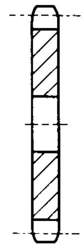
In order to avoid errors or misunderstandings please supply the following details:



Type A

Plate sprocket Type “A“

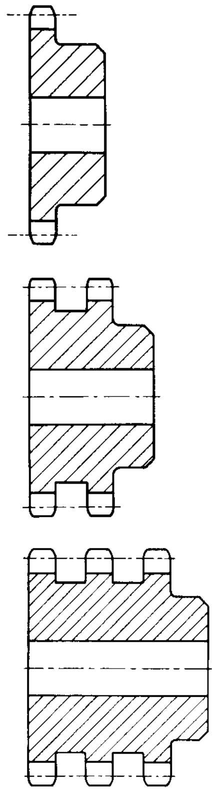
(for simplex roller chains according to DIN 8187)

1. Number of plate sprockets
2. ⚙-plate sprocket No. (e.g. plate sprocket with 20 teeth for simplex roller chain No. 462 – 1/2“ x 5/16“ = A 20 462)
3. Custom bore size (fit normal H7)

Sprocket Type “B“

(for simplex, duplex and triplex roller chains according to DIN 8187)

1. Number of sprockets
2. ⚙-sprocket No. (e.g. sprocket with 23 teeth for duplex roller chain No. D 501 – 5/8“ x 3/8“ = B 23 D 501)
3. Custom bore size (fit normal H7)
4. Groove sizes (for keyways also tightening direction); without additional specifications (e.g. if you merely state groove according to DIN) we will supply sprockets on the basis of DIN 6885 sheet 1
5. Inside threads or pin holes



Type B

Sprockets in special designs

(for all chains in our manufacturing line)

1. Number of sprockets
2. Appropriate ⚙-chain No. or ISO No.; alternatively pitch p, inner width b1 (between inner plates) and roller-Ø , pin-Ø or bushing-Ø
3. Number of teeth z
4. Bore size and fit
5. Hub diameter and hub length
6. Hub seat (one-sided or symmetrical); in case of asymmetrical hubs please state the two hub sections up to the sprocket centre
7. Groove sizes (for keyways also tightening direction)
8. Inside threads or pin holes

It is advisable to include a precise drawing when ordering sprockets in special designs.

Toothing

(for all chains in our manufacturing line including inverted tooth chains up to p = 25,4 mm)

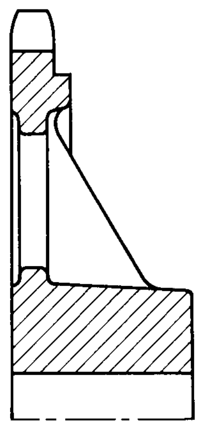
1. Number of wheel bodies to be toothed
2. ⚙-chain No. or ISO No.; alternatively pitch p, inner width b1 (between inner plates) and roller-Ø , pin-Ø or bushing-Ø
3. Number of teeth

Grooves

1. Number of parts to be grooved
2. Groove sizes (normal DIN 6885 sheet 1)

Lantern gear toothing

1. Number of lantern gears



Type B (Cast iron)

Chain tensioner SPANN-BOX®

1. Number of chain tensioners SPANN-BOX®
2. ⚙-chain No. or ISO No.
3. SPANN-BOX® size
4. Sliding profile (arch, semicircle or deflecting profile)
5. Spring tension (high or low) and design (ordinary steel or grade 1.4301 [V2 A])

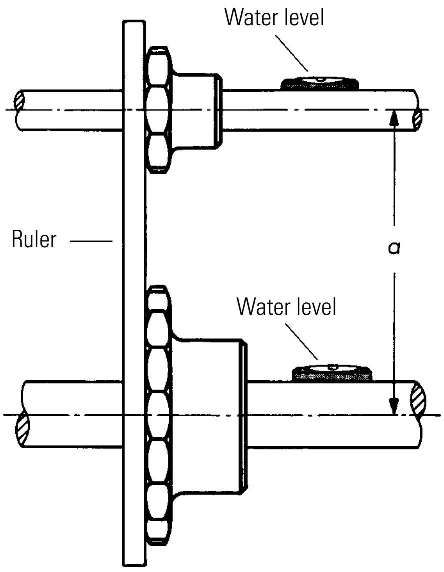
ETP Bushings

1. Number of bushings
2. Order number

Alignment of the sprockets

The wear life of a chain largely depends on the proper alignment of the sprockets. Sprockets must always align exactly. Alignment can be checked by means of a long ruler applied across the sprockets. This check must be repeated several times with the sprockets turned a little further each time. Subsequently, they have to be secured in axial direction.

The shafts must be aligned exactly horizontally. They must be axially parallel and free from runout. In order to avoid vibrations they should be dimensioned according to the weight of the sprockets, the design layout and the loads.



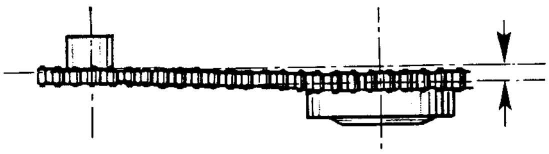
Chain tensioning

Unlike belt drives, chains do not require pre-tensioning, and they should have a slight slack span (see page 124). Chains must not be overtightened, since this would load the drive unnecessarily and lead to premature wear of the chain. However, if chains are fitted too loosely, they tend to "jump off" the sprockets. The chain slack span should be checked after a few weeks. Initial elongation is higher than during the subsequent operation period due to running-in wear.

Faulty mounting

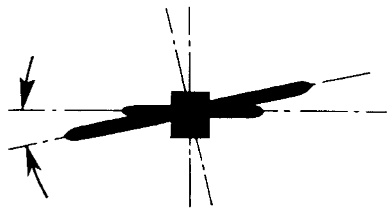
Chain runs on laterally offset sprockets

In this case the sprockets are not lopsided, but they are laterally offset. Therefore the chain runs laterally skewed. As a result, the chain plates heavily grind on the teeth of the sprocket and wear quickly. The lateral pressure also loosens the riveting. The chain cannot run smoothly and there is a relatively strong elongation due to the strong wear between pins and bushings.



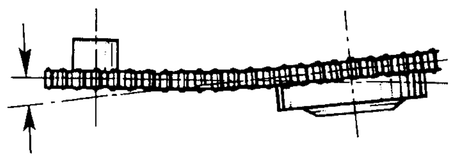
Tilted position of sprockets

Originally the sprockets were aligned. During tensioning the gear mechanism shifted and is now in an angle to the line of the sprocket on the machine shaft. The consequences are the same as before. Apart from that, axial forces put pressure on the machine and gearing shafts.



Skewed position of sprockets

The drawing shows that the sprockets are aligned, but that they are skewed, so that the driven sprocket, for example, has now a tilted position against the angle. In this case, the chain is also subject to extreme load and will wear prematurely.



The followings aspects should be considered when selecting a lubricant:

- Oil or grease lubrication
  Oils are normally used for continuous relubrication. Grease is preferred, if the ambient air contains dust (lime, talcum, flour etc.).

- Operating temperature
  This is one of the most significant aspects of lubricant selection. The decisive criterion is the temperature in the chain bearing during operation.

- Viscosity
  Viscosity must be high enough so that all the chain parts are protected against wear and galling. However, despite high viscosity the oil must be sufficiently capable of flow.

  The following rules of thumb apply:
  - Low bearing pressure, high chain speed = low viscosity
  - High bearing pressure, low chain speed = high viscosity
  - Low operating temperature = low viscosity
  - High operating temperature= high viscosity

- Initial lubricant
  It must have excellent corrosion protection qualities and guarantee sufficient wear protection up to the first relubrication. The envisaged operating conditions should be taken into account.

- Load-bearing properties
  Sufficient load-bearing properties of the lubricating oil film help to reduce wear.

- Friction point wetting
  The chain lubricant must be able to permeate the lubrication gap autonomously.

- Chain cooling
  In conjunction with appropriate lubrication procedures certain oils are suitable for cooling. The maximum service temperature of the lubricating oil must never be exceeded.

- Applications in the food industry
  Lubricants must comply with specific food law requirements.

- Applications in the textile industry
  Non-drip and non-adhesive oils should be used.

- Corrosion protection
  This is particularly important for chains used in corrosive environments.

- Applications in wet environments
  Lubricants must not be washed off by splash water. They must be capable of creep, and supply sufficient corrosion protection even as emulsions.

- Muffling of chain noises
  Lubricants with higher viscosity ensure better muffling properties than low viscosity lubricants. However, the lubricants must always be sufficiently capable of flow.

Also refer to the chapter "Maintenance of chain drives" on page 129.

- Contact with elastomers and synthetic materials
  Compatibility with elastomers and synthetic materials must be guaranteed. Compatibility tests are always required.

- Lifetime lubrication
  Lubrication has been designed in a way that the lubricant will be functioning during the entire lifetime of the chain.

- Lifetime lubrication for chains is possible, if
  - the chain load is low
  - the service temperature of the lubricant is considerably underrun
  - the overall operating time is low

  For lifetime lubrication special non-aging chain lubricants have been developed.

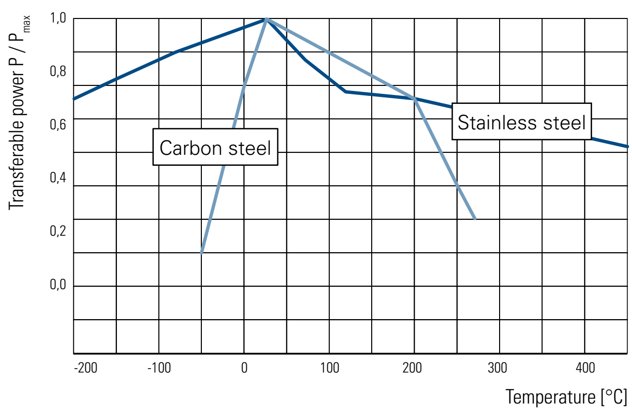
- Ground water hazards
  Please refer to the appropriate safety data specifications.

- General environmental compatibility
  Please use lubricants, which are biodegradable and particularly environmentally friendly.

Chain lubrication from production to operation

Chain manufacturers	Initial lubrication Corrosion and wear protection Selection of suitable lubrication method
Machine/engine manufacturers	Make already installed chains accessible for manual lubrication Plan chain protection boxes Provide oil pans Design lubrication facilities State reference values for lubrication schedules and lubricant dosage
Machine/engine operators	Inspection of lubrication state and, if necessary, evaluation of lubrication schedules and lubricant dosage Chain cleansing Chain conservation Relubrication

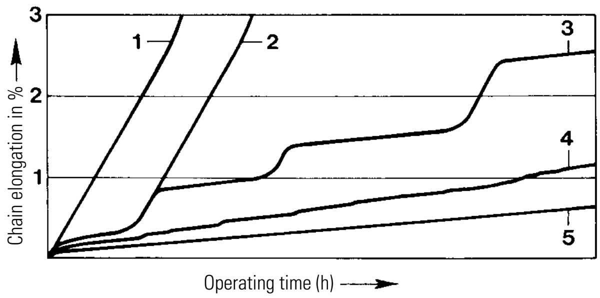
Performance of roller chains as a function of temperature



General information

Chains running on sprockets are subject to wear of the joints due to angle-sliding movements of the pins. Therefore efficient lubrication is of utmost importance. Even low-maintenance roller chains with plastic slide bearings should be relubricated occasionally.

