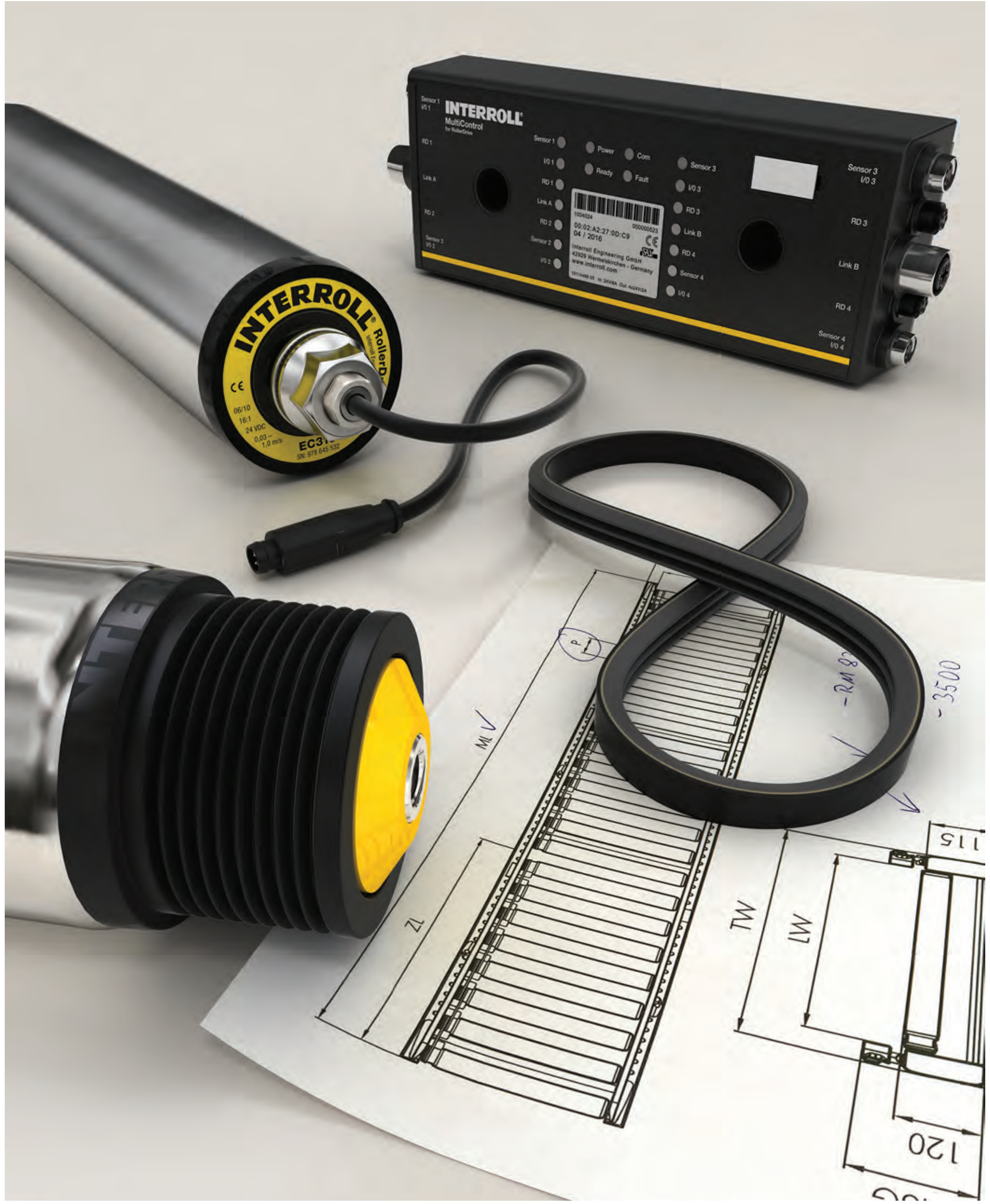

Material

This chapter is intended to provide support in the planning of conveyor systems and the selection of matching products.

The properties of the material to be transported, the requirements with regards the conveyor system and the ambient conditions are the basis for the planning of the system.

Length and width of material

The length and width of the material to be transported have an effect on several factors:

Straight running: The higher the ratio of length to width, the more stable will be the straight running of your items. With smaller length to width ratios, it may be necessary to put in place additional measures to stabilize the straight running of the materials.

Reference length: As a rule, the reference length corresponds to the conveyor width +50 mm or for large materials, such as pallets, +100 mm. In curves, Interroll recommends the use of tapered conveyor rollers whose length must be calculated separately (see page 262).

Roller pitch: To transport the material without problems, the roller pitch must be selected so that the material is carried by three conveyor rollers at any given time.

Surface pressure: The different Interroll conveyor rollers can be loaded with different forces. The static load capacity of a roller can be taken from the respective roller chapter. The values are based on the assumption that a material rests on the complete usable tube length and not just on a part of the tube. If a material has contact with less than approx. 50 % of the usable tube length, please have the application checked by Interroll beforehand.

Very long materials generally do not rest on all rollers that are located under them. If, for example, 20 rollers are under a piece of material, but the material contacts only 15 rollers, then the load capacity of a roller must be greater than one-fifteenth of the material. For very long materials, the tolerance of the roller fastening height should be kept as low as possible so that as many rollers as possible can carry the material.

Height of material to be conveyed

The greater the height of the material in relation to its bottom area, the higher is the risk of it tipping over when traveling on the conveyor. The following must be taken into consideration:

- Minimize the roller pitch as much as possible to ensure that the products are conveyed smoothly with as large a base surface as possible.
- Avoid rapid acceleration and harsh braking. When using RollerDrive, it is very convenient here to select ramps for starting and stopping.
- With inclined conveyor tracks, determine the center of gravity of the material to be transported and check whether there is a risk of it tipping.

Weight and weight distribution of the material to be conveyed

The weight of the material must be distributed on a number of conveyor rollers so that the maximum load capacity of the individual conveyor roller is not exceeded. This may mean that more than three conveyor rollers must support the material.

In principle the weight of the material should be distributed as evenly as possible. The more uneven the weight distribution is, the more difficult a reliable conveyance is.

If the weight in form of the goods is positioned, e.g. only at the start of the load carrier, then it is very likely that the rollers at the end of the load carrier support only very little weight. In the worst case scenario, the rollers at the start of the load carrier could be overloaded.

The greater the diameter of the tube is selected, the higher is the load capacity of the roller. The load capacity is increased if shafts are screwed together. In addition, the shafts reinforce the conveyor and act as a cross tie.

Drives, such as RollerDrive, must be selected so that the torque is sufficient to be able to move a system consisting of several conveyor rollers and drive elements. On top of that, the drive must be dimensioned for the material weight.

Drive elements, such as chains, round belts or flat belts, must also be selected while taking the material weight into consideration. For the container transport area, Interroll recommends the use of PolyVee belts whose service life and torque transmission are significantly higher than for round belts.

Material of conveying material

The material, and especially the condition of the base, has an effect on the rolling and starting resistance.

Hard materials, such as polymer containers, feature lower rolling and starting resistances than soft materials, such as cardboards. This has a direct impact on the required drive output and must be included in its calculation. The softer the underside of the material to be conveyed, the higher is the drive output required for a product with the same weight but with a hard underside. For example, white goods are often packaged with styrofoam on the underside. Depending on the roller pitch, material weight, exposure time and softness of the styrofoam, the styrofoam shapes itself onto the rollers. A waveform matching the roller pitch can then be seen in the styrofoam. On friction conveyors,

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Planning basics

the result can be that the materials will no longer start moving. In principle, the softer the material to be conveyed, the smaller the roller pitch needs to be.

Ribs, keyways, strips or grooves in the bottom of materials to be conveyed that run parallel to the direction of conveyance, do not pose a problem concerning transportability. The required drive output increases depending on their shape. Cross ribs can negatively impact the transporting. It may be necessary to determine the roller pitch empirically.

When checking whether a roller has sufficient load capacity for an application, it is important to take the condition of the material into consideration. Materials with an uneven bottom generally do not rest on all rollers that are located under them. With pallets, it must be ensured that only the rollers under the bulk of the pallet are actually bearing the load. The following diagram shows which runner load distribution occurs for an evenly loaded euro-pallet.

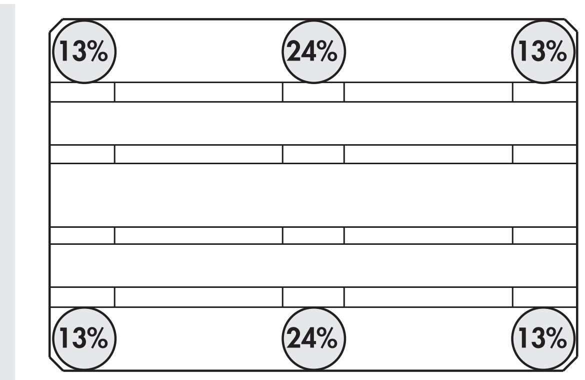


Fig.: Support of 2 runners

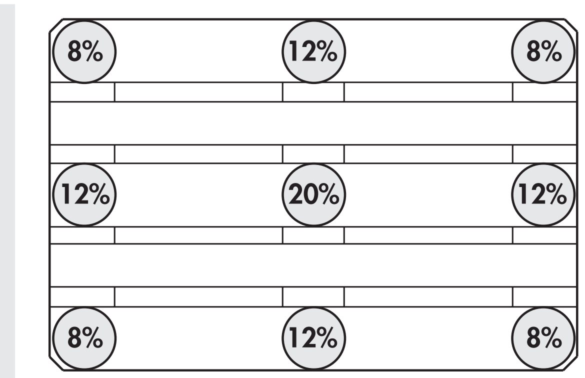


Fig.: Support of 3 runners

Conveyor requirements

The following fundamental parameters determine the configuration of the conveyor:

- Maximum throughput per time unit
- Geometry of material to be conveyed
- Weight and weight distribution of the material to be conveyed
- Control requirements
- Environmental conditions

Static charging

In principle, conveyance via rollers creates electrostatic charging which, among other things, depends on the properties of the material to be conveyed and the tube material.

To prevent electrostatic charging from occurring or dissipate it immediately and without creating sparks, Interroll offers antistatic versions for rollers with steel tube.

