ROLLER CHAIN
GUIDE

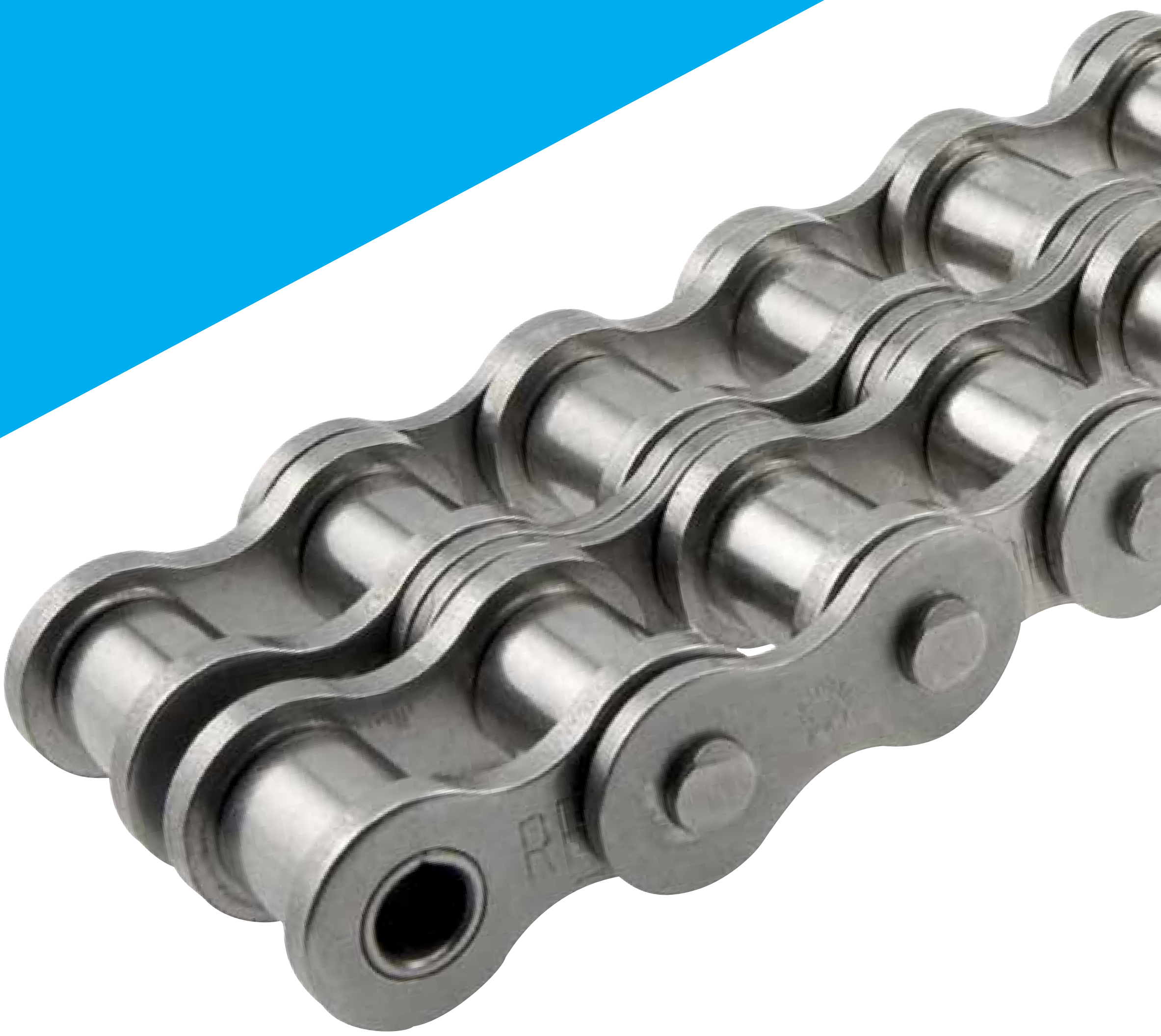
TransDev
THE POWER IN MOTION

Reprinted excerpts from the
Wippermann Catalogue 2015.

A TransDev Technical Report

CONTENTS

The information in this Technical Guide can also be found in the Wippermann Catalogue 2015. It forms part of a series designed to help you specify and identify the optimum Wippermann chain solution for your needs.



High efficiency:

η up to 0,98 with a properly lubricated chain under normal circumstances and with a drive working under full load.