Dry running condition (curve 1) causes excessive wear and destroys the chain within a very short time.



Chain elongation as a function of operating time with different lubrication states

One-time lubrication (curve 2) only delays the wear until the lubricant has been used up.

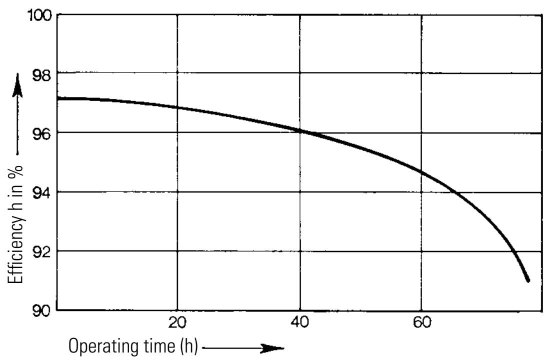
Intermittent dry running conditions (curve 3) frequently occur with manual lubrication, particularly if deadlines for relubrication have not been met.

Wrong lubrication (curve 4) results in uneven wear and may be caused by inferior, dirty, wrong (unsuitable viscosity) or too little lubricant.

Correct lubrication (curve 5) is crucial for chain drives according to performance diagrams.

Lubrication and degree of efficiency

The following graph shows the influence of lubrication on efficiency.



Degree of efficiency as a function of operating time with one-time lubrication (according to Worobjew)

Lubricants

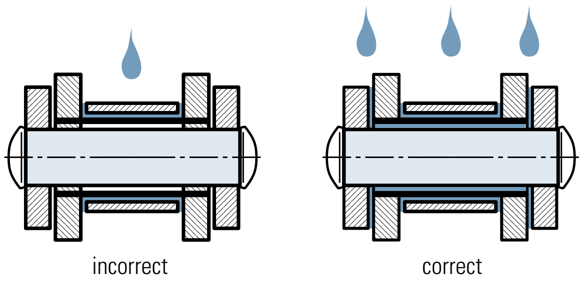
The selection of an appropriate lubricant depends first of all on the type of lubrication.

Low viscosity mineral oils are particularly suitable for chain drives.

Ambient temperature °C	Viscosity group of lubricant
- 5 up to + 25	ISO VG 100 (SAE 30)
25 up to 45	ISO VG 150 (SAE 40)
45 up to 65	ISO VG 220 (SAE 50)

For higher temperatures (e.g. furnace chains) graphite or molybdenum disulfide (MoS_2) applied either as additive or spray will facilitate lubrication.

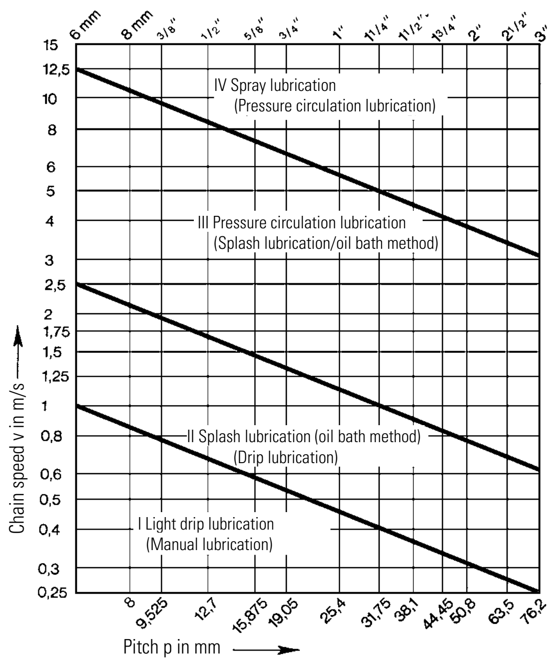
Low-viscosity or hardened grease products with a drop point of 70° C are also suitable for manual lubrication. In special cases liquidised grease may be sprayed on. Initial operation can start immediately after evaporation of the volatile carrier substance.



It is very important that the lubricant reaches the joints (pins, bushings), which are subject to wear.

Recommendations for lubrication

The type of lubrication depends on the chain pitch and the chain speed.



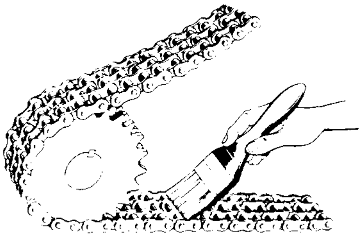
The lubrication types, which are not in brackets, are preferable to those in brackets (permitted).

In order to achieve a long wear life and high cost effectiveness for chain drives in lubrication range I (light drip lubrication or manual lubrication) relubrication schedules must be determined by tests.

Manual lubrication

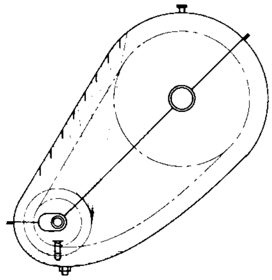
This type of lubrication by means of oil can and brush is not very safe and therefore only suitable for chains with occasional operation or for secondary drives and low chain speeds.

Sufficient lubrication should take place at least once a day (if possible every 8 operating hours). Lubricant colouration may not occur.



Spinning disk lubrication

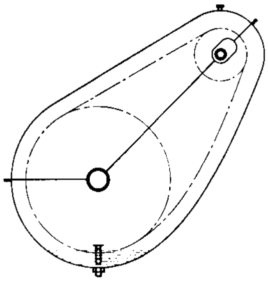
With this type of lubrication the chain operates above oil level. A disk submerging into the lower oil level (peripheral velocity between min. and max. 40 m/s) centrifuges oil against the casing walls from where it continuously runs down onto the chain via drip rails.



Splash lubrication (oil bath method)

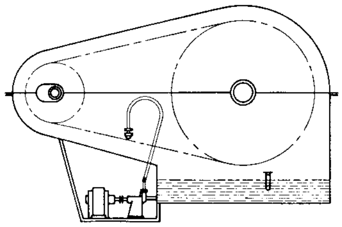
There is just enough oil in a sufficiently sized protection box (the worn and elongated chain must not be able to hit against the casing wall) to allow the chain plates to submerge into the bath up to the rollers or the bushings respectively.

Higher submerging depths cause the oil to heat up and lead to untimely oxidation of the oil.



Spay lubrication

Spray lubrication is very similar to pressure circulation lubrication. Instead of a lubrication shower, however, lubrication spray valves atomise the oil into aerosol form, and thus the fine oil mist can reach every single chain joint.



Drip lubrication

Drip lubrication by means of wick oilers, needle oilers or drip oilers is only suitable for low load bearing drives. Sufficient lubrication of the joint surfaces must be ensured. Lubricant colouration may not occur.

Pressure circulation lubrication

This type of lubrication is suitable for fast-running drives and high loads. The oil can be supplied via a connection to an existing pressure oil pipe or via an extra pump. By means of a lubrication shower situated near the large sprocket, oil is sprayed onto the inner side of the chain return strand in running direction over the whole width of the chain. High load-bearing drives need a second shower for cooling with the oil to be sprayed onto the pull strand. The oil quantity depends on the drive size and the amount of heat to be dissipated.

Lubrication overview

Lubrication range	Chain speed m/s	Lubrication a) favourable b) permitted	Transmissible power: correct lubrication (favourable/permitted)	insufficient lubrication: without contamination	insufficient lubrication: with contamination	without lubrication*
I	up to ≈ 1	a) Light drip lubrication b) Manual lubrication/grease lubrication		60 %	30 %	15 %
II	up to ≈ 2,5	a) Splash lubrication (oil bath method) b) Drip lubrication		30 %	15 %	
III	up to ≈ 12,5	a) Pressure circulation lubrication b) Splash lubrication (oil bath method), if possible with spinning disk	100 %			
IV	above 12,5	a) Spray lubrication b) Pressure circulation lubrication (possibly with oil cooling system)			not permitted	

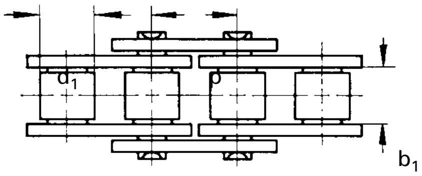
* a wear life of 15 000 hours cannot be guaranteed!

WIPPERMANN lubrication

Product	Oil	Grease	Spray	Application °C from	to	Technical features
WKS-C		✓		- 10	+ 100	**WIPPERMANN standard lubrication** Mineral oil-based soap-free chain grease, with wax and product-specific additives, for extreme requirements as to corrosion and wear protection Water resistant
WKS-W		✓		0	+ 80	**Lubrication wax for chains** "Quasi dry" non-tacky lubrication film Wear protection High corrosion protection Good adhesive properties Excellent water resistance
WKS-Rapid		✓		- 15	+ 120	**White chain lubricant** Difficult to centrifuge off Protects against corrosion and wear It has absorbing and rinsing properties and provides effective lubrication Resistant to water and vapour Quite resistant to acids and bases
WKS-D	✓			- 10	+ 80	**Corrosion protection oil** Chlorine-free lubricant made with mineral oil raffinates and corrosion protection additives; thin, waxen and pressure-resistant lubrication with anti-wear additives Excellent corrosion protection
WKS-H1	✓			- 10	+ 140	**Chain lubricant for hygienic and clean lubrication** Fully synthetic high performance chain lubricant for the pharmaceutical, food and beverage, cosmetics, feeding stuff, and tobacco industries as well as their suppliers. Complies with U.S. requirements as to guidelines of sec. 21 CFR of FDA regulations Increased performance range achieved by a combination of high-quality, mineral oil free synthetic base oils with a high-capacity additives package. Nonfood Compounds Program Listed H1, NSF Reg # 143954
WKS-Plus	✓		✓	- 10	+ 240	**High-temperature lubricant** Fully synthetic, temperature-stable high-performance oil especially developed for chain lubrication Improved protection against wear, ageing and corrosion due to a combination of synthetic ester oils and additives This product combines the special requirements of chain lubrication with demands on lacquer compatibility.
WKS-HT	✓			- 10	> 250 (as of +300 °C dry lubrication)	**High-temperature lubricant** Polyalkylene glycol oil, containing solid lubricants, for chain lubrication at high temperatures Excellent wetting properties and creep behaviour High stability This product can be used at temperatures of up to 500°C; above 200°C there is a gradual transition to dry lubrication.
WKS-T	✓			- 55	+ 90	**Lubricant for environments with low temperatures** Fast biodegradable and low-temperature multi-purpose oil based on synthetic ester with excellent wear protection The product has a low evaporation rate and is characterised by its excellent viscosity-temperature behaviour; it is also highly age resistant
WKS-Spezial			✓	- 10	+ 80	**Chain spray for relubrication** Mineral oil-based chain spray with synthetic wax, corrosion protection and anti-wear additives (propellant: propane / butane pressure gas mixture) For relubrication of open drive chains, conveyor chains in conveying systems as well as for load chains

All lubricants supplied by WIPPERMANN are free from chlorine and silicone.

