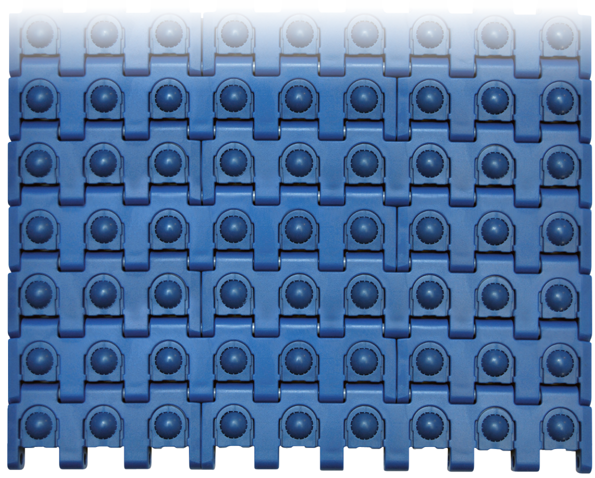
SYSTEM™ PLAST

Designed for Diversity
Multidirectional
Roller Top Belt
Series 2253 RT



Appendix to general Engineering Manual

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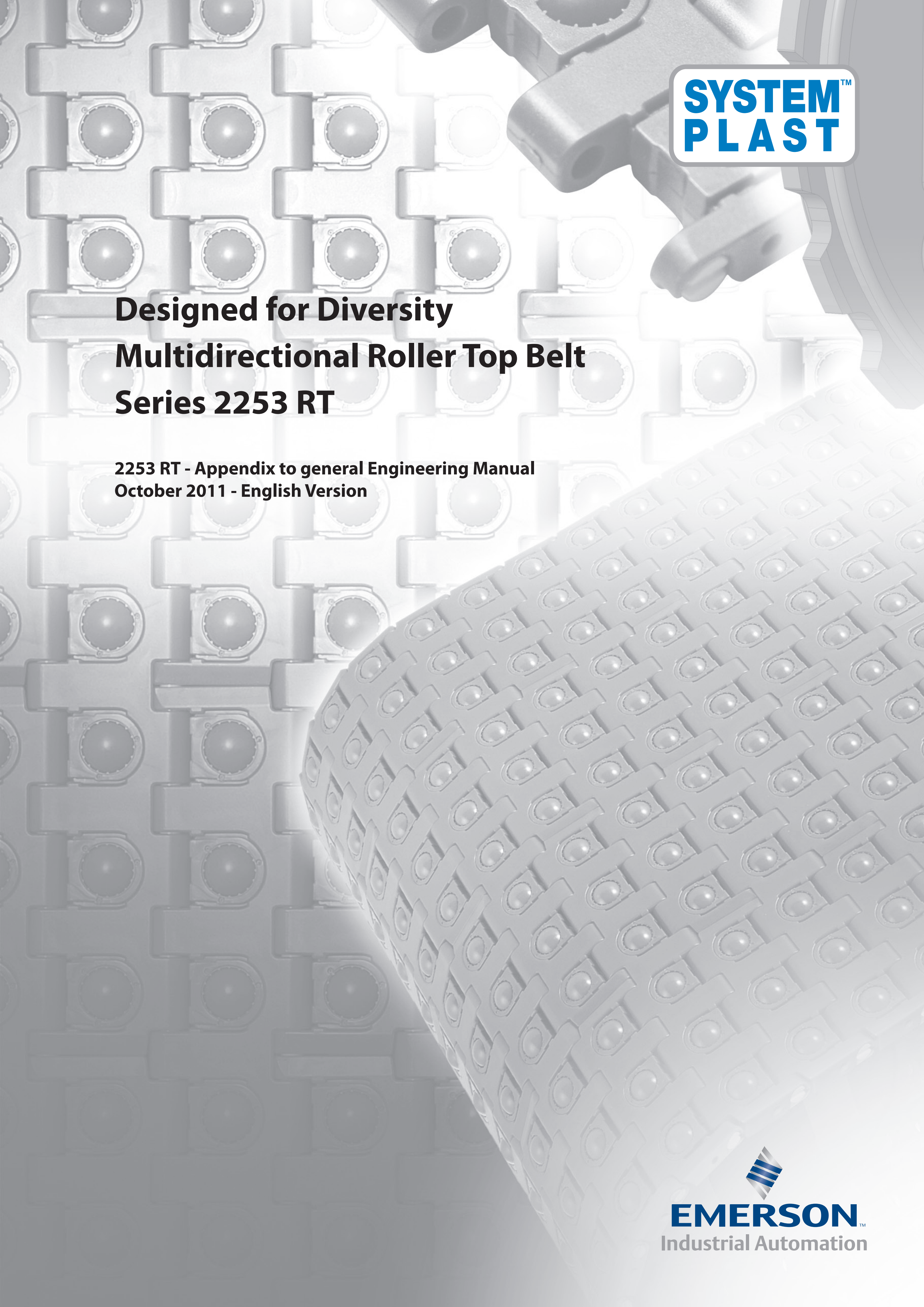

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Designed for Diversity
Multidirectional Roller Top Belt
Series 2253 RT

2253 RT - Appendix to general Engineering Manual
October 2011 - English Version

EMERSON™
Industrial Automation

APPLICATION CONSIDERATIONS.

The proper selection and application of power transmission products and components, including the related area of product safety, is the responsibility of the customer. Operating and performance requirements and potential associated issues will vary appreciably depending upon the use and application of such products and components. The scope of the technical and application information included in this publication is necessarily limited. Unusual operating environments and conditions, lubrication requirements, loading supports, and other factors can materially affect the application and operating results of the products and components and the customer should carefully review its requirements. Any technical advice or review furnished by Emerson Power Transmission Solutions and its divisions with respect to the use of products and components is given in good faith and without charge, and Emerson assumes no obligation or liability for the advice given, or results obtained, all such advice and review being given and accepted at customer's risk.
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Printed in Italy

Engineering manual

This Engineering Manual has been developed to assist you with specific engineering information when a new conveyor is designed.

We cannot take responsibility for imperfections, damage or injuries due to wrong conveyor design, poor installation or improper use of our products made with or without reference to the information in this manual.

We appreciate your suggestions to improve this Engineering Manual.

For additional data and information about technical details of our products please refer to:

- **Conveyor Chains & Belts catalogue**

- **Conveyor Components catalogue**

- **Leveling pads catalogue**

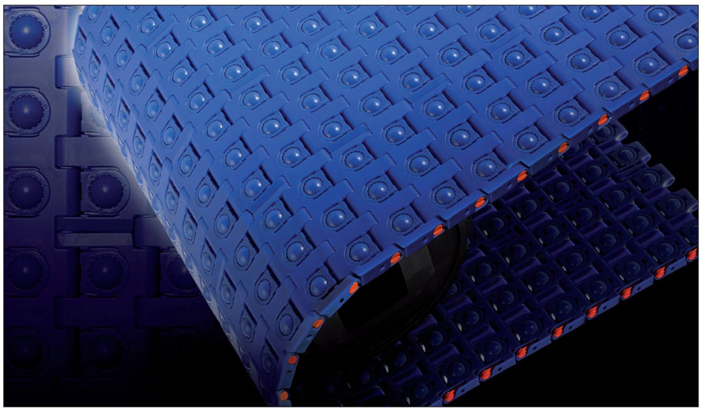
- **Bearing supports catalogue**

- **Engineering Manual**
- **Calculation program**

Contact us

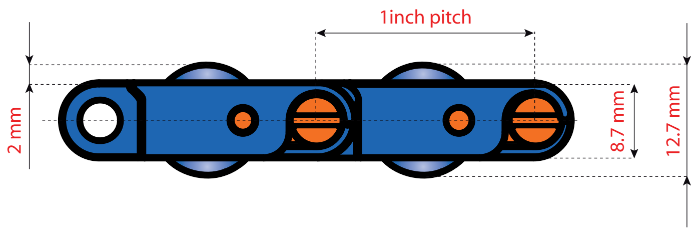
To contact your local Technical Support check our website **www.systemplast.com**
or send an email to: **technicalsupport@systemplast.com**

System Plast Roller Top Belt with Ball Transfer System



Principle of handling functions:

Conveyed goods make contact with plastic balls, which protrude from above and below modular links. Auxiliary drive units control the rotation of the balls, enabling handling operations such as lateral transfer and rotation.



