokes:
- XS: Cross serration according to ISO 12667

Please note:
All values given are nominal. Exact information should only be obtained from drawing.

Attention:
Not all DIN/SAE-flange-connection can transmit the function-limit-torque of the corresponding propshaft size by friction.

Flange fittings

X-Serration flange fittings (XS)



SPICER COMPACT 2000			2020	2025	2030	2035		2040		2045 2047		2050	2055	2060	2065
Tcs		kNm	3,5	5,0	6,5	10,0		14,0		17,0 19,0 (at 2047)		21,0	25,0	30,0	35,0
Connection	XS	-	120	120	120	120	150	150	150	180	180	180	180	180	180
Flange-Ø	A	mm	120*	120*	120*	120*	155**	155**	155**	180	180	180	180	180	180
Joint angle	ß	°	25	25	25	25	35	25	44	25	44	25	25	25	25
	M	mm	54	60	63,5	75	88	82	102	87	108	85	92	100	105
	B	mm	100	100	100	100	130	130	130	150	150	150	150	150	150
	I x H		4 x 11	4 x 11	4 x 11	4 x 11	4 x 13	4 x 13	4 x 13	4 x 15	4 x 15	4 x 15	4 x 15	4 x 15	4 x 15
Flange-Ø	A	mm			155**	155**		180	180	155**		180	180		
Joint angle	ß	°			25	25		25	44	37		35	35		
	M	mm			65	75		82	102	100		95	102		
	B	mm			130	130		150	150	130		150	150		
	I x H				4 x 13	4 x 13		4 x 15	4 x 15	4 x 13		4 x 15	4 x 15		

Explanations:

TCS Functional limit torque
I x H Threaded hole diameter and number of bores

Preferred range (shaded)

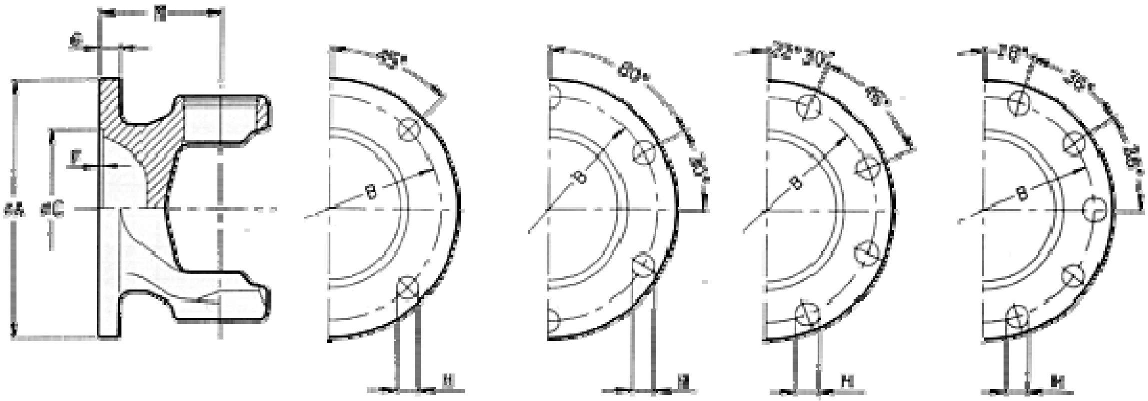
* Flange-Ø 122 mm available in addition
** Flange-Ø 152 mm available in addition

Companion flanges:
- according to ISO 8667

Propshaft flange yokes:
- according to ISO 12667

Please note:
All values given are nominal. Exact information should only be obtained from drawing.

Flange fittings (DIN)



SPICER COMPACT 2000			2015	2020	2025	2030	2035	2040		2045	2047	2050	2055	2060	2065
Tcs		kNm	-	3,5	5,0	6,5	-	-		17,0	19,0	-	-	-	35,0
TFR		kNm	1,5	-	-	-	7,4	12,1		-	-	20,5	20,5	-	20,5
Flange-Ø	A	mm	100	120	150	150	150	180		180	180	180	180	-	180
Joint angle	ß	°	25	25	25	35	35	44		35	35	35	35	-	35
	M	mm	48	54	60	78	95	102		95	95	100	115	-	110
	B	mm	84	101,5	130	130	130	155,5		155,5	155,5	155,5	155,5	-	155,5
	C	mm	57	75	90	90	90	110		110	110	110	110	-	110
	F	mm	2,5	2,5	3,0	3,0	3,0	3,0		3,0	3,0	3,0	3,0	-	3,0
	G	mm	7	8	10	10	10	12		12	12	12	14	-	15
	I x H		6 x 8,25	8 x 10,25	8 x 12,25	8 x 12,25	8 x 12,1	8 x 14,1		10 x 16,1	10 x 16,1	10 x 16,1	10 x 16,1	-	10 x 16,1
TFR		kNm			3,9	3,9	10,0	7,4	14,0	14,8	14,8				
Flange-Ø	A	mm			120	120	180	150	165	165	165				
Joint angle	ß	°			35	35	35	44	35	44	44				
	M	mm			70	72	90	102	90	112	112				
	B	mm			101,5	101,5	155,5	130	140	140	140				
	C	mm			75	75	110	90	95	95	95				
	F	mm			2,5	2,5	3,0	3,0	3,0	3,0	3,0				
	G	mm			8	10	12	10	12	12	12				
	I x H				8 x 10,25	8 x 10,25	8 x 14,1	8 x 12,1	8 x 16,1	8 x 16,1	8 x 16,1				

Explanation:

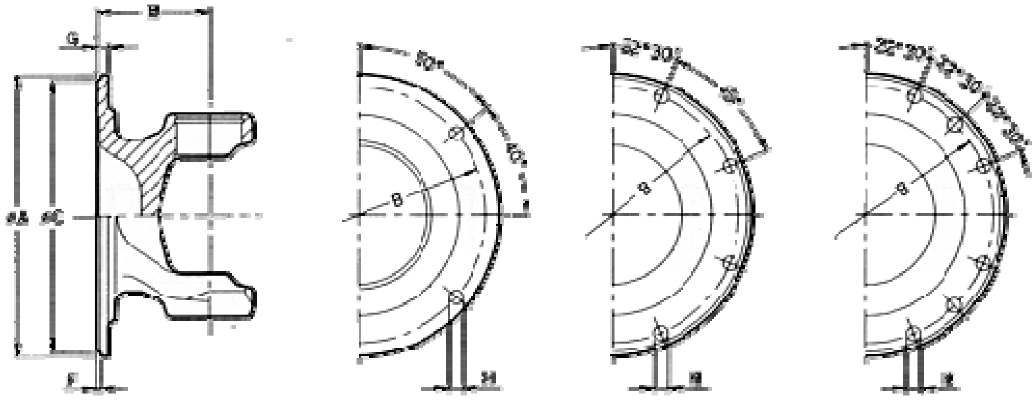
TCS Functional limit torque
TFR Friction torque
I x H Threaded hole diameter and number of bores

Preferred range

Companion flanges:
- according to ISO 7646

Please note:
All values given are nominal. Exact information should be obtained from drawing.

Flange fittings (SAE)



SPICER COMPACT 2000			2015	2020	2025	2030	2035	2040		2045 2047	2050		2055	2060	2065
TFR		kNm	1,5	2,7	4,6	5,9	5,9	10,6		10,6	10,6		10,6	10,6	15,6
Connection	SAE	Size	1300	1400	1500	1600	1600	1800		1800	1800		1800	1800	1800
Flange-Ø	A	mm	96,8	115,9	151	174,6	174,6	203,2		203,2	203,2		203,2	203,2	203,2
Joint angle	ß	°	25	25	25	25	35	25		25	25		25	25	25
	M	mm	43	48	60	60	88	70,5		86	76,5		92	92	110
	B	mm	79,37	95,27	120	155,6	155,6	184,15		184,15	184,15		184,15	184,15	184,15
	C	mm	60,32	69,85	95,25	168,2	168,2	196,8		196,8	196,8		196,8	196,8	196,8
	F	mm	1,4	1,4	1,6	3,0	3,0	3,0		3,0	3,0		3,0	3,0	3,0
	G	mm	7	8	10	9,5	9,5	9,5		11	11		11	11	14
	I x H		4 x 10,25	4 x 12,25	4 x 14,25	8 x 10,1	8 x 10,1	12 x 10,1		12 x 10,1	12 x 10,1		12 x 10,1	12 x 10,1	12 x 12,1
TFR		kNm			3,6			14	10,6	12,4	12,4	10,6	12,4	12,4	
Connection	SAE	Size			1510			1800	1800	1800	1800	1800	1800	1800	
Flange-Ø	A	mm			146			203,2	203,2	203,2	203,2	203,2	203,2	203,2	
Joint angle	ß	°			25			44	44	25	25	35	25	25	
	M	mm			60			100	100	86	76,5	95	92	92	
	B	mm			120			184,2	184,2	184,15	184,2	184,2	184,2	184,2	
	C	mm			95,25			196,8	196,8	196,8	196,8	196,8	196,8	196,8	
	F	mm			1,6			3	3	3	3	3	3	3	
	G	mm			10			9,5	9,5	11	11	11	11	11	
	I x H				4 x 12,25			12 x 12,1	12 x 10,1	12 x 11,1	12 x 11,1	12 x 10,1	12 x 11,1	12 x 11,1	

Explanations:

TFR Friction torque
I x H Threaded hole diameter and number of bores

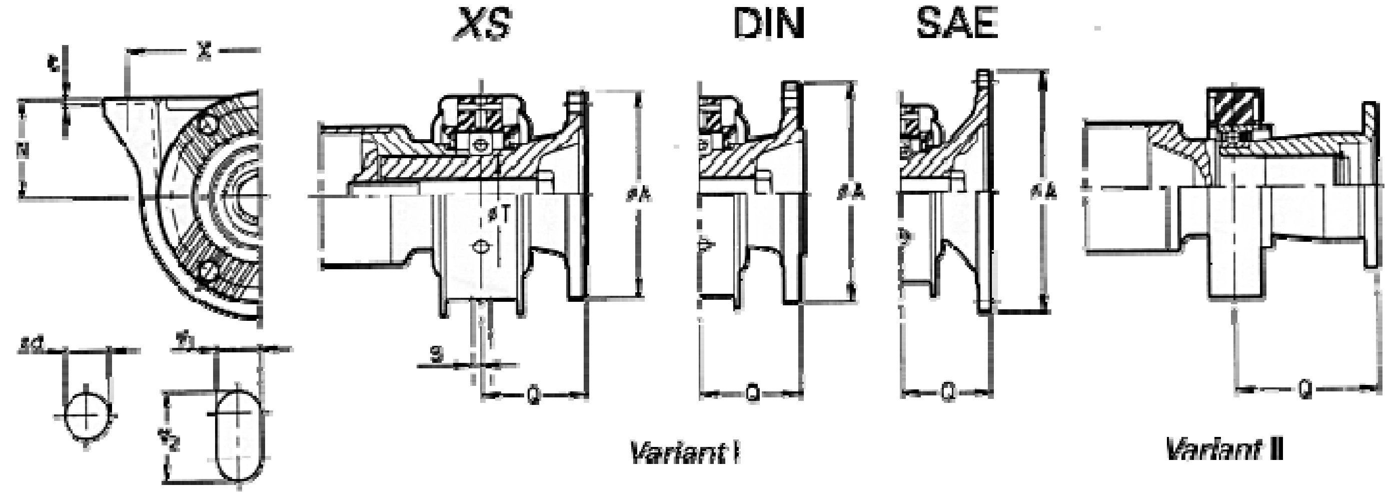
Preferred range

Companion flanges:
- according to ISO 7647

Please note:
All values given are nominal. Exact information should only be obtained from drawing.

Cardan 2000 compact

Centre bearing



SPICER COMPACT 2000				2015	2020	2025	2030	2035	2040	2045	2047	2050	2055	2060	2065
Bearing-Ø		T	mm	45	45	40	45	45	55	55	55	55	70	70	70
Variant				II	II	I	I	I	I	I	I	I	I	I	I
Hole-Ø1)		d	mm	-	-	12,7	-	-	-	15	15	15	15	15	15
Hole length1)		V1+V2	mm	13,5 x 18	13,5 x 18	14,5 x 13	14,5 x 13	14,5 x 13	14,5 x 16	15 x 30	15 x 30	15 x 30	15 x 30	15 x 30	15 x 30
Hole distance		X	mm	168,1	168,1	168,1	193,5	193,5	193,5	200	200	200	220	220	220
Flange thickness		t	mm	6,5	6,5	4	4,8	4,8	4,8	4,8	4,8	4,8	5,8	5,8	5,8
Flange distance		N	mm	58	58	63	69	69	71,5	71,5	71,5	71,5	85,8	85,8	85,8
XS	Flange-Ø	A	mm	-	-	120	120	155	180	180	180	180	180	180	180
		Q	mm	-	-	70	73	73	80	80	80	80	107	107	107
DIN	Flange-Ø	A	mm										180	180	180
		Q	mm										107	107	107
SAE	Connection		Size	1300	1400		1600								
	Flange-Ø	A	mm	96,8	115,9		174,5								
		Q	mm	78	78		89								

Explanations:

T Midship bearing diameter

1) Alternative long hole or round hole

Selection of midship see Cardan shaft without length compensation with midship.

Please note:
All value given are nominal. Exact information should only be obtained from drawing.

Attention:
Upon installation a stable centre bearing support should be enshured. (See Installations of drive lines). Please respsct this information concerning the safety of central bolt. If necessary contact us.

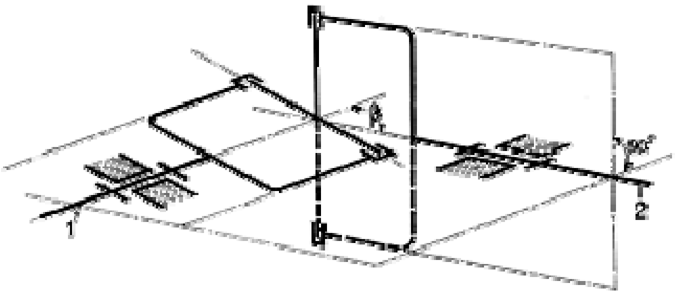
General fundamental theory

Kinematics of Hooke's joints

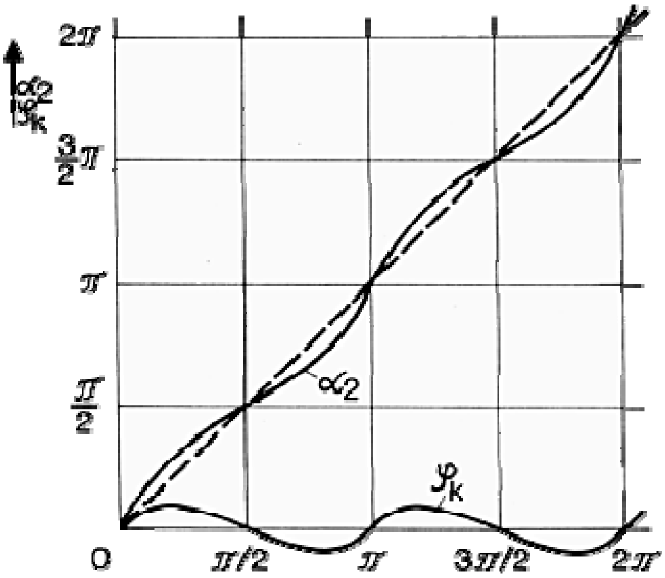
1. The joints

In the theory of mechanics the cardan joint or Hooke's joint is defined as a spatial or spherical drive unit with a non-uni form gear ratio or transmission. The transmission behaviour of this joint is described by the equation.

$$\alpha_2 = \arctan\left(\frac{1}{\cos\beta} \cdot \tan \alpha_1\right)$$



In this equation α_2 the momentary rotation angle of the driven shaft 2. The motion behaviour of the driving and the driven ends is shown in the following diagram. The asynchronous and / or non-homokinematic running of the shaft 2 is shown in the periodical oscilation of the asynchronous line α_2 round the synchronous line α_1 (dotted line).