Long wear life:

≈ 15000 operating hours if the correct drive was selected and with appropriate maintenance.

Extensive power and speed range:

P up to 225 kW with simplex roller chain p = 76,2 mm
Power diagram for roller chains according to ISO 606 see page 120 ff

Long shaft distance:

The shaft distance (usually between 30 times and 50 times the pitch) has no fixed measurements. It can easily be adjusted by shortening or lengthening of the chain, even after completed assembly, in order to meet altered construction requirements.

No slip:

In contrast to friction-locked drives chain drives have no slip. In motor vehicles, camshaft drives with chains guarantee exact valve timing.

Multiple transmission ratios:

The transmission ratio:

$$i = \frac{n_1}{n^2} = \frac{z_2}{z^1} \quad \text{(usually up to approx. 7:1)}$$

(in special cases up to 10:1 in one step possible)
remains constant during the entire operation period due to its positive locking connection. However, it may be easily altered by simply changing the sprockets and keeping the shaft distance.

High load capacity:

For the permissible bearing pressure with recommended lubrication please refer to the table on page 7.

Elastic properties:

Roller chain drives have a high elasticity, because of the plate material and the lubrication layer between rollers, pins and bushings.

Versatile applications:

Roller chains are mainly used as drive elements for power transmission or as load chains; equipped with special links they can also be used for transportation and conveyance purposes. One chain is able to simultaneously drive several shafts with the same or opposite rotational direction at the same or at different speeds. It can also be employed as a rack and pinion assembly (lantern gears).

Cost effectiveness:

Roller chains do not need to be pre-tensioned. Therefore there are only minor bearing loads. Space-saving construction, simple mounting, low service and maintenance costs make chain drives very economical.

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General information

The selection criteria discussed below apply to general mechanical engineering applications. Application areas such as hoisting devices (e.g. for lifting loads etc.) are excluded.

The chain life is exclusively determined by its wear behaviour. Wear occurs in the chain joints on pins and bushings. Primarily, wear depends on the chain tensile force, on deflection movements of links running along the sprockets, on the bearing area as well as on lubrication and on the number of rotations.

Therefore the chain must be dimensioned in a way that prevents overloads and fatigue failure. This means that plates and pins resist the transmissible tensile forces, rollers withstand the loads occurring when meshing with the sprocket, and that wear in the joints and on the tooth flanks remains within permissible limits.

Chain drives only have a satisfactory wear life, if the sprockets align, if they are subjected to sufficient lubrication, if there are re-tensioning facilities to compensate for the elongation occurring during operation, and if vibrations of the pull and return strands or torsional vibrations of the entire drive are eliminated. With new chains, the slack span in the return strand should be about 1 % of the shaft distance.

Basic information for chain selection

In order to be able to select a chain, at least the following values for power transmission must be known:

1. Transmissible power P in kW
2. Speed of driving sprocket n1 in min-1
3. Transmission ratio $i = n_1/n_2 = z_2/z_1$
4. Operating conditions of drive (Stoßbeiwert fy)
5. Shaft distance a in mm

If possible, sprockets with at least 17 teeth should be selected. For chain drives with medium speeds or more, and for maximum loads we recommend sprockets with 21 tempered teeth. Normally, the maximum number of teeth should not exceed 150.

The optimal shaft distance is 30 times p - 50 times p and should allow an angle of lap of at least 120° on the smaller sprocket. On chain drives with an inclination of more than 60° clamping-jockey sprockets or automatic chain tensioners must be mounted to ensure the required chain tension.

There often is a choice between a simplex roller chain with a longer pitch and a multiplex roller chains with a shorter pitch. However, chain drives with multiplex roller chains allow smaller sprocket diameters in restricted spaces. They cause less noise and fewer vibrations than chains with a long pitch, which run on sprockets with fewer teeth.

Factor f_y to take into account specific operating conditions

	Driven equipment		
Driving motor / engine	Centrifugal pumps and compressors Printing machines Conveyors with regular infeed Paper calenders Escalators Stirring devices for liquids Rotary driers Ventilators Generators (apart from welding generators)	Piston pumps and compressors with three or more cylinders Concrete mixers Conveyors with irregular feed Screw conveyors Rolling mills direct Saws and reciprocating saws Stirring devices for solid matter Spinning and rinsing machines Brick work machines	Planing machine and pulp grinders Excavators and other building plant Roller crushers Pulling machines Welding generators Choppers Rubber processing machines Piston pumps and compressors with one or two cylinders Gas or oil drill poles Dough mixers
Electric motors in continuous operation Internal combustion engines with hydraulic coupling Water, steam or gas turbines	1,0	1,4	1,8
Electric motors, which are repeatedly started and stopped with fewer than 10 cycles/min Internal combustion engines with six or more cylinders and mechanical coupling	1,1	1,5	1,9
Electric motors, which are repeatedly started and stopped with more than 10 cycles/min Internal combustion engines with fewer than six cylinders and mechanical coupling	1,3	1,7	2,1