Detailed product description and safety data sheets on request.



Steel link chains

Generally, steel link chains can only operate on one plane, and they are primarily used as drive elements for chain drives.

They are precisely determined by three main measurements:

p = **Pitch** is the distance from pin centre to pin centre.

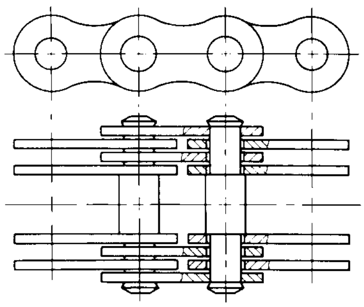
b_1 = **Inner width** is the distance between the inner plates.

d_1 = **Roller diameter, bushing diameter or pin diameter** is the outer dimension of the cylindrical parts between the inner plates.

The characteristic feature of a steel link chain is the chain joint.

It consists of an outer and an inner link. On this joint the calculated bearing area equals the projection of the pin onto the bearing area of the inner link. It has a different size depending on the type of chain.

In the following overview the characteristic features of various types of steel link chains are briefly described.



Galle chains

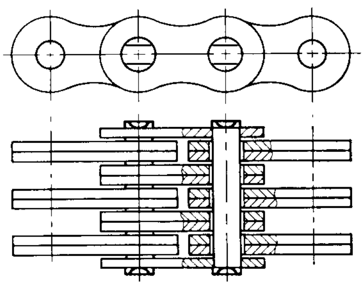
Galle chains were named after their inventor André Galle (1761-1841). A Galle chain is the simplest type of steel link chain.

The plates rotate directly on the pin lug. With this type of chain the bearing area is very small.

Therefore the chain speed should not exceed 0,3 m/s.

Consequently, Galle chains are less suitable for power transmission, and they are almost exclusively used as load chains (e.g. counterweight chains, lock chains and tack chains).

Galle chains on request (see page 76)



Leaf chains

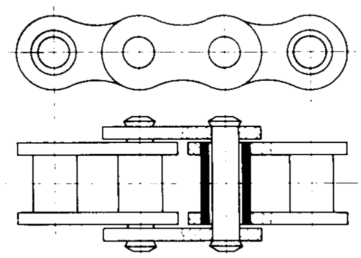
Leaf chains in normal design or reinforced design are used as load chains in cranes, hoisting gear and lifting equipment as well as for counterweights, e.g. on machine tools, and also to transmit back-and-forth movements.

The plates of leaf chains are punched from high-grade steel and are subsequently hardened and tempered to guarantee high fatigue strength. Very narrow tolerances ensure that all plates bear the same load proportions. Pins made of high alloy case-hardened steel are tempered to achieve high wear resistance. The tightly adjoining plates are designed in various combinations and rotate on the pins.

One special design is the heavy-duty type series U. On chains of this type all plates are mounted with a sliding fit and are also secured with laterally attached riveted disks. This design guarantees an even load distribution and reduces the bending load of the pins. These chains were especially developed for heavy loads and operations under harsh conditions. Due to their high fatigue strength they are particularly suitable for such application areas.

Due to their design (no tooth meshing) leaf chains cannot transmit torques. Their force direction, however, can easily be deflected by means of rollers. Even with a small working width they have a high breaking load.

Dimensions as of page 68 ff.



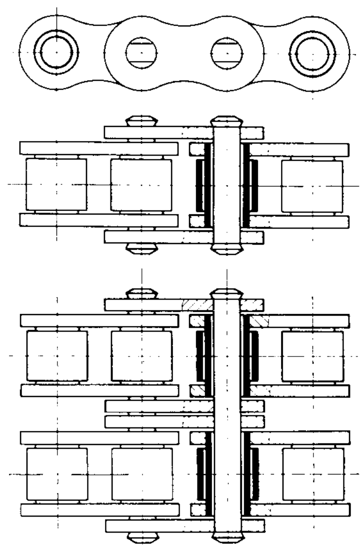
Bush chains

Bush chains are more wear-resistant than Galle chains. The inner links consist of two inner plates with two force-fitted bushings. The outer links consist of two outer plates with two force-fitted and riveted pins.

Chain speeds of up to 5 m/s are possible depending on the pitch.

Due to their robust design bush chains are mainly used as drive and conveyor chains, particularly where there are rough operating conditions, e.g. in mining or construction site equipment.

For dimensions see page 47.



High performance roller chains

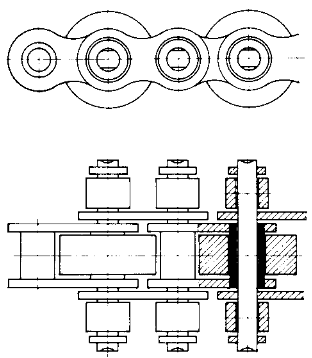
Compared to bush chains, high performance roller chains are of better quality due to the use of higher steel grades and heat treatment. Furthermore, they are produced with higher accuracy and narrower tolerances. The visible difference is the rollers, which are mounted on the bushings with running fit, and which absorb the meshing impact in the sprocket and thus reduce sprocket wear. Plates and rollers are hardened and tempered in order to achieve high fatigue strength, whereas bushings and pins, which are subject to wear, are case-hardened.

For high power transmission under restricted mounting conditions multi-strand roller chains can be used. This means that several simplex roller chains are connected by means of an end-to-end pin to form one single unit. Duplex and triplex chains are standardised.

Roller chains can be employed universally and are therefore the most common chain type. They are not only used as drive and gear chains in machine construction, but also in special designs with attachments for transport and conveyance purposes or instead of rack and pinion arrangements.

Roller chains RF made of stainless and acid-resistant steel grade 4301 have proved their value on corrosion-endangered drives and because of their anti-magnetic properties for many years. They are mainly used in the chemical, beverage and food industry.

Dimensions as of page 10 ff.

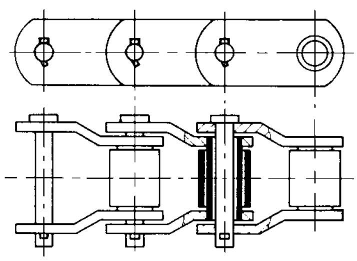


Accumulator chains

Accumulator chains are employed, when accumulation of piece goods during transportation is required. The chain runs on lateral support rollers, whereas the conveyor roller in the middle runs freely.

The particular advantages of this type of chain lie in the simple control, the exact guiding possibilities as well as in the smooth transition from one direction to another without abrupt acceleration. During intentional or unintentional accumulation of the transported piece goods no excessive impact pressure is put on the following transport units since the power and free conveyor chain will continue to run smoothly under the goods until the end of the accumulation, when transportation will continue due to friction.

For dimensions see page 38, 39, 60 - 62.



Cranked link chains (Rotary chains)

Cranked link chains (Rotary chains) are in fact roller chains, but only cranked plates are used. These plates help to give the chain a high amount of elasticity so that load impacts can easily be absorbed. It is also quite straightforward to repair cranked link chains since each individual link can be replaced.

Cranked link chains (Rotary chains) are mainly employed for applications with intermittent impacts and where the drive is exposed to rough soiling, e.g. in excavation machinery, crawlers for excavators and dozers or drilling equipment.

Cranked link chains (Rotary chains) on request 76)

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 122.

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.

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

Dimensioning of leaf chains

The transmissible load as well as the operating conditions i.e. type of load, chain speed, chain activity rate, impact level and operating temperature must be considered when selecting a leaf chain.

The permissible dynamic tensile force depends on the fatigue strength of plates and pins. As an indirect benchmark the breaking load of chains is used, and thus fatigue strength is taken into account by including a sufficient safety factor. Type and design of the chain determine the safety factor to be selected. In order to be able to dimension leaf chains, the tensile force F as well and the operating conditions for assessing further dynamic loads have to be known. The tensile force F, the factor f_1 for the operating conditions and the safety factor S are crucial to calculate the required minimum breaking load F_B of the chain.

The safety factor S is subject to the regulations stipulated by various authorities and the German Technical Inspection Authority (TÜV). If there are no specific regulations, the factor S can normally be selected between 7 and 12 according to the type and design (combination of plates) of the respective chain.

Calculation of the minimum breaking load FB

$F_B \geq F \cdot f_1 \cdot S$

$F_B \geq F \cdot f_1 \cdot (n_{LW} \cdot 100 \cdot f_u)^{0,1}$

F_B : Minimum tensile strength of chain

F : Tensile force in chain

f_1 : Operating factor

S : Safety factor

n_{LW} : No. of load cycles (fatigue limit: $n_{LW} = 10^7$)

f_u : Correction factor for PCD

$S = (n_{LW} \cdot 100 \cdot f_u)^{0,1}$

$d_0 = d_u + g$

d_0 : PCD of deflection

d_u : Diameter of contact surface of deflection roller

g : Plate height

p : Chain pitch

Load type	f_1
no impact	1,00
uniform, single slight impacts, slightly swelling load	1,25
repeated slight impacts, moderately swelling load	1,37
repeated slight impacts, highly swelling load	1,59
repeated high impacts, moderately swelling load	1,72
repeated high impacts, moderately swelling load	1,85

PCD d_0	f_u
4,5 · p	9,10
5,0 · p	7,14
5,5 · p	5,95
5,8 · p	5,43
6,0 · p	5,13
6,5 · p	4,52
7,0 · p	3,79
7,5 · p	3,70

Chain speed	**Minimum safety factor S**
up to 5 m/min.	7
> 5 ... 10 m/min.	10
> 10 ... 30 m/min.	12

Further details:

- For temperatures as of 100 °C higher safety factors apply. On request we will give you more detailed information as to these safety factors.
- The higher the number of plates the higher the safety factor S should be.
- For single lacing the safety factor should be higher than for double lacing.

Calculation of the bearing pressure p_r

$$p_r = \frac{F \cdot f_1}{f} \leq p_{rzul}$$

p_r : Bearing pressure
f : Chain joint area
p_{rzul} : Permissible pressure in bearing area
F : Tensile force in chain
f_1 : Operating factor

Chain speed		P_{rzul}
up to	5 m/min.	14000 N/cm²
>	5 ... 10 m/min.	12000 N/cm²
>	10 ... 30 m/min.	9000 N/cm²

In case of permanent tensile force (counter balances) p_{rzul} must be smaller than with a regularly released chain.

Check and maintenance of leaf chains

Permissible wear elongation may be max. 3 %. If a chain has elongated by 3 % caused by wear in the joints, it must be replaced. Therefore leaf chains must be subjected to wear checks at regular intervals. These checks should comprise:

1. Check of elongation in working area (max. 3 %)
2. Check of play in joints (by pushing the chain together, pulling it apart again and measuring the length difference)
3. Check of pin fit in outer plates
4. Check for fatigue failure (cracks in plates)
5. Check for deformed plates
6. Check for corrosion (pitting corrosion)
7. Check of flexibility (sufficient lubrication)

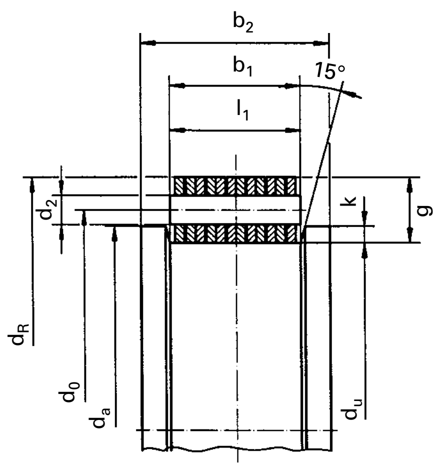
Leaf chains must be relubricated at regular intervals (see as of page 105 - 108). Sufficient lubrication will considerably reduce wear and increase the wear life by a multiple.