A measure for the non-uniformity is the difference of the rotation angles α_2 and α_1 or the transmission ratio of the angular speeds ω_2 and ω_1.

Expressed by an equation, that means:

a) rotation angle difference

$$\varphi_K = \alpha_2 - \alpha_1$$

(also called gimbal error)

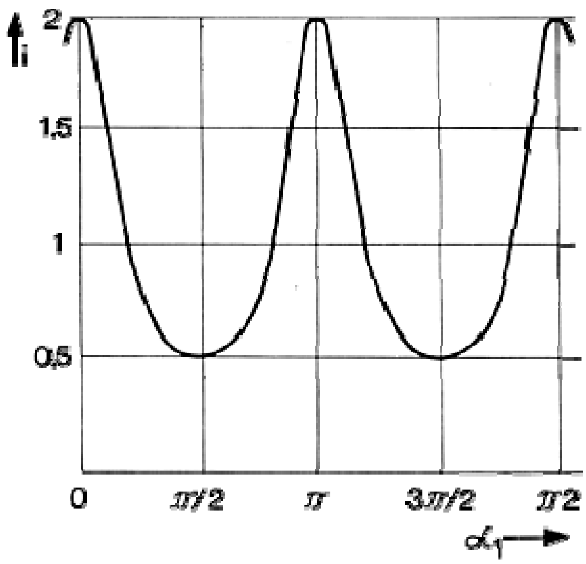
$$\varphi_K = \arctan\left(\frac{1}{\cos\beta} \cdot \tan\alpha_1\right) - \alpha_1$$

$$\varphi_{K\,max.} = \arctan\left(\frac{\cos\beta - 1}{2\sqrt{\cos\beta}}\right)$$

b) Gear ratio

$$i = \frac{\omega_2}{\omega_1} = \frac{\cos\beta}{1 - \sin^2\beta \cdot \cos^2\alpha 1}$$

The following diagram shows the gear ratio i = Φ_2/ $\Phi_1$for a full revolution of the universal joint for ß = 60°.



The degree of non-uniformity U is defined by:

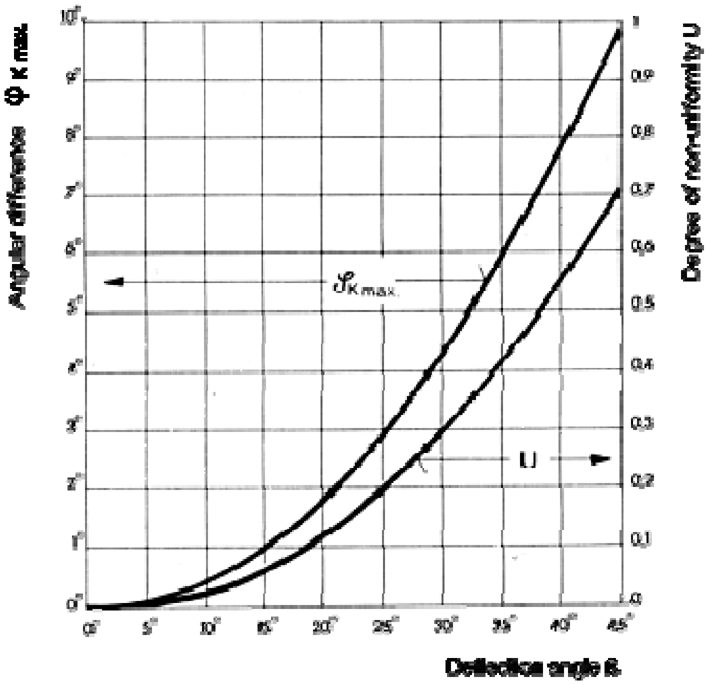
U = i max. - i min. = tan ß * sin ß

where:

$$U = i\,max. - i\,min. = \tan\beta \cdot \sin\beta$$

$$i\,max. = \frac{1}{\cos\beta}$$

$$i\,min. = \cos\beta$$



The diagram shows the course of the degree of nonuniformity U and of the angular difference φ_{Kmax} as a function of the deflection angle of the joint from 0 to 45°.

From the motion equation it is evident that a homokinematic motion behaviour corresponding to the dotted line under 45° - as shown in the diagram - can only be obtained for the deflection angle ß = 0°. A synchronous or homokinematic running can be achieved by a suitable combination or connection of two or more joints.

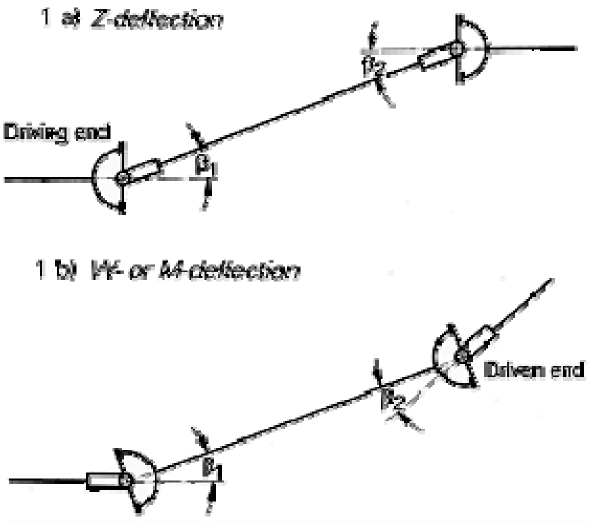
2. The universal shaft

The rotation angle difference φ_k or the gimbal error of a deflected universal joint can be offset under certain installation conditions with a second universal joint. The constructive solutions are the following:

1) The deflection angles of both joints must be equal, i.e.

$$\beta_1 = \beta_2$$

Two arrangements are possible:



2) The two joints must have a kinematic angular relationship of 90° (π / 2), i.e. the yokes of the connecting shaft are in one plane.

For a more intensive study of universal shaft kinematics we refer you to the VDI-recommendation 2722 to the relevant technical literature and especially to the book ,,Kardangelenkgetriebe und ihre Anwendung" (Cardan joint drives and their application) by Florian Duditza, published by VDI.

General technical terms of propshaft application

For the application of propshafts of the series Compact 2000 a special calculation method and software has been developed. This calculation method is based on general physical terms and additional experiences of real vehicel measurements.

The fundamental items of the "VAMP-method" *(Vehicle Application Method for Propshafts)* reflect to:

- vehicle parameters
- operating conditions
- characteristical values of Compact 2000 propshafts
- special customer requirements

According to these the following parameters are checked:

- Fatigue Strength
  Criteria for fatigue strength is the maximum generated torque in the driveline under normal operating conditions. It is determined by:

  a) the maximum driving torque

  b) the maximum adhesion torque

- In relation to the relevant criterion the size of propshaft with the sufficient static capacity Tcs is determined. Up to this torque limit a shaft can be loaded without disturbing the function of the driveline.

- Structural Strength
  The structural strength is based on the maximum torque which can occure under extreme conditions or misuse. Limitations which refer to the adhesion torque are also taken into account.

- Lifetime of a Unit Pack
  The lifetime of a unit pack is calculated by use of specific load distributions from the customer or parameters of general inhouse measurements and experiences.

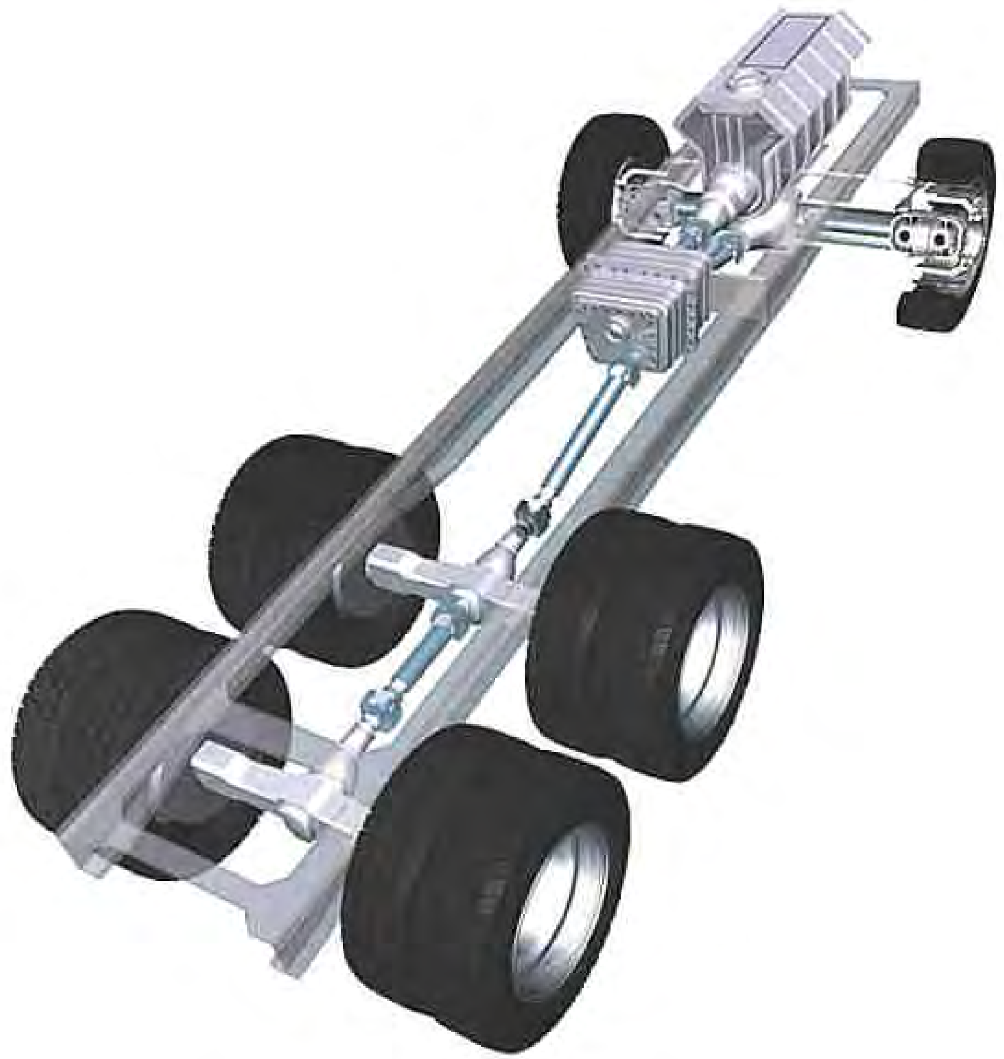
- Speed, Working Angle, Length
  Criteria are:

  - the relation of the maximum speed during
  - the excitation of torsional vibrations genera-ted by propshaft speed and working angle

Finally the optimal propshaft size will be recom-mended.

To identify specific characteristical values of e.g. special dynamic behaviour of drivelines we can support the customers with simulation calculations and vehicle measurements.

Please contact our application experts for these and all other items.



Directions for inquiries and order

The handling of inquiries and orders for unsiversal joint shafts will be easier and quicker if information of the following points is provided.

1. Type and description of the plant or unit
2. Operating conditions
3. Engine data
4. Drive data
5. Installation conditions
6. Dimensions of the connected units

(see "Technical Questionnaire - Automotive")

Installation and Maintenance

Installation conditions

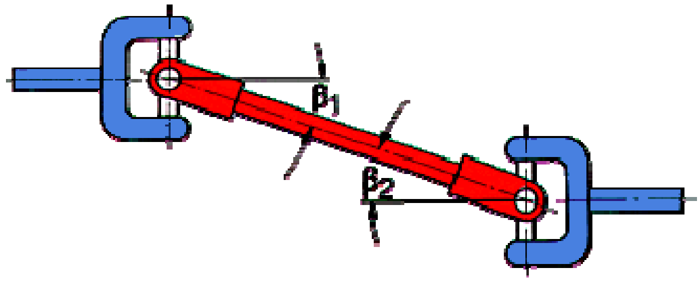
While rotating, the universal joint has a sinuslike, fluctuating angular speed depending on the deflection angle. As described in detail in the chapter ,,General fundamental theory", this system-linked fault can be offset for a driving line equipped with two or more joints by choosing special joint arrangements.

When dimensioning the drive or the auxlliarv drive, the following rules must be observed in practice:

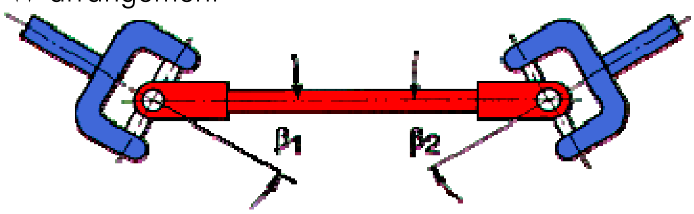
Angle conditions of the universal shaft

1. Shaft with two joints

"Z-arrangement"



"W-arrangement"

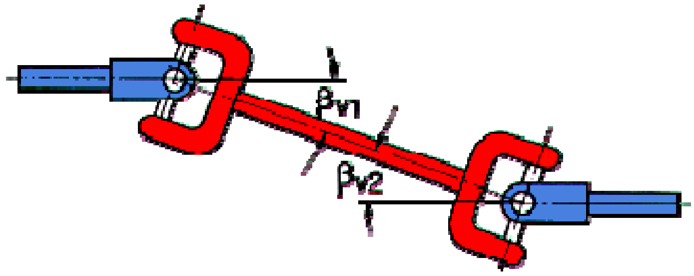


- The deflection angles of the joints must be equal: $\beta_1 = \beta_2$
  This rule is also applicable to front view and top view pictures.
- The joint yokes of the connecting shaft must be in one plane.
- All three shafts must be in one plane.