All-Plastic construction, energy-efficient conveyance:

The freely rotating balls reduce rolling resistance, making energy-efficient conveyance possible.

1 inch pitch:

Offers maximum product support due to a comparatively high number of balls creating a high number of contact points between belt and product (1" pattern). That's important in terms of product stability.
Offers comparatively short transfers / dead plates between connecting conveyors due to small idler wheel / shaft diameters, particulary with middle drive conveyor design.

Ball versus rollers:

Balls offer the highest grade of flexibility regarding conveying options and at the same time different product flow directions combined in only one conveyor. With cylindrical roller e.g. it is not possible to combine products flow directions along and across the running direction in one conveyor with only one drive.

Easy Maintenance

Roller Top Belt can easily be disassembled thanks to the patented, pin clip system. In the unlikely event of damage, the part of the modular link that was damaged can be quickly replaced, making repair operations fast and efficient. The ball elements are interchangeable.

Wide Conveying Surface

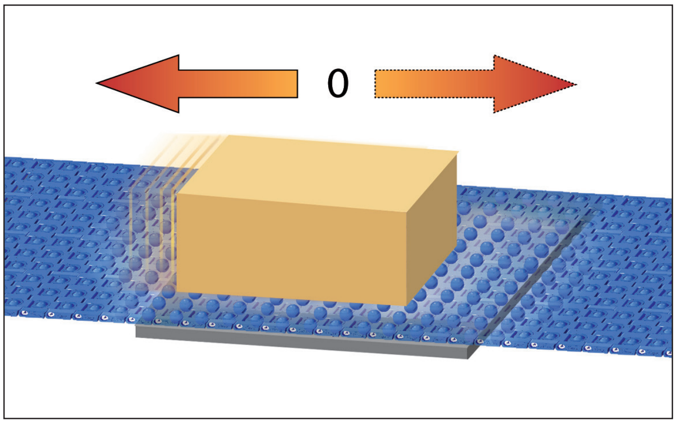
A wide, belt-like conveying surface with modular links assembled into a bricklayed arrangement similar to conventional modular belts offers maximum product support. The standard width system is in 3" steps.

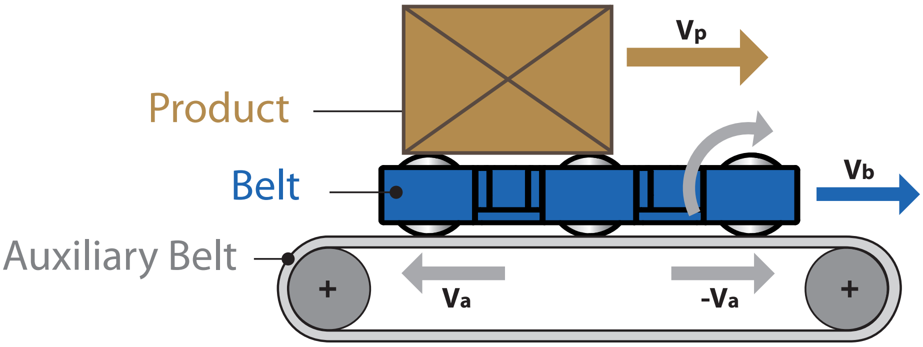
Application examples

Variable-Speed Conveyance:

When the belt is moving and the rollers are in contact with a fixed support area, the rollers will start rotating. This will result in a movement of the product with a speed that is e.g. twice the speed of the belt.
This function is very useful when products have to be separated from each other.

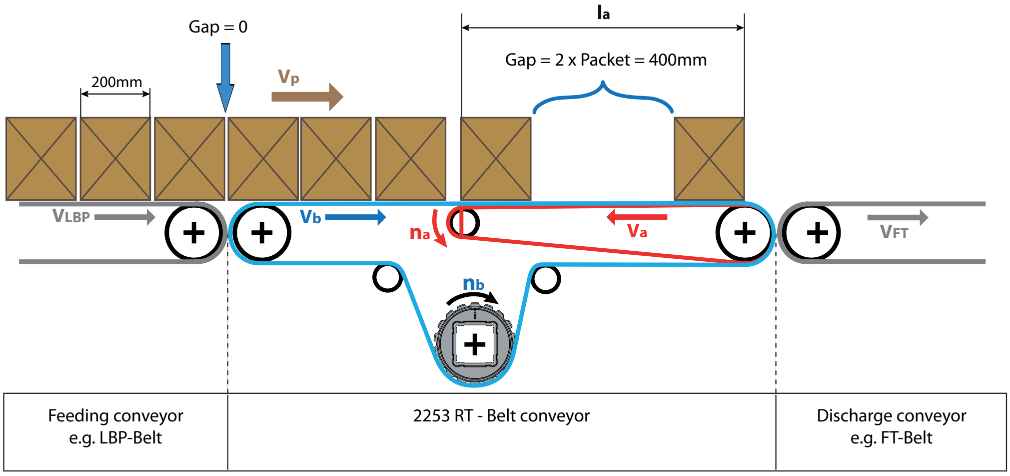
The following table "Operation Mode" can give you a brief overview about possible applications.





Operation mode	Belt speed V_b	Auxiliary belt speed V_a	Product speed $V_p = 2 \times V_b + V_a$	Application example
Acceleration	V_b	$V_a > 0$	$V_p > 2 \times V_b$	Pull gap between products.
Standard conveying	V_b	$-V_a = V_b$	$V_p = V_b$	No relative movement between products
Stop	V_b	$-V_a = 2 \times V_b$	$V_p = 0$	Stop product e.g. in front of check device, while belt is running. At the same time close gap.
Deceleration	V_b	$-V_a > 0$	$V_p < 2 \times V_b$	Close gap between products.
Double speed	V_b	$V_a = 0$	$V_p = 2 \times V_b$	Pull gap between products
Reverse	V_b	$-V_a > 2 \times V_b$	$V_p > -V_b$	Run product in the opposite direction of the belt. At same time close gap.

Example how to create a gap of twice the packet length



Searched:

1. V_a = Speed of the auxiliary drive
2. n_a = Revolutions of the auxiliary drive
3. n_b = Revolutions of the belt
4. l_a = Length of auxiliary drive unit

Given:

V_{LBP} = Speed of the feeding LBP-belt = 15m/min
Product pitch on the feeding line = 200mm
Material of packet = carton
Friction factor $\mu_{(Packet\text{-}Ball)} = 0{,}25$

Sprocket z= 18, Pitch diameter H = 146,3mm
Drive shaft of aux. belt diameter d = 63mm
Weight of packet m = 6kg

Conditions:

Product pitch on the feeding belt=200mm
Product pitch on the discharge belt=600mm — Factor 3
V_{FT} = Speed of the discharge belt = 3 x V_{LBP} = 45m/min

V_b = Roller Top Belt speed $\overset{!}{=}$ V_{LBP}
V_p = Product speed $\overset{!}{=}$ V_{FT}

1. Solution for speed Va:

$$V_p = 2 * V_b + V_a$$
$$V_a = V_p - 2 * V_b$$
$$V_a = V_{FT} - 2 * V_{LBP}$$
$$\boldsymbol{V_a = 15m/min}$$

2. Solution for revolutions na:

Diameter of drive shaft for auxiliary belt = 63mm

Angular frequency of auxiliary belt shaft:

$$\omega_a = \frac{\upsilon_a}{R} = \frac{15m}{0.0315m * 60s} = 7.94\frac{1}{s}$$

Revolutions of auxiliary belt shaft:

$$n_a = \frac{\omega_a}{2\pi} = 1.26\frac{1}{s}$$

Drive of auxiliary belt shaft:

$$n_a \approx 76\frac{1}{min}$$

3. Solution for revolutions nb:

Sprocket Pitch diameter = 146,3mm

Angular frequency of belt sprocket:

$$\omega_b = \frac{\upsilon_b}{R} = \frac{15m}{0.07315m * 60s} = 3.42\frac{1}{s}$$