Deflection of leaf chains

$d_0 = d + g$
$d_a = d_u + 2 \cdot k$
$d_R \geq d_u + 2 \cdot g$
$b_1 \geq l_1$
p : Chain pitch
d_0 : PCD of deflection
d_R : Diameter with fitted chain
b_1 : Width of contact surface
g : Plate height

$$k = 0{,}86 \cdot \frac{g - d_2}{2}$$

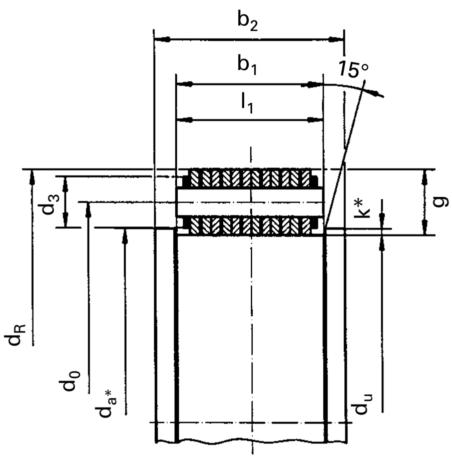
$b2 \geq 1{,}2 \cdot b_1$
d_u : Diameter of contact surface of deflection roller
d_a : Outer diameter of roller
b_2 : Roller width
l_1 : Width of chain over pin
k : Height of collar
d_2 : Pin diameter



Leaf chains heavy duty design U

$$k^* = 0{,}86 \cdot \frac{g - d_3}{2}$$

$d_a^* = d_u + 2 \cdot k^*$
da* : Outer diameter of rollers (for chains with washers)
k* : Height of collar (for chains with washers)
d_3 : Diameter of washers



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 118)

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

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 page 107, 127, 128)
i) Regular operation without overload, impacts or frequent restarts
j) Clean and sufficient lubrication (see page 108 - 111)

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

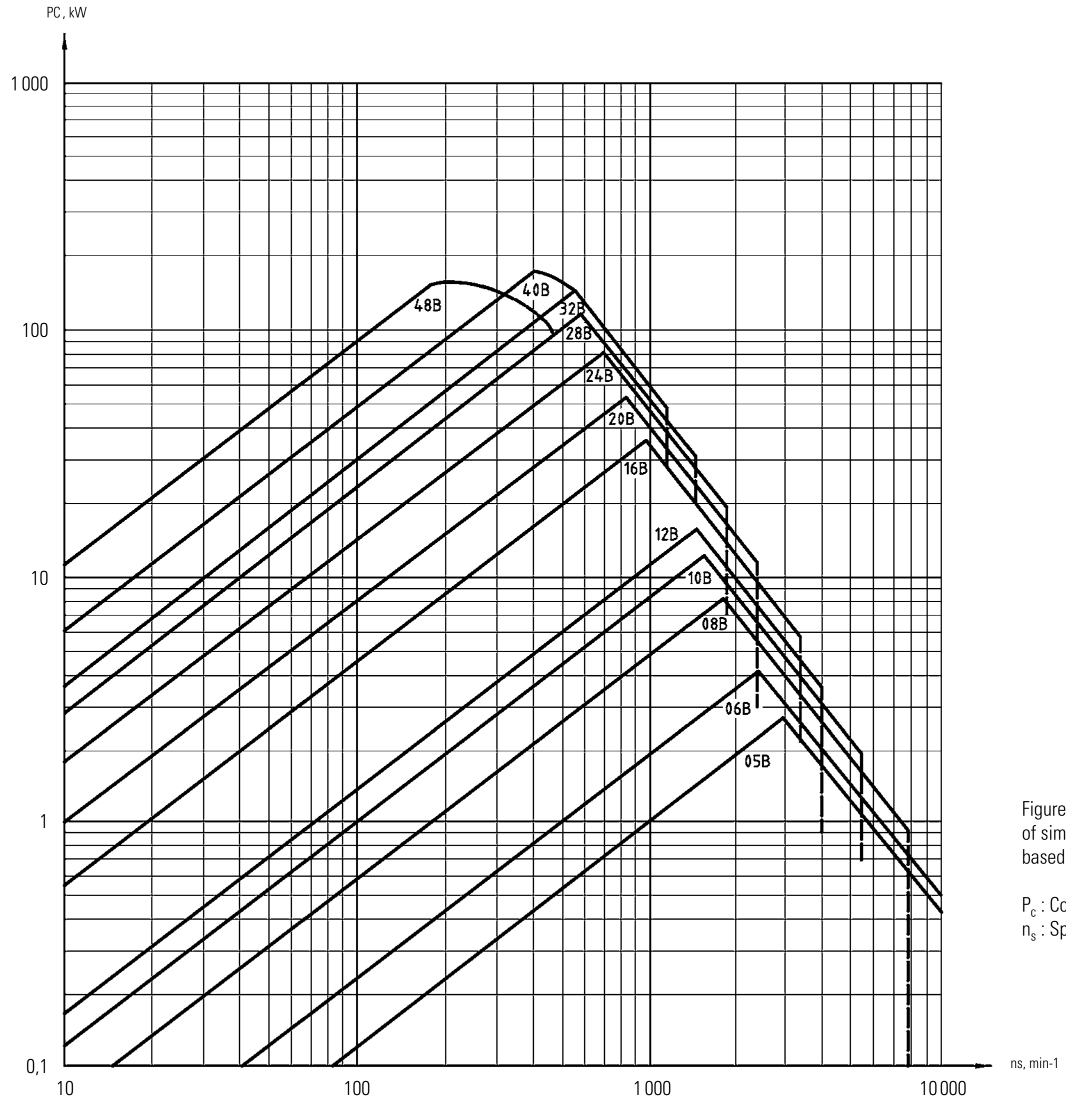


Figure 1: Typical power diagram for selection of simplex chains type B according to ISO 606, based on a sprocket with 19 teeth

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.

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 $Fd = F \cdot fy$ zu berechnen.

The safety factor should be at least S = 7!

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

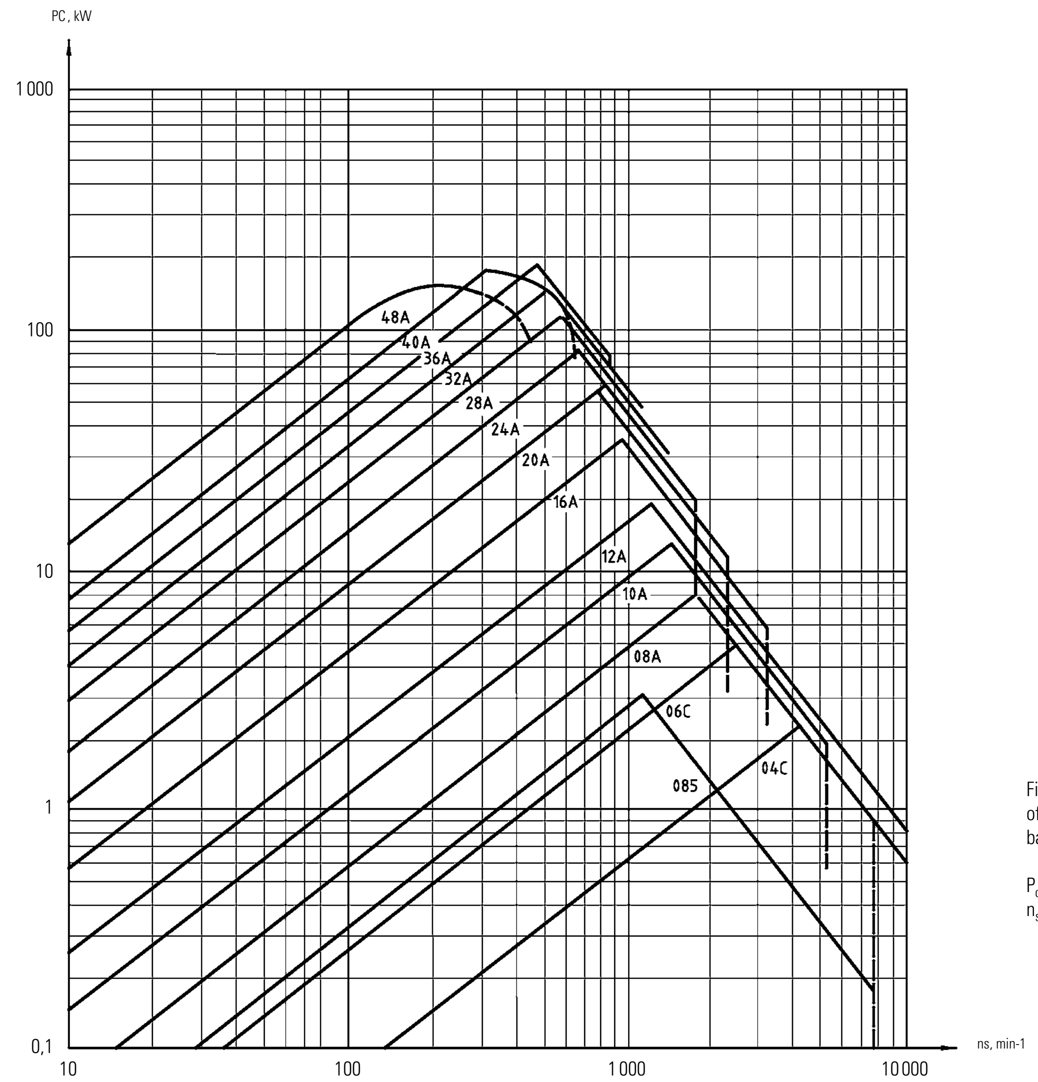


Figure 2: Typical power diagram for selection of simplex chains type A according to ISO 606, based on a sprocket with 19 teeth

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)