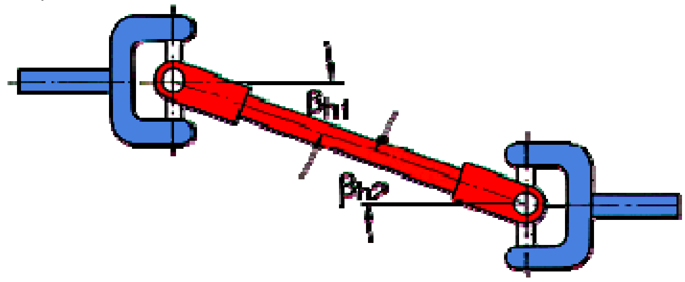
Note: All these three rules must be observed simultaneously.

A joint arrangement in two planes must be avoided if possible. It is always given when the driving and driven shafts are not in the same plane. If this arrangement is unavoidable and rigid on the installation side, this ,,fault" can be kinematically compensated by a joint misalignment.

Front view: $(\beta_{v1} = \beta_{v2})$



Top view: $(\beta_{h1} = \beta_{h2})$



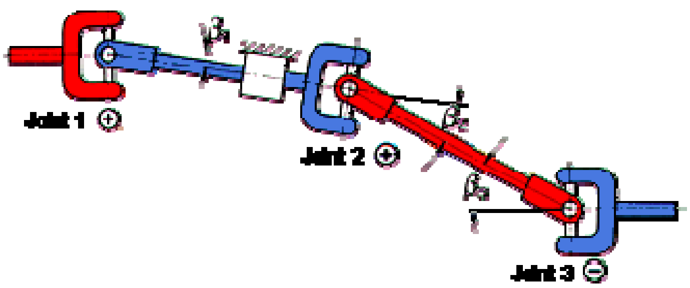
For the resulting deflection angles the following equations are applicable:

$$\beta_{res1} = \arctan \sqrt{\tan^2\beta_{v1} + \tan^2\beta_{h1}}$$

$$\beta_{res2} = \arctan \sqrt{\tan^2\beta_{v2} + \tan^2\beta_{h2}}$$

2. Shaft with three joints

In cases where greater distances between units have to be bridged, the universal shaft must be supported by an additional, mostly elastic, bearing.



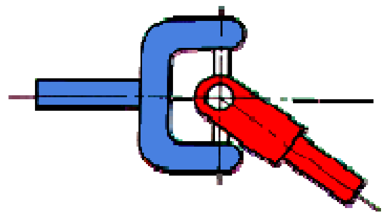
In order to keep the remaining irregularity in the drive (joint 3) as small as possible, the sum of all irregulanties of the individualjoints must be equal to or almost equal to zero.

$$\Sigma U = U_1 \pm U_2 \pm U_3 \simeq 0$$

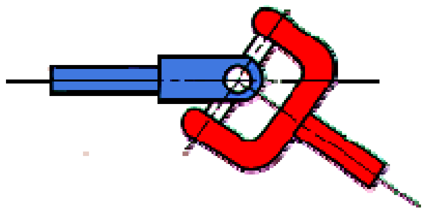
(See "Kinematics of Hooke's joints")

The signs must be entered according to the following sign rule. Here the sign rule is:

⊕ for the joint position



⊖ for the joint position



The remaining non-uniformity if any should not be greater than:

$$\Sigma U \leq 0{,}0027$$

The minimization of the remaining non-uniformity can also be achieved by the so-called equivalent deflection angle $ß_E$ erfolgen.

$$\beta_E = \sqrt{\pm \beta_1^2 \pm \beta_2^2 \pm \beta_3^2} \leq 3°$$

The sign rule is also applicable here.

The equivalent deflection angle $ß_E$ = 3° is the equivalent deflection angle of a single joint which corresponds with a degree of non-uniformity U = 0,0027.

3. Shafts with several joints

In case of an arrangement with more than three joints proceed as described above.

General recommendations for lorry drives:

- For fast-running drive shafts observe the instructions on the transverse whirling speeds for installation length.
  (See "Influence of speed and deflection angle")
- Choose small resulting deflection angles for the main drive range:
  (See also (n x ß)perm. "Influence of speed and deflection angle")
- Minimize the angular difference between the joints and the remaining inequaltity

If these recommendations are not observed, one must reckon with vibrations and noises and with a reduced driving comfort as well as with a reduced lifetime of the units.

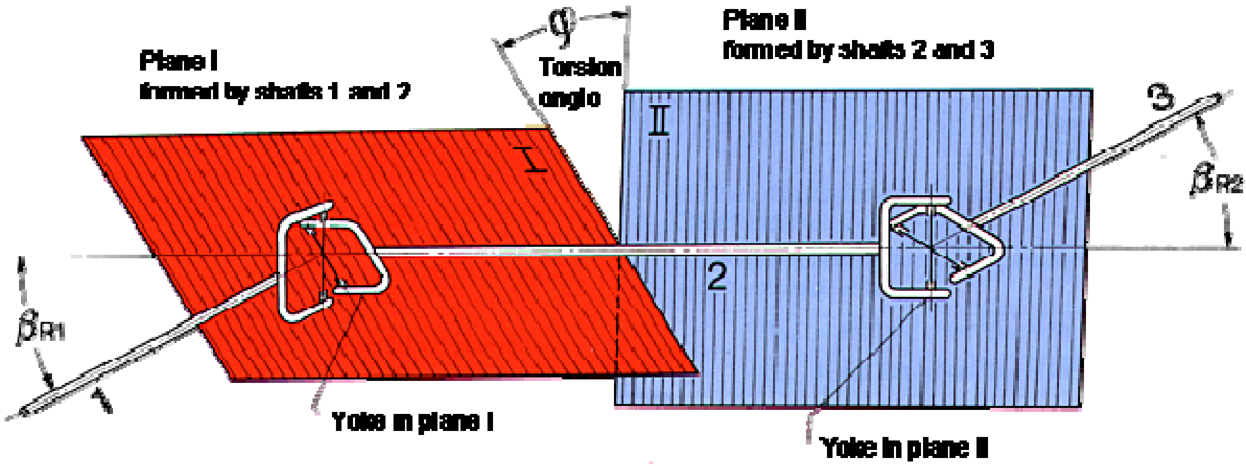
Deflection of joints in two planes

If a "classic shaft arrangement" cannot be realized and the joint deflection cannot be changed, this can be offset by turning the joints. For this shaft arrangement the Installation rule that the resulting deflections of the joints must be equal remains in force, i.e.

$$\beta_{res1} = \beta_{res2}$$

Plane 1 formed by the driving shaft 1 and the connecting shaft 2 on the one hand and Plane II formed by the connecting shaft 2 and the driven shaft 3 on the other hand form the angle Ψwhich is offset by turning the joints correspondingly.

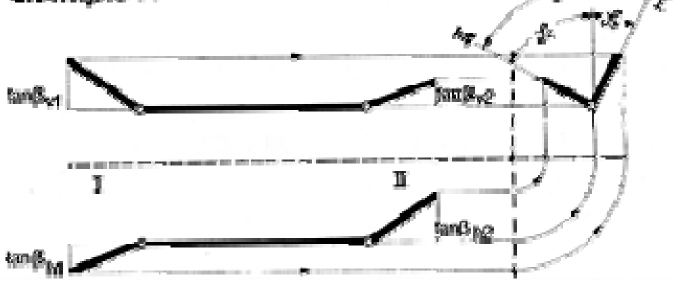
The torsion angle Φis determined as follows:



The rotation direction results ifom the side view, i.e. joint 1 must be turned to plane 1 by the angle Ψ.

The shaft must be mounted according to these statements and this before a possible balancing. This position of the joints must be marked with arrows.

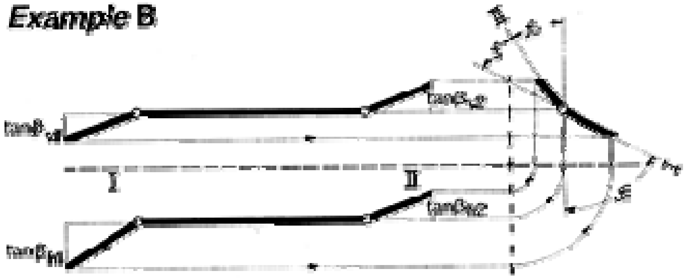
Example A



$$\tan\varphi_1 = \frac{\tan\beta_{h1}}{\tan\beta_{v1}} \qquad \tan\varphi_2 = \frac{\tan\beta_{h2}}{\tan\beta_{v2}}$$

$$\varphi = \varphi_1 + \varphi_2$$

Example B



$$\varphi = \varphi_1 - \varphi_2$$

Influence of speed and deflection angle

Speed

The permissible speed of the universal joint shaft is influenced by the following parameters:

- size of the shaft
- widening of the yokes due to centrifugal force
- quality of balancing
- true running of the connected flanges
- deflection angle during operation
- length of the shaft

Speed x deflection angle

Theoretical considerations and observations of various applications have shown that certain mass acceleration moments of the centre part of the shaft must not be exceeded if a quiet running of the shaft drives is to be achieved. This mass acceleration moment depends on the speed n, the deflection angle ß and the mass moment of inertia of the centre part of the shaft.

The mechanically possible deflection angle for each joint depends on the size of the shaft. Owing to the kinematic conditions of the universal joint described before, the practical deflection angle must be limited in relation to the rotational speed.

The following table shows the max. speeds and the max. permissible values for the product

n x ß

of the various shaft sizes for a moment of inertia of the centre part according to a shaft length of approx. 1500 mm.

When approaching the critical rotational speed and in the light of the demand of maintenance of balance quality (see Balancing of Propeller shafts) , it may be necessary to reduce the rotational speed.

Joint size	n max. [1/min.]	(n x ß) perm. [°/min.]
2015	6 000	27 000
2020	6 000	26 000
2025	6 000	24 000
2030	6 000	22 000
2035	5 600	21 000
2040	5 000	20 000
2045	4 700	19 000
2047	4 500	19 000
2050	4 500	19 000
2055	4 500	18 000
2060	4 100	17 000
2065	3 900	17 000

Since the quiet running of the universal shaft in practice also largely depends on the installation conditions, the n x ß values shown in the table can only be regarded as a guidance. Slightly higher values are possible. In case of favourable spring and mass conditions the values may be exceeded by up to 50 %.

Transverse whirling speed

Universal shafts are flexible elastic units, which must be calculated considering the bending vibrations and the transverse whirling speed.
For reasons of safety the max. perm. operating speed must be sufficiently below the transverse whirling speed.

The diagram on the end of this page shows the **transverse whirling speeds** of the varbus shaft sizes depending on the operating lengths and the tube dimensions shown in the catalogue.

The diagram values apply to normal installation conditions with a supposed distance of the centre point of the joint shaft from the adjacent bearing equal to 3 x M and a rigid suspension of the connected units.

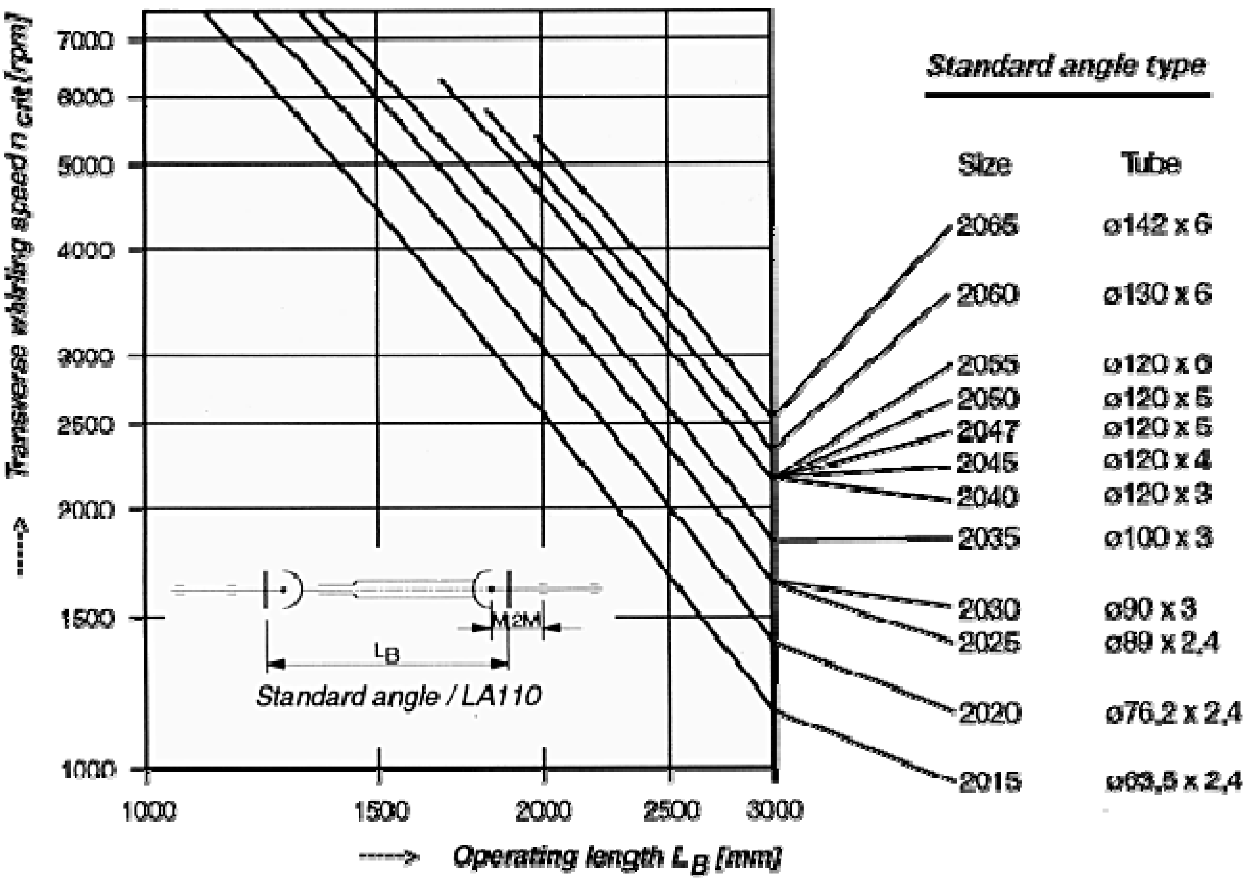
In order to achieve a safe and quiet running behaviour the max. perm. operating speed, i.e. including a possible excess speed, must not exceed 80 % of the transverse whirling speed shown in the diagram.

$$n_{perm.max} \cong 0{,}8 \cdot n_{crit} \quad [rpm]$$

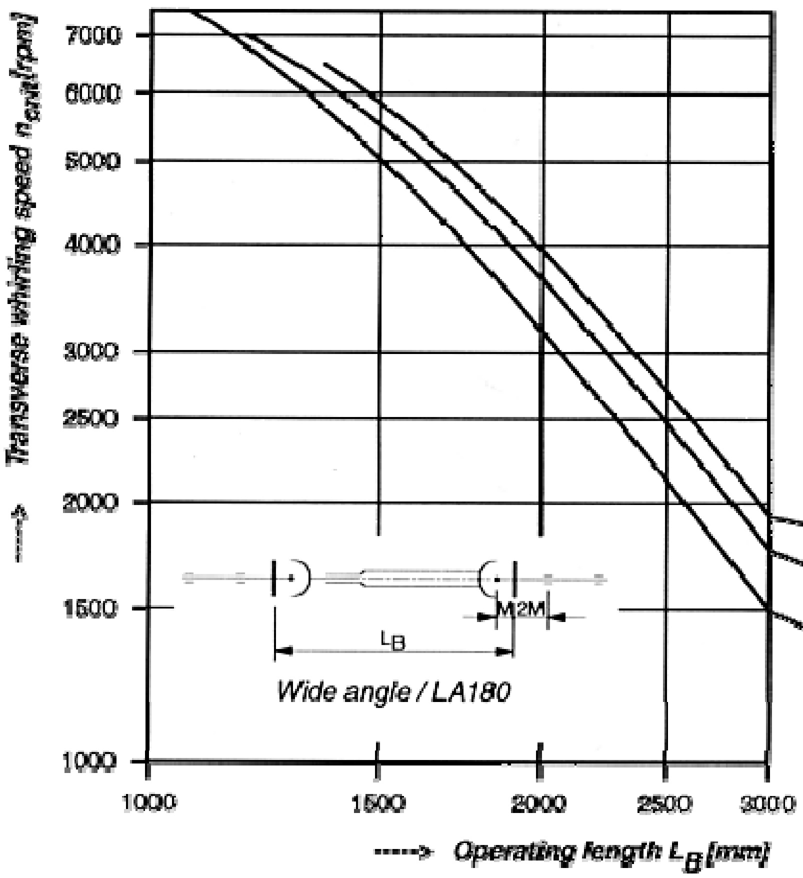
If the permissible speed is exceeded, the length of the universal shaft must be reduced or an intermediate bearing must be provided.