Table of tolerable bearing pressures with recommended type of lubrication

Chain speed in m/s	Bearing pressure p_r in N/cm² with number of teeth z on smaller sprocket														
	11	12	13	14	15	16	17	18	19	20	21	22	23	24	≥ 25
0,1	3080	3120	3170	3220	3270	3300	3320	3350	3400	3430	3450	3480	3500	3530	3550
0,2	2810	2850	2880	2930	2980	3000	3030	3060	3100	3120	3140	3170	3190	3220	3240
0,4	2700	2740	2780	2830	2870	2890	2910	2950	2980	3000	3020	3070	3070	3100	3120
0,6	2580	2620	2650	2700	2740	2760	2780	2820	2850	2870	2890	2910	2930	2960	2980
0,8	2490	2490	2560	2610	2650	2670	2680	2720	2750	2770	2790	2810	2830	2860	2880
1,0	2380	2420	2450	2490	2520	2540	2560	2590	2620	2640	2660	2680	2700	2720	2740
1,5	2290	2330	2360	2400	2430	2450	2470	2500	2530	2550	2570	2590	2610	2630	2650
2,0	2210	2240	2270	2310	2350	2370	2380	2410	2440	2460	2470	2490	2510	2530	2550
2,5	2130	2160	2190	2230	2260	2280	2290	2320	2350	2370	2380	2400	2440	2470	2500
3,0	2050	2080	2110	2140	2170	2190	2210	2240	2260	2290	2320	2350	2380	2420	2460
4,0	1740	1830	1920	2000	2070	2100	2130	2160	2180	2220	2260	2300	2340	2380	2420
5,0	1400	1550	1690	1770	1840	1910	1970	2010	2050	2100	2150	2180	2210	2240	2280
6,0	1050	1230	1410	1540	1640	1730	1810	1880	1950	1990	2040	2070	2110	2140	2180
7,0	850	1000	1150	1280	1400	1510	1620	1740	1850	1870	1900	1940	1980	2020	2060
8,0	-	800	1020	1110	1200	1310	1420	1560	1700	1740	1780	1820	1870	1910	1960
10,0	-	-	810	900	1020	1110	1200	1320	1430	1460	1500	1570	1640	1700	1770
12,0	-	-	-	-	820	910	1070	1170	1260	1300	1350	1410	1480	1540	1600
15,0	-	-	-	-	-	-	890	970	1050	1100	1150	1210	1270	1330	1400
18,0	-	-	-	-	-	-	-	-	880	960	1050	1110	1180	1240	1300

This applies to chains according to ISO 606 with pins and bushings made of case-hardened steel.
Annotation: If requested, we can supply chains made of steel grades that can be subjected to particularly high bearing pressure.

Ratio between speed n and chain pitch p for z_1 = 25

Pitch p	mm	8	9,525	12,7	15,875	19,05	25,4	31,75	38,1	44,45	50,8	63,5	76,2
	inch	-	3/8“	1/2“	5/8“	3/4“	1“	11/4“	11/2“	13/4“	2“	21/2“	3“
Speed n_{max}	min^{-1}	6000	5000	3600	2700	2000	1500	1200	900	700	550	450	300

Factors to be considered in case of different operating conditions

Impact coefficients f_y (see table on page 3)

Number of teeth of driving sprocket

z	11	13	15	17	19	21	23	25	31	37
f_z	1,80	1,50	1,30	1,13	1,00	0,90	0,81	0,74	0,60	0,50