An option is available to conduct the charge via an antistatic element at low resistance from the tube to the shaft. If a conducting connection exists between roller shaft and side profile, it allows the charge to be discharged to the grounded side profile. Rollers with sleeve, with tapered elements or with polymer drive head always feature an antistatic element so that they can be connected with ground potential in the area of a tube projection. Static charge cannot be discharged from the PU and PVC sleeve or the gray tapered elements.

Compared to the gray versions, black tapered elements for a tube diameter of 50 mm are suitable for discharging static charges.

All RollerDrive variants, including in the IP66 design, as well as MSC 50, are always designed to be antistatic.

All solutions require the proper manufacturing and check of the conducting connection between shaft and side profile and the grounding of the side profile by the system manufacturer .

Rollers with welded steel sprocket head or double sprocket head can also be connected with ground potential via the chain.

Noise level

Noise is created by different components of a conveyor and the material itself.

Every drive creates noise. The Interroll RollerDrive is designed with decoupling elements which reduce the noise of the gear box. In most cases, the noise level of the RollerDrive is below 50 dBA. More and more zero-pressure accumulation conveyor systems are converted from pneumatic solutions with a centrally arranged drive to a RollerDrive solution. The significantly lower noise level is a deciding factor here.

The following applies to the noises of drive elements: A chain drive causes more noise than a belt drive.

Noise development at rollers depends on the bearing and how it is fastened in the tube. Precision ball bearings, such as those in series 1700, run significantly quieter than bearings such as those used in series 1100. The material of the bearing housing, in which the bearing is installed, also plays a role. A metal bearing housing is installed in series 1200 for extreme ambient temperatures, but it is significantly louder than one of the roller series 1700. Almost all of the roller series from Interroll are manufactured with technopolymer bearing housings in order to obtain the perfect noise reduction.

Very quiet rollers, drives and drive elements are of little use if the material on the conveyor creates noise. Various measures can counteract it. The following should be observed in this case:

- A small roller pitch generally causes less noise than a large roller pitch.
- Watch for small height tolerances at transitions and at the fastening of the rollers/RollerDrive.
- Fitting the rollers/RollerDrive with noise-reducing materials, e.g. with a PVC or PU sleeve
- Use of noise reduction inside of rollers for rollers with a diameter of 50 mm – see page 39

Humidity

Humidity can occur in different forms as a result of the following:

- moist materials, e.g. bottle crates stored in the rain
- moist environment, e.g. sculleries
- applications that become moist, e.g. because of cleaning or tripped sprinkler systems

If humidity can be expected in a system, then all components should be checked for corresponding resistance.

Interroll offers a series of products that are suitable for applications with humidity:

Tube material: Rollers and RollerDrive can be manufactured from rust-free material, such as stainless steel. In addition, materials can be protected with different finishing processes, such as zinc-plating, chrome-plating or carbonitriding.

Shaft material: Shafts can be manufactured from rust-free material, such as stainless steel.

Drive elements: Some drive elements are better suited for moist applications. PolyVee belts are much better suited than round belts which are guided via grooves in the tube. The round belts could slip in the smooth groove.

Drives: The RollerDrive already has a high degree of protection with protection rating of IP54. If high humidity or water jets can be expected in the application, Interroll recommends the design with protection rating IP66.

Bearing: All rollers with precision ball bearings are well protected against moisture and dust. For systems with constant humidity or moisture, Interroll offers designs with stainless steel ball bearings.

For series 1500, all components are suitable for moisture. Shaft pins are made of stainless steel and cannot rust. The tube can be manufactured from stainless steel, and grease cannot be flushed out of the slide bearings used, and the slide bearings cannot rust.

Applications in freezer area

Applications with an ambient temperature of approx. −28 °C are particularly prevalent in the food processing sector. Many items must be taken into account in the so-called freezer area:

- Does the startup of components change, such as for rollers?
- Do drives require more output since the viscosity of grease types may increase or components are frozen?
- Are all the components functionally dependable, even if, e.g., different materials contract differently?

The Solutions from Interroll

Materials: For various products, Interroll offers variants that are particularly suited for freezer applications. The gray tapered elements are not brittle and, for this reason, well suited for freezer applications. The bearing housings of series 1700 are designed as high impact-resistant for freezer applications.

Drives: The RollerDrive EC310 is available in a freezer design. Even after a longer standstill, the RollerDrive starts up again. This is made possible by a special freezer grease and matched components or materials.

Drive elements: Before using a drive element, its suitability for freezer applications should be checked. It should also be ensured that the friction at temperatures below zero is sufficient and the drive elements cannot freeze since frozen drive elements could pose unplanned torque requirements for the drive.

Bearing: The precision ball bearings used also work in freezer conditions. However, the startup of the roller is higher in this case than at an ambient temperature of 20 °C. Drives are either designed for this higher startup, or oiled ball bearings are being used. The oiled bearings run significantly smoother at temperatures below zero.

Under freezer conditions, materials such as steel and polymer contract in different ways. For functional reliability, a PolyVee drive head for a RollerDrive is not only pressed into the steel tube, but it is also flanged. Additional security against twisting is provided by a metal star. This star, which is being produced with laser cutting, is engaged in the drive head and channels itself into the inside wall of the tube. This innovative solution inside the tube allows avoiding interfering edges on the outside contour of the tube. This solution is available as an option for various designs series 3500 and 3500KXO.

Series 1200 is specifically designed for extreme temperature applications. Metal bearing housings in metal tubes offer the highest functional reliability.

Drive concepts

With respect to drives, Interroll distinguishes between drives (such as round belts, PolyVee belts, chains, etc.) and the actual drive. Different drives are used in conveyor systems, such as drum motors, gear motors, motor rollers, etc. Furthermore, the potential energy of materials to be conveyed, e.g. on gravity conveyors, is also being utilized.

Gravity conveyors

A gravity conveyor differs significantly from the other concepts. It is not horizontally aligned, but always mounted at an incline. There are driven and non-driven gravity conveyors. The discussion below refers to a gravity conveyor without drive. Gravity conveyors use the potential energy of materials to be conveyed. This means that other technology must first move the material to a corresponding spatial height.

The material rolls without additional drive as a result of the potential energy up to the end of the conveyor or up to the preceding material. Due to the missing drive, a gravity conveyor is usually a cost-effective solution. The speed and the restart capability of materials is heavily influenced by:

- The incline of the conveyor
- The already existing speed of a material when placed upon the gravity conveyor
- The ease of movement of the rollers
- The conveyor length
- The condition of the underside of a material to be conveyed
- The weight of the material
- Other properties

On the one hand, the material must reach the end of the conveyor. It must not stop because its weight is too low to start moving rollers at rest. If many materials are already on a gravity conveyor and, as a result, a piece of material stops in the last section of the conveyor, then it must be ensured that the last item will start again and reach the end of the gravity conveyor after the first materials have been conveyed.

On the other hand, the speed of the materials must not be or get too high. There is the risk that a material hits another jammed material or the end stop at the end of the conveyor. This creates an injury risk for employees who may want to remove the material by hand, as well as the risk of damaging the material.

Establishing the matching properties of a gravity conveyor becomes a challenge if different materials have to be moved. Generally, the materials on a gravity conveyor differ by at least one of the following properties: Weight, size, material and base condition. A mixture of different materials can also be transported by a gravity conveyor with respect to personnel and material safety as well as process reliability. Interroll offers different products for this purpose. The rollers of series 1100 are designed for use in gravity conveyors.

The following should be observed when selecting rollers for a gravity conveyor:

- Select rollers with particularly smooth startup.
- Rollers with oiled ball bearings turn more easily than those filled with grease.
- The weight of the rollers: The wider the gravity conveyor, the longer and, as a result, heavier the roller. Ideal are rollers with low mass inertia (lightweight tube material).

The magnetic speed controller MSC 50 enables the restart of materials starting at 0.5 kg and reliably decelerates materials up to 35 kg depending on the properties of the conveyor. If materials are lighter than 0.5 kg or heavier than 35 kg, it is also possible to use the RollerDrive series EC310.

The driven RollerDrive ensures that every lightweight material, regardless of its weight, can be moved or moved again. When decelerating heavy materials, the energy recovered by the RollerDrive must not be too high. If one or several RollerDrive are used within a gravity conveyor, it also provides the advantage of accumulation pressure reduction. If a RollerDrive, which may be connected with additional rollers via drive elements, is stopped, then the materials stop. This allows reducing the pressure on materials that are already on the conveyor or on the stop at the end of the conveyor. On long gravity conveyors, it may be advisable to use several RollerDrive in order to reduce the accumulation pressure even further. If the incline is so high that materials slide over the steel tube of stopped RollerDrive or rollers, then the friction may be increased due to PVC sleeve on the tube.

In principle, it is recommended to test every gravity conveyor design under original conditions.

Fixed drive conveyor

If a material moves in harmony with the drive, then it is generally a fixed or constantly driven conveyor. The drive head of the rollers used is permanently connected with the tube. If the fixed drive heads are replaced with friction drive heads, they create a friction conveyor. Depending on the drive element, it is also possible to use rollers without drive head, e.g. for a flat belt conveyor. Many different types of fixed drive conveyors are possible. They generally differ with respect to the selected drive element, such as chains, PolyVee belts, round belts used together with drive shafts or from roller to roller, flat belts, etc. and the drives used.

For all current fixed drive conveyors, Interroll offers matching conveyor rollers, with the RollerDrive EC310, the Pallet Drive and PolyVee belt even drives and drive elements. When using a RollerDrive as drive, it is recommended to place it in the middle of the driven conveyor rollers (for additional planning information about the RollerDrive, see page 268. Information about the Pallet Drive is located in separate product documents.) If many rollers have to be driven, then PolyVee belts offer advantages over round belts. The use of PolyVee belts reduces the number of roller revolutions with increasing distance to the RollerDrive. Additional information is also located in the chapter "Drive Elements" at page 255.

Friction conveyor

Friction conveyors are generally used to transport and accumulate materials. The special thing about friction conveyors is that an accumulation of materials can be accomplished with only little accumulation pressure when the drive is switched on. The same situation on a fixed drive conveyor would cause the materials that were stopped first to receive so much pressure from the subsequent materials that fragile cardboards could be damaged. Friction conveyors are well suited for buffer sections with non-uniform loading and unloading.

Friction conveyor rollers are available with many different drive elements, see page 259. Even a conveyor with drive shaft can be used as friction conveyor. The guide wheel of series 2600 enables not only guiding a round belt, but it also enables the drive shaft to turn while the wheel remains at rest. It must be ensured that the round belt does not slip through as this could significantly shorten its service lie. For additional information, see page 257.