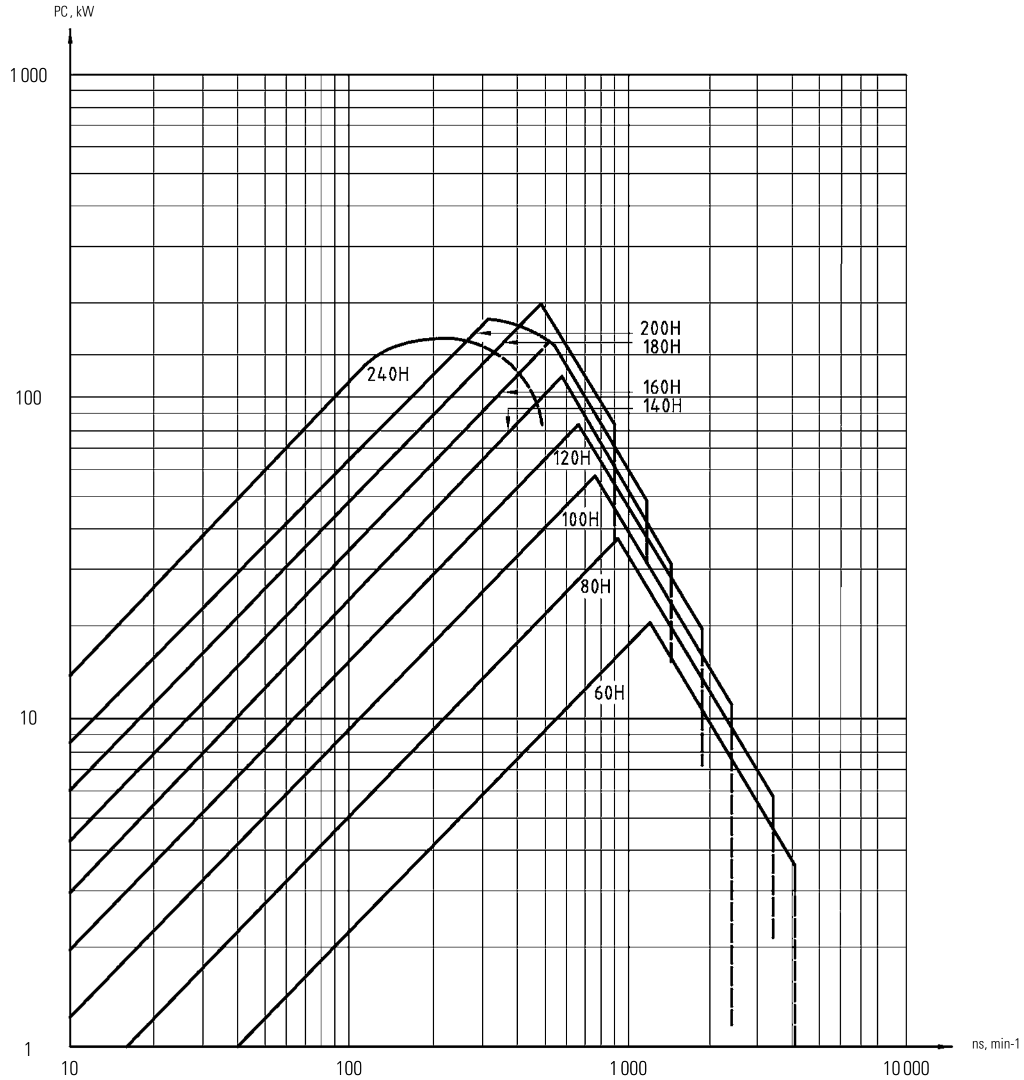
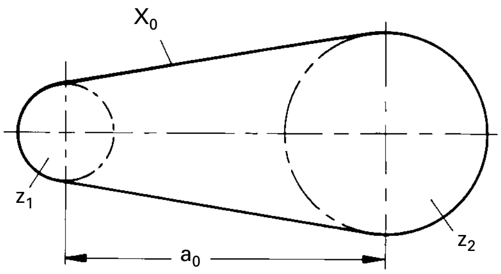


Figure 3: Typical power diagram for selection of reinforced simplex chains type A according to ISO 606, based on a sprocket with 19 teeth

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.



- X = Chain length in links
- X_0 = Theoretical chain length
- a = Shaft distance in mm
- a_0 = Theoretical shaft distance
- p = Pitch in mm
- z_1 = Number of teeth on small sprocket
- z_2 = Number of teeth on large sprocket
- C = Coefficient from table

$$C = \left(\frac{z_2 - z_1}{2\pi} \right)^2$$

With the same number of teeth $z_1 = z_2$ the chain length is:

$$X_0 = 2 \frac{a_0}{p} + z$$

With different numbers of teeth z_1 and z_2 the chain length is:

$$X_0 = 2 \frac{a_o}{p} + \frac{z_1 + z_2}{2} + \frac{C\,p}{a_0}$$

The calculated number of links must always be rounded up. In case of minor differences, one pitch should be added in order to avoid assembly difficulties. If the calculation results in an uneven number of chain links, one single cranked link (0,8 of breaking load) has to be mounted. In such cases it is recommended to select the next even number of links. Then the exact shaft distance can easily be calculated according to the detailed information on page 124.

Values für "C" = $\left(\frac{z_2 - z_1}{2\pi} \right)^2$

Example:

a_0 = 700 mm z_1 = 19
p = 19,05 mm z_2 = 45
C = 17,12 (für $z_2 - z_1$ =26)

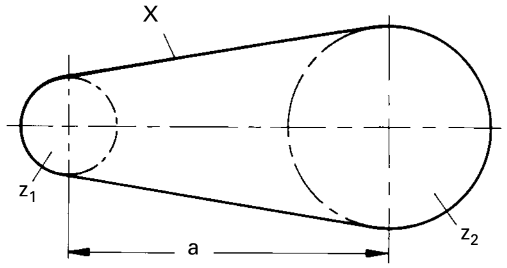
$$X_0 = 2 \frac{a_0}{p} + \frac{z_1 + z_2}{2} + \frac{C \cdot p}{a_0}$$

$$X_0 = \frac{2 \times 700}{19,05} + \frac{19 + 45}{2} + \frac{17,12 \times 19,05}{700}$$

X_0 = 73,49 + 32 + 0,466 = 105,956

X = 106 links

$z_2 - z_1$	C	$z_2 - z_1$	C	$z_2 - z_1$	C	$z_2 - z_1$	C
1	0,025	41	42,58	81	166,19	121	370,86
2	0,101	42	44,68	82	170,32	122	377,02
3	0,228	43	46,84	83	174,50	123	383,22
4	0,405	44	49,04	84	178,73	124	389,48
5	0,633	45	51,29	85	183,01	125	395,79
6	0,912	46	53,60	86	187,34	126	402,14
7	1,240	47	55,95	87	191,73	127	408,55
8	1,620	48	58,36	88	196,16	128	415,01
9	2,050	49	60,82	89	200,64	129	421,52
10	2,530	50	63,33	90	205,18	130	428,08
11	3,070	51	65,88	91	209,76	131	434,69
12	3,650	52	68,49	92	214,40	132	441,36
13	4,280	53	71,15	93	219,08	133	448,07
14	4,960	54	73,86	94	223,82	134	454,83
15	5,700	55	76,62	95	228,61	135	461,64
16	6,480	56	79,44	96	233,44	136	468,51
17	7,320	57	82,30	97	238,33	137	475,42
18	8,210	58	85,21	98	243,27	138	482,39
19	9,140	59	88,17	99	248,26	139	489,41
20	10,130	60	91,19	100	253,30	140	496,47
21	11,170	61	94,25	101	258,39	141	503,59
22	12,260	62	97,37	102	263,54	142	510,76
23	13,400	63	100,54	103	268,73	143	517,98
24	14,590	64	103,75	104	273,97	144	525,25
25	15,830	65	107,02	105	279,27	145	532,57
26	17,120	66	110,34	106	284,61	146	539,94
27	18,470	67	113,71	107	290,01	147	547,36
28	19,860	68	117,13	108	295,45	148	554,83
29	21,800	69	120,60	109	300,95	149	562,36
30	22,800	70	124,12	110	306,50	150	569,93
31	24,340	71	127,69	111	312,09	151	577,56
32	25,940	72	131,31	112	317,74	152	585,23
33	27,580	73	134,99	113	323,44	153	592,96
34	29,280	74	138,71	114	329,19	154	600,73
35	31,030	75	142,48	115	334,99	155	608,56
36	32,830	76	146,31	116	340,84	156	616,44
37	34,680	77	150,18	117	346,75	157	624,37
38	36,580	78	154,11	118	352,70	158	632,35
39	38,530	79	158,09	119	358,70	159	640,38
40	40,530	80	162,11	120	364,76	160	648,46



a = Shaft distance in mm
X = Chain length in links
p = Pitch in mm
z_1 = Number of teeth on small sprocket
z_2 = Number of teeth on large sprocket

The calculation of a chain length rarely results in an even number of links. Mostly, the result must be rounded up. In order to avoid a cranked link in the chain, an even number should be selected.

The exact shaft difference is calculated according to the following formulas:

With the same number of teeth $z_1 = z_2 = z$ the shaft distance is:

$$a = \frac{X - z}{2} p$$

With an uneven number of teeth z_1 and z_2 the shaft distance is:

$$a = p\,[2\,X - (z_1 + z_2)]\;B$$

The coefficient "B" is a function of $K = \frac{X - z_1}{z_2 - z_1}$ and can be taken from the following table.

Example:

X = 106 links $z_1 = 19$
p = 19,05 mm $z_2 = 45$

$$a = p\,[2\,x - (z_1 + z_2)]\;B$$

$$k = \frac{X - z_1}{z_2 - z_1} = \frac{106 - 19}{45 - 19} = \frac{87}{26} = 3{,}34615$$

The table shows a value B = 0,24825 for K = 3,2
and a value B = 0,24849 for K = 3,4

B must be calculated by means of interpolation.
The following applies:

$$\frac{\text{Difference K times table difference B}}{\text{Table difference K}}$$

$$B = 0{,}24825 + \frac{(3{,}34615 - 3{,}2) \times (0{,}24849 - 0{,}24825)}{3{,}4 - 3{,}2}$$

$$B = 0{,}24825 + \frac{0{,}14615 \times 0{,}00024}{0{,}2}$$

B = 0,24825 + 0,00017538 = 0,24843 (rounded up)

The exact shaft distance is

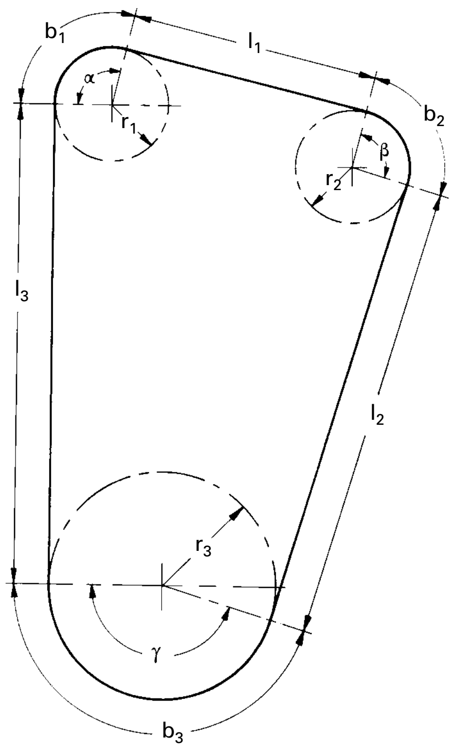
a = 19,05 (2 x 106 - 19 - 45) 0,24843

a = 700,4 mm

Coefficient "B"