Diagram power $PC = P \cdot f_y \cdot f_z \cdot f_i = P \cdot k$

Transmission ratio

i	1 : 1	2 : 1	3 : 1	5 : 1
f_i	1,22	1,08	1,00	0,92

Shaft distance

a	10 p	20 p	40 p	80 p
f_a	1,30	1,15	1,00	0,85

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Diagrams 1, 2 and 3 are typical power diagrams for chain drives with the following operating conditions:

a) Chain drive with two sprockets on parallel, horizontal shafts
b) Driving sprocket with 19 teeth
c) Simplex chain without a cranked link
d) Chain length 120 links (for shorter chains the chain life decreases proportionally)
e) Speed reducing ratio from 1:3 up to 3:1
f) 15000 h expected wear life; 15000 operating hours only with a maximum of 3 % elongation caused by wear
g) Operating temperature between - 5°C and + 70°C
h) Sprockets aligned and chain tensioned according to specifications (see Chain Drive Design guide)
i) Regular operation without overload, impacts or frequent restarts
j) Clean and sufficient lubrication (see chain maintenance guide)

Power diagram for roller chains according to ISO 606 (European type)

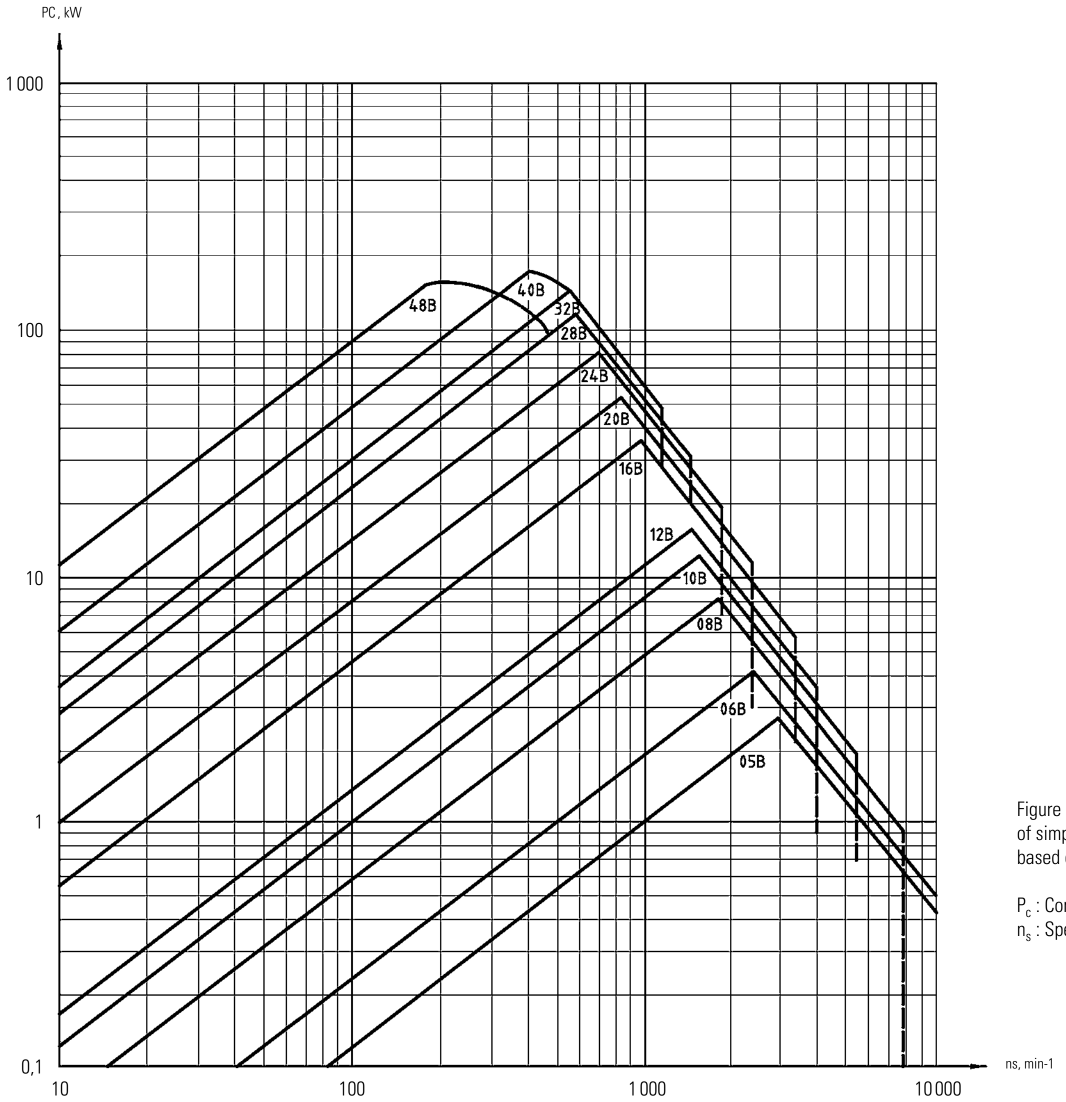

Figure 1: Typical power diagram for selection of simplex chains type B according to ISO 606, based on a sprocket with 19 teeth

P_c : Corrected power
n_s : Speed of smaller sprocket

Annotation 1: The nominal values for the performance of duplex roller chains can be calculated by multiplying the P_C-value for simplex chains with the factor 1,7.