Revolutions of belt sprockets:

$$n_b = \frac{\omega_b}{2\pi} = 0.544\frac{1}{s}$$

Drive of belt shaft:

$$n_b \approx 32\frac{1}{min}$$

4. Solution for theoretical minimum length of auxiliary drive unit:

$$\Delta\upsilon = \upsilon_{FT} - \upsilon_{LBP} = 30\frac{m}{min} = 0.5\frac{m}{s}$$

$$F = m * a < m * g * \mu$$

$$a < g * \mu$$

$$a < 2.45\frac{m}{s^2}$$

$$t = \frac{\Delta\upsilon}{a} = 0.204s$$

$$l_a = \upsilon_{FT} * t = 45\frac{m}{min} * 0.204s$$

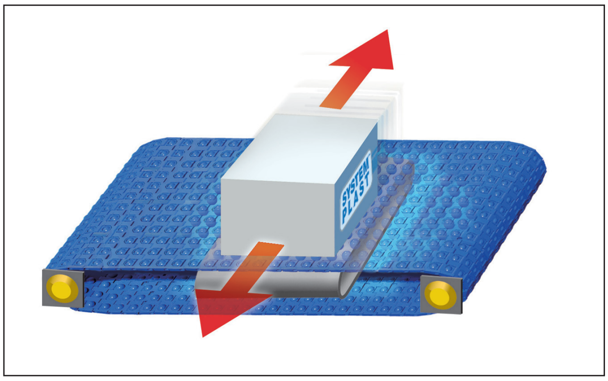
$$l_a \approx 0.15m$$

Recommendation for l_a:
Generally: 2 * Lengt of packet + gap

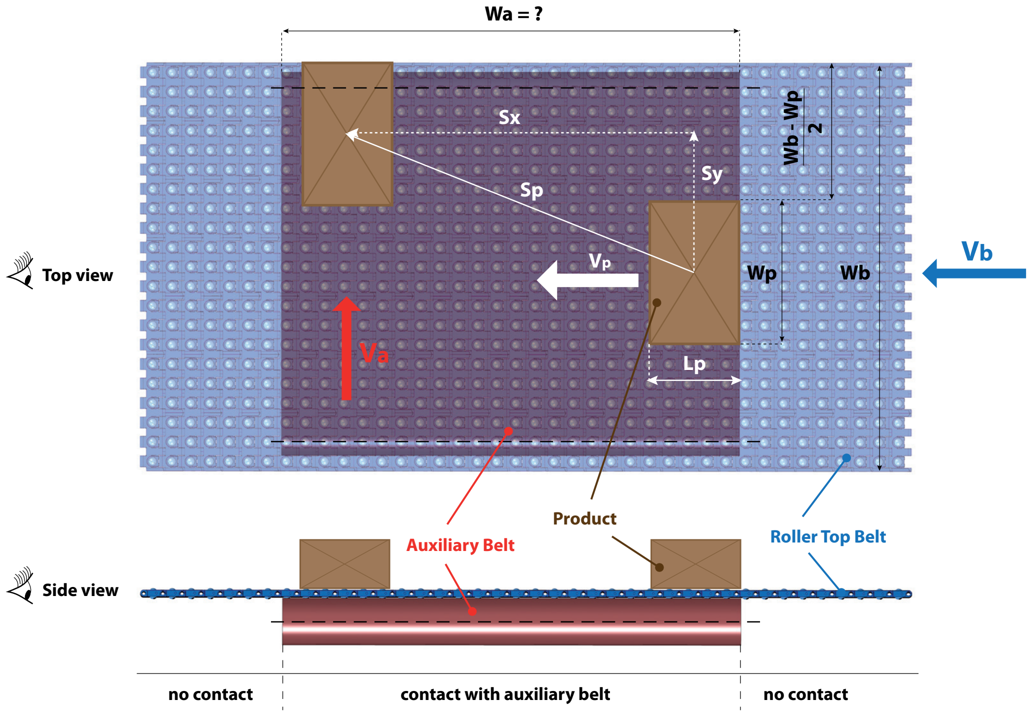
$$l_a \approx 0.8\ m$$

Lateral Movement:

Auxiliary drive units underneath the belt, running at right angles to the direction of belt travel, enable lateral transfers (left- or right side sorting) of conveyed goods. It can also be used to position a product, for example in front of a palletizer. Since no push-off devices, etc., are necessary, this approach works to prevent jamming, and allows for compact, space-saving layouts.



Example how to make a lateral movement:



Searched:

1. W_a = Width of auxiliary belt

Given:

W_b = Width of Roller Top Belt

W_p = Width of packet

L_p = Length of packet

The below calculation example is valid only for the situation where the centre line of the pack arrives exactly on the centre line of the belt and the side of the pack needs to go to the side of the belt. See the above drawing.

1. Solution for Width of auxiliary belt = Wa:

I. $v_p = 2 * v_b$ (Double Speed)

II. $t_y = \frac{s_y}{v_a} = \frac{W_b - W_p}{2 * v_a}$

III. $t_y = t_x$

IV. $s_x = t_x * v_p$

V. $W_a > s_x + L_p$

$W_a > t_x * v_p + L_p$

$W_a > t_x * 2 * v_b + L_p$ ($t_y = t_x$ II. in V.)

$W_a > \frac{W_b - W_p}{2 * v_a} * 2 * v_b + L_p$

$W_a > (W_b - W_p) * \frac{v_b}{v_a} + L_p$

Note:

1. By changing the formula you can calculate for example the speed of the auxiliary drive.

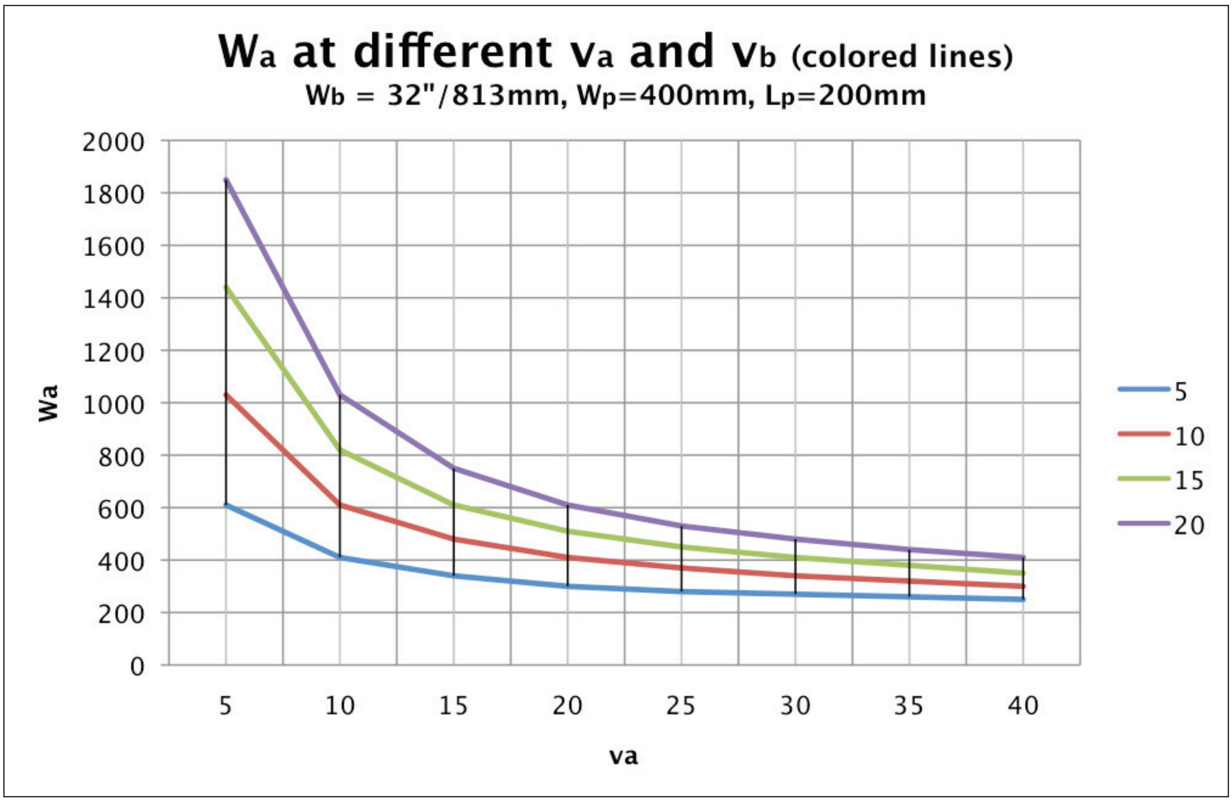
$$v_a > v_b * \frac{W_b - W_p}{W_a - L_p}$$