For some application's, it is a disadvantage if the materials touch, even if the accumulation pressure is reduced by the friction operation. In this case, a conveyor working at zero pressure accumulation may be better suited – see the next chapter (for additional information about friction conveyors, see page 259).

Zero pressure accumulation conveyor

The zero pressure accumulation conveying is often abbreviated as ZPA. A ZPA conveyor is generally divided into zones. The zone length is based on the length of the material or the longest material. Each zone features an option of identifying material to be conveyed, e.g. via a photo cell. In addition, every zone can be switched in and out. The zones are driven in different ways, see the examples below.

One option consists of a central drive, often a gear motor, that drives a flat belt. The flat belt is pressed onto the rollers using a switchable unit or guided past them. In the case of bypassing, the rollers are also often decelerated. It is feasible that the flat belt is pressed onto only a few rollers of a zone and the remaining rollers are connected with them by means of other drive elements. In many cases, this switching unit consists of pneumatic valves. They frequently cause an undesired noise level.

Another option always presses the flat belt against a section of a roller in every zone. The remaining portion of the roller is switched in or out via a coupling. The remaining rollers of every zone are connected with the driven roller via other drive elements.

Another concept is the use of decentral drives. Motor rollers are often used for this purpose. In this case, drives which are directly driving the respective rollers, are installed in one or several rollers of a zone. A drive element connecting the entire conveyor is redundant. The remaining rollers of a zone are generally connected with the motor roller(s) using PolyVee belts or round belts. The zones can be activated or deactivated by switching the motor rollers on or off in a targeted way.

Depending on the length of the conveyor, the design with central drive usually falls below the investment costs of a solution with motor rollers. However, the operating costs tend to be higher due to the constant turning of the drive, even when nothing may be conveyed at the time. For most solutions with motor rollers, higher investment costs are possibly amortized after a short time.

Not only the lower energy consumption speaks in favor of a solution with motor rollers, but also the compact design. The motor is installed in a roller and does not have to be placed next to or below the conveyor.

Compared to gear motors, motor rollers are maintenance-free, they do not have to be greased and generally offer a higher safety level with a protected extra-low voltage.

But solutions with motor rollers can also have disadvantages. For solutions with many motor rollers per zone, the availability decreases – the more motors are being used, the higher the probability that a motor roller fails.

For this reason, Interroll recommends the use of the RollerDrive EC310. In this case, one drive per zone is generally sufficient, and flexible control concepts are available. Furthermore, the controls offer many other options, such as change of direction of rotation or start and stop ramps which are not being offered by conventional ZPA conveyors. For technical data, please refer to page 200.

Drive elements (belt, chain)

With respect to drives, Interroll distinguishes between the actual drive, such as RollerDrive, drum motor, Pallet Drive, gear motor, etc. and the drive elements. Drive elements refers to different types of the torque transmission.

Interroll offers conveyor rollers for all common drive elements:

- Chains
- Toothed belt
- PolyVee belt
- Round belt
- Flat belt

In principle, there are two possible types of power transmission for many drive elements:

- Tangential: Via a lateral medium running alongside the conveyor, such as a chain
- Roller-to-roller: From conveyor roller to conveyor roller or from drive shaft to conveyor roller.

Both types of power transmission can be used for friction conveyors and fixed drive conveyors.

Chains

The chain is a tried and trusted method for driving conveyor rollers and conveyor elements in conveyor systems. Chains are characterized by their robustness and durability and are not sensitive to dirt and environmental influences. Very high levels of power can be transmitted with a chain. It is recommended to protect the chain drive against inadvertent contact.

Chains are not maintenance-free and are relatively loud in operation. They must be lubricated regularly in order to achieve an optimum service life. The noise created by a chain as drive element increases with increasing speed. For this reason, speeds higher than 0.5 m/s are not recommended.

Conveyor rollers with flanges welded on are often used for guiding pallets. Guiding pallets via flanges increases the power demand and must be taken into account during the dimensioning of the drive and drive elements.

The maximum drive length to be moved by a drive is limited by the permissible load of the chain. The following factors determine the maximum drive length "L":

- The permissible tensile load of the chain F_{MAX} in N
- The gravitational force of the individual material to be transported F_T in N
- The roller resistance μ of the conveyor track, whereby a value of 0.1 is generally selected
- The projected conveying speed "S" in m/s
- The placement cycle "t" of the materials (in S), i.e. the time between two successive pieces of material to be conveyed

The maximum drive length "L" is being calculated:

$$L = \frac{F_{MAX} \cdot S \cdot t}{F_T \cdot \mu}$$

If the drive station is positioned in the middle of the conveyor for the drive from roller to roller, then twice the drive length can theoretically be implemented. The sprockets that transfer the drive output must not be overloaded in such a case.

Based on the overall efficiency of this system, long drive lengths should be avoided. In many cases, drive lengths of more than 15 m have proven to be problematic.

F_{MAX} can be determined with the permissible breaking load F_B of the chain used. A safety factor of 7 (for which the wear of the chain is also within an acceptable range) is generally used for this purpose so that F_{MAX} can be determined as follows:

$$F_{MAX} = \frac{F_B}{7}$$

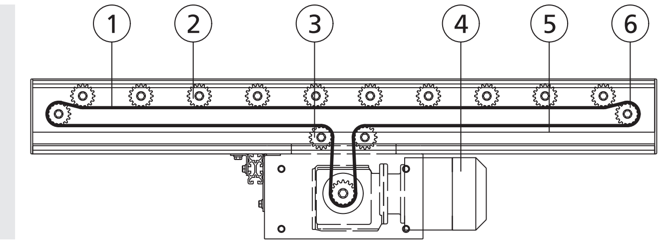
According to DIN, the following breaking loads must be assumed:

Chain designation	Breaking load F_B	F_{MAX}
06B (3/8")	9100 N	1300 N
08B (1/2")	18,200 N	2600 N
10B (5/8")	22,700 N	3243 N

The drive output "P" required for maximum length can be calculated as follows:

$$P = \frac{L \cdot \mu \cdot F_T}{t}$$

Tangential transmission of force



The tangential chain drive is characterized by its good level of efficiency and simple design. The drive head (2) consists only of one sprocket. For this reason, the installation length of the conveyor roller is shorter for a roller-to-roller drive. A single chain (1) drives all of the rollers in a conveyor. The chain is guided to the sprockets by a chain guide profile. The chain guide profile (5) is usually made of special plastic and must guide the chain extremely precisely.

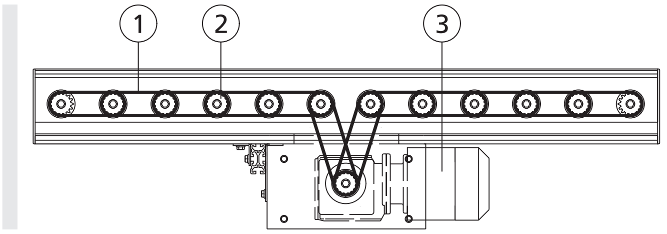
When used in fixed drive conveyors, the sprockets are permanently connected with the tube of the conveyors. Friction conveyors use rollers whose sprockets are not permanently connected with the outside tube. 1 to 2 teeth of the sprockets mesh into the chain and only transfer the driving power required for the individual roller. The chain can be guided either along the top of bottom of the conveyor rollers. The precise positioning of the chain guide in relation to the conveyor rollers is extremely important. The maximum play in terms of height is 0.5 mm. The central motor station (4) must be installed in such a way that the driving side of the chain is as short as possible. It is advisable to provide the motor station with additional equipment for adjusting the chain tension. Idler pulleys (3, 6) guide the chain at the drive and/or end of conveyor in the corresponding direction. It is also possible to use the last conveyor rollers as chain deflection. In this case, it must be ensured that these rollers feature a DIN gearing.

Idler pulleys, which have to carry not only the load of the material to be conveyed, but also the chain traction forces, must be checked specifically with regard to their permissible bearing load. The driven conveyor length is restricted by the permissible breaking load of the chain and by the weight of the material to be conveyed.

The roller spacing (roller pitch) can be selected as required with tangential drives. Compared with roller-to-roller drives, the conveyor rollers are easy to fit and remove with tangential drives since they are not wrapped by the chain.

Starting at 1,000 operating hours, a lengthening of the chain of up to 2 % can be expected.

Wrapped force transmission



With wrapped force transmission, every conveyor roller is connected to the next one by a chain (1). For this reason the conveyor rollers require double sprocket heads (2). They need more space than with a tangential drive, so that the installation length of the roller is longer. Double sprocket heads always feature a DIN gearing (standard gearing).

An additional chain guide is not required. The roller pitch is subject to very tight tolerances and depends on the chain pitch.

$$Pc \cdot \frac{nc - nt}{2}$$

t = Roller pitch
nc =- Number of chain links
nt = Number of teeth of drive head
Pc = Chain pitch

The maximum conveyor length depends on the drive output of the motor station (3) and the permissible breaking load of the chain. The chain experiences its maximum load at the motor station. The tolerances for the roller pitch "Pr" and the breaking load are listed in the following table.

Chain pitch/ designation	**Pc [mm]**	**Tolerance of Pr [mm]**	**Breaking load [N]**	**F_{max}**
06B (3/8")	9.52	0 to −0.4	9100	1300 N
08B (1/2")	12.70	0 to −0.5	18200	2600 N
10B (5/8")	15.88	0 to −0.7	22700	3243 N

Pc = Chain pitch
Pr = Roller pitch

PLANNING BASICS
DRIVE ELEMENTS (BELT, CHAIN)

Toothed belt

The share of toothed belts as drive element in roller conveyor systems is declining. Toothed belts are generally used from roller to roller and are unable to negotiate curves. Compared to round or PolyVee belts, the power requirement of a toothed belt is significantly higher because of its design. This must be taken into account in the selection of the drive. Toothed belts pose a high demand on the tolerance of the roller pitch since the tooth engagement is form-fit with the profile of the drive head. Interroll recommends obtaining the tolerances to be followed from the manufacturer of the selected toothed belt.

One advantage of the toothed belt compared to round and PolyVee belts, is the fact that it passes movements without slipping when used properly. On top of that, toothed belts are low-noise and maintenance-free, lubricating or retensioning is not required.

The drive length of a conveyor with toothed belt drive should be dimensioned so that the overall load of 12,000 N material being conveyed at the same time is not being exceeded.