Annotation 2: The nominal values for the performance of triplex roller chains can be calculated by multiplying theP_C-value for simplex chains with the factor 2,5.

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In case of different operating conditions, the value of the transmissible power "P" must be multiplied with the respective factor "k" in order to be able to select the appropriate chain from the diagram on the basis of the

Diagram power $P_C = P \cdot k$

The operating factor "k" takes into account the operating conditions of the drive, the number of teeth on the small sprocket, the transmission ratio and the shaft distance.

Longer wear lifes can be achieved by transmitting less power than shown in the diagram.

If roller chains are operated with very low speeds or idly (e.g. as load chains), the tensile force must be calculated according to the formula Fd = F · fy zu berechnen.

The safety factor should be at least S = 7!

Power diagram for roller chains according to ISO 606 (American type)

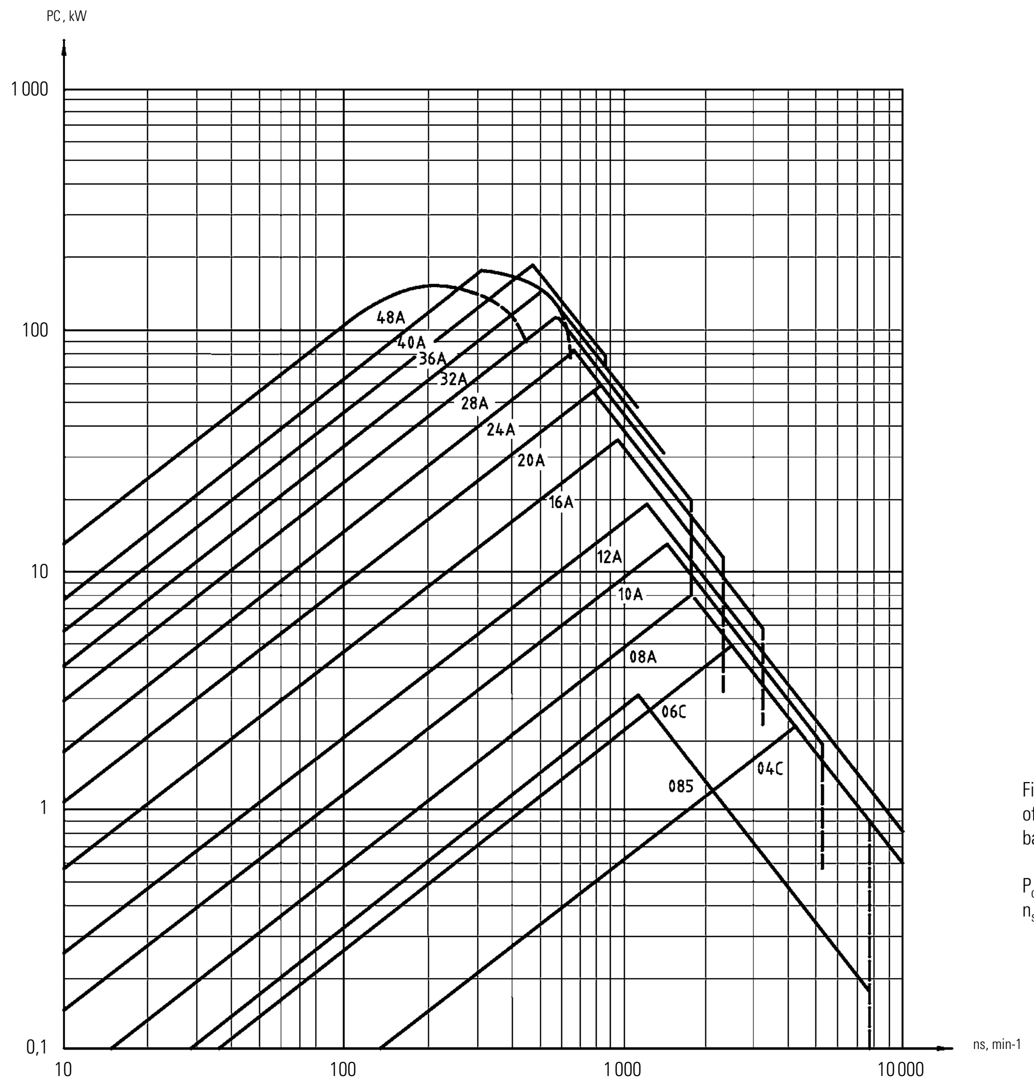


Figure 2: Typical power diagram for selection of simplex chains type A according to ISO 606, based on a sprocket with 19 teeth