K	B	K	B	K	B	K	B
13,0	0,24 991	**2,70**	0,24 735	**1,54**	0,23 758	**1,26**	0,22 520
12,0	990	**2,60**	708	**1,52**	705	**1,25**	443
11,0	988	**2,50**	678	**1,50**	648	**1,24**	361
10,0	986	**2,40**	643	**1,48**	588	**1,23**	275
9,0	983	**2,30**	602	**1,46**	524	**1,22**	185
8,0	978	**2,20**	552	**1,44**	455	**1,21**	090
7,0	970	**2,10**	493	**1,42**	381	**1,20**	0,21 990
6,0	958	**2,00**	421	**1,40**	301	**1,19**	884
5,0	937	**1,95**	380	**1,39**	259	**1,18**	771
4,8	931	**1,90**	333	**1,38**	215	**1,17**	652
4,6	925	**1,85**	281	**1,37**	170	**1,16**	526
4,4	917	**1,80**	222	**1,36**	123	**1,15**	390
4,2	907	**1,75**	156	**1,35**	073	**1,14**	245
4,0	896	**1,70**	081	**1,34**	022	**1,13**	090
3,8	883	**1,68**	048	**1,33**	0,22 968	**1,12**	0,20 923
3,6	868	**1,66**	013	**1,32**	912	**1,11**	744
3,4	849	**1,64**	0,23 977	**1,31**	854	**1,10**	549
3,2	825	**1,62**	938	**1,30**	793	**1,09**	336
3,0	795	**1,60**	897	**1,29**	729	**1,08**	104
2,9	778	**1,58**	854	**1,28**	662	**1,07**	0,19 848
2,8	758	**1,56**	807	**1,27**	593	**1,06**	564

K > 13 B = 0,25



L	= Chain length in mm
X	= Chain length in links
p	= Pitch in mm
$l_{1,2,3}$	= Tangent lengths in mm
$r_{1,2,3}$	= Pitch circle radiuses in mm
α, β, γ	= Central angles in degrees
$b_{1,2,3}$	= Arc lengths in mm
	$= r_1 \text{ arc } \alpha,\ r_2 \text{ arc } \beta,\ r_3 \text{ arc } \gamma$

Example:

(see above drawing)

Chain pitch p = 15,875 mm

r_1 = 43,2 mm α = 104° l_1 = 188 mm
r_2 = 43,2 mm β = 93° l_2 = 345 mm
r_3 = 86,0 mm γ = 163° l_3 = 363 mm

$b_1 = r_1 \text{ arc } \alpha = 43{,}2 \times 1{,}8151 = 78{,}41$ mm
$b_2 = r_2 \text{ arc } \beta = 43{,}2 \times 1{,}6232 = 70{,}12$ mm
$b_3 = r_3 \text{ arc } \gamma = 86{,}0 \times 2{,}8449 = 244{,}66$ mm

$$L = b_1 + b_2 + b_3 + l_1 + l_2 + l_3$$
$$= 78{,}41 + 70{,}12 + 244{,}66 + 188 + 345 + 363$$
$$= 1289{,}19 \text{ mm}$$

$$X = \frac{L}{p} = \frac{1{,}289{,}19}{15{,}875} = 81{,}21 = \underline{\underline{82 \text{ links}}}$$

If a chain runs on several sprockets (as shown in the drawing), graphics will usually suffice to determine the chain length since this method is sufficiently accurate and considerably simpler than mathematical calculations. To begin with, the drive is drawn schematically, if possible on a scale of 1:1 or larger. Then tangents are drawn to the pitch circles, and the central angles of the circular arc spanned by the chain are determined.

For the respective arc values please refer to the table "arc lengths".

The chain length L can then be calculated by adding up the partial lengths.

$$L = l_1 + l_2 + l_3 + \ldots + b_1 + b_2 + b_3 \ldots$$
$$X = L/p$$

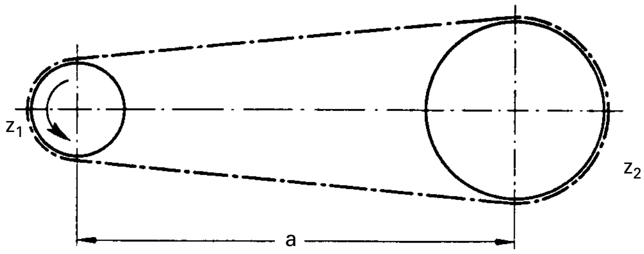
The result must always be rounded up, if possible to the next even number of links. Uneven numbers should be avoided!

Arc lengths for the radius r = 1

Central angle φ°	Arc length arc φ	Central angle φ°	Arc length arc φ	Central angle φ°	Arc length arc φ	Central angle φ°	Arc length arc φ
1	0,0175	46	0,8029	91	1,5882	136	2,3736
2	0,0349	47	0,8203	92	1,6057	137	2,3911
3	0,0524	48	0,8378	93	1,6232	138	2,4086
4	0,0698	49	0,8552	94	1,6406	139	2,4260
5	0,0873	50	0,8727	95	1,6580	140	2,4435
6	0,1047	51	0,8901	96	1,6755	141	2,4609
7	0,1222	52	0,9076	97	1,6930	142	2,4784
8	0,1396	53	0,9250	98	1,7104	143	2,4958
9	0,1571	54	0,9425	99	1,7279	144	2,5133
10	0,1745	55	0,9599	100	1,7453	145	2,5307
11	0,1920	56	0,9774	101	1,7628	146	2,5482
12	0,2094	57	0,9948	102	1,7802	147	2,5656
13	0,2269	58	1,0123	103	1,7977	148	2,5831
14	0,2443	59	1,0297	104	1,8151	149	2,6005
15	0,2618	60	1,0472	105	1,8326	150	2,6180
16	0,2793	61	1,0647	106	1,8500	151	2,6354
17	0,2967	62	1,0821	107	1,8675	152	2,6529
18	0,3142	63	1,0996	108	1,8850	153	2,6704
19	0,3316	64	1,1170	109	1,9024	154	2,6878
20	0,3491	65	1,1345	110	1,9199	155	2,7053
21	0,3665	66	1,1519	111	1,9373	156	2,7227
22	0,3840	67	1,1694	112	1,9548	157	2,7402
23	0,4014	68	1,1868	113	1,9722	158	2,7576
24	0,4189	69	1,2043	114	1,9897	159	2,7751
25	0,4363	70	1,2217	115	2,0071	160	2,7925
26	0,4538	71	1,2392	116	2,0246	161	2,8100
27	0,4712	72	1,2566	117	2,0420	162	2,8274
28	0,4887	73	1,2741	118	2,0595	163	2,8449
29	0,5061	74	1,2915	119	2,0769	164	2,8623
30	0,5236	75	1,3090	120	2,0944	165	2,8798
31	0,5411	76	1,3265	121	2,1118	166	2,8972
32	0,5585	77	1,3439	122	2,1293	167	2,9147
33	0,5760	78	1,3614	123	2,1468	168	2,9322
34	0,5934	79	1,3788	124	2,1642	169	2,9496
35	0,6109	80	1,3963	125	2,1817	170	2,9671
36	0,6283	81	1,4137	126	2,1991	171	2,9845
37	0,6458	82	1,4312	127	2,2166	172	3,0020
38	0,6632	83	1,4486	128	2,2340	173	3,0194
39	0,6807	84	1,4661	129	2,2515	174	3,0369
40	0,6981	85	1,4835	130	2,2689	175	3,0543
41	0,7156	86	1,5010	131	2,2864	176	3,0718
42	0,7330	87	1,5184	132	2,3038	177	3,0892
43	0,7505	88	1,5359	133	2,3213	178	3,1067
44	0,7679	89	1,5533	134	2,3387	179	3,1241
45	0,7854	90	1,5708	135	2,3562	180	3,1416

1. Given are:

(Refer to the drawing in example 1, which illustrates this worked example)



Input power	P = 0,16 kW
Input speed	n_1 = 36 min^{-1}
Output speed	n_2 = 10,75 min^{-1}
Transmission ratio	$i = \frac{n_1}{n_2} = 3{,}35$
Mode of drive	electric gear motor
Driven machine	Conveyor (with uneven charging)
Approx. shaft centre distance	$a_0 \approx$ 530 mm

2. Selection of sprockets

Selected number of teeth on drive sprocket: $z_1 = 17$
Number of teeth on driven sprocket: $z_2 = i \cdot z_1$; $z_2 = 3{,}35 \cdot 17 = 57$

3. Calculations and selection of chain

3.1 Correction of chain

Correction factor for operating conditions: $k = f_y \cdot f_i \cdot f_z$ ($f_y = 1{,}4$; $f_i = 1$; $f_z = 1{,}13$)
Correction factor for number of teeth: $k = 1{,}4 \cdot 1 \cdot 1{,}13$
Corrected power: $P_C = P \cdot k$
$P_C = 0{,}16 \text{ kW} \cdot 2{,}17$
$P_C = 0{,}35 \text{ kW}$

3.2 Selection of chain

For P_C = 0,35 kW and n_1 = 36 rpm the roller chain 10A-1 or 10B-1 is selected from the power diagrams (see pages 117-119)
The chain pitch p for a chain 10A-1 or 10B-1 is 15,875 mm (according to ISO 606).

3.3 Chain length

Calculation of number of links

$$X_0 = 2\frac{a_0}{p} + \frac{z_1 + z_2}{2} + \frac{C \cdot p}{a_0}$$

Here C = 40,529 for $z_2 - z_1 = 57 - 17 = 40$
Result:

$$X_0 = \frac{530}{15{,}875} + \frac{17 + 57}{2} + \frac{40{,}529 \cdot 15{,}875}{530}$$

$X_0 = 104{,}99$

Selected number of links X = 106 (i.e. the next higher even number).

3.4 Chain speed

$$v = \frac{n \cdot z \cdot p}{60\,000} = \frac{36 \cdot 17 \cdot 15{,}875}{60\,000} = 0{,}16 \text{ m/s}$$

4. Maximum shaft centre distance of sprockets

Maximum shaft centre distance:
$a = p\,[2X - (z_1 + z_2)]\,B$

Results B = 0,24567 für $\frac{X - z_1}{z_2 - z_1} = \frac{106 - 17}{57 - 17} = 2{,}23$ (interpolated)

This is the value for the shaft centre distance:
a = 15,875 [2 · 106 - (17 + 57)] 0,24567
a = 538,2 mm

5. Lubrication

For v = 0,16 m/s and for a chain type 10A-1 or 10B-1 the diagram (page 109) shows the lubrication range I. Consequently, the simplest lubrication method, i.e. regular manual oil lubrication, will be sufficient in this case.

General information

Slack span of the return strand for horizontal drives approx. 1 % to 2 % of the shaft distance.

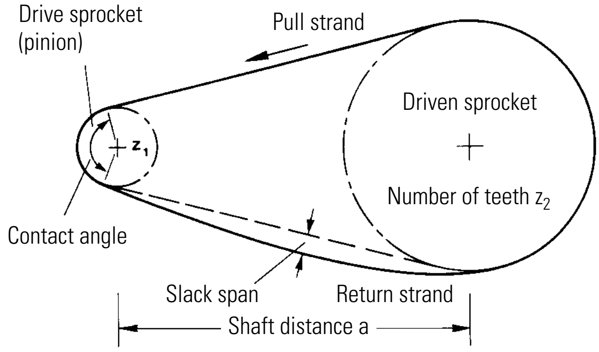
Chain contact angle on the drive sprocket 120° if possible (always the case when $a > d_0 2 - d_0 1$)

at least 90° for higher number of teeth ($z \geq 25$).