With the series 3500 and 3600, Interroll offers different conveyor rollers with toothed belt drive head. A maximum toothed belt width of 12 mm and a Poly Chain GT gearing is recommended for the series 3500, a maximum toothed belt width of 20 mm and an HTD gearing for the series 3600.

PolyVee belt

PolyVee belts are ribbed V-belts that are generally used for the torque transmission from roller to roller in roller conveyor systems. The belts must feature a flexible tension member which renders them significantly less flexible than most round belts. Nevertheless, they can accept tolerances within the roller pitch because of their flexibility and used as drive elements in curves. For the installation of PolyVee belts, Interroll recommends the use of a PolyVee tensioning device, see page 241.

Compared to round belts, PolyVee belts can transfer a higher torque of up to 300 %, the service life is longer and, when used properly, a PolyVee belt does not slip over the drive head. In start-stop operation, the rollers can be stopped more precisely and, compared to round belts, a higher number of conveyor rollers can be driven because of the high torque transmission.

Due to the design of the PolyVee drive head and the small width of the belts, they can be placed very close to the side profile. This leads to an optimal tube utilization for materials. With the small diameter of the PolyVee drive head, any contact of PolyVee belt and material is generally ruled out.

In conveyor systems, 2-rib and 3-rib PolyVee belts are generally used. Interroll offers PolyVee belts for these designs for the most common roller pitches (see page 240). The 9-rib drive head also allows using 4-rib belts. The ability of high torque transmission also carries with it a high demand on safety. Injuries, such as jammed fingers between PolyVee belt and drive head, must be avoided. Interroll offers a finger guard for the most common roller pitches. It does not have to be fastened to the side profile and, for this reason, can be used for almost all side profiles (see page 241).

Round belt

Round belts, also referred to as O-rings, are available in different materials, colors and diameters. They are often used for the torque transmission from roller to roller. Long round belts, which may be guided under the rollers and drive several rollers, are rather rare. Round belts are cost-effective with respect to their purchase, are very flexible and can be installed with ease. The disadvantage is a relatively poor power transmission and relatively short service life. For this reason, the use of PolyVee belts predominates in conveyor systems.

Round belts are also being used in conveyors with drive shaft. In this case, a drive shaft runs under the entire conveyor. This shaft is generally driven by a gear motor. Special wheels are usually affixed on the drive shaft (e.g. series 2600, see page 168). One wheel guides and moves a round belt in each case. The round belt is twisted by 90 degrees when it is inserted in the groove of a conveyor roller. The wheels can either be fixed or sit loosely on the drive shaft. In case of a loose connection, it creates a conveyor with low accumulation pressure, see page 254.

Interroll offers several products for the use of round belts.

Series 1700: Rollers can be fitted with grooves as follows to be able to guide round belts:

- With one groove for the use described above in a conveyor with drive shaft
- With two grooves, e.g. for use in a conveyor with torque transmission from roller to roller
- With up to 4 grooves for additional application scenarios

Series 3500: As an alternative to guiding via grooves, Interroll offers a round belt drive head. The drive head made from polyamide offers the advantage that the round belts can be guided closer at the end of the roller or at the side profile of the conveyor. In this case, it is more likely to separate torque transmission and running surface of materials to be conveyed.

The round belt head offers a higher conveyance for most belts because of its material. This significant advantage must be taken into account if acceleration and deceleration for start-stop operation are so high that the belt briefly slips and wears out. The better the conveyance from the guide, the higher the wear in this case. Groove solutions in tubes and also the round belt drive head offer 10-mm wide grooves. This allows using round belts with a maximum diameter of 6 mm. In case of higher round belt diameters, there is the risk of two contact points of the round belt

– at the bottom and at the side of the groove. In this case, the belt is subjected to two different speeds and experiences above average wear.

Series 2600: The series offers a wheel which enable guiding round belts on drive shafts.

Flat belt

Flat belts are used for tangential force transmission. In this case, the flat belt is guided under the rollers and, in each case, pressed against a part of the roller. This can be the tube or a drive head. Flat belts are used to construct fixed drive conveyors and friction conveyors. It is also possible to drive zero-pressure accumulation conveyors with flat belts. In such a case, the flat belt is permanently driven. Stopping subsections is done by decoupling the roller with the moving flat belt. Given the constantly turning central drive, this type of zero-pressure accumulation conveying leads to significantly higher energy consumption. Interroll recommends the use of RollerDrive as an alternative.

Flat belts hardly ever need any maintenance. A precise guiding of the belt is required. The flat belt is generally put in motion by a gear motor can must be brought to a pretension of approx. 1 % with a tensioning device. The drive power is generally transmitted more reliably if the loop angle of the flat belt on the roller can be increased with narrowing wheels.

Interroll offers different products for the use of flat belts. The conveyor rollers of series 1700 are frequently used for fixed drive conveyors. The series 3500 as fixed drive head is available with a flat belt drive head. The series 3800 offers friction solutions for flat belts. And the series 2600 offers several pressure rollers to guide and press on flat belts.

Friction rollers

Introduction

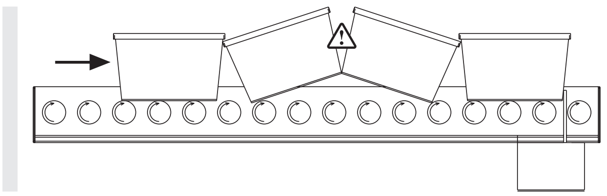
If materials are accumulated on a roller conveyor and the rollers continue to be driven, it creates accumulation pressure. This accumulation pressure continues to grow the more materials are being driven by rollers. As a result, it can damage the underside of the material to be conveyed. In addition, it is possible that the first piece of material, which is generally stopped by a mechanical stopper, will be squashed. Friction rollers prevent these problems by reducing the accumulation pressure.

Friction rollers are based on the principle of the slip coupling. In this case, the friction force in the coupling must overcome the rolling friction between material and roller. Friction rollers offer the option of setting up accumulation conveyors with minimal accumulation pressure. When materials are stopped, the rollers will also stop. The drive of the friction rollers continues to turn in this case. When the stop is canceled, the complete roller units turn again and move the materials. In this case, the conveyance is load-dependent.

The bearing housing of the series 3800 is designed as a greased-for-life slip coupling and guarantees the roller's constant conveyor force. A tangential drive has proved itself to be especially economical when used on friction conveyors. For this purpose, a central drive moves a long chain or a flat belt. The flat belt or the chain are guided past the drive unit underneath the conveyor rollers so that all conveyor rollers are operating.

Application notes

- Materials to be conveyed
  - Even and stable bases of the materials to be conveyed are ideal so that each friction roller carries the material evenly. Soft, lightweight or uneven materials, e.g. cardboards, can be unsuitable for a friction conveyor.
  - Only those materials can be used that prevent a mutual lifting out because of their shape. If necessary, the number of materials to be accumulated must be restricted.
  - Round materials are generally not suitable since they distribute randomly on the conveyor during accumulation. To prevent round materials from falling off of the conveyor during accumulation, a suitable side guide is required.



- The conveyor force, which is produced by the friction roller by means of friction, regulates itself relative to the weight of the material to be conveyed. The conveyor force is seriously affected by the following factors:
  - Weight of conveyed material
  - Base condition of material to be conveyed
  - Position of material to be conveyed
  - Humidity
  - Temperature
  - Percentage of accumulation mode over the entire running time

  These factors have, to an extent, a considerable effect on the operation and operational lifespan of the conveyor roller. The task is to find out the sufficient conveyance for the respective material to be conveyed. A dimensioning test under original conditions is generally required for this purpose.
- To enable starting up the conveyor even with complex materials, the following measures may be helpful:
  - Selection of the correct friction roller. An adjustable or a double friction roller may be better suited.
  - Reducing the roller pitch: With less load on each roller, its conveyance ability is also reduced.
  - Creating an axial force of the drive head against the bearing housing, similar to the adjustable friction roller.
  - Design of a minor incline in conveying direction
- Duration of accumulation mode
  - Accumulation mode should only be used for as long as is necessary. When it can be seen that no conveyance will take place, then the central drive should be switched off. No energy will be used and the service life of the conveyor system will be increased. An overtemperature of the abradant polymer elements must be avoided.
  - For long accumulation mode, steel sprocket drives offer an improved dissipation of the friction heat.
- Placement of material to be conveyed
  - If the material is significantly narrower than the friction roller, it can affect the conveyance ability. With single friction rollers, the conveyance decreases the further away the material is from the friction drive.
  - The same applies to the center of gravity of a material to be conveyed. The closer the center of gravity is to the friction drive, the better the conveyance.
- Friction roller
  - Flanges as well as other side guides cannot be used for friction rollers. The friction that is being created could possibly not be overcome by the conveyor force of the friction coupling.
  - The use of friction rollers represents a minimum requirement on the tolerance of the installation height of the rollers. If a friction roller that is installed at a low level is followed by a roller installed slightly higher, this may represent an interfering edge to the material to be conveyed that cannot be overcome.
  - When using tube sleeves (e.g. PVC sleeves), a maximum sleeve material thickness of 2 mm is recommended.
- The maximum permissible conveying speed is 0.5 m/s.

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FRICTION ROLLERS

- Use only under dry conditions
- The bearing housings that are part of the friction element, contain pockets. These pockets are filled with special grease. The grease must not be removed! It allows better startup values, due to the high adhesive force of the grease. In addition, friction heat that is being created, is dissipated better through the grease, and the wear of the polymer parts is reduced.
- The conveyance values listed below are non-binding. They refer to standard climate (65 % relative humidity and a temperature of +20 °C) and material positioned in the center.

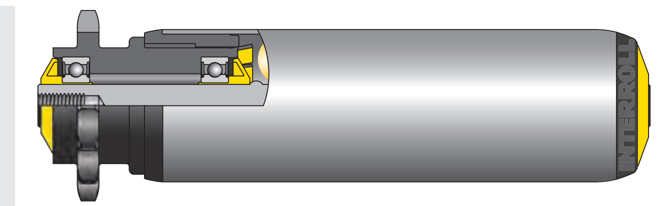
Conveyor force	Friction	Ø Friction roller [mm]
4 – 6 %	One-sided friction element	50
2 – 5 %	One-sided friction element	60
8 – 13 %	Two-sided friction element	50/60
4 – 6 % (12 %)	One-sided, adjustable friction element	50/60

Functional differences

Series 3800

Series 3800 offers different drive heads. A drive head is set in motion using a drive element and turns inside the bearing housing. The bearing housing applies force onto the drive head with the weight of tube and material to be conveyed. This friction force causes the conveyance of bearing housing and tube. The material to be conveyed is moved through the rotation of the tube.