The following diagrams only refer to universal shafts of the standard design. For special designs with greater length compensations than normal or with other alterations reducing the flexural strength a special calculation of the critical speed is required. In this case please ask our advice.

Transverse whirling speed of cardan shafts dependent on operating length L_B



Wide angle type



Size	Tube
2045	Ø 110 x 5
2040	Ø 100 x 4.5
2035	Ø 85 x 5

Load on connection bearings

The bearings of the driving and the driven shafts are strained by statle and dynamic forces and moments.

These bearing forces result from:

Static bad due to
- the weight of the universal shaft
- the length compensation under torque
- the torque deviation in case of deflected universal shafts

Dynamic bad due to
- the remaining unbalance of the shafts
- the aperiodical length compensation (axle movement) under torque
- the torque deviation in case of rotating, deflected shafts and
- centrifugal forces in case of untrue running of the connected units

Bearing forces due to torque deviation

The torque equation for a deflected joint is:

$$\alpha_2 = \arctan \frac{\tan\alpha_1}{\cos\beta}$$

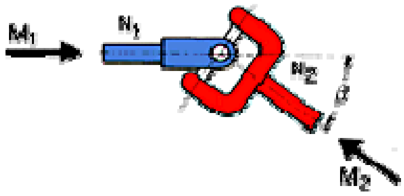
$$i = \frac{\omega_2}{\omega_1} = \frac{\cos\beta}{1 - \sin^2\beta \cdot \cos^2\alpha_1}$$

$$U = \frac{\omega_{2\,max.} - \omega_{2\,min.}}{\omega_1}$$

$$\textit{if} \quad \omega_{2\,max.} = \frac{1}{\cos\beta};\ \omega_{2\,min.} = \cos\beta$$

(See "General fundamental theory ")

If the transmitted power (N) is taken as constant (no friction losses), the torque relation can also be es follows:



$$N_1 = N_2 = \text{konst.}$$
$$M_1\omega_1 = M_2 \cdot \omega_2 = \text{konst.}$$

$$\textit{if} \quad i = \frac{\omega_2}{\omega_1}$$

$$\textit{then} \quad i = \frac{M_1}{M_2} = \frac{\cos\beta}{1 - \sin^2\beta \cdot \cos^2\alpha_1}$$

The extremes of the transmission i are:

$$i_{max.} = \frac{1}{\cos\beta} \qquad \textit{for}\ \alpha_1 = 0°;\ 180°$$

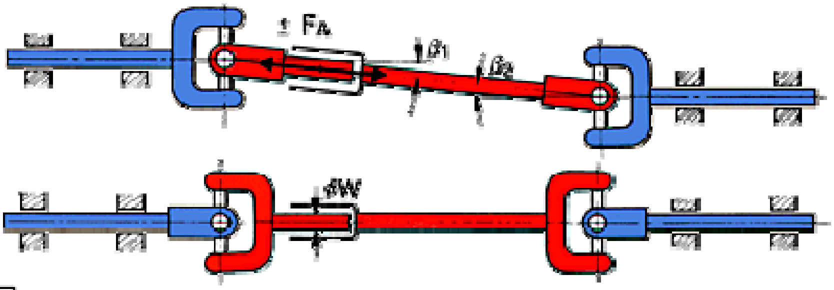
$$i_{min.} = \cos\beta \qquad \textit{for}\ \alpha_1 = 90°;\ 270°$$

Thus also:

$$M_{2max.} = \frac{M_1}{\cos\beta}$$

$$M_{2min.} = M_1 \cdot \cos\beta$$

Bearing forces due to lengh alteration



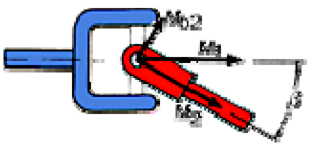
$$F_A = \pm M_{2max.} \cdot \frac{2}{W} \cdot \mu$$

With a constant drive capacity resp. with a constant drive torque M_1 and a constant angular drive velocity ω_1 an irregular torque behaviour is obtained in the drive. Since the torque is only transmitted in the journal cross plane, the cross, however, has a horizontal position with regard to the drive shaft at one moment and a vertical position with regard to the driven shaft at another moment, depending on the position of the yoke, there is, in the former case, a bending torque M_{b2} on the yoke of the driven shaft and, in the latter case, a bending torque M_{b1} on the yoke of the driving shaft.

Thus the driven torque M_2 fluctuates twice per rotation between the extreme values

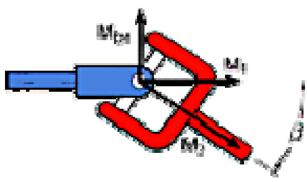
M_1/ cos ß and M_1* cos ß

α_1 = 0°; 180°



$$M_{2min.} = M_1 \cdot \cos\beta$$
$$M_{b2max.} = M_1 \cdot \sin\beta$$
$$(M_{b1min.} = 0)$$

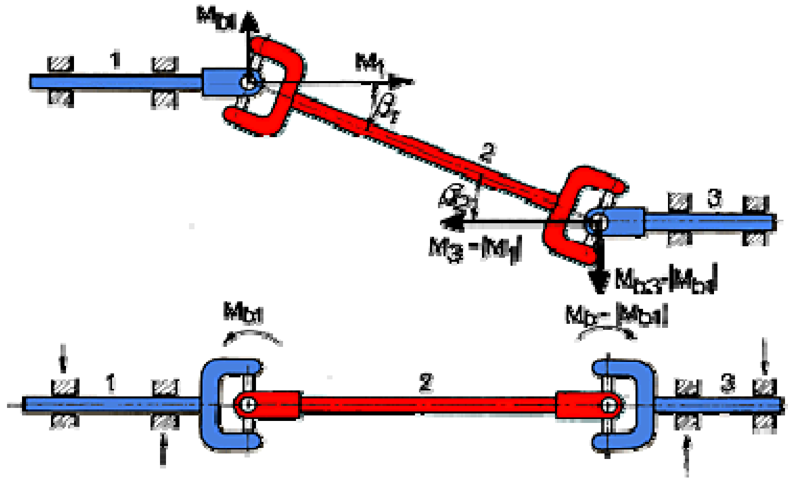
α_1 = 90°; 270°



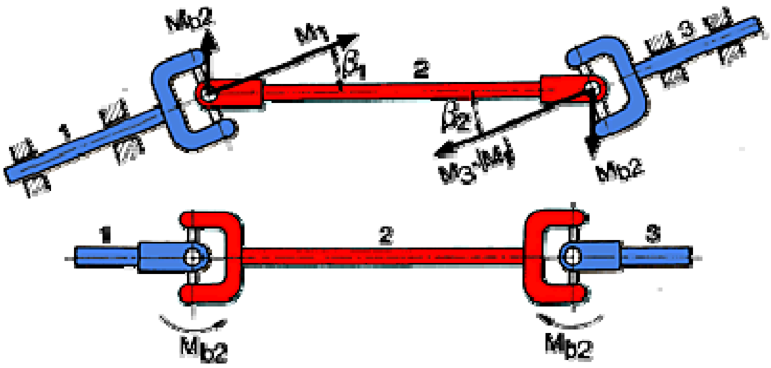
$$M_{2max.} = M_1 \cdot \frac{1}{\cos\beta}$$
$$M_{b1max.} = M_1 \cdot \tan\beta$$
$$(M_{b2min.} = 0)$$

The universal shaft with two joints in the Z-arrangement shown is loaded with the following moments. Here, as for the single joint, only the two extreme positions are shown.

$\alpha = 90°; 270°$
$\beta_2 = \beta_1$



$\alpha = 0°; 180°$
$\beta_2 = \beta_1$



In general:

$$M_{b1} = M_{b3} = M_1 \cdot \tan\beta \cdot \sin\alpha_1$$

Radial forces on connecting bearings

For universal shafts with two joints mounted normally while observing the installation instructions it is usually enough to know the greatest reaction forces in the bearings of the driving and driven shafts, which occur two times per rotation. The following calculation scheme may be helpful. (See "Calculation scheme")

Axial forces on connecting bearings

Axial forces on connecting bearings are encountered in the form of reaction forces due to:

- displacement of the engine / transmission and / or transfer box units
- axle displacements

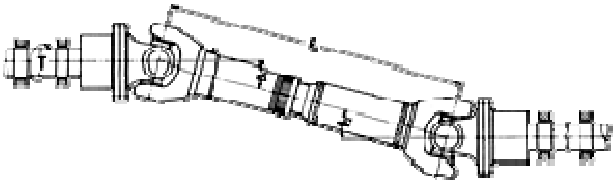
These axial forces are a function of:

- the amounts of torque to be transmitted
- the sectional dimensions of lon gitudinal compensating elements
- the friction coefficient in lon gitudinal compensating elements
- the deflection angles of the cardan shaft under operating conditions
- the relative dynamic displacement of engine and transmission units
- additional loads due to hydraulic effects arising when the grease chamber in the lon gitudinal displacement system is filled beyond capacity

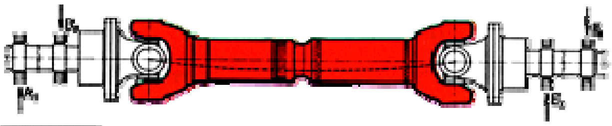
Calculation scheme of radial forces on connecting bearings

Universal shaft in Z-arrangement

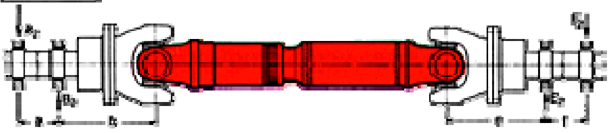
Position 0° flange yoke right-angled to drawing plane
Position $\pi/2$ flange yoke in drawing plane



$\alpha = 0°$



$\alpha = 90°$



$\alpha = 0°$

$$A_1 = M \cdot \frac{\cos\beta_1 \cdot b}{L \cdot a} \cdot (\tan\beta_1 - \tan\beta_2)$$

$$B_1 = M \cdot \frac{\cos\beta_1 \, (a + b)}{L \cdot a} \cdot (\tan\beta_1 - \tan\beta_2)$$

$$F_1 = M \cdot \frac{\cos\beta_1 \cdot e}{L \cdot f} \cdot (\tan\beta_1 - \tan\beta_2)$$

$$E_1 = M \cdot \frac{\cos\beta_1 \, (e + f)}{L \cdot f} \cdot (\tan\beta_1 - \tan\beta_2)$$

$\alpha = \pi/2 = 90°$

$$A_2 = B_2 = M \cdot \frac{\tan\beta_1}{a}$$

$$F_2 = E_2 = M \cdot \frac{\sin\beta_2}{f \cdot \cos\beta_1}$$

Gelenkwellenführung mit gleichen Beugewinkeln und gleichen Lagerabständen — $\beta_1 = \beta_2$, $a = f$, $b = e$

Universal shaft arrangement with equal deflection angles and equal bearing distances

$\alpha = 0°$ $\quad A_1 = F_1 = B_1 = E_1 = 0$

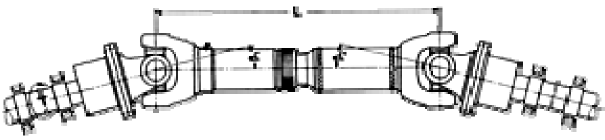
$\alpha = \pi/2 = 90°$

$$A_2 = B_2 = M \cdot \frac{\tan\beta_1}{a}$$

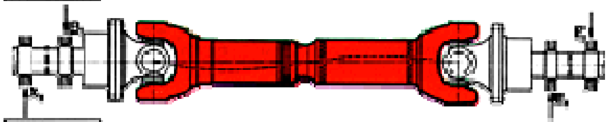
$$F_2 = E_2 = M \cdot \frac{\tan\beta_1}{a}$$

Universal shaft in W-arrangement

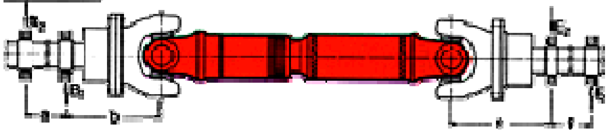
Position 0° flange yoke right-angled to drawing plane
Position $\pi/2$ flange yoke in drawing plane



$\alpha = 0°$



$\alpha = 90°$



$\alpha = 0°$

$$A_1 = M \cdot \frac{\cos\beta_1 \cdot b}{L \cdot a} \cdot (\tan\beta_1 + \tan\beta_2)$$

$$B_1 = M \cdot \frac{\cos\beta_1 \, (a + b)}{L \cdot a} \cdot (\tan\beta_1 + \tan\beta_2)$$

$$F_1 = M \cdot \frac{\cos\beta_1 \cdot e}{L \cdot f} \cdot (\tan\beta_1 + \tan\beta_2)$$

$$E_1 = M \cdot \frac{\cos\beta_1 \, (e + f)}{L \cdot f} \cdot (\tan\beta_1 + \tan\beta_2)$$