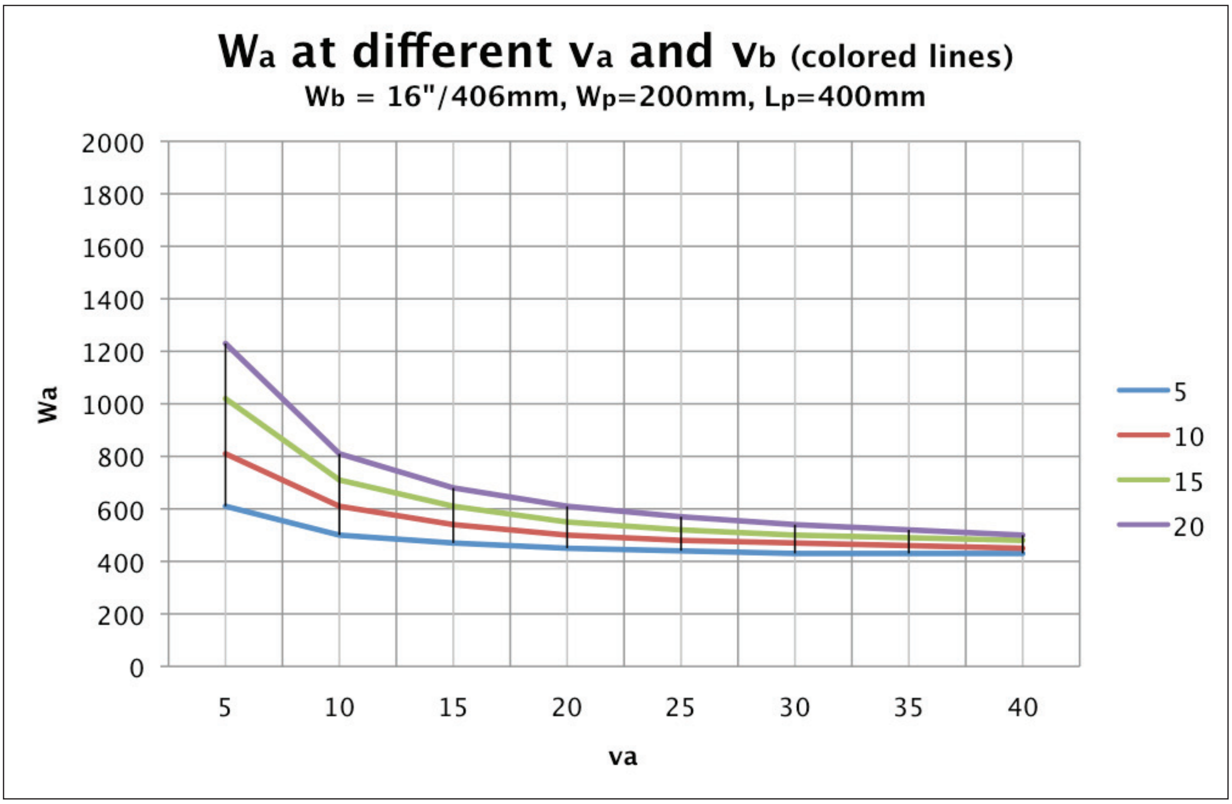
2. Friction respectively slip due to lateral acceleration not considered.

If the situation is different than the above example, the formula in general terms is as follows: $W_a > S_y * 2v_b/v_a + L_p$

Determine how much exactly the pack should be moved laterally (S_y) and then calculate the minimum width of the auxiliary belt (W_a)

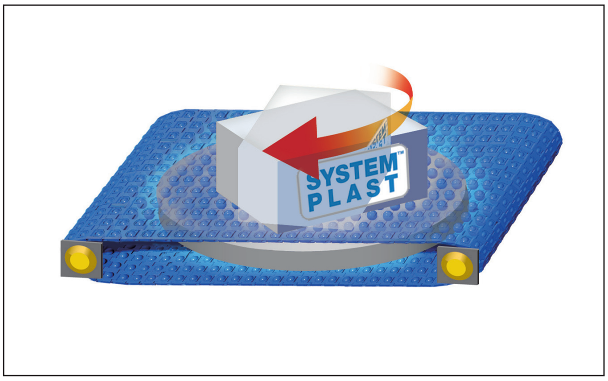
The graphs show how different combinations of belt (v_b) and auxiliary belt (v_a) speed influence the required width of the auxiliary belt (W_a) in order to move a package (W_p x L_p) from centre position on the belt (W_b) to lateral position.





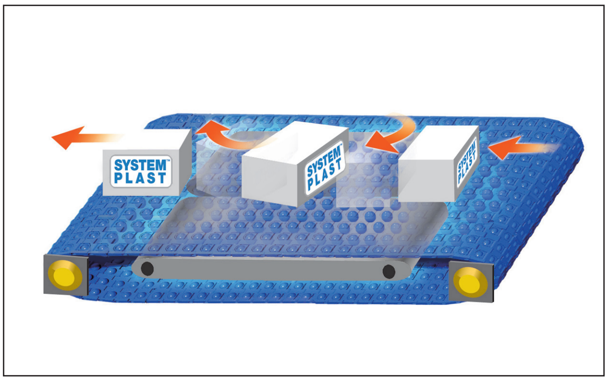
Rotation:

An auxiliary turntable positioned underneath the main belt makes it possible to rotate conveyed goods exactly to the desired angle. Handling is smooth and safe because goods are handled on the same surface as they are conveyed. During the rotation the Roller Top belt must be stopped.



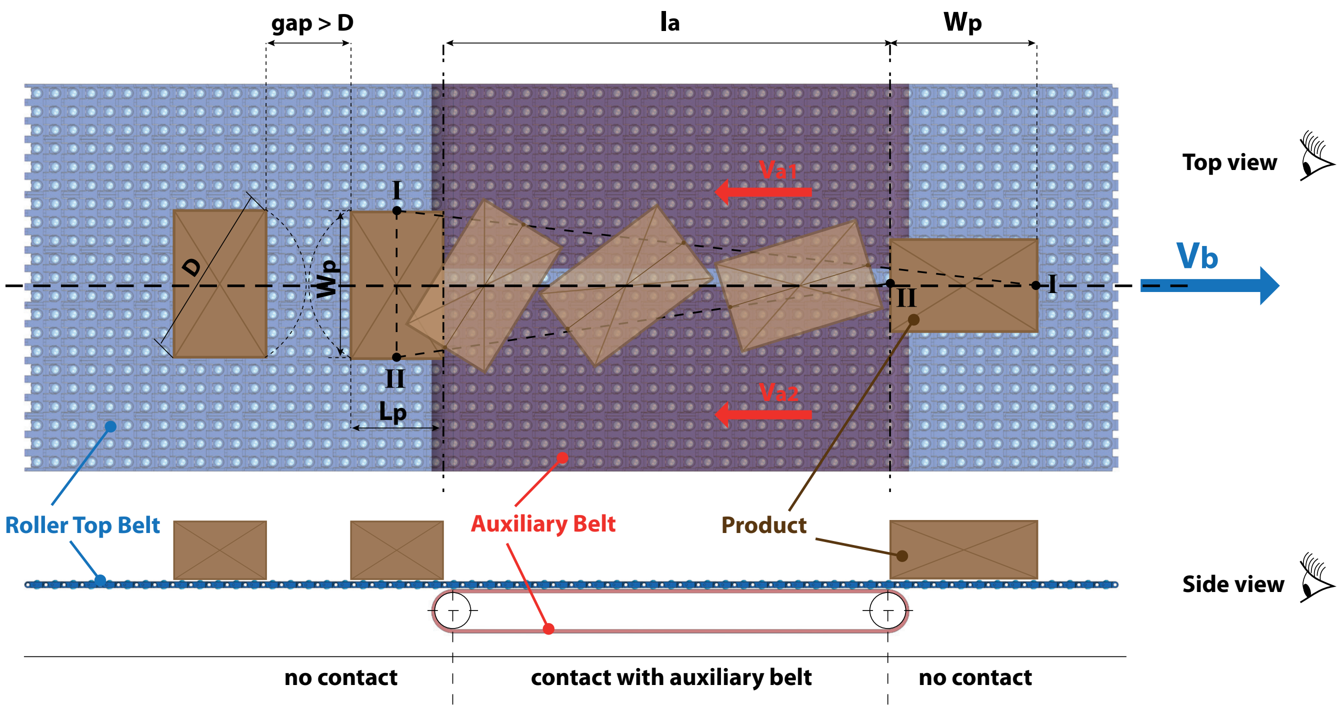
Rotation with Product Moving (no stop):

When two parallel running belts are positioned underneath the Roller Top belt, running at different speeds, the product that is in the middle of the conveyor will start rotating. This is ideal for applications where the product orientation is important, for example in front of a palletizer. The product can be rotated while it is moving forward and so without affecting the line throughput.