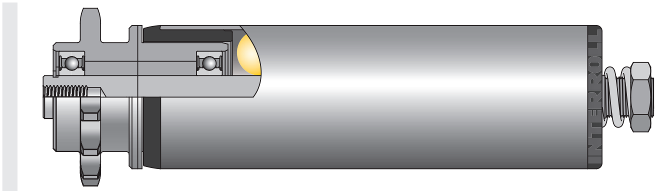
If the material is stopped, the tube stops and the drive head turns inside the bearing housing.



The product description of series 3800 is located on page 128.

Series 3800 – adjustable

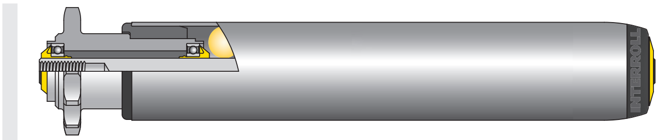
With the adjustable series 3800, a 1/2" steel sprocket drive head with 14 teeth is available, whereby the operating principle corresponds to the one described above. In addition, a male threaded shaft protrudes from the roller on the other side of the drive head. There is a nut and a spring on the shaft. Tightening the nut tensions the spring, which exerts an axial force from the drive head onto the bearing housing. This axial force increases the conveyance to up to 12 % of the roller load. The more the nut is tightened, the earlier the tube is turning.



The product description of the series is located on page 128.

Series 3800 light

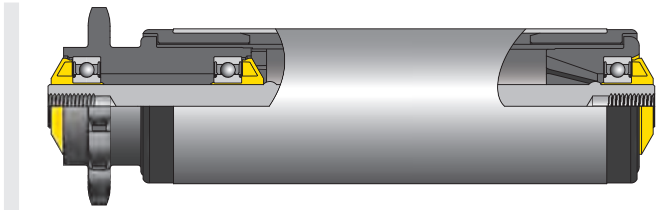
The series 3800 light offers a single friction solution as well as a double friction solution. The rollers have a diameter of 30 mm. The single friction rollers are equipped with steel sprocket heads and the double friction rollers with polymer drive heads for flat belts. The operating principle of the single friction corresponds to that of series 3800 and that of the double friction to that of series 3870.



The product description of series 3800 light is located on page 124.

Series 3870

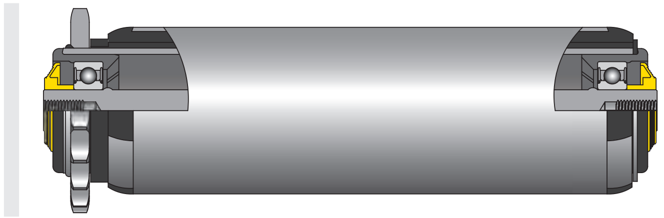
Series 3870 offers different polymer sprocket heads. A drive head and a bearing assembly on the other side are pressed into an internal tube. This unit is integrated into the external tube. The operating principle corresponds to series 3800, whereby the internal tube rotates in the two bearing housings of the external tube. If a material to be conveyed is stopped, the drive head turns together with the internal tube, and the external tube is standing still. The advantage of this solution is that both sides of the roller feature a friction unit and conveyor force is generated with an off-center load.



The product description of series 3870 is located on page 138.

Series 3880

Series 3880 offers a single and a 5/8" double sprocket head with 18 teeth. The operating principle corresponds to series 3870, whereby series 3880 does not use a drive head. The sprocket disk used here is welded onto the internal tube. With a roller-to-roller drive, two sprocket disks are welded onto the internal tube.



The product description of series 3880 is located on page 144.

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PLANNING BASICS
HOW TO BUILD A CURVE?

How to build a curve?

It is possible to build roller curves with cylindrical rollers. With such a design, materials to be conveyed are not conveyed in the center of the curve, but alongside a required side guide. This requires more energy and it poses the risk of damage to the side guide or material that is being conveyed. For this reason, the design with tapered conveyor rollers is recommended.

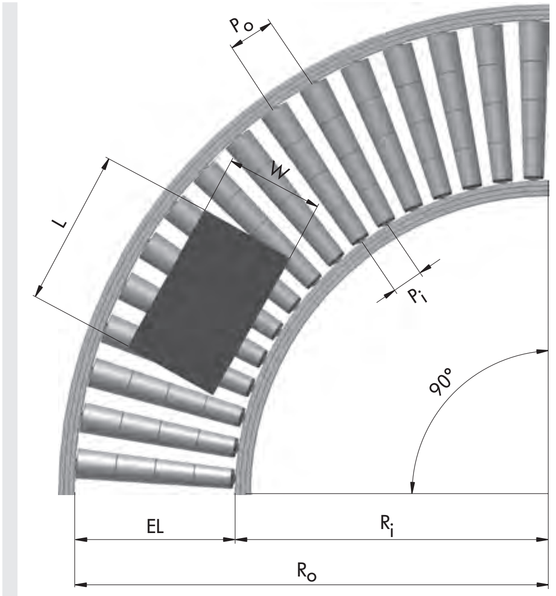
The diameter of the tapered rollers increases towards the direction of the outside curve diameter. With the increasing diameter, the circumferential speed increases. This allows materials to be transported through the curve without losing their orientation. With the usual speeds (max. 0.8 m/s) and ideal curve design, a side guide is not required.

Interroll offers different curve-capable rollers that feature the designation KXO. These are rollers with cylindrical steel tube onto which tapered elements are pushed. The following series are suitable for use in roller curves.

Series	Based on Ø [mm]	Conicity	Drive elements
3500KXO light	20	1.8°	Round belt
1700KXO	50	1.8° and 2.2°	Round belt
3500KXO	50	1.8° and 2.2°	Round belts, PolyVee belts, chains

Curve dimensioning

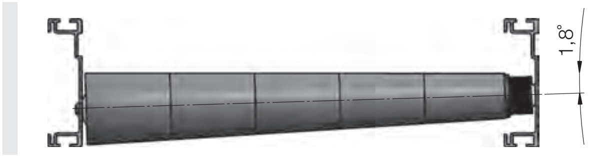
Based on this curve diagram, Interroll recommends the following steps:



EL	Installation length of the conveyor roller	R_i	Internal radius of the curve
L	Max. material length	P_o	Roller pitch on the external diameter
W	Max. material width	P_i	Roller pitch on the internal diameter
R_o	External radius of the curve		

1. Curve definition
   - Driven or non-driven curve (for the drive, see RollerDrive EC310 page 200)
   - With driven curves, determination of the drive elements (see sub-chapter Drive elements on page 263)
2. Selection of the roller series (drive element, based on a diameter of 20 or 50 mm)
   - Series 3500KXO light see page 102
   - Series 1700KXO see page 76
   - Series 3500KXO see page 106
3. Determining the dimensions of the largest possible material to be conveyed
4. Selecting the inside radius (note under "Radii")
5. Calculating the minimal outside curve radius R_o
   $R_o = 50\text{ mm} + \sqrt{(R_i + W)^2 + \left(\frac{L}{2}\right)^2}$
6. Calculating the minimal installation length of the conveyor rollers
   Installation length $EL_{MIN} = R_o - R_i$
7. The reference lengths of the rollers are calculated based on the lengths of the tapered tube sleeves. The lengths must be greater than the calculated installation length.
8. Calculating the actual installation length of the selected curve roller (see the note in the respective chapter of the roller series)
9. Calculating the actual outside curve radius R_o
   $R_o = EL + R_i$ with selected standard EL
10. Determining the roller pitch at the inside diameter or angle between the rollers
11. Calculating the roller pitch at the outside diameter P_o
   $P_o = P_i \cdot \frac{R_o}{R_i}$

Installing the rollers



For the curve construction, it must be taken into account that the top side of the curve roller is level. Hence, the fastening shaft of the roller is not horizontal. As a result, vertically arranged side profiles do not have a 90° angle. For this reason, Interroll recommends an angle compensation so that the fastening shaft does not experience any warping. Due to the required angle compensation, curve rollers cannot be designed with tapered shaft-shuttle. RollerDrive can be used in curves only with protection rating IP54, and Interroll also recommends implementing an angle compensation in this case.

The installation length of curved sections must be longer than that of straight sections to ensure that the material to be conveyed does not touch the side guide in the curve. Please select the next larger installation length grid.

Drive

Using a RollerDrive as the drive for driven roller curves has established itself as the most cost-effective and attractive of all drive solutions. Curves with RollerDrive combined with the aforementioned tapered conveyor rollers are silent, compact and have a simple design.

Drive element

Round belts, chains and PolyVee belts are suitable as drive elements.

Round belts can be guided via grooves which are located in the area of a tube projection. As an alternative, round belts can also be guided via a drive head at the inside radius.

PolyVee belts are exclusively guided via a drive head, also at the inside radius.

A roller-to-roller drive is often implemented for chains. In such a case, the chains are guided via double sprocket heads at the outside radius.

The most frequent solution is the PolyVee belt. For use in curves, 2-rib and 3-rib flexible belts are suitable. The belts must occupy the first grooves from the direction of the inner curve radius. A distance of one groove is required between the two belts. Please read the notes in the chapter Drive Elements page 255.

Length of tapered elements

1.8° elements: The first tapered element has a length of 45 mm or 95 mm. All additional elements have a length of 100 mm. This allows selecting the total length of the tapered elements in increments of 50 mm. The different lengths of the first tapered elements result in 2 different inside curve radii.

2.2° elements: The length of the first tapered is always 140 mm. Hence, the inner curve radius does not vary.

Radii

Different inside curve radii can be created with the different Interroll curve rollers. A material will be conveyed perfectly through a curve only if the radii are being maintained.

Curve rollers of series 1700KXO and 3500KXO can be manufactured with a tube projection. It is possible that the tube projection is located on the side of the tapered element with the smaller diameter. The first tapered element will then have the corresponding distance to the curve side profile. With this design, it must be taken into account that the inner curve radius must be reduced with a tube projection of more than 20 mm. A tube projection on the side of the tapered element with the larger diameter does not have any effect on the inner curve radius.