$\alpha = \pi/2 = 90°$ Siehe Z-Beugung $\alpha = \pi/2$
see Z-arrangement

Gelenkwellenführung mit gleichen Beugewinkeln und gleichen Lagerabständen — $\beta_1 = \beta_2$, $a = f$, $b = e$

Universal shaft arrangement with equal deflection angles and equal bearing distances

$\alpha = 0°$

$$A_1 = F_1 = 2M \cdot \frac{\sin\beta_1 \cdot b}{L \cdot a}$$

$$B_1 = E_1 = 2M \cdot \frac{\sin\beta_1 \, (a + b)}{L \cdot a}$$

$\alpha = \pi/2 = 90°$ Siehe Z-Beugung $\alpha = \pi/2$
see Z-arrangement

Length dimesions

The operating length of a universal shaft is determined by:

- the distance between the driving and the driven units
- the length compensation during operation

The following abbreviations are used:

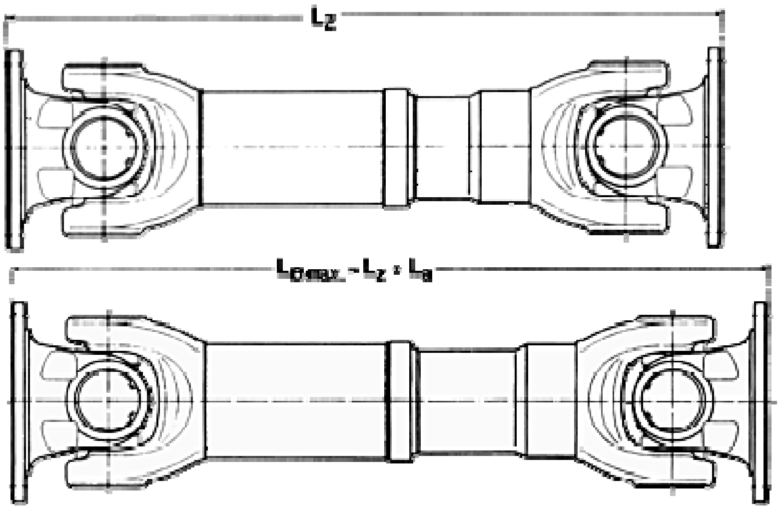
Lz = Compressed length

This is the shortest length of the shaft. A further compression is not possible.

La = Length compensation

The universal shaft can be expanded by this factor La is a constant factor for each universal shaft. An expansion beyond that factor is not permissible.

Lz + La = Max. perm. operating length LBmax.



During operation the universal shaft can be expanded up to this length. The optimum working length LB of a universal shaft is achieved if the length compensation is extracted by one-third of its length.

$$L_B = L_z + \frac{1}{3} L_a \quad \text{[mm]}$$

This rough rule appiles to most of the arrangements. For applications where larger length alterations are expected the operating length should be chosen in such a way that the movement will be within the limit of the permissible length compensation.

Arrangements of cardan shafts

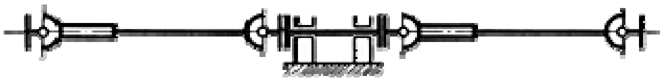
A tandem arrangement of universal shafts could become necessary
- to cope with greater installation lengths
- to by-pass construction units

Basic forms of shaft combinations:

Universal shaft with intermediate shaft

Universal shaft with two intermediate shafts

2 universal shafts with double intermediate bearing



In case of such arrangements the individual yoke positions and deflection angles are to be adjusted with regard to one another in such a way that the degree of non-uniformity (see "Installation conditions") and the reaction forces acting on the connection bearings (see "Load on connection bearings") are minimized.

Balancing of cardan shafts

The cardan shafts used in motor vehides are balanced.

This balancing is performed to equalize eccentrically running masses, thereby preventing vibrations and reducing the bad on downstream units as a result of free centrifugal forces.

Balancing is carried out in accordance with IS0 Standard 1940. "Balance quality of rotating rigid bodies". According to this standard, the permissible residual imbalance is dependent on the quality grade and operating speed of the balanced component. If the customer does not specify a balancing speed or quality grade, balancing is per formed to GWB Standard 4100-005. This standard reflects the following criteria:

- Balancing speed
  The balanclng speed is selected from a graded scale determined for various cardan shaft sizes. These balancing speed levels are defined on the basis of statistical evaluations of the r.p.m. conditions prevailing in the associated vehicle categories.

- Quality grade
  In defining a quality grade, it is necessary to consider the reproducibility levels achieveable in the customer's own test rig during verification testing. Quality grades are dependent on the following variables:
  - type of balancing machine (hard, rigid or soft suspension)
  - accuracy of the measuring system
  - joint bearing radial play
  - angular backlash in Iongitudinal displacement direction

Field analyses have shown that the sum of these factors may result in inaccuracies of up to 80%. This observation has given rise to the definition of the following balancing quality grades:
- factor balancing: G16
- customer verification tests: G32

Flange boltings

To connect the cardan shaft to the companion flanges it is imperative to use high-tensile bolts of the quality 10.9 and the corresponding all-metal self-locking nuts of the quality 10 or such bolts and nuts that the manufacturer of the vehicle has prescribed. Complete sets of bolting are available for all DIN and cross-Serrations flanges.

The tightening torques Ta given in the table are valid for:

- 90% utilization of the elastic limit
- bolts in a lightly-oiled condition (Friction coefficient µ ges. = 0,13).
- metallic bare surface areas

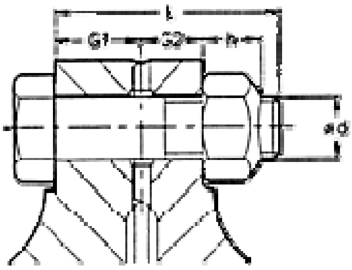
Do not use molycote paste or any other grease on the bolts and nuts.

- For additional information on flange connections, corrosion protection, assembly and dismantling see our specification GWB-A 100-005.

Companion flanges

Generally cardan shafts are connected to the units by companion flanges. The companion flange material must have an interfacial pressure of min. 700 N/mm²

Cross-Serration flanges (XS)



Joint flange

Hexagon bolt:
similar to DIN 931/10.9
Hexagon nut:
similar to DIN 980/10
self-locking

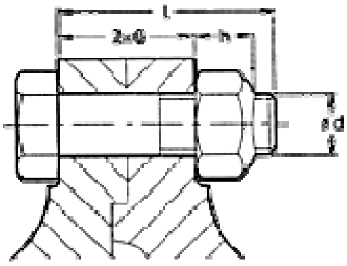
Type of nut: all-metal

Shaft connection	Thread Ød [mm]	Length L [mm]	Wrench size [mm]	Flange thickness G1 [mm]	Flange thickness G2 [mm]	Grip G1 + G2 [mm]	Height of nut h [mm]	Torque Ta [Nm]	⚠
XS 120	M10	40	17	14	10	24	9	62	±20%
XS 150	M12	45	19	16	12	28	11	105	
XS 180	M14	50	22	18	14	32	12	170	

We recommend a socket for wrenches

Wrench size	Order-No.
17	GETA 197-17 GWB ½
19	GETA 197-19 GWB ½
22	GETA 197-22 GWB ¾

DIN-flanges



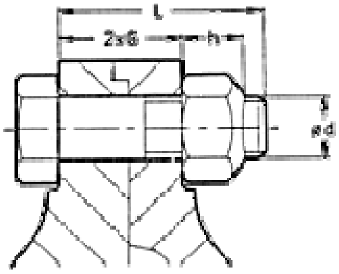
Joint flange

Hexagon bolt:
similar to DIN 931/10.9
Hexagon nut:
similar to DIN 980/10
self-locking

Type of nut: all-metal

Shaft connection	Thread Ød [mm]	Length L [mm]	Wrench size [mm]	Grip 2 * G [mm]	Height of nut h [mm]	Torque Ta [Nm]	
DIN	M8	25	13	12/24	8	35	
	M10	30	17	16	10	70	
	M12	40	19	20	12	120	± 7%
	M16	45	24	24	16	295	
	M16	50	24	30	16	295	

SAE-flanges



Joint flange

Hexagon bolt:
similar to DIN 931/10.9
Hexagon nut:
similar to DIN 980/10
self-locking

Type of nut: all-metal

Shaft connection	Thread Ød [mm]	Length L [mm]	Wrench size [mm]	Grip 2 * G [mm]	Height of nut h [mm]	Torque Ta [Nm]	
SAE	M8	30	13	16	8	35	
	M10	30	17	16	10	70	
	M10	35	17	19/21	10	70	± 7%
	M12	35	19	16	12	120	
	M12	40	19	21	12	120	

When using bolt connections other than those recommended the torque must be adjusted accordingly in order to guarantee the safety of the connection!

Safety instructions

Our products have been developed and tested in keeping with the latest technological developments. The characteristic features of the products described in our information material or specified in writing by ourselves were subjected to proper and careful inspection.

Other layouts are possible but are subject to our written confirmation.

The knowledge of the various demands on our product for a particular application lies with the purchaser, and it is incumbent on him to verify the drawings and documents prepared by ourselves on the basis of the data made available by the purchaser and to examine the suitability of the product for the proposed use. The selection of shaft types and the specification of their sizes on our part shall in all cases be considered as a recommendation only.

When using and handling cardan shafts, the following safety instructions must be strictly observed to prevent damage to persons and property.

- Where danger to people or material can be caused by rotating cardan shafts, a safety device has to be installed by the user and/or operator.
  Observe the EC Regulations for Machinery!
- Installation, assembly and maintenance work may only be carried out by qualified personnel.
- The operating data of the cardan shafts, such as max. torque, speed, deflection angles, lengths etc. must never be exceeded.
- If cardan shafts are in any way altered without our written consent, they are no longer covered by our warranty.

Cardan shafts of the series COMPACT 2000 are delivered as complete units ready for installation. The shafts are greased for operation. They are balanced and painted in accordance with the technical information sheets.

The balance state of a cardan shaft must on no account be altered. An inadmissable out-of-balance of a shaft may result in uneven running and premature wear of the joints and the bearings of the units to which the cardan shaft is connected.

In extreme cases the cardan shaft could break and shaft components could be thrown at speed from the vehicle or machine.

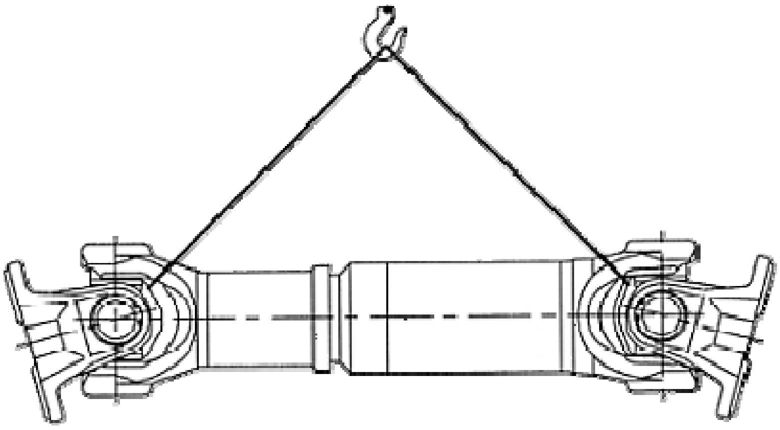
Further safety instructions are incorporated in the following subjects.

Transport and storage

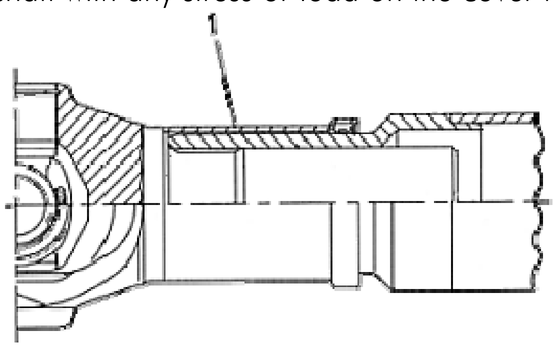
To prevent personal injury and damage to the cardan shafts always make sure that the shafts are safely transported and stored.

Please observe the following precautions:

- Use strong nylon ropes or lifting belts. When using steel cords, protect the edges.
- Cardan shafts should be transported in a horizontal position (see illustration). For non-horizontal transportation additional precautions must be taken to prevent the splined parts from separating.
  Danger of injury!



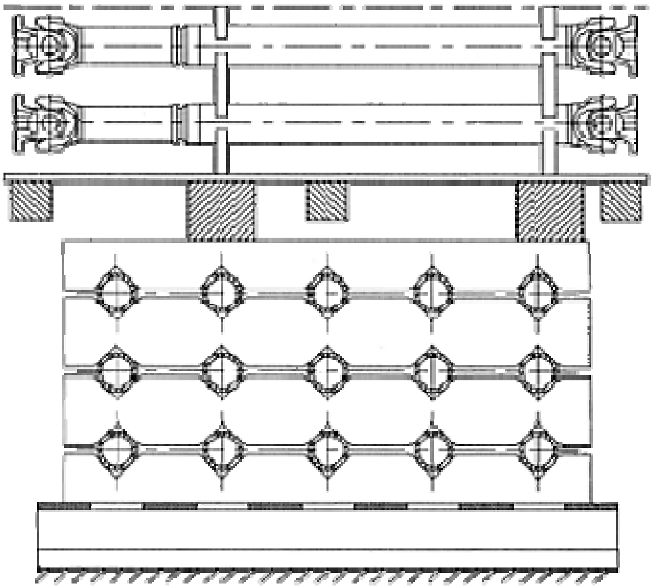
- When lifting or putting down the shaft, the moving parts (flange yoke and journal cross) may tilt and lead to injuries.
  Keep hands away from the joint!
  Danger of crushed hands!
- Avoid bumps and knocks during transport and storage.
- Do not store or handle the shaft with any stress or load on the cover tube (1).



- Use appropriate frames or racks for storage (see example).

  When cardan shafts are stored on pallets stacked up on top of one another, the supports must be one below the other because otherwise the tubes may bend and the result may be uneven running or imbalance of the shaft.

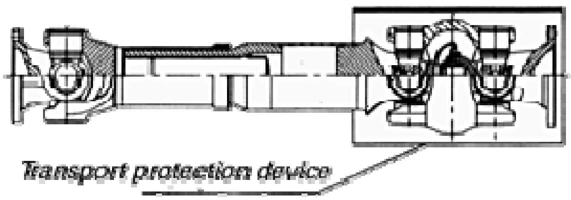
  The supports may only be used in the area of cardan tubes and never in the area of the cover tube or the length compensation.