Note: frequency inverters for fine adjustment of main and auxiliary drive are necessary.

Examples how to make a 90° rotation



Searched:

1. How to calculate the speeds v_{a1} and v_{a2} of auxiliary belts for a 90° rotation.

Given:

l_a = Length of auxiliary belts
L_p = Length of packet
W_p = Width of packet

1. Solution for speeds of auxiliary belt:

$$\Delta v \approx \Delta x$$

$$x_I = \frac{L_p}{2} + l_a + W_p$$

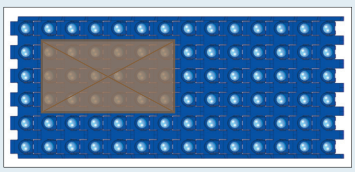
$$x_{II} = \frac{L_p}{2} + l_a$$

$$\Delta x = x_I + x_{II} = W_p$$

$$\frac{v_{a1}}{v_{a2}} = \frac{x_I}{x_{II}} = 1 + \frac{W_p}{\frac{L_p}{2} + l_a}$$

$$\frac{v_{a1}}{v_{a2}} = 1 + \frac{W_p}{\frac{L_p}{2} + l_a}$$

For a properly working rotation we advise a length/width ratio of max. 2



Note:

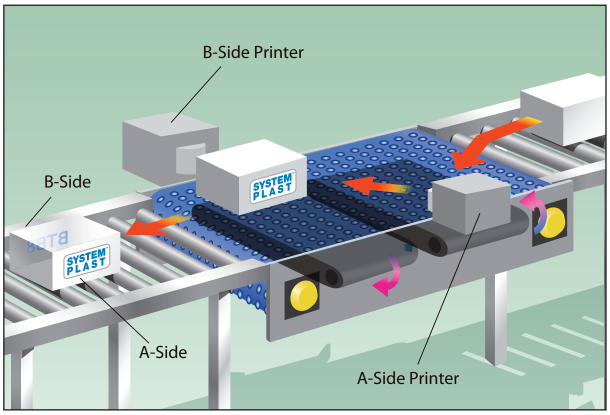
1. Gap in feeding line must be bigger than D.

$$D = \sqrt{W_p^2 + L_p^2}$$

2. Rotation works at any speed v_b. Regarding speed differential between v_a and v_b refer to table “Operation Mode” on page 5.

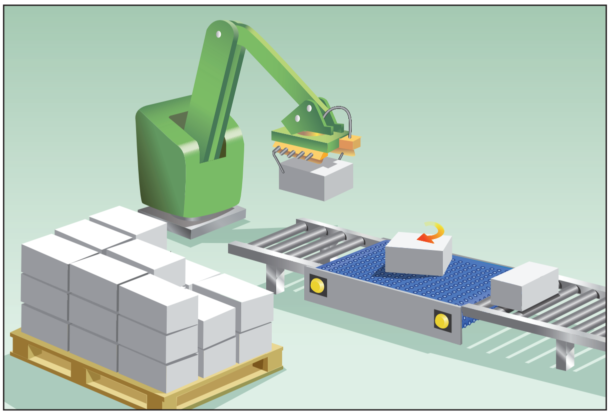
Application examples

Product positioning:
- Printing
- Labelling
- Reading Barcodes

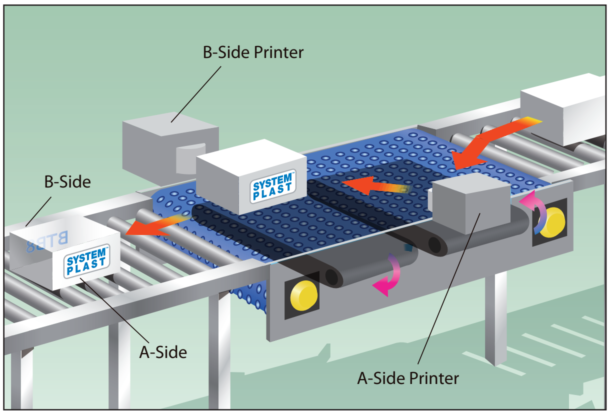


Note: Installation of guides is recommended.

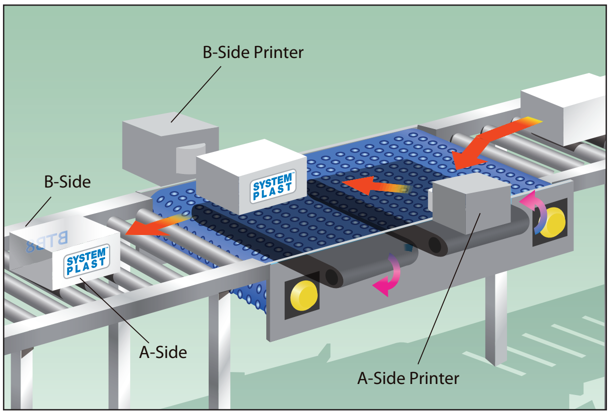
Product orientation:
- Palletizers
- Casing Machines



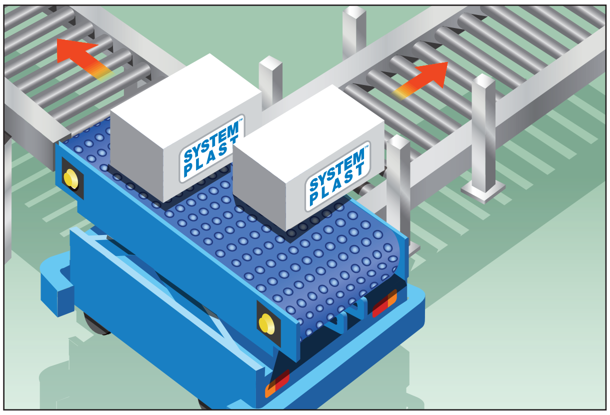
Reject stations:
- Inspection Equipment, e.g. metal detector.
- Measuring Devices, e.g. weighing.



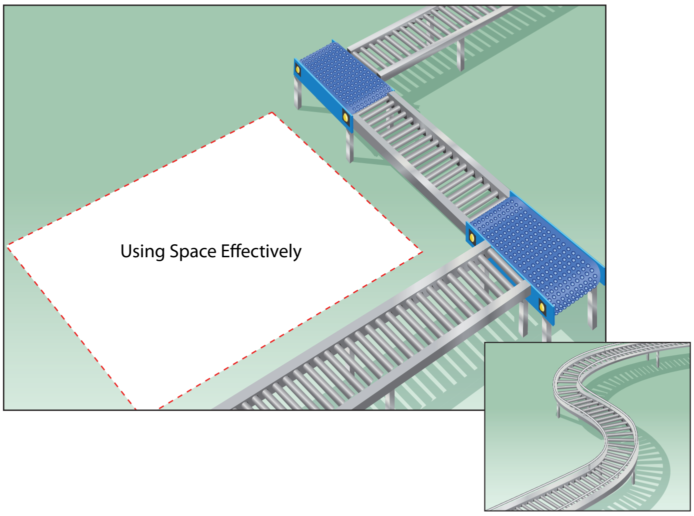
Automatic storage systems:
- Distribution Center
- Linde Divider
- Sorting



Mounting on AGVs:
- Lifter / Raising and Lowering Equipment
- AGV (Automated Guided Vehicle)