Inside curve radii for rollers with PolyVee or round belt drive head

Inner curve radius	Conicity	Roller series	Roller reference lengths [mm]
660 mm	2.2°	3500KXO	190, 240, 290, 340, 440, 540, 640, 740
820 mm	1.8°	3500KXO	150, 250, 350, 450, 550, 650, 750, 850, 950
770 mm	1.8°	3500KXO	200, 300, 400, 500, 600, 700, 800, 900, 1000

Inner curve radii for non-driven rollers

Inner curve radius	Conicity	Roller series	Roller reference lengths [mm]
357 mm	1.8°	3500KXO light	150, 250, 350, 450, 550
357 mm	1.8°	3500KXO light	200, 300, 400, 500, 600
690 mm	2.2°	1700KXO	190, 240, 290, 340, 440, 540, 640, 740
850 mm	1.8°	1700KXO	150, 250, 350, 450, 550, 650, 750, 850, 950
800 mm	1.8°	1700KXO	200, 300, 400, 500, 600, 700, 800, 900, 1000

Inner curve radii for rollers driven via chain

Inner curve radius	Conicity	Roller series	Roller reference lengths [mm]
690 mm	2.2°	3500KXO	190, 240, 290, 340, 440, 540, 640, 740
850 mm	1.8°	3500KXO	150, 250, 350, 450, 550, 650, 750, 850, 950
800 mm	1.8°	3500KXO	200, 300, 400, 500, 600, 700, 800, 900, 1000

Inside curve radii for rollers with grooves

Grooves are applied within a tube projection at the inner curve radius. The table "Inside curve radii for non-driven curves" lists the curve radii for the rollers of series 1700KXO. The tube projection must then be subtracted from the corresponding curve radius.

Roller pitch

The roller pitch depends on the selected drive element.

PolyVee belt: For example, if a PolyVee belt is used in the curve for a roller pitch of 75 mm, then a hole pitch of 73.7 mm must be planned at the inside radius. The roller pitch at the outside radius can be calculated using the following formula:

$$P_o = P_i \cdot \frac{R_o}{P_i}$$

P_o = Roller pitch on the outside diameter
P_i = Roller pitch on the inside diameter
R_o = Outside radius of the curve

Interroll recommends an angle of 5° between two rollers. The angle must not be greater than 5.5°.

Round belts: Any length can be used here. To ensure a sufficient distance of the rollers,Interroll recommends not to plan more than 22 rollers in a 90° curve. This also applies to non-driven curves.

Chains: The chain as drive element allows only a limited number of roller pitches. The roller pitch is always a multiple of the ½" chain pitch and can be calculated as follows:

$$P_{Chain} = \frac{(N_T - N_c)}{2 \cdot 12.7}$$

P_{chain} = Chain pitch
N_c = Number of teeth
N_T =- Number of chain links

The calculation of the roller pitch is performed at the outside radius. With a roller-to-roller drive, the inside and outside sprockets are used alternatingly. The roller pitch should be dimensioned so that a chain on the outside sprockets is perfectly tensioned. With the same roller pitch in the curve, the chain on the inside sprockets will be tensioned a little bit less because of the reduced distance of the sprockets to each other.

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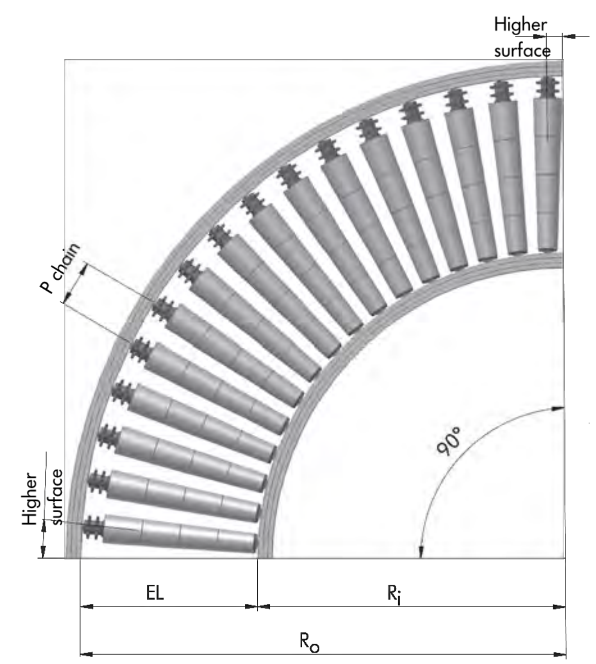
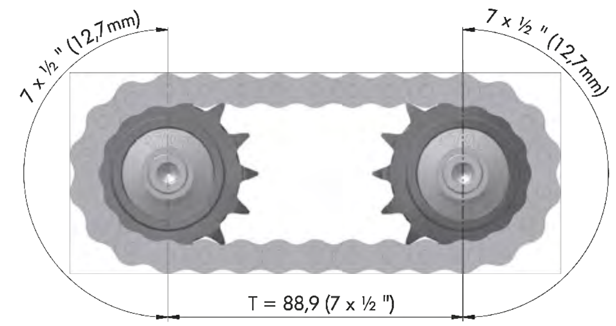
HOW TO BUILD A CURVE?

The roller pitches at the inside and outside radius must be calculated on the basis of the chain pitch.





The following theoretical pitches (measured at the sprocket with a pitch of 1/2" and 14 teeth) have been proven and tested:

Number of chain links	Pitch measured on the sprocket [mm]
28	88.9
30	101.6
32	114.3
34	127.0
36	139.7
38	152.4

The following information on the number of conveyor rollers required relates to a 90° curve on which a higher surface to the 90° angle of the side frame has been designed in for equalization.

Reference length [mm]	Pitch measured on the sprocket [mm]					
	88.9	101.6	114.3	127.0	139.7	152.4
250/300	19	16	14	13		
350/400	20	18	16	14	13	
450/500		19	17	15	14	13
550/600		21	18	17	15	14
650/700			20	18	16	15
750			21	19	17	16
800				19	17	16
850/900				20	18	17

Number of rollers

The calculation or determination of the roller pitch and the angle of the roller curve result in the number of rollers to be used, which is not always an even number. In this case, the value must be rounded up or down.
If a PolyVee belt is used in the curve for a roller pitch of 73 mm (based on a straight conveyor line), it results in an even roller count for the following curve angles:

Angle	Number of rollers
30°	6
45°	9
90°	18
180°	36

Speed

For a material to be conveyed perfectly through the curve, the curve speed and the speed of the straight conveyor line must be identical before and after the curve. The curve speed refers to the average speed, see the following sample calculation. If the speeds of straight and curve are different, the material to be conveyed can loose its orientation and, as a result, reach the side guide.

Sample calculation of average diameter

First, the average diameter of the tapered rollers is to be calculated. When tapered elements with an angle of 1.8° and a length of 450 mm are used, the starting diameter is 55.6 mm and the ending diameter 84.0 mm.

$$\varnothing_{\varnothing} = \frac{(\varnothing_{min} + \varnothing_{max})}{2} = \frac{55{,}6\text{ mm} + 84{,}0\text{ mm}}{2} = 69{,}8\text{ mm}$$

$\varnothing_{\varnothing}$ = Average diameter of tapered elements
$\varnothing_{min.}$ = Starting diameter
$\varnothing_{max.}$ = Ending diameter

Sample calculation of same speed

Let us assume that the straight section before and after the curve is equipped with 50-mm diameter rollers and runs at a speed of 0.8 m/s. The speed in the curve is to be of the same value and must be converted to the average diameter of 69.8 mm.

$$S_{RD} = \frac{S_{Strai.}}{\varnothing_{\varnothing}} \cdot \varnothing_{Strai.} = \frac{0{,}8\text{ m/s}}{69{,}8\text{ mm}} \cdot 50\text{ mm} = 0{,}57\text{ m/s}$$

S_{RD} = Speed to be set of the RollerDrive
$S_{Strai.}$ = Required speed on the straight line
$\varnothing_{\varnothing}$ = Average diameter of tapered elements
$\varnothing_{Strai.}$ = Diameter of rollers on the straight line

Interroll recommends using different gear stages for the straight line sections and curves. A gear stage of 24:1 would be ideal for the calculated curve example. Based on a diameter of 50 mm, a maximum speed of 0.65 m/s can be calculated. Based on an average diameter of 69.8 mm, a RollerDrive with this gear box could also be set to 0.8 m/s. For sections with cylindrical rollers and RollerDrive before and after the curve, a gear stage of 20:1 would present itself. In general, the gear stage 20:1 could also be used in both parts of the system. The recommendation of the gear stage 24:1 for the curve is based on the fact that it has a higher torque and a higher torque is often required in curves.

Different forces occur in a curve. If the centrifugal force is greater than the static friction force, materials to be conveyed will almost always loose their orientation. This occurs at speeds over 0.8 m/s. At that point, materials will no longer be conveyed through the center of the curve and come into contact with the side guide at the outside radius. This depends on various factors, such as material and condition of the underside of the material to be conveyed, and these factors should also be taken into account during the planning of the curve.

Deep-freezing

Roller curves ca also be operated in the freezer area. An ideal drive is the RollerDrive EC310 in deep-freezer design. Rollers should feature oiled ball bearings so that the required drive power is not increased unnecessarily. Interroll recommends PolyVee belts as drive element. They have to be watched for suitability for deep-freezing and that the belt tension is not too high.

Dimensioning of magnetic speed controller

The magnetic speed controller MSC 50 is a mechanical speed controller that ensures a controlled speed on gravity conveyors with materials weighing up to 35 kg.

In contrast with conventional products, the speed controller operates without a gear box, thus enabling startup for very lightweight containers starting at 0.5 kg. The maximum mechanical output is 28 W, thus providing the required consistently high braking power for heavy containers. The operating principle is based on an eddy current brake. A double shielding of the magnets enables a uniform braking action.

Conventional products often contain brake shoes. The heavier a material, the more stronger the braking of these brake elements. This purely mechanical braking process causes wear. It means that such products have to be replaced after a certain time since the brake shoes are worn off. Such a wear does not take place in the MSC 50.

The hexagon shaft used serves the torque within the side profile. A loose, form-fit installation of the hexagon shaft is possible with hexagon holes in the side profiles. A hole size of 11.5 mm is required for an oblique installation. With a fixed installation using a female threaded shaft, a minimum torque of 20 Nm must be applied. Interroll recommends the additional use of a screw locking device.

The speed controller without PU sleeve is manufactured with a tube diameter of 51 mm. Together with conveyor rollers of 50 mm diameter, a minimum higher surface of 0.5 mm is created. This provides sufficient contact to the material to be conveyed, which leads to an optimal braking function.