P_c : Corrected power
n_s : Speed of smaller sprocket

Annotation 1: The nominal values for the performance of duplex roller chains can be calculated by multiplying the P_C-value for simplex chains with the factor 1,7.

Annotation 2: The nominal values for the performance of triplex roller chains can be calculated by multiplying theP_C-value for simplex chains with the factor 2,5.

Power diagram for roller chains according to ISO 606 (American type, reinforced)

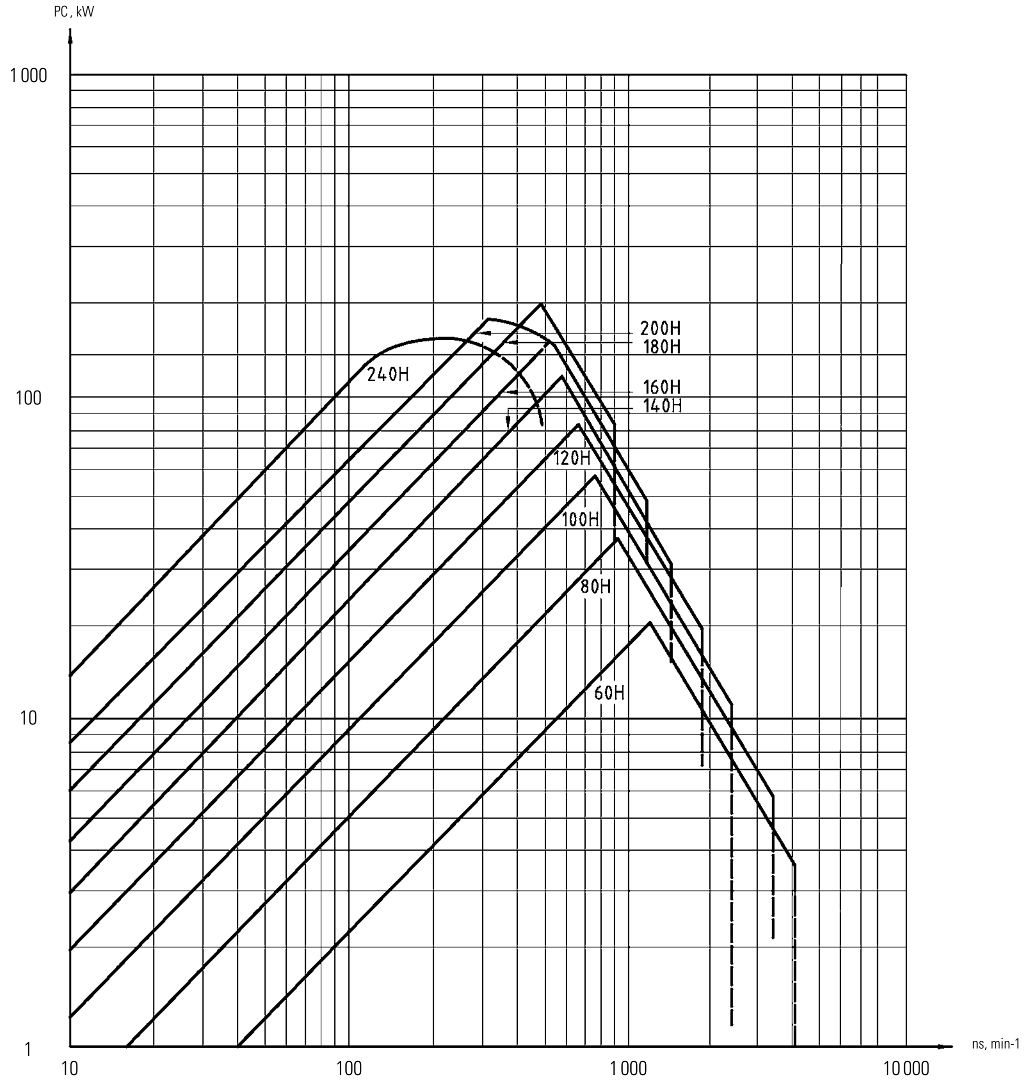
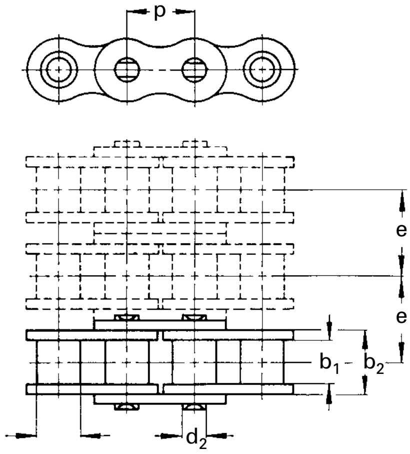