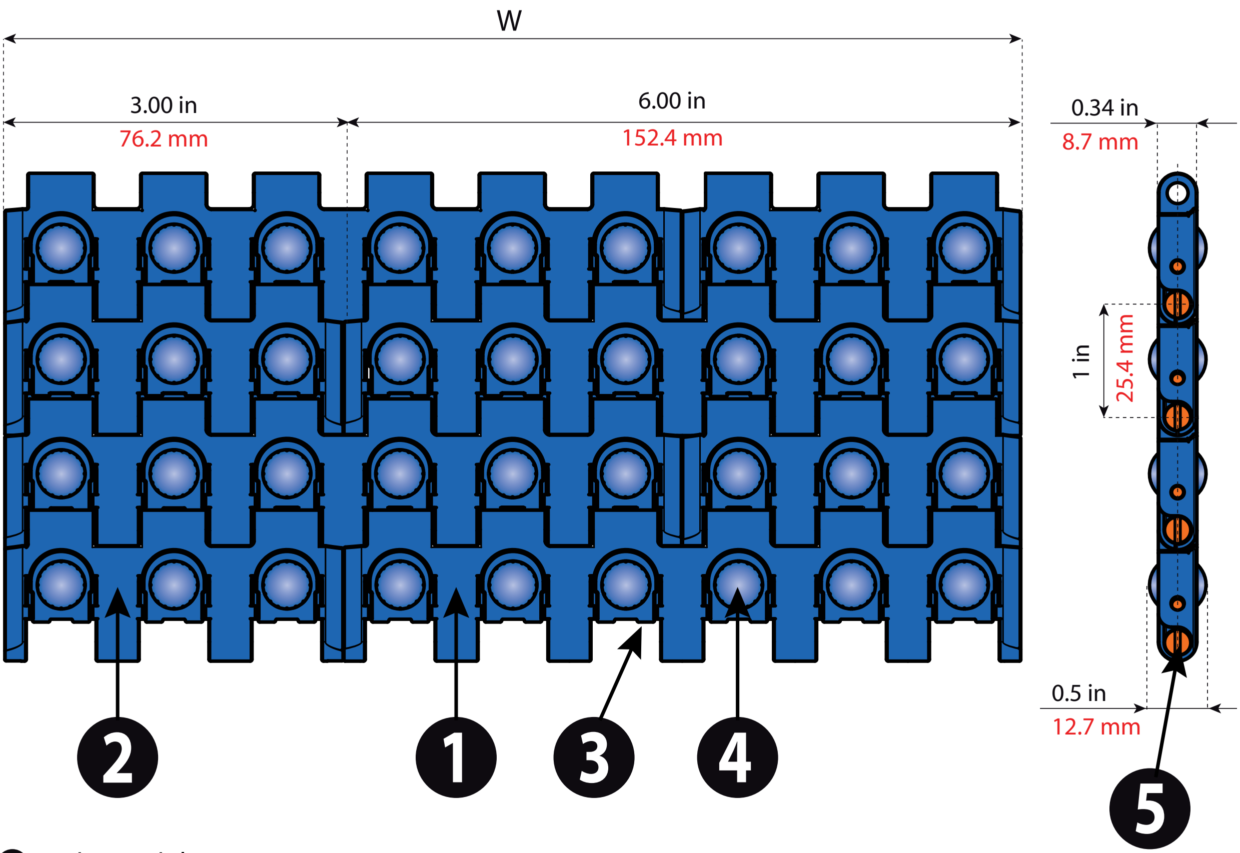


No space for curves:



Note:
Accumulating products on the belt is not reccommended.

Belt Specification



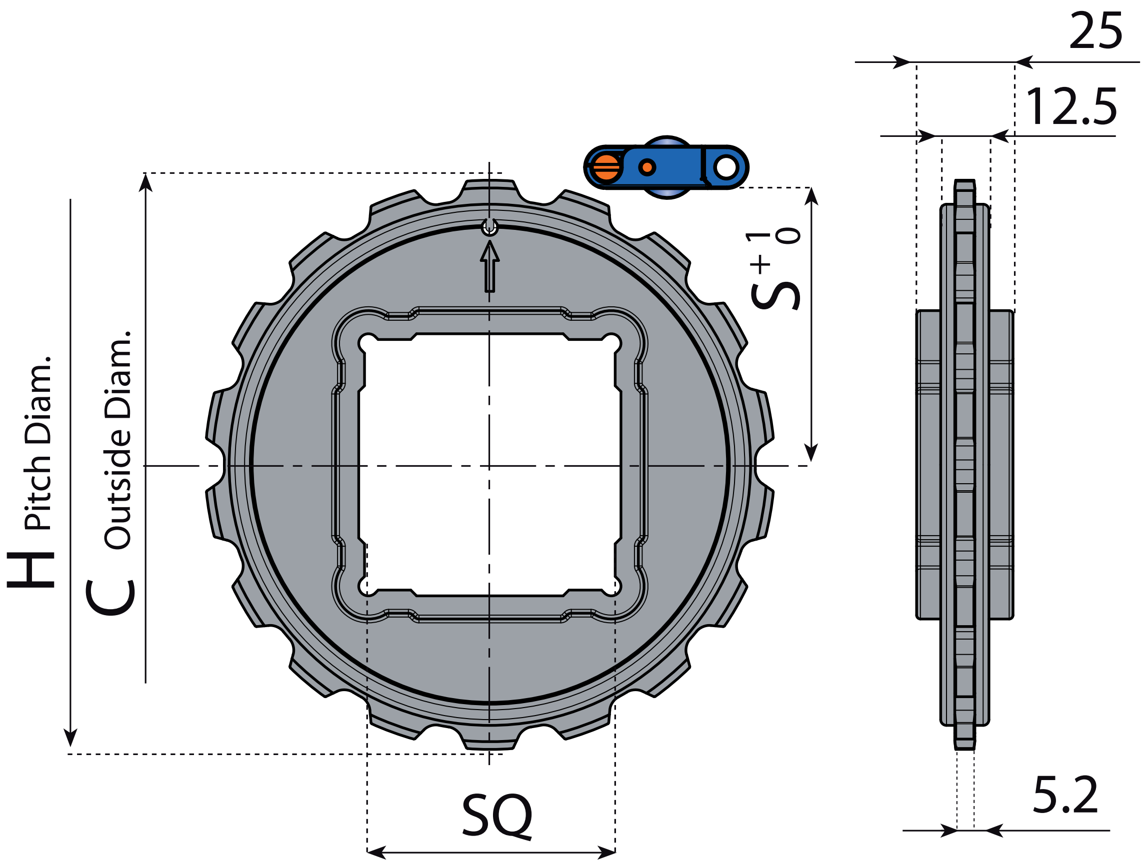
1. Wide module
2. Narrow module
3. Ball retainner
4. Ball
5. Pin Clip

Notes:
1. Value for maximum allowable load capacity assumes that tension acts uniformly over the entire belt width.
2. Values for maximum allowable load capacity and maximum live load per ball are at ambient temperature. Because these values will vary depending on operating conditions (temperature, speed, etc.), refer to the maximum allowable load graph.
3. For use in dry environments only (no lubrications or water).
4. Maximum recommended belt speed: 50 m/min.
5. Minimum back-flex radius: 25mm
6. Materials:

• Links:	LFB (standard) NGG (on request)
• Pins:	PBT
• Pin clips:	PBT
• Balls:	PA
• Ball retainers:	Acetal

7. Maximum load capacity: 9000 N/m
8. Belt weight: 10,5 kg/m2
9. Max. live load per fully supported ball: 0,5 kg ≅ 800 Kg / m^2 belt
10. Operating temperatures: For material limits refer to our Engineering Manual. Recommended range with respect to safely turning balls: 0 – 60°C

Sprocket Specifications



Material: polyamide.

Z	C mm	H mm	S mm
18	147.65	146.3	68

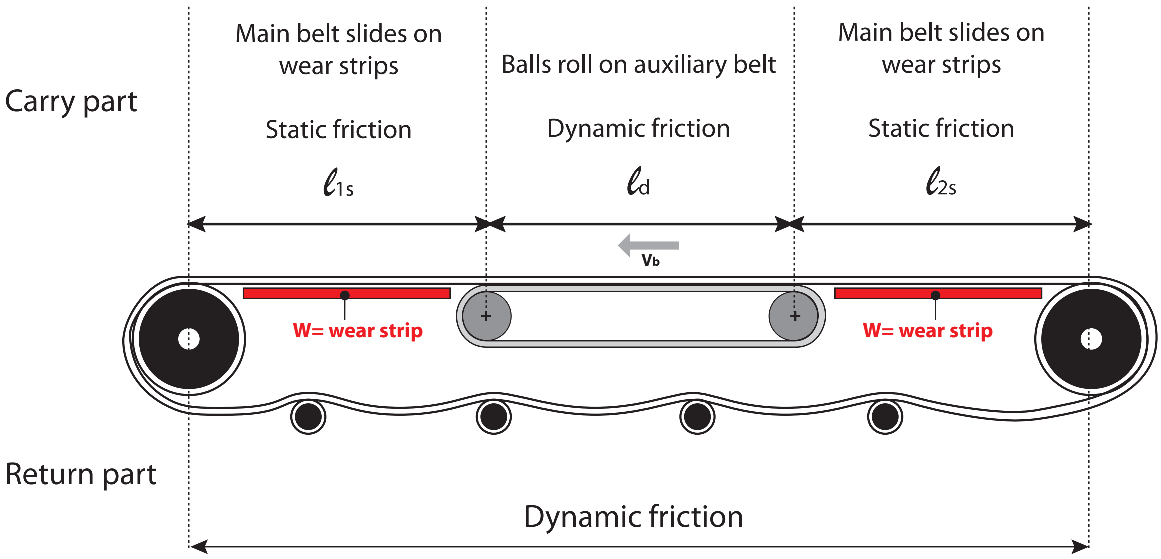
STANDARD SPROCKETS

⌀ 40x40	⌀ 65x65
Part number	**Part number**
123213	**123214**

Notes:

1. These sprockets are made to fit loosely on the shaft to absorb differences in thermal expansion between the belt and conveyor, and alignment errors between sprocket and belt.
2. These sprockets have an alignment mark for phase matching.