- When cardan shafts are stored in an upright position, make sure they cannot fall over.
- Keep cardan shafts in a dry place.

Transport and storage of Centered Double Cardan Shafts

In order to prevent any exessive deflection of the double joint and thus damage to the location bearing during transport, the cardan shaft is provided with a transport protection device which encloses the double joint.



The transport protection device must not be removed until the cardan shaft is installed.

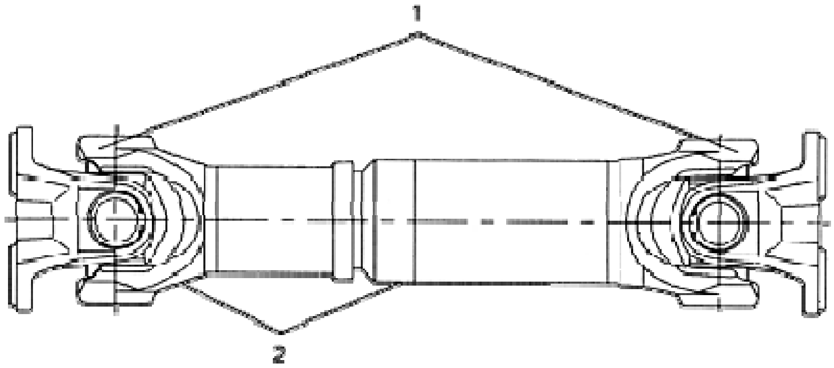
- Use appropriate frames or racks for storage.
- Use chocks or blocks to prevent cardan shaft from rolling.
- Secure shaft against falling over if it is stored in a vertical position.

Installation/dismantling

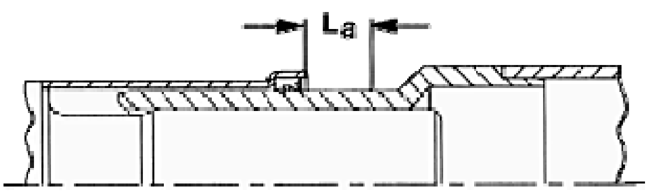
In order to guarantee the properties of the cardan shaft as described in the information brochure they must not be altered.

Whenever people or material might be endangered by rotating cardan shafts, the user must take for the corresponding safety measures.

- Safety relevant components of the vehicle and brake lines, electric lines, hydraulic and fuel lines must be arranged in such a way that they cannot be damaged by a defective cardan shaft.
  Danger of breakdown of important units!
  Danger of fire!
- Suitable safety devices (e.g. catch bows, solid safety guards) must be provided to prevent the parts of the shaft from being thrown around and to prevent damage to other parts of the unit if the cardan shaft should become defective. In the view of GWB such safety devices may be dispensed with provided that a comparable form of security is guaranteed during operation of the vehicle through suitable engineering measures taken by the vehicle manufacturer.
  Danger to life!
- The fronts of the DIN and SAE shaft flanges and companion flanges must be free of dust, grease or paint in order to guarantee a safe connection.
  The anti-corrosive on cross-Serration flange teeth need not be removed. Other particles must be removed.
- Be careful when handling the cardan shaft.
  Freely moving yokes may cause injuries!
- Check position of the yokes (1) of the shaft. Observe the arrow markings (2). (They must be in alignment.) The spline components are matched for a smooth fitting and must not be interchanged or remounted at a different angle.



- Before installation remove any transport retainer device. If in doubt please contact the supplier.
- Check the side and radial runout as well as the fit of the mounted flanges and the connected units (see companion flanges for cardan shafts).
- Do not turn the joints of the cardan shafts with assembly levers because this may damage the grease nipples or seal arrangement on the bearings.
- When painting ensure that the sliding range of the seal (length compensation La) is protected.

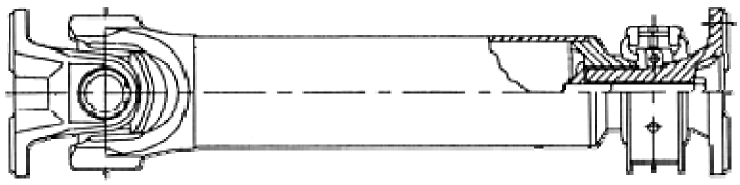


- Protect rilsan coated splines (sleeve muff or sleeve yoke) against
  - heat
  - solvents
  - mechanical damage
- When cleaning cardan shafts, do not use aggressive chemical agents or pressurized water or steam jets because the seals may be damaged and dirt or water may penetrate.
- If cardan shafts are subjected to higher temperatures, e.g. due to noise-reduction measures or retarders, suitable means should be provided to ensure that the limit values are not exceeded.

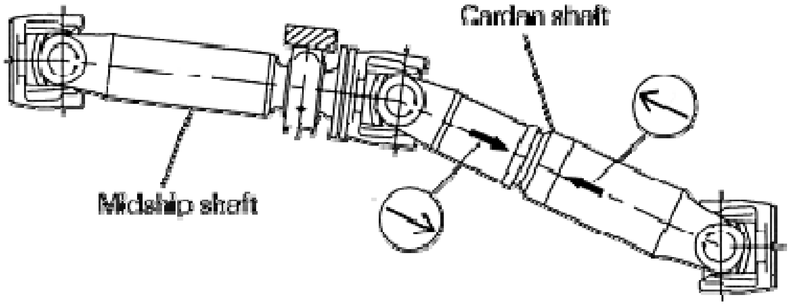
Installation of drive lines

Midship shafts are supplied complete with centre bearings ready for installation.
The centre bearing and the companion flange are fixed on the midship shaft by means of bolts which are secured against working loose.
For reasons of safety these bolts must never be loosened or retightened on new shafts. They may only be loosened for repair work, but they must be properly secured again after the repair.

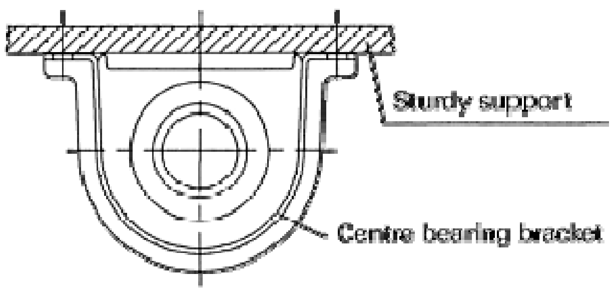
Midship shaft
without length compensation
with centre bearing



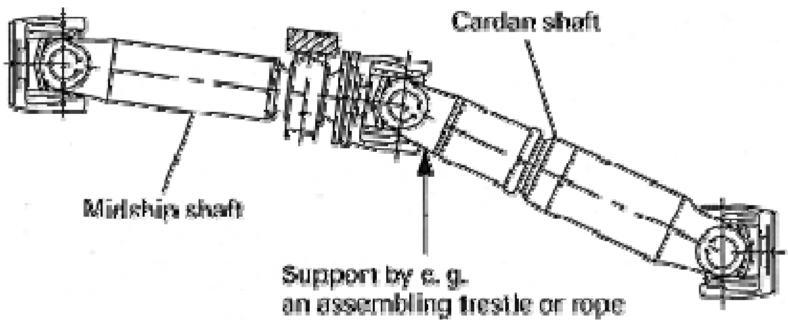
To avoid cases of non-uniformity, drive lines consisting of the midship shaft with the centre bearing and the normal cardan shaft must be installed in accordance with the yoke position of the joints prescribed by vehicle manufacturer.



When installed, the centre bearing must be vertical in all directions with regard to the horizontal axis of the midship shaft and be in a central position. Suitable mounting supports must be provided on the frame side. A continuous stable support must be provided between the centre bearing bracket and the mounting support (see illustration).



- To guarantee a safe bolting of the centre bearing bracket of the midship shaft to the frame of the vehicle, always use the bolting prescribed by the manufacturer of the vehicle.
- These bolts must be strictly secured against working loose in accordance with the instructions of the vehicle manufacturer.
- The centre bearing of the midship shaft must be installed without force.
  Therefore the centre bearing must not be bolted to the frame of the vehicle until the drive and the driven sides of the drive line have been bolted down.
- To avoid damage to the joint bearings it is important to protect them against excessive sagging or deflection during the entire installation procedure.



Moreover, the general instructions in our cardan shaft catalogues for vehicles and industrial application are to be observed for the dimensioning, arrangement and installation of drive lines and midship shafts.

Installation of centred double cardan shafts

When installing the cardan shaft, care should be taken not to damage the location bearing by excessively deflecting the joint. This can be achieved by using a mounting rope.

Flange boltings

- see Catalogue description

Dismantling

- Before dismantling secure the cardan shaft against the sliding elements coming apart.
- Before removing the shaft from the companion flange, make sure it cannot fall down.
  The yoke may tilt over when removing the cardan shaft from the companion flange.
  Danger of injury!
- Observe the directions for transport, storage and installation of cardan shafts.

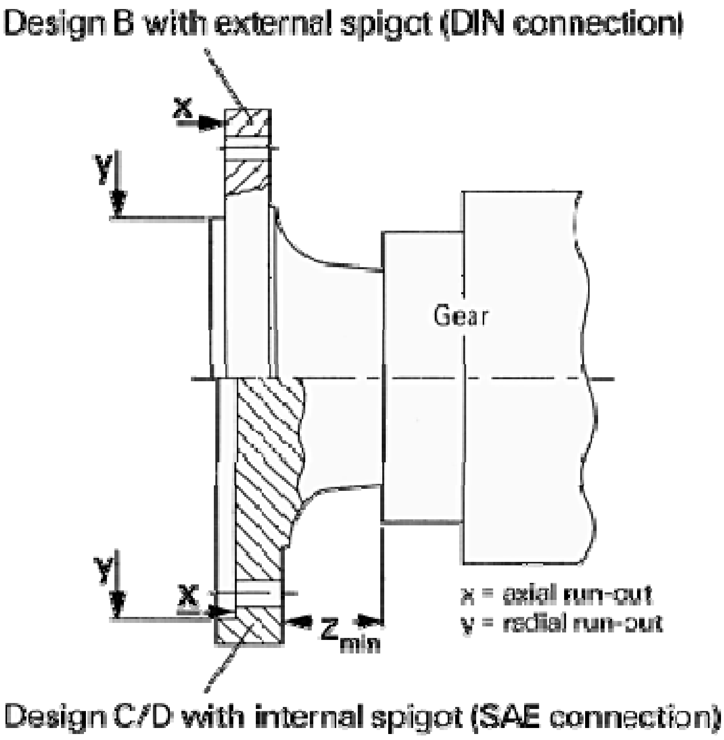
Companion flanges

Generally cardan shafts are connected to the units by companion flanges. The companion flange material must have an interfacial pressure of min. 700 N/mm².

For standards of frictional grip flanges see ISO 7646 (DIN flanges), ISO 7647 (SAE flanges) and positive connection flanges with 70° cross-Serration ISO 8667 (XS flanges).

The accurate running of a cardan shaft requires certain tolerances for the axial and radial run-out (see by DIN-flanges ISO 7646, by SAE-flanges ISO 7647 and by XS-flanges ISO 8667).

x = axial run-out
y = radial run-out



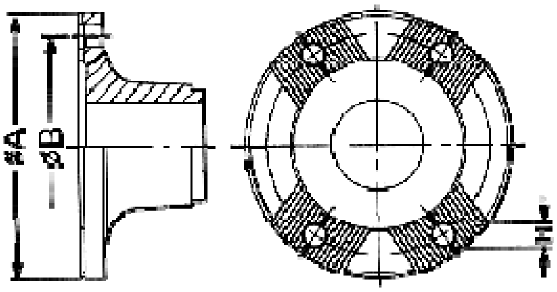
The dimensions of the companion flanges correspond with those of the same size of cardan shafts, except for the centering depth FA and the fit CA, and can be taken from the tables in the catalogues or from the following tables.

For better bolt locking we recommend designing the recessed diameter of the companion flange as a bolt head location and inserting the bolts from the companion flange side. In this case an adequate distance Zmin must be maintained between the flange and the adjacent unit.

Zmin = bolt length (incl. bolt head).

If it is not possible to insert the bolts from the companion flange side, the bolts can he inserted from the joint side, except for some sizes. Make sure that the nuts can be easily tightened on the companion flange side. If necessary, use companion flanges with pre-assembled bolts.

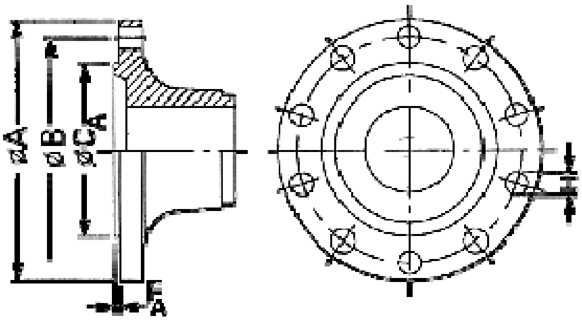
Design A - Connection with staggered teeth according to ISO 8667



Shaft connection	A [mm]	B [mm]	I*(1)* x H*(2)*	Design
XS 120	122*(3)*	100	4 x 11	A
XS 150	155*(4)*	130	4 x 13	A
XS 180	180	150	4 x 15	A
XS 200	200	165	4 x 15	A

(1) Number of bolt holes per flange
(2) Tolerance + 0,2 mm
(3) Ø 120 mm also possible
(4) Ø 152 mm also possible

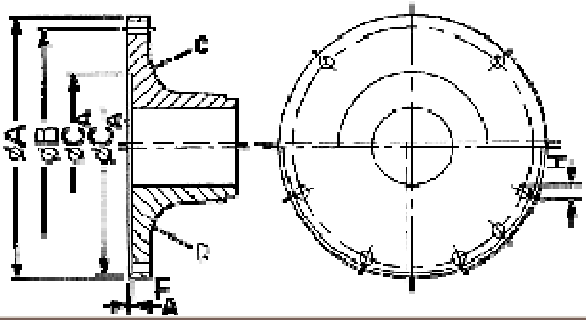
Design B - DIN connection according to ISO 7646



Shaft connection	A [mm]	B [mm]	CA [mm]	FA [mm]	I*(1)* x H*(2)*	Design
	90	74,5	47 h7	2,3 - 0,2	4 x 8,1	B
	100	84,0	57 h7	2,3 - 0,2	6 x 8,1	B
	120	101,5	75 h7	2,3 - 0,2	8 x 10,1	B
DIN	150	130,0	90 h7	2,3 - 0,2	8 x 12,1	B
	165	140,0	95 h7	2,3 - 0,2	8 x 16,1	B
	180	155,5	110 h7	2,3 - 0,2	10 x 16,1	B
	225	196,0	140 h7	4,0 - 0,2	12 x 16,1	B

(1) Number of bolt holes per flange
(2) Tolerance + 0,2 mm

Design C/D - SAE connection according to ISO 7647



Shaft connection		A [mm]	B [mm]	CA [mm]	FA [mm]	I*(1)* x H*(2)*	Design
SAE *(Spicer)*	1100	87	69,85	57,10 H7	2,0 + 0,2	4 x 8,1	C
	1300	97	79,37	60,32 H7	2,3 + 0,2	4 x 10,1	C
	1400	116	95,25	69,85 H7	2,3 + 0,2	4 x 12,1	C
	1500	151	120,65	95,25 H7	2,3 + 0,2	4 x 14,1	C
	1510	146	120,65	95,25 H7	2,3 + 0,2	4 x 12,1	C
	1600	175	155,57	168,22 H7	1,5 + 0,2	8 x 10,1	D
	1700	203	184,15	196,86 H7	1,5 + 0,2	8 x 10,1	D
	1800	203	184,15	196,86 H7	1,5 + 0,2	12 x 10,1	D

(1) Number of bolt holes per flange
(2) Tolerance + 0,2 mm

Cardan 2000 compact

Maintenance

Maintenance work on cardan shafts used in vehicles and industrial equipment must be done at regular intervals.