The distribution, number and design of the speed controller in a conveyor track depends on many parameters:

- Incline of conveyor track
- Roller pitch
- Infeed speed, e.g. by a sorter
- Material weight
- Condition of the underside of the material to be conveyed

The data listed below has been determined by means of numerous tests. Materials to be conveyed with optimal undersides were used for this purpose. The data is intended to provide a reference point for the dimensioning of applications, whereby the combination of critical parameters is very large. Due to the multitude of influencing factors, Interroll cannot provide specific information about conveying speeds and, for this reason, recommends to empirically determine the final layout:

- Lightweight materials can run very slowly (approx. 0.01 m/s).
- Under optimal conditions, heavy materials can run at 0.5 m/s.
- The design with PU sleeve is intended to improve the static friction for smooth plastic containers. The PU sleeve is particularly recommended in combination of conveyor tracks with large inline and high material weights.
- For cardboards and many other materials, the friction in combination with zinc-plated steel tube is sufficient.
- Inclines from 5 % to 10 % were examined in numerous tests. The following distances between the magnetic speed controllers were tested successfully:

Material weight [kg]	Distance of MSC 50 [kg]
0.5 to 10	Maximum 2000
10 to 20	800 to 1500
20 to 35	Adjusted to the length of the material to be conveyed

- With infeed speeds into the gravity conveyor greater than 1 m/s, Interroll recommends the installation of three to four MSC 50 at the beginning of the gravity conveyor. The placement on the first 1,000 mm is used for immediate reduction of the speed. On the rest of the gravity conveyor, the distance values specified above can be applied as guide values.

RollerDrive dimensioning

Variant selection

RollerDrive EC310 is available in different variants. The following information should help in finding the correct design for a specific application.

Tube material

Various aspects must be taken into account when selecting the correct tube material.

If the material or the environment is moist, if water is used for cleaning, or if there is a risk that a sprinkler system could be activated, then a tube with a high corrosion protection should be selected. A tube made of stainless steel is recommended. If the RollerDrive is used in a weight-sensitive area, a RollerDrive with aluminum tube can reduce the weight. Many conventional motor rollers are generally heavier than the RollerDrive EC310.

The RollerDrive and also adjacent rollers must be capable of reliably moving the material. In many cases, this also includes stopping and starting the material without letting it slide on the tubes. This is particularly important for conveyors with an incline. For many materials, the friction to the metal tube of the RollerDrive is sufficient, e.g. tires. For other materials, a suitable sleeve or a lagging of the tube is required. It is recommended to fit the tube with a PU sleeve. It is more robust than a PVC sleeve and more cost-effective than a lagging. However, it is indispensable to adjust the friction of the RollerDrive to the application properties.

A metal tube, the different sleeve variants or the lagging are suitable for use in straight running conveyor line. Cylindrical RollerDrive can also be used for a curve. It must be taken into account that the material to be conveyed has to be force-guided in this case via a lateral confinement. The result can be damage to the material or the side guide. To avoid it, it is recommended to use RollerDrive and rollers with tapered elements.

Fastener

On the conducting side, the RollerDrive is fastened via a hexagon shaft in the side profile. The hexagon features an M12 male thread, an M12 fastening nut can be supplied on request. This nut features ribs on the contact surface to the side profile which prevents a loosening of the nut in almost all side profiles due to vibration. This very simple solution prevents the shaft from turning inside the fastening hole and damaging the connecting cable. The nut must be tightened with a torque of 70 Nm. A fastening socket for a torque wrench with opening for the RollerDrive connecting cable is suitable for this purpose, see page 242.

On the opposite side, the RollerDrive can be fastened in different ways. An M8 screw can be screwed into a shaft pin with female thread. For the IP66 variant, the shaft pin sits in a slide bearing. For the conventional variant with protection rating IP54, it sits in a ball bearing. The fastening is also possible for a spring-loaded shaft solution. In combination with a drive head, e.g. a PolyVee drive head, the spring-loaded shaft is designed as hexagon. Without drive head, e.g. if round belts are guided via grooves, the spring-loaded shaft is designed as tapered hexagon. With this solution, the hexagon slides so far into the fastening hole until it is backlash-free. This solution reduces the noise level and possible wear.

RollerDrive with tapered elements require an angle compensation during fastening.

Protection rating

The RollerDrive has a protection rating of IP54. If this should not be sufficient due to moisture or dirt, a version with protection rating of IP66 is available.

Temperature range

The RollerDrive EC310 is designed for a temperature range from 0 to 40 °C. For freezer applications up to −30 °C, Interroll recommends the use of a corresponding freezer variant, see page 206.

Drive element

Several drive heads are available, and grooves can also be fitted in the tube, see chapter EC310, page 200 for further details. A comparison of the different drive elements is located on page 255. Interroll recommends the use of PolyVee belts since they are suitable for almost all applications (straight, curve, gravity, etc.).

Speed/torque

The RollerDrive EC310 covers all common speeds for ZPA conveyors. 9 gear stages are available to meet the requirements of different applications. The gear stage should be selected with respect to the required speed and the required torque. For this purpose, the RollerDrive can be varied with respect to speed. For example, the gear ratio 16 : 1 can turn with a maximum speed of 1 m/s, but also with every lower speed up to 0.1 m/s.

Compared with some drive solutions without gear box, the RollerDrive allows implementing a broad spectrum of applications with different torque requirements. It is sufficient to use the same drive with the same interface and control at all times, but employ different gear stages.

Planning

For safe and reliable conveyance, at least one RollerDrive and two conveyor rollers have to be located under the material to be conveyed. It is recommended to place the RollerDrive in the center of the conveyor roller that it is driving.

If the material to be conveyed is to be moved on a conveyor perpendicular to the direction of the roller shaft, that is free of transverse force, then the static friction and rolling friction have to be overcome.

The following equation applies to materials to be conveyed, which are moved at a constant speed along a conveyor track:

$$F = m \cdot g \cdot \mu$$

F = Required tangential force in N
m = Mass in kg
g = Max. gravitational acceleration 9.81 m/s
μ = Coefficient of friction

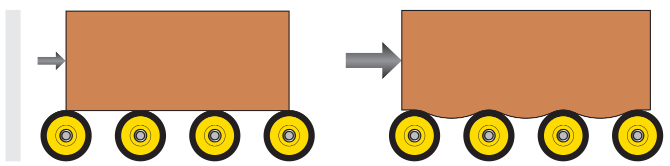
Sample calculation

If the weight of the material is 30 kg and the coefficient of friction is 0.04, the resulting required tangential force is 11.8 N.

With a roller radius of 25 mm, the required torque (force × distance) is 0.3 Nm. The required mechanical power at a speed of 0.5 m/s (force × speed) measures 5.9 W.

Coefficients of friction for different container materials when using rollers with steel tubes:

Material	Coefficient of friction μ
Steel	0.03
Polymer, smooth	0.04
Polymer, profiled	0.05
Wood	0.05
Boxes	0.06



During zero-pressure accumulation conveying, the RollerDrive is started and stopped many times. The RollerDrive is designed for such a high number of cycles. The previously described calculations are used for checking to what extent a RollerDrive is capable of conveying certain materials. On top of that, the cycle count, i.e. how often the RollerDrive switches off and on per time unit, also plays a decisive role. The higher the cycle count, the higher the motor temperature. The motor temperature is also affected by the turning time per time unit. The less the standstill time of the motor, the less cooling time for the motor. With cycle times that are too high and standstill times that are too low, the RollerDrive switches to a temperature protection function and can no longer be operated until is has cooled off. This must be taken into account for the planning.

The required drive force to convey an item at a constant speed along a roller conveyor depends on the condition of the underside of the material. A minimal force has to be exerted for a rigid, difficult to deform underside, such as a steel container.

However, a steel container tends to slide on the tube material during acceleration and deceleration. Approx. 3 % of the material weight must be applied as propelling force during constant travel. μ is approx. 8 % with a cardboard container. This can be explained by the soft and malleable underside. With a cardboard container, the differential figure is applied to the steel container for the deformation of the underside of the container and is therefore no longer available for the forward motion.

As a conveyor cycle consists of acceleration, constant travel and braking, acceleration is critical for assessing the output.

In the acceleration phase, the static friction is overcome and a transition to significantly lower roller friction takes place. For this reason, a power surge can be measured at the start of every conveyor cycle.

For zero-pressure accumulation conveying, the conveyor should be divided into zones. As a rule, every zone is driven by a RollerDrive. The zone length must orient itself at the material length or the longest material to be conveyed. The zone length must be longer than the longest material to be conveyed so that a gap prevents the materials from contacting each other. In most cases, light barriers are used to detect material in every zone. The run-on depends on various factors, such as speed or material weight, but also the selected drive element. The run-on describes the distance from the sensor to the front edge of the material to be conveyed. In an ideal case, the run-on is very small, although the material comes to a standstill later in most cases. To prevent the material from being partially conveyed onto the first roller of the next zone, the position of the sensor must be optimized accordingly. The programming of the logic of the zero-pressure accumulation conveying does not have to be complex, it is already contained in most Interroll controls. A power surge can be measured at the switch-on time of the RollerDrive. This application-dependent power surge must be taken into account when dimensioning the power supply, see the chapter Power supply dimensioning, page 270.

Power supply dimensioning

Introduction

The Interroll RollerDrive and its different controls are operated with a voltage of 24 V DC. Interroll offers a 24-V power supply labeled PowerControl for this purpose. The PowerControl is exactly dimensioned for the requirements of the RollerDrive and its controls (see page 236). The following must be observed if conventional power supplies are used:

- The rated and startup current of the RollerDrive must be taken into account when dimensioning the power supply.
- The RollerDrive, and also its controls, feed back voltage, i.e. the power supply must be feedback-capable.
- The voltage must not be set to ≥ 25.2 V. Starting at 25.2 V, the brake chopper in the controls is activated. Long line lengths should be avoided since they could be accompanied by a high voltage drop.

Basic information

The RollerDrive EC310 can be connected to the following controls:

- DriveControl 20
- DriveControl 54
- ZoneControl
- SegmentControl
- ComControl
- MultiControl

Each control (without connected RollerDrive or connected sensor) allows a current flow of approx. 0.5 A (generally significantly lower). This current is not taken into account for the power supply dimensioning in the following example. The same applies to the sensors. As a rule, they can be assumed to have a current flow of 50 mA and are also not included in the sample calculation. If additional current-relevant inputs or outputs are switched, they should be included in the dimensioning.