Figure 3: Typical power diagram for selection of reinforced simplex chains type A according to ISO 606, based on a sprocket with 19 teeth

P_c : Corrected power
n_s : Speed of smaller sprocket

Annotation 1: The nominal values for the performance of duplex roller chains can be calculated by multiplying the P_C-value for simplex chains with the factor 1,7.

Annotation 2: The nominal values for the performance of triplex roller chains can be calculated by multiplying the P_C-value for simplex chains with the factor 2,5.



In order to avoid errors or misunderstandings please supply the following details:

Number of chains

-Chain No.

If this is unknown e.g. when ordering replacement chains, please supply a short part of the chain as a sample (at least one inner link) or, alternatively, state the following dimensions according to the adjoining drawing:

1. Pitch p
2. Inner width b_1
3. Inner link width b_2
4. Roller and bushing diameter as well as
5. Pin diameter for Galle chains d_1
6. Shoulder diameter for Galle chains d_2
7. Transverse pitch (only for multiplex roller chains)
8. Please state, if simplex, duplex or multiplex chain designs are required

For replacement chains it is sufficient to state the main dimensions p, b_1 and d_1 as well as e for multiplex chains. If a chain is to be extended or repaired, all the dimensions shown in the drawing must be supplied.

Please note: In case of replacements it is important to replace both sprockets as well as chains!

Length of chain in meters or links

1.) When ordered by length in metres (e.g. 5 m) the end links are always inner links. Connecting links must be ordered separately.

2.) When ordered by number of links:

Orders for chains with even number of links

	chain is supplied:
ready to be installed	including one connecting link
open*	end links = inner links including one single cranked link
endless	riveted

Orders for chains with odd number of links

	chain is supplied:
einbaufertig*	(up to a pitch of p = 19,05 mm = 3/4") including one double cranked link and one connecting link (up to a pitch of p = 25,4 mm = 1") including one single cranked link
open	end links = inner links
endless*	riveted (including one cranked link)

* When cranked links are used, roller chains may only have 80 % of the breaking load. Avoid if possible!

What will the chain be used for?

Please inform us on the application area of the chain. Only then will we be able to offer you the perfect chain for the application you have in mind – and you will benefit from our long-time experience!

Parallel running chains

Chains envisaged for parallel running operation are matched for length, pre-stretched and marked at extra cost.

It is important to clearly stipulate this requirement when ordering!

In special cases measured chains can be supplied at extra cost.

Designation	Symbol	Unit	Basic equations
Input speed	n	min^{-1}	
Operating factor	k		$k = f_y \cdot f_i \cdot f_z$
Minimum tensile strength	F_B	N	see chain tables
Torque	M	Nm	$M = \frac{9550\,P}{n} = \frac{F \cdot d_0}{2000}$ in Nm
Correction factor for impact loads	f_y		see page 118
Correction factor for transmission ratio	f_i		see page 119
Correction factor for shaft distance	f_a		see page 119
Correction factor for number of teeth	f_z		see page 119
Bearing area	f	cm^2	see chain tables
Bearing pressure	p_r	N/cm^2	$p_r = \frac{F}{f}$ see page 117
Speed	v	m/s	$v = \frac{z \cdot p \cdot n}{60\,000}$ in m/s
Weight of chain per meter	q	kg/m	see chain tables
Power	P	kW	$P = \frac{F \cdot v}{1000} = \frac{M \cdot n}{9550}$ in kW
Diagram power	P_c	kW	$P_c = P \cdot k$ in kW
Safety factor	S		$S = \frac{F_B}{F_G}$
Impact coefficient	Y		see page 118
PCD	d_0	mm	$d_0 = \frac{p}{\sin \frac{180°}{z}}$ in mm
Pitch	p	mm	see chain tables
Transmission ratio	o		$i = \frac{n_1}{n_2} = \frac{z_2}{z_1}$
Shaft distance	a	mm	
Number of teeth	z_1, z_2		
Tensile force	F	N	$F = \frac{1000\,P}{V} = \frac{2000\,M}{d_0}$ in N
Tensile force, dynamic	F_d	N	$F_d = F \cdot f_y$ in N
Tensile force, centrifugal	F_F	N	$F_F = q \cdot v^2$ in N
Tensile force, total	F_G	N	$F_G = F_d + F_F$ in N