Conveyor Design



Tension in return part [N]: $R = L * w_b * \mu_R * 9{,}81\ m/s^2$

Tension in carry part created by static friction [N]:

$$C_S = (\ell_{1S} + \ell_{2S}) * (w_b + w_p) * \mu_N \text{ or } \mu_{SS} \text{ or } \mu_U * 9{,}81\ m/s^2$$

Tension in carry part created by dynamic friction [N]:

$$C_d = \ell_d * (w_b + w_p) * \mu_B * 9{,}81\ m/s^2$$

$$C = C_S + C_d$$

Belt Tension: $T = R + C$ [N]

Net shaft power: $P = \dfrac{T * v_b}{3600}$ [W]

$L = \ell_{1S} + \ell_d + \ell_{2S}$	[m]
w_b = belt weight	[Kg/m]
μ = coefficient of friction, refer to table	
w_p = product weight	[Kg/m]
v_b = speed of main belt	[m/min]

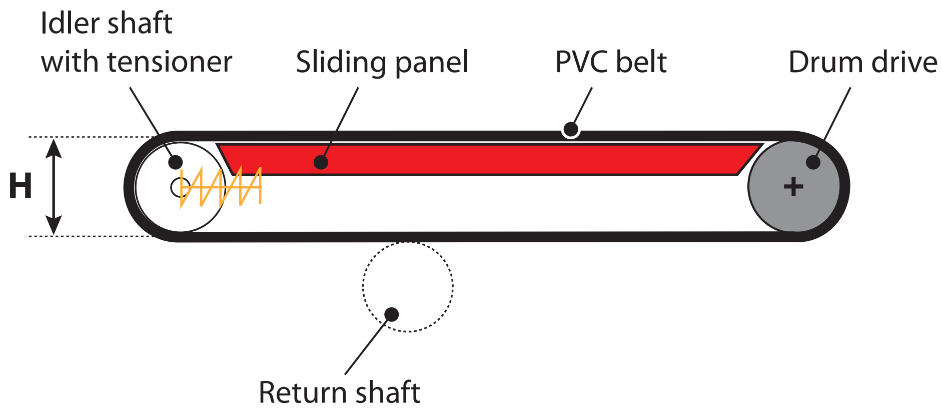
Coefficent of friction: at 20°C, dry, clean conditions

	μ_N	μ_{SS}	μ_U	μ_R	μ_B
	static			return	dynamic
Main belt sliding on Nolu-S	0.18				
Main belt sliding on Stainless Steel		0.24			
Main belt sliding on UHMWPE			0.20		
Main belt rolling over return rollers				0.1	
Main belt rolling on balls*					0.18

* Same value for PVC, rubber coated 70 shore A, any hard surface.

Auxiliary belt

Example of conveyor design:



Idler shaft approx. D 30 mm: D as small as possible for short transfers.
Drum drive approx. D 80 mm: Depending on required drive data.
Tensioner: Spring loaded or manually adjustable.
Return shaft: If conveyor is longer than 1 m, shaft every 0,5 m.
Sliding panel: UHMWPE or PA or wood.

Note:

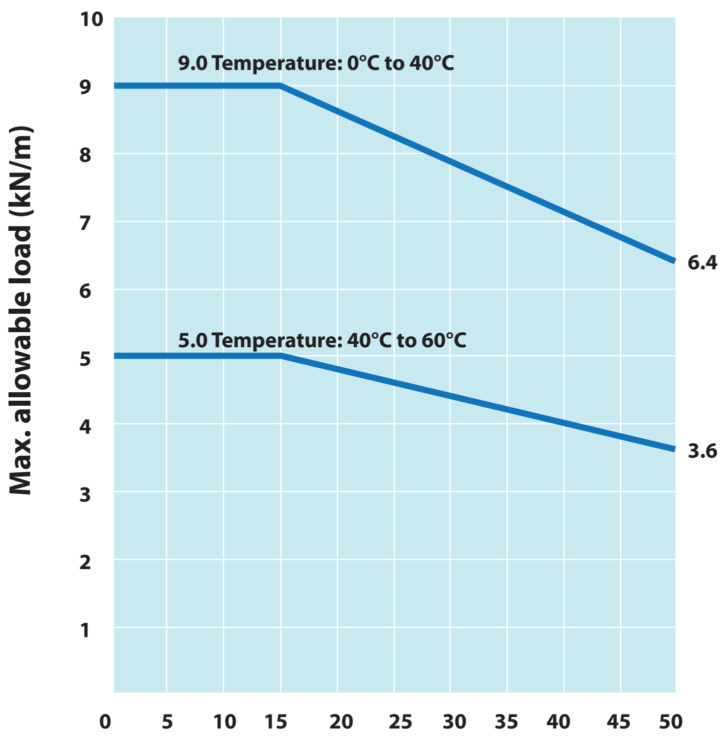
1. In case of PVC belt regard self aligning design (convex drum or belt with integral side guides) of drive as well as wrap around angle.
2. The whole auxiliary conveyor must fit in between carry and return part of the main belt, H_{MAX} < Pitch diameter of sprocket - 12,7 mm.

Determine Usability of Belt

The maximum tension applied to the belt (T) is converted into belt tension per one meter of belt width by the following formula.

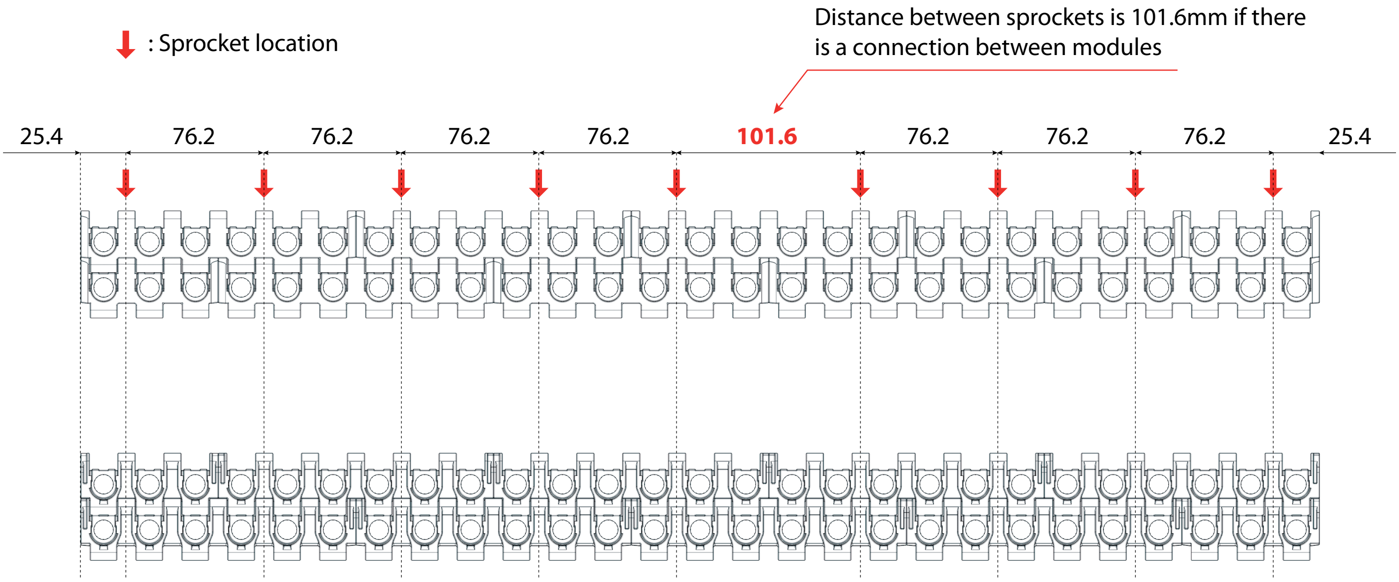
$$T' = \frac{T \quad [kN]}{\text{belt with} \quad [m]}$$

A belt can be used when the tension per one meter of belt width (T′) is below a curve representing the maximum allowable load of the belt that takes into account belt speed and temperature.