The shaft distance is normally 30 times p - 50 times p.

minimal $a_{min} > \frac{dk1 + dk2}{2}$

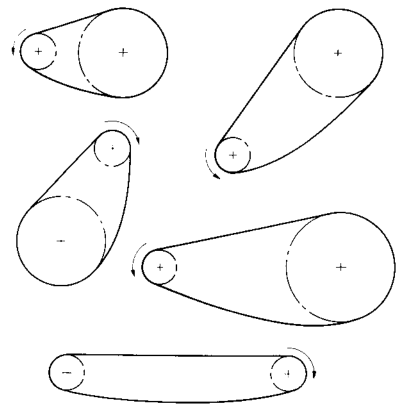
With longer shaft distances, heavy drives or vertical shafts, the chain weight of the pull strand and the return strand must be supported by means of chain support wheels, support rollers or guide strips. The number of teeth on the drive sprocket should be 19 if possible. The minimum number of teeth on a sprocket is 6 (d_o = 2 p), which is then only suitable for manual operation because of the polygon effect!



Chain drive configurations (assessment)

Favourable

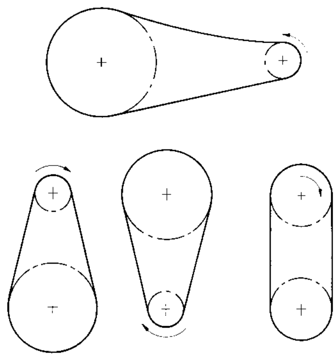
In order to guarantee trouble-free operation and a long wear life, the correct chain run for the different drive configurations has to be selected. A horizontal drive or a configuration with a drive inclined by up to 60° is common and favourable. In this case the pull strand should be at the top and the return strand at the bottom.



Less favourable

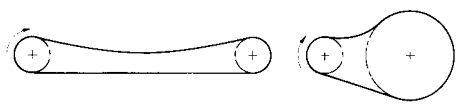
With horizontal drives and normal shaft distances the return strand may also be at the top.

Vertical drives should have the smaller sprocket at the top. The chain must be kept rather tight to stop it from getting slack and jumping off the lower sprocket. A minor deviation from the vertical position will improve the running conditions. It might be necessary to mount a jockey sprocket.

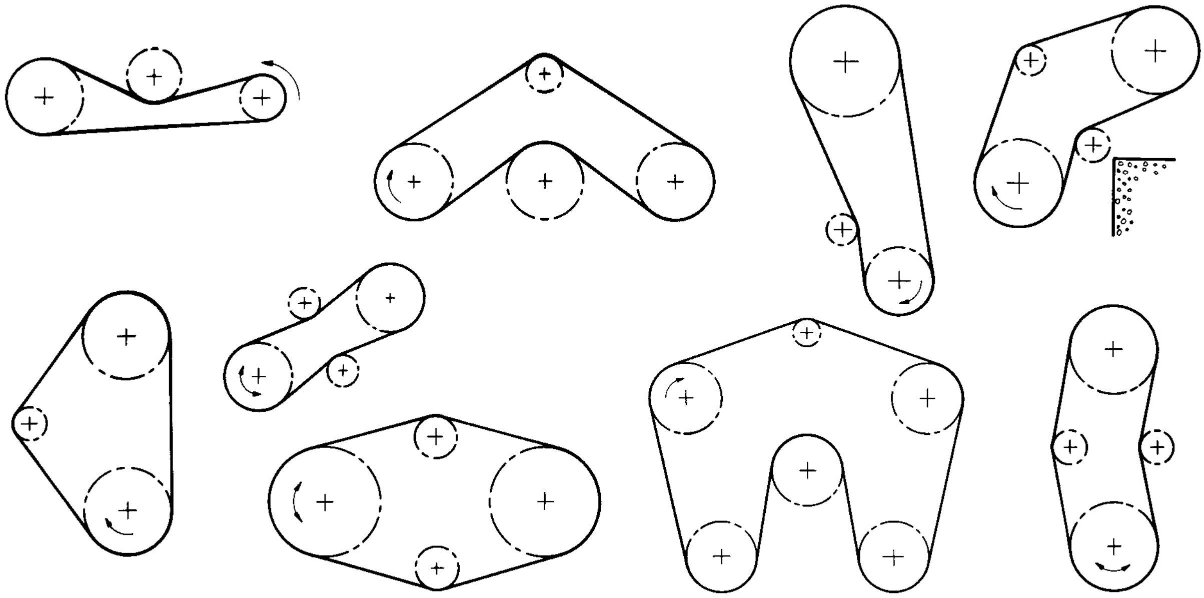


Please avoid if possible

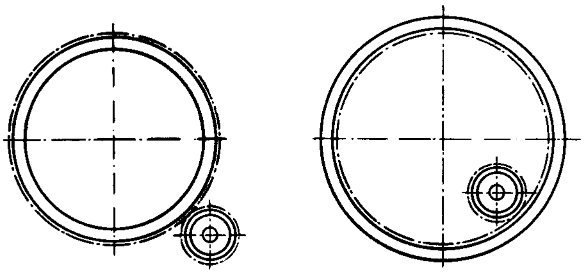
In case of short or long shaft distances the pull strand should be at the top if possible!



Jockey sprockets should have approximately three teeth in mesh with the return strand of the chain. On the basis of the selected number of teeth, the maximum speed (see page 119 "ratio between n and p") must not be exceeded.



Instead of jockey sprockets, support wheels or deflexion pulleys, plastic guide rails might be advantageous in some cases to support or deflect a chain.



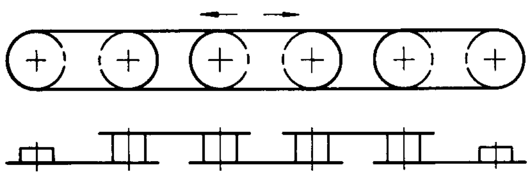
a) as outer sprocket

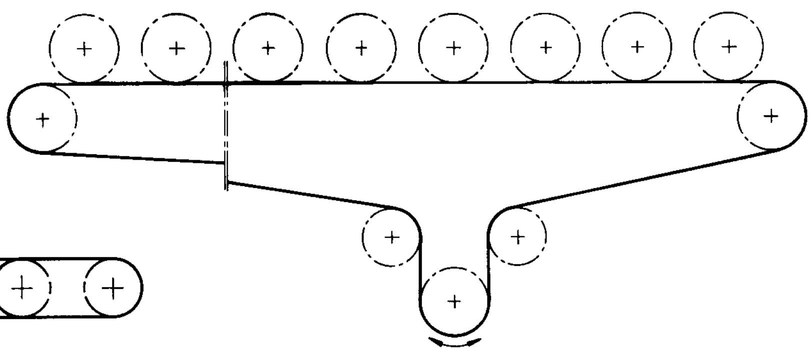
b) as inner sprocket

Roller chain instead of a sprocket for large wheel bodies, drums, revolving platforms etc.

Driving of roller conveyors

a) by means of alternate individual chain strands driving from roller to roller
b) by means of a circulating chain with lantern gear toothing sprockets (p.88)





General information

A chain drive needs relatively little maintenance, if the correct chain was selected, if it was installed correctly and if it is lubricated according to the recommended procedure.

However, the chain should be protected against dirt and adverse environmental influences. A chain protection box helps to prevent dirt, averts accidents and absorbs noise.

In case of protected drives maintenance comprises a regular (annual) cleaning of the oil container and a renewal of the oil filling.

Open running chain drives must be cleaned every 3 to 6 months.

Shorter periods may be necessary, if the chains are very dirty. When cleaning the chain drives, wheel alignment and chain tension should be checked as well.

Cleaning

First of all, in order to clean a chain drive properly, the external rough dirt must be removed by means of a hard or steel brush. Subsequently, the chain is rinsed in cleaning solvent, paraffin or diesel oil.

Furthermore, it is important to clean the inner parts of the chain. Therefore the chain is placed into paraffin, diesel oil or another solvent for approximately 24 hours in order to soak the dirt in the joints as well as the hardened lubrication remnants.

If the chain is moved several times back and forth in the solvent bath, joints will be thoroughly cleaned.

After the chain has been properly cleaned it should not make anymore scratching noises when the links are moved; if it does, the remaining dirt in the joints will form a grinding compound with the lubricating agent, which would destroy the chain very quickly.

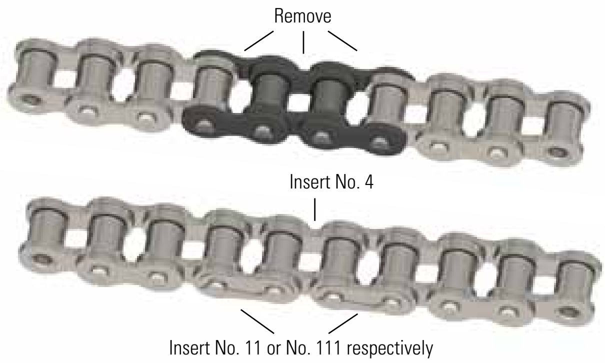
Repair

Subsequently the chain should be carefully examined for defective links, which must be replaced, if necessary.

A damaged outer link is replaced with a connecting link. Outer links are riveted into endless chains.

If an inner link or a roller is broken, the two adjoining links must also be removed; they must then be replaced by an inner link with two connecting links.

With endless chains outer links are to be used. However, if a chain looks really worn, it should be replaced by a new one.



Relubrication

Thorough relubrication is to be carried out immediately after cleaning and, if necessary, repair of the chain. It is important to ensure that quality and viscosity of the lubricant comply with the operating conditions of the chain drive, e.g. temperature and velocity (please refer to pages 105 ff. It is not recommended to add just a few drops from the oil can or simply douse the chain, since the oil will not reach the chain links, i.e. those parts which actually have to be lubricated. Even if the inner and outer plates are oiled, this will by no means guarantee a proper lubrication of the inner parts such as pins and bushings.

For perfect lubrication the chain is placed into a container with liquidised special chain lubricant heated up to 120° C. The chain is left in the lubricant bath until it has reached its temperature, before it is then taken out. Excess lubricant must be allowed to drip off since it will not aid the lubrication of the chains links if it sticks to the outer plates.

However, in practice, such perfect lubrication will rarely be possible. In this case an excellent engine lubricating oil should be used according to the recommendations on page 106 Please ensure that the lubricant will actually reach the links, which are to be lubricated.

Sprockets

The sprocket teeth must be thoroughly cleaned before the chain is finally put back on. It is particularly important to remove dirt sediments, which would stretch the chain, from the bottom of the tooth gaps. Subsequently, the sprocket must be examined in order to determine, if the teeth are worn too much. In case of excessive wear or hooked-shaped teeth, sprockets should be replaced with new ones.