The scope and the intervals of maintenance work depend on the individual operating conditions of the vehicle or the equipment.

Maintenance intervals for cardan shafts in commercial vehicles

Depending on the type of vehicle, the mileage or the service life and the operating conditions two different scopes and intervals of maintenance are required. These are the "**minor inspection**" and the "**major inspection**".

Use of vehicle	Inspection intervals	
	Minor inspection	Major inspection
Commercial vehicles in long-distance traffic or similarly used vehicles	Every **100.000 km** or after **1 year** max.	Every **500.000 km** or after **5 years** max.
Commercial vehicles used on road and off road and in city traffic and similar	Every **50.000 km** or after **1 year** max.	Every **300.000 km** or after **5 years** max.
Buses in long-distance traffic	Every **100.000 km** or after **1 year** max.	Every **300.000 km** or after **3 years** max.
Buses in city traffic	Every **50.000 km** or after **6 months** max.	Every **200.000 km** or after **2 years** max.
Commercial vehicles used on sites, communal vehicles, construction machines, cranes, vehicles used in agriculture and forestry, tractors, military vehicles and similar	Every **25.000 km** or after **6 months** max.	Every **100.000 km** or after **2 years** max.

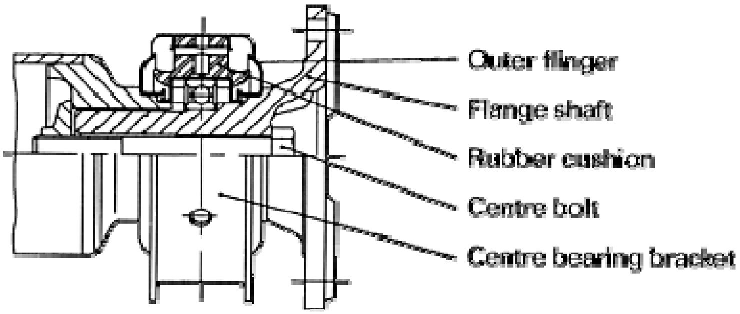
After a change of the vehicle owner or in case of an accident we recommend a "**major inspection**" of the cardan shaft.

Scope of maintenance

Minor inspection

The "minor inspection" includes checking the cardan shaft installed in a vehicle or in an industrial plant.

- Check the bolts of the flanges and of the centre bearing bracket for tightness (e.g. undamaged paint coat). If necessary, retighten the bolts with a suitable torque wrench and the torques prescribed by the manufacturer of the vehicle or equipment.
- Check whether there are snap rings on all bearing bushes.
- Check whether balance weights are loose or missing.
- Check the bottoms of the bearing bushes for change of colour or form due to excessive heat.
- Visual inspection of the seals of bearing bushes and the length compensation. Defective seals may result in excessive grease loss and breakdown of the cardan shaft.
- Check whether there are grease nipples on the journal crosses and whether they are in good condition (exception: maintenance-free joints).
- Check whether the rilsan coat on the sleeve is damaged or shows abrasion.
- Visual inspection of the centre bearings of drive lines with regard to:
  - correct position of the rubber cushion in the centre bearing bracket
  - correct position of the flange shaft



  If the distance between the rubber cushion and the outer flinger is too large, the centre bolt may work loose. In this case a check should be made as a part of a major inspection.

- Carry out a visual inspection for possible damage, e.g.:
  - damaged paint coat
  - deformed tubes
  - eccentricity of the length compensation cover tube
  - cracks on components and tube
- Check the joints and the length compensation for visible or tangible backlash.

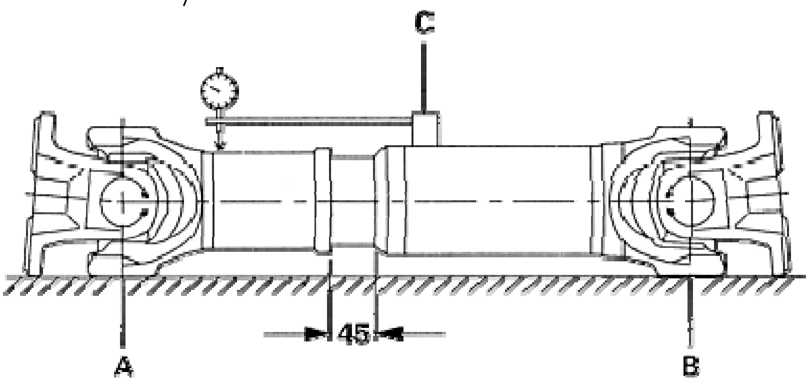
If the inspection shows that the cardan shaft is damaged, it must be removed at once and sent to a repair shop that is authorized either by us or by the manufacturer of the vehicle or the equipment.

Furthermore, the vehicle or the equipment must be immediately taken out of operation in the case of any extraordinary noise, vibration or otherwise abnormal behaviour. Before recommissioning the cardan shaft it must be checked within the scope of a "minor inspection".

Major inspection
Each "major inspection" includes the scope of checking prescribed for a minor inspection. In addition, the cardan shaft must be removed from the vehicle or the equipment for the "major inspection".
The following checking or work must be carried out on the cardan shaft:

- Checking the joint bearings
  - Check the two flange yokes for tangible backlash or resistance (e.g. hooking) by deflecting them by hand into vertical and horizontal positions (swing them to and fro).
  - Grease the cross assemblies through the grease nipples and check whether the grease escapes from the seals. If no grease escapes from one or more bearing bushes of a cross assembly or if grease escapes together with water, rust or dirt, the cardan shaft must be sent to an authorized shop for repair.

  If the joints are in proper condition, regrease them through the grease nipples until the grease escapes from the seals.
- Checking the length compensation components
  The involute spline is centred and guided on the spline outer dia. This design allows a maximum backlash of 0,2 mm. The radial backlash need not be checked.
  - Extend the cardan shaft by approx. 45 mm and place the lugs of the inner yokes at points A and B on a solid support (see illustration).

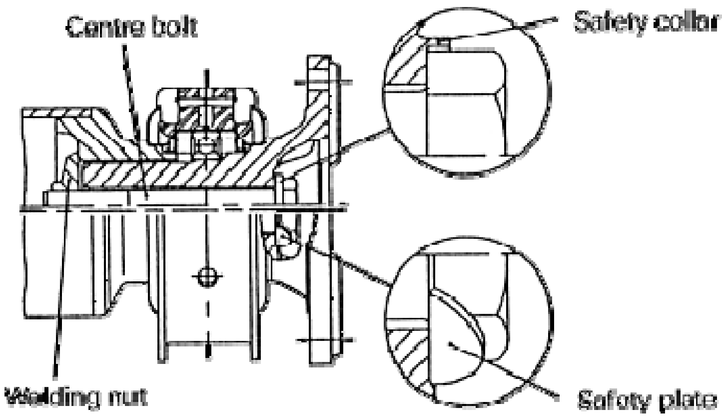


    Fix the dial gauge holder at point C next to the weld on the tube and place the dial gauge directly next to the weld of the protective sleeve (cover tube). Lift the cardan shaft at its center of gravity so that the supports at points A and B become free.
    Read axial backlash on the dial gauge.
    The max. permissible value is 0,17 mm.
  - Visual checking of the parts:
    Extend the cardan shaft completely and check the length compensation for damage to the inside and outside areas of the spline muff and the teeth of the yoke shaft.
  - Check the seal of the cover tube for damage.

  If the length compensation is undamaged:
  - regrease the parts of the length compensation in the sealing area *(for grease see Lubrication)* and bring the length compensation together to its original length.

Attention:
Make sure that the marking arrows are opposite one another!

- Check the centre bearing of drive lines with regard to:
  - damage to the rubber cushion
  - firm seat of the ball bearing in the rubber cushion



Retighten the central bolt with a torque of 350 Nm.

Attention:
Centre bearings of older designs with a central nut or holding plate and two bolts (not shown) must not be retightened because the bonding may become damaged and the securing function of the bolting is no longer guaranted. After checking (by retightening) or loosening the bolting a completely new bonding is required.

If a major or minor inspection reveals any damage to the shaft, It must be sent to a repair shop that is authorized by either GWB or the manufacturer of the vehicle or equipment.

Attention:
After each repair the cardan shaft must be rebalanced dynamically.

When reinstalling the cardan shaft, please observe the relevant installation instructions (see Installation/disassembly).

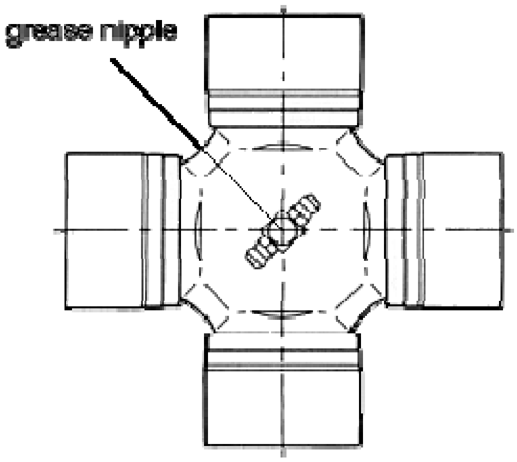
If the cardan shaft is obviously twisted due to over-loading (plastic deformation), it can no longer be used or repaired.

Lubrication

Cardan shafts of the series COMPACT 2000 are lubricated ready for operation.

The length compensation of the Standard designs is maintenance-free.
This does not apply to special designs with an extra large length compensation and a large deflection angle (e.g. cardan shafts between tandem axles). Such a length compensation requires regreasing through a grease nipple in the sealing sleeve of the spline protection until the grease escapes at the scraper seal of the sealing sleeve.
The centre bearing is protected by a cover and, filled with grease, is service-free.

Cross assemblies must be regreased.
The grease reservoir in the cross assemblies can be replenished through a grease nipple. Regreasing must be carried out until the grease escapes out from the seals of the bearings.



If it is not possible to grease all four bearings of a cross assembly (i.e. no grease escapes out from the seals), the bearings must be assumed to be damaged.
In this case the cardan shaft must be removed and the cross assembly must be replaced in an authorized repair shop. We recommend replacing the other cross assemblies at the same time.

- For the lubrication of cardan shafts only that grease may be used, which is defined in our standards 4006-005 corresponding to the different application temperatures.
  Do not use lubricants with MoS2 additives.
- Clean grease nipples before lubricating.
- Do not lubricate at high pressure or with pressure surges.
- Cardan shafts that have been stored for more than 6 months must be regreased before use.
- The cardan shaft must not be cleaned with pressurized water or a steam jet. In case of doubt the shaft must be regreased until the grease escapes from the seals of the bearings.

Recommended regreasing intervals for cardan shafts in commercial vehicles

Unless otherwise prescribed by the manufacturer of the vehicle, we recommend the following regreasing intervals. The data in the table refer to European and similar conditions. Operating conditions other than those shown here may require shorter regreasing intervals.

- Regreasing intervals for joints
(applicable only in conjunction with approved greases)

Use of vehicle	Regreasing intervals	
Commercial vehicles in long-distance traffic or similarly used vehicles	Every or after	50.000 km 1 year max.
Commercial vehicles used on road and off road and in city traffic and similar	Every or after	25.000 km 1/2 year max.
Buses in long-distance traffic	Every or after	50.000 km 1/2 year max.
Buses in city traffic	Every or after	25.000 km 1/4 year max.
Commercial vehicles used on sites, communal vehicles, construction machines, cranes, vehicles used in agriculture and forestry, military vehicles* and similar	Every or after * if driven through water shorter greasing intervals are recommended	12.500 km 1/4 year max. *(250 h)*

- Greasing intervals for length compensation and centre bearing
As standard the length compensation and the centre bearing are service-free. The lubricating intervals for types designed for periodic relubrication are the same as for joints.

Repair

For reasons of safety, cardan shafts may only be repaired by competent repair shops of vehicle or plant manufacturers, by GWB or by repair shops authorized by GWB .

The repair of cardan shafts is carried out in a professional manner by our Cardan Shaft Service experts. Overhauling and repair work is carried out by using original spare parts only.

<u>Manufacturer specifications for the inspection of propeller shafts and for the exchange of individual components and groups of components</u>

The following GWB standards and specifications/directions may be be requested/demanded from GWB as required:

- *Dismantling/assembly of complete Unit Pack Assemblies*
- *Dismantling/assembly of Centre Bearing Assemblies*
- *Guidelines for the inspection of Compact 2000 cardan shafts*
- *Guidelines/service information for centred Double-Cardan Shafts*

Modification of Propeller Shafts

Advice on technical changes to propeller shafts in drive trains as a result of vehicle conversions

Changes to vehicles which my have an effect on the drive train include, among others:
- Changes to the wheelbase
- Later fitting of retarders
- Replacement of gearbox or differential
- Later fitting of ancilliary drives

The following advice must be followed on all accounts:

- Observe safety advice on taking out and replacing the cardan shaft (see Installation/Dismantling of cardan shafts).
- All technical changes to our propeller shafts (e.g. extending length, shortening, flange changes etc.) are to be carried out exclusively by our Service Organisation).
  (Subsequent straightening and balancing will be necessary)
- Length changes to propeller shafts require changes in the working angle in the as-fitted state. For general guidelines and limit values (see Installation conditions).
- When extending the length of a propeller shaft attention must be paid to guard against critical bending speeds being reached. In some cases an additional propeller shaft with a centre bearing may be required.
- Engine, gearbox, distribution box, differential and primary retarder must be tested on and brought to the same fitted plane of inclination in order to avoid unequal working angles within the individual propeller shafts.
- On re-installation of propeller shafts the length compensation (splined shaft connection) must on all accounts be lined up correctly (with arrows pointing →←).
  (see Installation/Dismantling of cardan shafts)
- On re-tightening the bolt on the flange connection attention must be paid to the maintenance of the correct bolt starting torque. A torque wrench will be necessary.
  (see Flange boltings)

Should any questions or technical problems arise complete the "Technical Questionnaire" and send it, along with the installation plan and any supplementary details on the existing cardan shafts, and on any which are to be re-conditioned, to the given GWB ✉e-mail address.