Questionnaire for chain drives

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What is to be conveyed or driven by the chain? (If an existing chain drive is to be replaced, please state which one!)

....

....

Chain drive

Please underline where applicable and enter the respective data if necessary!

Power requirement (max. power to be transmitted): power output P = ... PS/kW   torque M = ... Nm   tensile force F = ... N

Drive (type and performance): .... / .... hp/kW
(e.g. electric motor, internal combustion engine / 2, 4, 6 cylinders etc.)

Chain loading: operation period .... hours/day
□ regular □ cyclic □ impact □ alternating direction ....times per hour
□ interruption (re-start) approx. .... times per hour

Centrifugal mass for impact compensation: □ existing □ possible □ not existing □ not possible

Axial distance: a = ... mm
shaft distance is adjustable by .... mm / not adjustable
□ jockey sprocket □ clamping rail □ clamping spring □ automatic chain tensioner

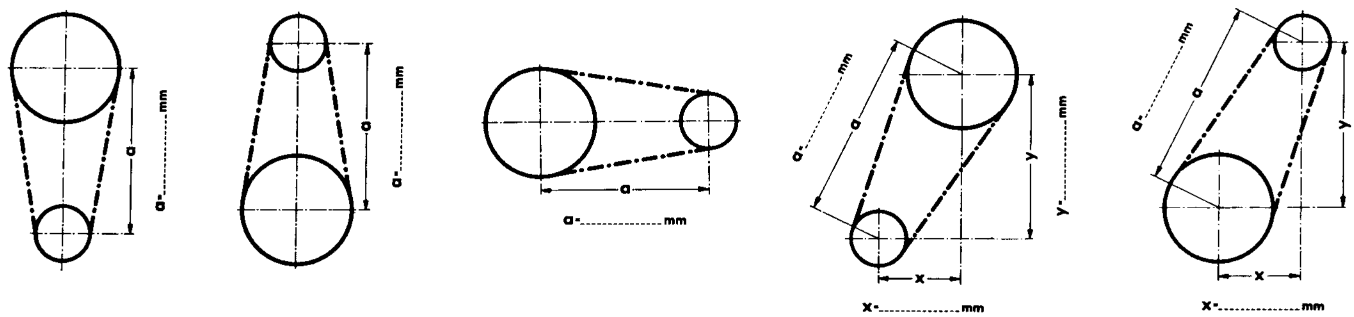
Ambient influences: □ nothing in particular □ dust □ fibres □ sand □ humidity
temperatures up to .... °C corrosion caused by ....

Chain protection box: □ dust proof □ not dust proof □ installation not possible
□ chain unprotected □ chain protected by engine / machine housing

Lubrication: □ not permitted □ manually (occasionally) □ drip feed
□ oil bath □ pressure circulation

Sprockets

	Driving sprocket	Driven sprocket
Speed	n_1 = ...rpm	n_2 = ...rpm
or		
planned transmission ratio	i = ...:..................	
Sprocket diameter (Ø) Largest possible incl. chain	max. = ...mm	max. = ...mm
Sprocket width Largest possible incl. chain	max. = ...mm	max. = ...mm
Sprocket design	....	....
Hub bore (shaft Ø)	d_1 = ...mm	d_2 = ...mm
Hub length	L_1 = ...mm	L_2 = ...mm
Hub design One-sided: standard Double-sided: symmetrical or asymmetrical	....	....
Installation on the shaft (groove sizes according to DIN)	....	....



Please enter the dimensions of the requested drive into the drawing. The driving wheel designation should be T. Please indicate the rotation direction by an arrow and in case of alternating rotation direction by a double arrow (◄—►).

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