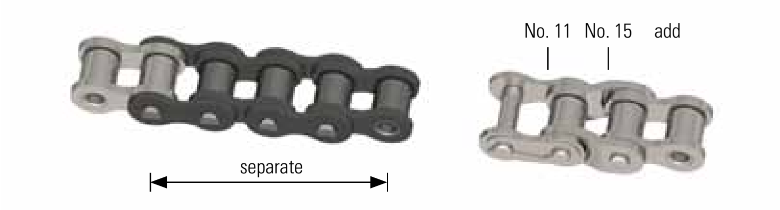
It is not recommended to simply turn a worn sprocket around so that it works in reverse running direction. New sprockets are to be checked according to the specifications on page 92.

Please note that a new chain should never be placed around a worn sprocket, because this will definitely reduce the lifecycle of the chain.

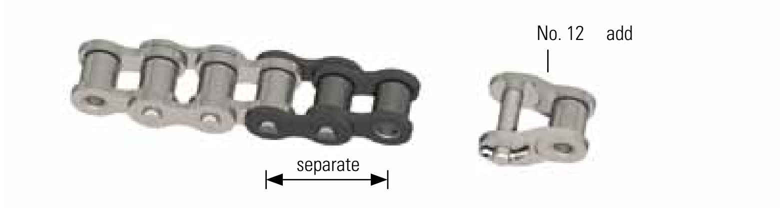
Shortening by 1 link

a) **Even number of links**

up to a pitch of 19,05 mm

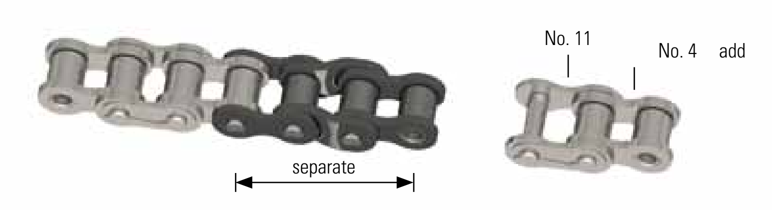


Pitch as of 25,4 mm

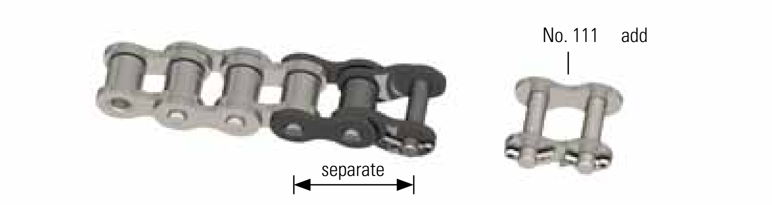


b) **Odd number of links**

up to a pitch of 19,05 mm



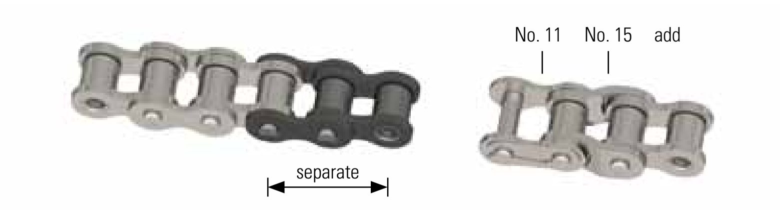
Pitch as of 25,4 mm



Extending by 1 link

a) **Even number of links**

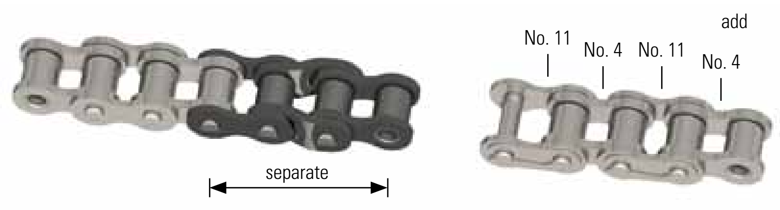
up to a pitch of 19,05 mm



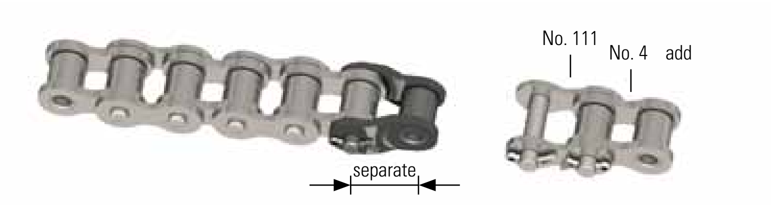
Pitch as of 25,4 mm

b) **Odd number of links**

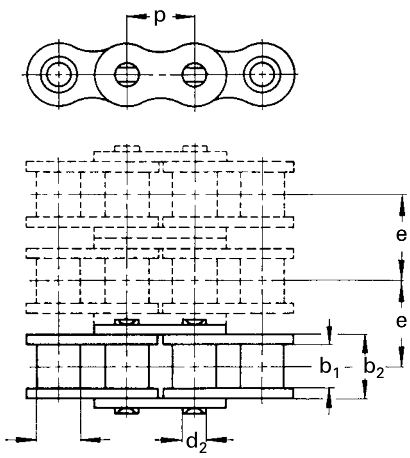
up to a pitch of 19,05 mm



Pitch as of 25,4 mm



Please note: When cranked links are used, roller chains may only have 80 % of the tensile strength.



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.

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

Number of chains

-Chain No. of the basic chain

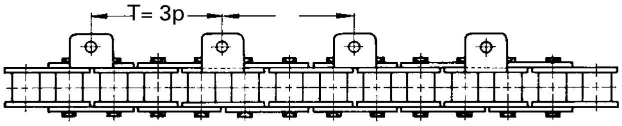
Type of attachment links

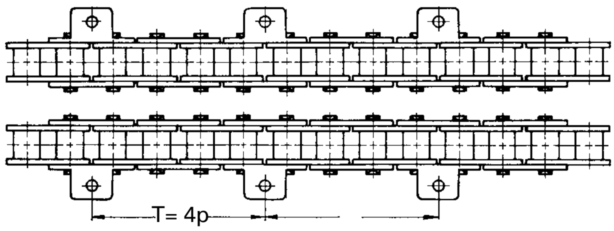
(e.g. A, B, C, D, E or F); for other special designs please state if single-sided or double sided attachments are required.

Attachment spacing T of special links

in (preferably even) multiples of pitch p

If attachments are also available on the inner link, the attachment spacing can be arranged in any way. In case of an odd number (e.g. T = 3 p) the attachment is alternated on the outer and inner rings. If inner link attachments are not available, an odd number spacing can only be made possible by mounting a cranked connecting link No. 12 or a double cranked link No. 15. In this case the chain may only have 80 % of the breaking load!





Length of chain in metres and links

a) When ordered by length in metres, the end links are always inner links. Connecting links must be ordered separately!

b) When ordered by a certain number of links, this number should be divisible by the distance T of the special links (e.g. chain length 176 links, T = 4 p, i.e. every 4^{th} link is a special link; the chain includes 176 : 4 = 44 special links).

If the chain length cannot be a multiple of T, but has to be longer or shorter for design reasons, this fact must be clearly stated as: "Does not work out even!"
In such a case the distance T at the end of the chain will be alternately longer or shorter.

Chains with an even number of links will be delivered with a connecting link and are ready for assembly. With a distance of T = 2 p (each outer link is a special link) the connecting link is supplied in the respective special design. With a distance of T = 4 p and more the connecting link will be supplied in the standard design.

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

Matched or pre-stretched special chains

Parallel running chain strands used for transport and conveying purposes are often required to have highly matching opposite attachments. At extra cost we will supply the appropriately matched chain strands and mark them accordingly.

When ordering your chain, please state clearly: Please supply matched, pre-stretched and marked chain strands!

The installation of guide rails is recommended to help support and guide chains with long span lengths.

Questionnaire for chain drives

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

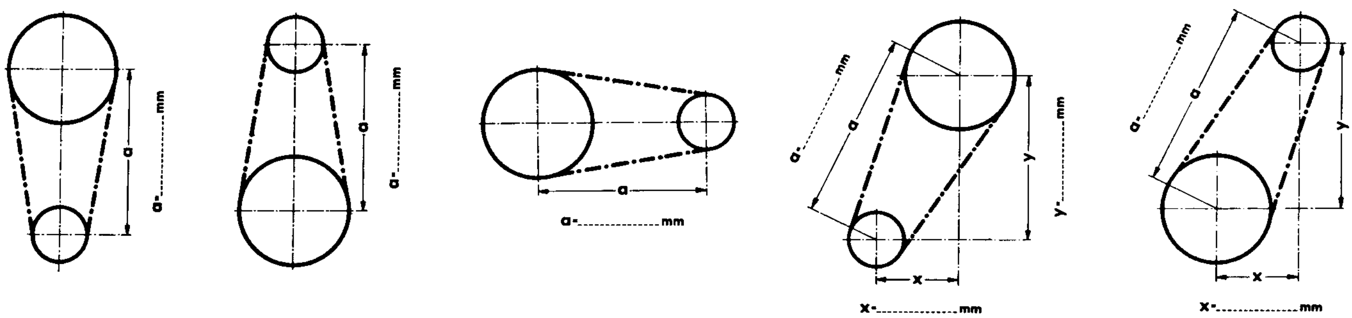
Ambient influences
□ nothing in particular □ dust □ fibres □ sand □ humidity
temperatures up to .... °C corrosion caused by ....

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 (◄►).

Conditions/Symptoms	Possible cause	What to do
One-sided wear on chains and sprockets	1. Shafts not parallel, sprocket and pinion not aligned	1. Realign
Wear on inner plates or on sides of sprocket teeth	1. Sprocket and pinion not aligned or shaft wobble	1. Realign sprockets
Wear on tooth heads	1. Chain elongation 2. Tooth error	1. Replace chain 2. Replace pinion and sprocket
Wear on tooth flanks, sprockets	1. Low material strength	1. Exchange for hardened sprockets
Wear on outer plates	1. Chain striking an obstruction	1. Make sure chain is not obstructed
Chain vibrates with high frequency	1. Eccentricity or sprocket wobble 2. Broken chain roller	1. Replace sprockets 2. Replace chain links or chain
Premature elongation	1. Insufficient lubrication or wrong chain size	1. Increase oil supply and check chain size
Rust-coloured discolouration of chain and pins	1. Insufficient lubrication	1. Improve lubrication
Chain jumps off sprocket	1. Excess chain slack 2. Chain riding too high on sprocket teeth due to chain wear	1. Adjust shaft centre distance or jockey sprocket 2. Replace chain
Broken chain parts	1. Drive overloaded 2. Excess chain slack and chain jumps off sprocket 3. Chain striking solid object 4. Chain speed too high 5. Imprecise toothing on the sprockets 6. Insufficient lubrication 7. Corrosion	1. Select another chain or avoid overload 2. Regular check and adjustment of shaft centre distance 3. Make sure chain is not obstructed 4. Check chain dimensioning 5. Change sprockets 6. Improve and increase lubrication 7. Avoid corrosion or use chains made of stainless material (please enquire)
Excessive noise	1. Chain striking an obstruction 2. Insufficient lubrication 3. Missing or broken rollers 4. Misalignment 5. Chain jumps off sprocket	1. Make sure chain is not obstructed 2. Improve lubrication 3. Replace chain or defective parts 4. Align shafts and sprockets 5. Re-adjust shaft centre distance