I. Home

GKN Service International GmbH
Service-Center Berlin
Marzahner Chaussee 211
D-12681 Berlin
Telefon: (030) 54 99 82-51
Telefax: (030) 54 99 82-60

GKN Service International GmbH
Service-Center Düsseldorf
Gutenbergweg 2/Max-Planck-Str.
D-40699 Erkrath
Telefon: (02104) 93 37-46
Telefax: (02104) 93 37-43

GKN Service International GmbH
Service-Center München
Siemensstr. 11
D-85221 Dachau
Telefon: (08131) 90804-0
Telefax: (08131) 90804-25

GKN Service International GmbH
Service-Center Hamburg
Ottensener Straße 150
D-22525 Hamburg
Telefon: (040) 54 00 90-0
Telefax: (040) 54 00 90-44

GKN Service International GmbH
Service-Center Frankfurt
Am Erlenbruch 5
D-63505 Langenselbold
Telefon: (06184) 93 94-11
Telefax: (06184) 93 94-19

GKN Service International GmbH
Service-Center Halle
Mägdeberge 9
D-06188 Braschwitz
Telefon: (034604) 2 06 51
Telefax: (034604) 2 06 54

GKN Service International GmbH
Service-Center Hannover
Alter Flughafen 14a
D-30179 Hannover
Telefon: (0511) 67 10 11
Telefax: (0511) 63 85 33

GKN Service International GmbH
Service-Center Nürnberg
Am Keuper 1
D-90475 Nürnberg
Telefon: (09128) 92 75-3
Telefax: (09128) 92 75-40

GKN Service International GmbH
Service-Center Dresden
Köhlerstraße 16
D-01239 Dresden
Telefon: (0351) 2 88 10 36
Telefax: (0351) 2 88 10 39

GKN Service International GmbH
Service-Center Dortmund
Frydagstraße 21
D-44536 Lünen-Lippholthausen
Telefon: (0231) 441025
Telefax: (0231) 458513

GKN Service International GmbH
Service-Center Stuttgart
Max-Eyth-Straße 12
D-71254 Ditzingen
Telefon: (07156) 93 94-0
Telefax: (07156) 93 94-25

II. Abroad

Australia / Australien
Hardy Spicer Australia
trading as Unidrive Pty. Ltd.
P.O. Box 146 Rosebank M.D.C.
Clayton, Victoria 3168
Tel. 0061-39 54 24 100
Fax 0061-39 54 48 117
Email: hspicer@hardyspicer.com.au

Austria / Österreich
GKN Service Austria GmbH
Slamastrasse 32
A-1232 Wien
Tel. 0043-1-61 63 880
Fax 0043-1-61 63 880 28
Email:
office.hookes@mail.gkngsa.co.at

Belgium / Belgien
S.A.B. Glaenzer Seurre B.N.V.
au. Me. Paul Gilsonlaan 441
B-1620 Drogenbos
Tel. 0032-2-37 11 811
Fax 0032-2-37 11 826
Email: industrie@gknauto.com

Brazil / Brasilien
Dana Albarus S.A.
av. Presidente Medice, 939
Osaco - Sao Paulo - Cep: 06280-000
Tel. 0055-117 06 34 89
Fax 0055-117 06 17 50
Email: fabricio.santos@dana.com

Denmark / Dänemark
Dansk Uni-Cardan A/S
Baltorpbakken 10
DK-2750 Ballerup
Tel. 0045-4486 6844
Fax 0045-4486 8822
Email: info@uni-cardan.dk

Egypt / Ägypten
Landmark Mechanical Works
Behind 27a Ismailia Street
Roush dy, Alexandria
Tel. 00203-544-9201/9202
Fax 00202-544 4703
Email: lmw@internetaler.com

Finnland / Finnland
Oy Unilink AB
Lapinrinne 1
FIN-00180 Helsinki-Helsingfors
Tel. 00358-9-68 66 170
Fax 00358-9-69 40 449
Email: unilink@unilink.fi

Hungary / Ungarn
Szücs Co. Kardantech KFT
Ipari kepriselelek
Aradi Vértanúk út 16
H-9022 Györ
Tel. 0036-96-518 930
Fax 0036-96-518 931
Email: szucsco@ax.hu

Hidropress
Soroksari UT150
H-1095 Budapest
Tel. 0036-1-280 63 48
Fax 0036-1-280 71 71

Indien / Indien
Hindustan Hardy Spicer Ltd.
78-B, Dr. Annie Besant Road
Worli, Bombay 400018
Tel. 0091-22-377 451-3
Fax 0091-22-493 193-5
Email: exolin@vsnl.com

I. R. Iran / I. R. Iran
Ali Reza Harati
No. 37 Ghobadian St.,
Vali-Asr Ave.
Teheran
Tel. 021-87 70-217/206
Fax 021-87 83 988
Mobile: 0911-2041093

Ireland / Irland
GKN International (Ireland) Ltd.
Dublin Industrial Estate Glasnevin
Dublin 11
Tel. 00353-1-77 122-5/6/7

Israel / Israel
Frank Agencies
P.O. Box 22307, 10 Pinkas Str.
IL-62661 Tel Aviv
Tel. 00972-3-54 41 941-46
Fax 00972-3-54 41 438
Email: frank-ag@frank.co.il

Italy / Italien
Spicer Italcardano S.p.A.
Via Torino 10
I-13044 Crescentino (Vercelli)
Tel. 0039-01-61 83 33 11
Fax 0039-01-61 84 37 71
Email: ic-ug@ntt.it

Poland / Polen
Cardan Polska Sp. zo.o.
ul. Dabrowskiego 262
PL-60406 Poznan
Tel. 0048-61-8477001
Fax 0048-61-8477011
Service 24h 0606449944
Email:
p.j.czerniak@cardanpolska.com

Saudi-Arabia / Saudi Arabien
C.H. Tecke GmbH
Hamburger Str. 103
D-24558 Henstedt-Ulzburg
Tel. 041-93 95 81 3
Fax 041-93 95 81 40
Email: info@tecke.de

Sweden / Schweden
Svenska Uni-Cardan AB
Stensätravägen 9
Box 3100
S-12703 Skeärholmen
Tel. 0046-86039700
Fax 0046-86039702
Email: info@unicardan.se

Switzerland / Schweiz
Schaffner - Behrend AG
Althardstrasse 141
CH-8105 Regensdorf
Tel. 0041-1-871 60 70
Fax 0041-1-871 60 80
Email: sbs@gknauto.com

Spain / Spanien
Gelenk Industrial S.A.
Balmes, 152
E-08008 Barcelona
Tel. 00349-3-2374245
Fax 00349-3-2372580
Email: gelenk1@infonegocio.com

South Africa / Süd-Afrika
MIDAS Ltd. (TMI Propshafts)
294 Brickfield Road
Meadowdale,
GERMISTON 1401
Tel. 0027-11 879 6 322
Fax 0027-11454 0 380
Email: rnaidoo@midas.co.za

France / Frankreich
Glenco Industrie
1565, Route de Quarante-Sous
F-78630 Orgeval
Tel. 0033-1-39 11 80 00
Fax 0033-1-39 75 47 12
Email: industrie@gknglenco.com

Greece / Griechenland
Hellas Cardan GmbH
P.O. Box 40105
GR-56430 Stawrupolis
Tel. 0030-1-65 68 06
Fax 0030-1-65 68 06

Great Britain / Großbritanien
GKN Driveline Ltd.
Unit 5, Block 79, Kelvin Avenue
Hillington Industrial Estate
Glasgow G52 4LT
Tel. 0044-141-88 32 206
Fax 0044-141-88 31 589

GKN Driveline Ltd.
Burton Street, Leek
Staffs. ST13 8BX
Tel. 0044-1538-38 42 78
Fax 0044-1538-37 12 65

GKN Driveline Ltd.
Unit 5, Kingsbury Buisiness Park
Kingsbury Road, Minworth
Sutton Coldfield,
B76 9DL West Midlands
Tel. 0044-121-31 31 606
Fax 0044-121-31 32 074

Japan /Japan
Najico Spicer Co., Ltd.
Tsukiji Najico Bld. 2nd Floor
10-10,3-chome, Tsukiji, Chuo-Ku
Tokyo 104-0045
Tel. 0081-3-3549-7767
Fax 0081-3-3549-7769

Korea / Korea
Dana Korea Co., Ltd.
8th Floor, Asia Tower, No. 726,
Yokosam-Dong, Kang Nam-Ku,
Seoul, 135-719
Tel. 0082-2 563 9451-3
Fax 0082-2 563 1762

Netherlands / Niederlande
GKN Service Benelux B.V.
Haarlemmer-Straatweg 155-157
NL-1165 MK Halfweg
Tel. 0031-20-40 70 20 7
Fax 0031-20-40 70 22 7
Email: industrie@uni-cardan.nl

Norway / Norwegen
Uni-Cardan NORGE A.S.
Postboks 40
N-0409 Oslo 4
Tel. 0047-22098800
Fax 0047-22098809
Email: rk@gkn-unicardan.no

Portugal / Portugal
Sipavel LDA
Rua do Acucar, 88-ARM-8
P-1900 Lisboa
Tel. 00351-1-8681587/88/89
Fax 00351-1-8681527

Czech Republic / Slovakia
Rudolf Bucek
Mladcova 383
CZ-76001 Zlin
Tel. 00420-57-7142004
Fax 00420-57-7243478
Email: RBucek@iol.cz

Turkey / Türkei
Orbis Ticaret Mümessilik
ve Danismanlikhanesi
TR-80072 Beyoglu P.O. Box 151
Istiklal Cad.
Beyroglu Is Merkezi 361
Blok B Kat 1 No 120-121
Beyoglu-ISTANBUL
Tel. 0090-212-251 1002
Fax 0090-212-2518721

USA / USA
GWB North America
Merovan Business Center
1200 Woodruff Road
Suite A-5
Greenville, S.C. 29607
Tel. 001-864-987-0281
Fax 001-864-987-0295

APRIL LDA
QUALIDADE ASSEGURADA
Rua Jorge Barradas, 44A / 46A
Apartado 40097 1514-801 Lisboa Codex - Portugal
E-mail geral: info@april.pt
Tel.: +351 21 762 0910 Fax: +351 21 762 09 19
VAT N.º PT - 501 776 869

DANA
SPICER DRIVESHAFT EUROPE

Technical Questionnaire

- Automotive -

Adressed to SPICER Comp.

- ☐ DANA ☐ U.K
- ☐ NKA ☐ Frankreich
- ☐ IC ☐ Italien

Customer [ ]

Adress [ ]

Telephone, Fax [ ] Production start:

Vehicle model [ ] [ ]

No. of wheels x No. of driven wheels

4 x 2☐ 4 x 4☐ 6 x 2☐ 6 x 4☐ 6 x 6☐ 8 x 2☐ 8 x 4☐ 8 x 6☐ 8 x 8☐

Wheelbase: [ ]
Other: [ ]

Type of vehicle

- ☐ Truck
- ☐ Bus
- ☐ Excursion Coach
- ☐ Articulated Vehicle
- ☐ Other
- ☐ Coach

Kind of operation (% of time)

- Long Dist.: ☐ [ ] [%]
- Regional: ☐ [ ] [%]
- Urban: ☐ [ ] [%]
- Off Road: ☐ [ ] [%]
- Other: ☐ [ ] [%]

Service Temperatures

- Max. Service Temp. [ ] [°C]
- Peak Temp. [ ] [°C]
- Min. Service Temp. [ ] [°C]

Max. vehicle speed

	Vmax [km/h]	combinated with Iax
Normal		
Altern. 1		
Altern. 2		

Engine	Gear Box	Transfer Box	Tyre
Model:	**Model:**	**Model:**	**Model:**

Engine

Model:

Max.
- Power: PENG [ ] [kW]
- Speed: nENG [ ] [rpm]
- Overspeed: nENG [ ] [rpm]
- Torque: TENG [ ] [Nm]

Diesel: ☐ Petrol: ☐

No. of cylinders: [ ]

Gear Box

Model:

Type:
Automatic ☐ Manual ☐

- 1. Rear Ratio: [ ]
- i-Low: [ ]
- i-High: [ ]
- i-Rev: [ ]

Transfer Box

Model:

- i-High: [ ]
- i-Low [ ]

Distribustion:
- Front: [ ] [%]
- Rear: [ ] [%]

Diff. Lock:
Yes ☐ No ☐

Permanent:
Yes ☐ No ☐

Tyre

Model:

- Stat. Radius [ ] [m]
- Dyn. Radius [ ] [m]
- Friction u [ ] [m]

DANA
SPICER DRIVESHAFT EUROPE

Technical Questionnaire

- Automotive -

Adressed to SPICER Comp.

☐ DANA ☐ U.K
☐ NKA ☐ Frankreich
☐ IC ☐ Italien

Clutch

☐ Friction Clutch
☐ Fluid Clutch

Torque Converter

Stall Torque Ratio

iC= [ ]

Max. Stall Torque

TTC= [ ] [Nm]

Retarder (Model)

☐ Electric ☐ Hydraulic
☐ Primary ☐ Sekundary

Break Torque [ ] [Nm]

Weights

Gross comb. weight GCW	[ ]	[t]
Gross vehicle weight GVW	[ ]	[t]
Max. weight 1st front axle FA1	[ ]	[t]
Max. weight 2st front axle FA2	[ ]	[t]
Max. weight 1st rear axle RA1	[ ]	[t]
Max. weight 2st rear axle RA2	[ ]	[t]
Max. weight other axles W	[ ]	[t]

Axle Type

Ratio	Normal	Alternativ
Total Axle Ratio: iax	[ ]	[ ]
Differencial Ratio: idiff	[ ]	[ ]
Wheel Hub Ratio: ihub	[ ]	[ ]

Differential lock ☐ Yes ☐ No

Single wheel suspension ☐ Length ☐ Cross
☐ Yes ☐ No

Comments

In addition we ask for the following information:

- Arrangement of propshafts in vehicle (Sketch)
- Normal operating length Lmin. and Lmax.
- Normal operation deflection angles ßmin. and ßmax.
- Extreme conditions of length and deflection angles Lmax. and ßmax.
- Flange connections (Sketch or exact description)
- Limited swing diameter Yes/No
- Type of mission/load spectrum

Alphabetic Index

SPICER® NORDISKA KARDAN AB

Rua Jorge Barradas, 44A / 46A
Apartado 40097 1514-801 Lisboa Codex - Portugal
E-mail geral: info@april.pt
Tel.: +351 21 762 0910 Fax: +351 21 762 09 19
VAT N.º PT - 501 776 869