The RollerDrive EC310 has a rated current of 2 A and a startup current of 4 A. The currents depend on different factors, e.g. start ramp of the RollerDrive, number of rollers connected to the RollerDrive, weight of the material to be conveyed, speed of the RollerDrive, etc. In many applications, the rated current is 1 A and the startup current 3.5 A.

In general, several RollerDrive are supplied by one power supply. The RollerDrive are mostly used for zero-pressure accumulation conveying. In this case, not all RollerDrive are started simultaneously in the so-called single release. For the power supply dimensioning, it would therefore be possible to include a simultaneity factor. If it is not clear how many RollerDrive could start simultaneously, Interroll recommends dimensioning the power supply with the assumption that all RollerDrive will start simultaneously.

Sample calculation/dimensioning

The calculation refers to the PowerControl, a 20-A power supply which can be loaded with 30 A up to 4 seconds.

Eight RollerDrive shall be supplied with voltage. Depending on the application, the RollerDrive requires a rated current of 1 A and a startup current of 3.5 A. In the system, it is possible that all RollerDrive start simultaneously.

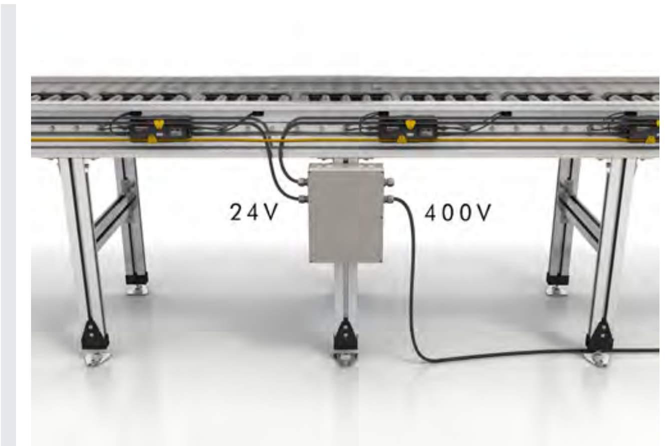
Total rated current: 8 · 1 A = 8 A
Total startup current: 8 · 3.5 A = 28 A

Explanations

If only the rated current is included, a 10-A power supply without power reserve could be sufficient. This can lead to incorrect behavior of controls or the installation: If all RollerDrive switch on simultaneously, a 10-A power supply with 28 A startup current would be overloaded. The power supply would switch off or the voltage would collapse. Hence, it is important that the startup current also be taken into account.

Which rated current and startup current are to be taken into account for the calculation, should be determined empirically. If this is not possible, Interroll recommends calculating with 2-A rated current and 4-A startup current for safety reasons.

Power supplies that allow for an output to the left and to the right should be used. Hence, the power supply can be positioned in the center of the controls to be supplied. This measure saves line and reduces voltage drop on the line.



Flat cables with cross sections of 2.5 mm² can generally be loaded with a continuous current of 16 A.

If train release is used instead of single release, it must be assumed for conventional logic programs that all RollerDrive start simultaneously. The Interroll controls avoid a cumulative high startup current of all RollerDrive:

- ZoneControl: The control has a permanently set delay time of 125 ms in the train release program. After an enabling signal, the first RollerDrive starts. The next RollerDrive starts 125 ms later, etc.
- ConveyorControl: The delay time is adjustable, function identical to ZoneControl.
- MultiControl: The delay time is adjustable, function identical to ZoneControl.

Tubes

Material	Standards	Specification
Uncoated steel, zinc-plated steel	DIN EN 10305-1 DIN EN 10305-2 DIN EN 10305-3	Limited tolerances and material specifications by Interroll
Zinc-plating	DIN EN ISO 2081 DIN 50961	Galvanized zinc sleeve with additional blue passivation (chromium IV-free) Sleeve complies with RoHS regulations Plating thickness 6 to 15 µm
Stainless steel	DIN EN 10312	1.4301 (X5CrNi18-10) and 1.4509 (X2CrTiNb18) Limited tolerances by Interroll
Aluminum	DIN 755	AW 6060 T66 (AlMgSi 0.5 F22) For 16 mm and 20 mm E6/EV1, stained, natural and anodized Surface layer thickness 20 µm, isolating and non-conductive For 50 mm mill-finished, unfinished, thus conductive
PVC	–	PVC-U (rigid polyvinyl chloride, softener-free, silicon-free, highly impact-proof) Contains only materials, which have been tested and registered to comply with the REACH Directive (EC No. 1907/2006) RAL7030 (stone gray) RAL7024 (dark gray) RAL5015 (sky blue)

Bearings

Precision ball bearings, lubricated (689 2Z, 6002 2RZ, 6003 2RZ, 6204 2RZ, 6205 2RZ), used by Interroll:

Standard	DIN 625
Material	Rings and balls are made of stainless steel of material grade 100Cr6 Hardness: 61 ± 2 HRC, with metal cages
Bearing play	C3
2RZ Seal	Non-grinding 2-lip seal with labyrinth effect manufactured from steel-reinforced acrylonitrile-butadiene rubber (NBR)
2Z Seal	Non-grinding cover discs made of sheet steel
Lubrication	Multi-grade grease, silicon-free

Precision ball bearing, lubricated (6002 2RZ)

Standard	DIN 625
Material	Rings and balls are made of stainless steel of material grade 100Cr6 Hardness: 61 ± 2 HRC, with metal cages
Bearing play	C3
2RZ Seal	Non-grinding 2-lip seal with labyrinth effect manufactured from steel-reinforced acrylonitrile-butadiene rubber (NBR)
Lubrication	Multi-grade oil, silicon-free

Precision ball bearings made of stainless steel, lubricated (6002 2RZ, 6003 2RZ)

Standard	DIN 625
Material	Rings and balls made of stainless steel, material 1.4125 (X105CrMo17), with a material grade to comply with AISI 440C Hardness: 58 ± 2 HRC, with polyamide cages
Bearing play	C3
2RZ Seal	Non-grinding 2-lip seal with labyrinth effect manufactured from steel-reinforced acrylonitrile-butadiene rubber (NBR)
Lubrication	Multi-grade grease, silicon-free

Steel conical mount

Material	Wheel body material DX53D + Z, zinc-plated Bearing parts, hardened
Lubrication	Multi-grade grease, silicon-free

Polymer bearing

Material	External ring and cone made of polypropylene Balls made of carbon steel or stainless steel
Lubrication	Multi-grade grease with low viscosity, silicon-free, FDA-tested

Shafts

Material	Standards	Specification
Uncoated steel, zinc-plated steel	DIN EN 10277-3	1.0715 (11SMn30) Limited tolerances and material specifications by Interroll
Zinc-plating	DIN EN 12329 DIN 50961	Galvanized zinc sleeve with additional blue passivation (chromium IV-free) Sleeve complies with RoHS regulations Plating thickness 6 to 15 µm
Stainless steel	DIN EN 10088-23	1.4305 (X5CrNi18-9) Limited tolerances by Interroll

PolyVee belt

Standards	ISO 9982 (DIN 7867) PJ profile for 2-rib and 3-rib V-ribbed belts (PolyVee)
Material	Complies with the Directive 2011/65/EC (RoHS) Contains only materials, which have been tested and registered to comply with the REACH Directive (EC No. 1907/2006) Halogen-free, silicon-free, PVC-free, flame-resistant
Certification	UL-certified
Hardness	Ribs 70 Shore A
Electrical conductivity	< 7 MΩ (antistatic)
Temperature range	−30 to +80 °C
Dimensions	In accordance with ISO 9982 (DIN 7867), profile PJ

Please contact the relevant manufacturer for information on other drives.

Polymers

Interroll uses components made of polymer in almost all conveyor elements. Polymer has many advantages over steel:

- Sound reduction
- Easy to clean
- Excellent impact strength
- Corrosion resistance
- Lightweight
- High quality design

PLANNING BASICS
MATERIAL SPECIFICATION

Properties and applications

Polymer	Properties	Uses
Polyamide (PA)	• Outstanding mechanical properties • Excellent wear resistance • Low coefficient of friction • Good chemical resistance	Sprocket drive heads, seals and bearing seats
Polypropylene (PP)	• Low specific weight • Excellent heat resistance • Not hygroscopic • Good chemical resistance	Wheels, seals and bearing seats
Polyvinyl chloride (rigid PVC)	• Scratch-resistant • Impact-resistant • Good chemical resistance	Tubes for polymer conveyor rollers
Polyoxymethylene (POM)	• Outstanding mechanical properties • Excellent wear resistance • Low coefficient of friction • Very dimensionally stable • Minimal absorption of water • Used on parts which require a very high level of precision	Toothed belt drive head and slide bearing

Resistance

Symbol	Meaning	Explanation
++	Very good resistance	Continuous exposure to the medium causes no damage
+	Generally resistant	Continuous exposure to the medium can cause damage, which is reversible when no longer exposed to the medium
–	Mostly non-resistant	Only resistant if there are optimum ambient and application conditions but generally some damage is to be expected
––	Completely non-resistant	The medium may not come into contact with the polymer

The resistance of the polymers is affected by temperature, exposure to force, UV exposure, and the duration of exposure and concentration of the medium.

A thorough suitability test of the polymer to be used by the user is indispensable. The following overview serves as orientation aid.

Product	Polyamide (PA)	Polyoxymethylene (POM)	Soft PVC	Rigid PVC	Polypropylene (PP)
Ethers	++	++	–	++	–
Lower alcohols	++	++	++	–	++
Petrol	++	+	––	++	–
Esters	++	––	––	––	–
Fats	++	++	–	++	+
Hydrofluoric acid	––	––	–	–	–
Ketones	++	–	––	––	++
Aliphatic hydrocarbons	++	++	––	++	++
Aromatized hydrocarbons	++	+	––	––	–
Chlorinated hydrocarbons	–	++	––	––	––
Unsaturated, chlorinated hydrocarbons	+	++	––	––	––
Weak bases	+	++	++	++	++
Strong bases	–	++	–	++	++
Mineral oil	++	++	–	++	–
Oils	++	++	–	++	+
Oxidizing acids	––	––	–	––	––
Weak acids	––	–	++	++	++
Strong acids	––	––	++	–	––
Strong, organic acids	–	++	–	+	++
Inorganic salt solutions	++	++	++	++	++
Turpentine	–	–	––	––	––
Fuel mixture	+	++	––	––	–
Water	++	++	++	++	++