Belt speed in m/min.
Dry environment only

Determine Sprocket Locations

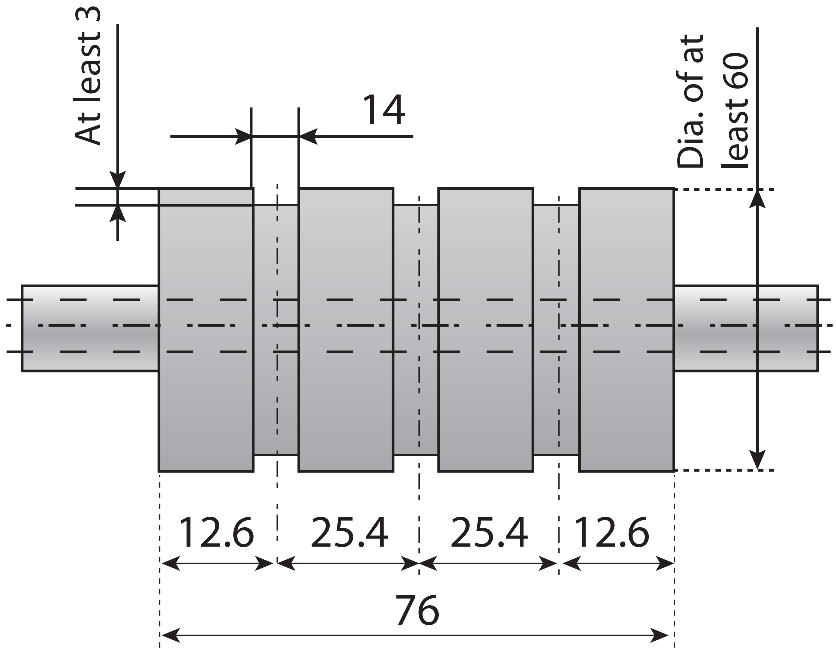


Sprockets are possible every inch (25,4mm) according to the available pockets for sprocket interaction at the opposite side of the belt.

Minimum recommended number of sprockets as per sketch. Calculate: $\frac{\text{belt width [inch]}}{3}$

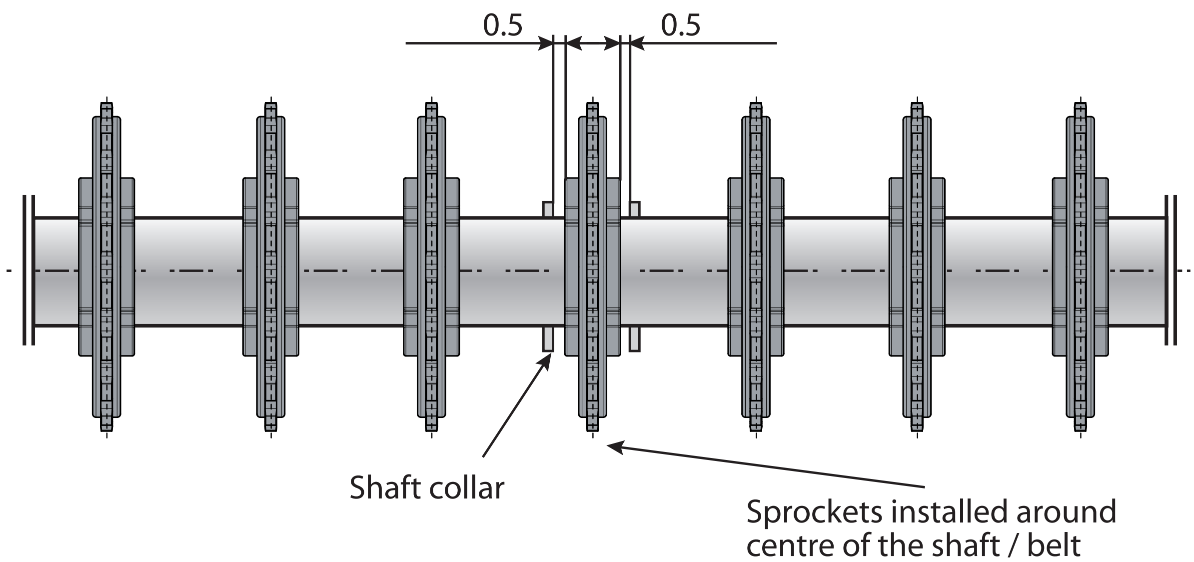
Special Return Rollers

Grooves formed in the return rollers are designed to prevent the balls from making contact with the rollers.



Locking Sprockets:

The sprockets and the shaft are loosely fitted in order to absorb differences in thermal expansion between the belt and the conveyor and also installation errors of the belt and the sprockets. However, a shaft collar should be mounted on each side of a sprocket installed around the centre of the belt with about 0.5 mm clearance with the sprocket.

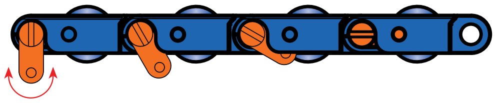


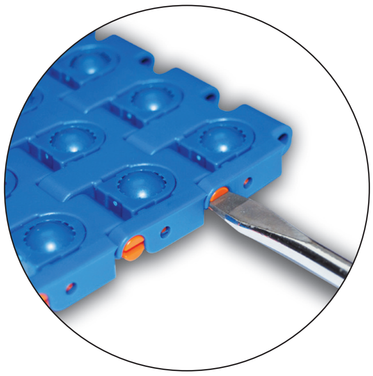
Disconnecting and Reconnecting of the Belt

Follow the procedure below to disconnect and /or reconnect the belt when installing the conveyor or performing maintenance.

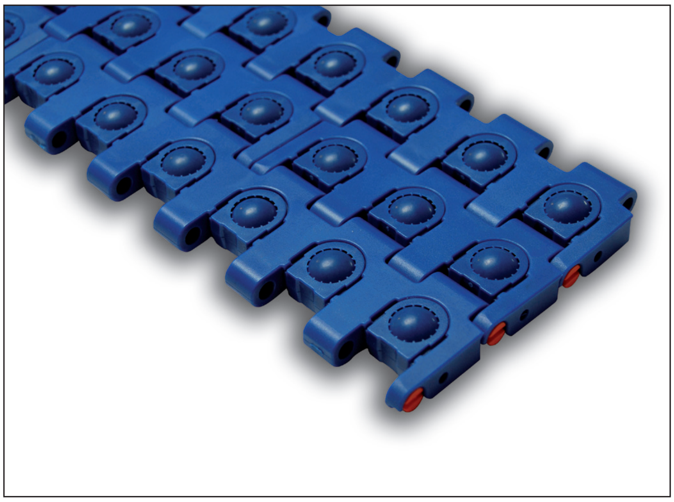
1) Procedure for disconnecting and reconnecting

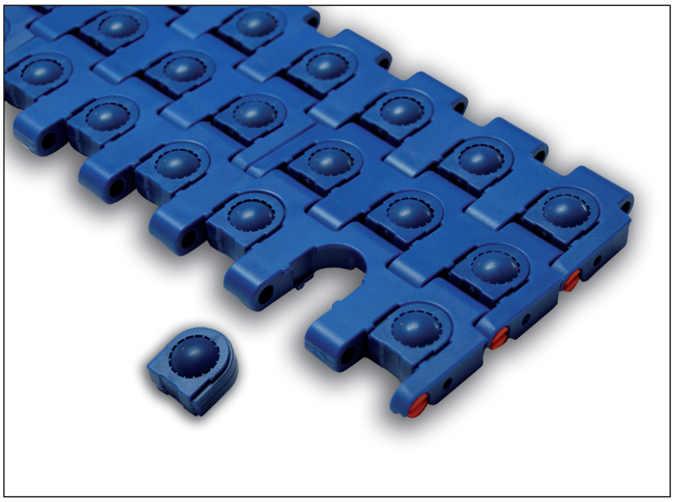
Open the clip with a screwdriver by rotating about 90 degrees.

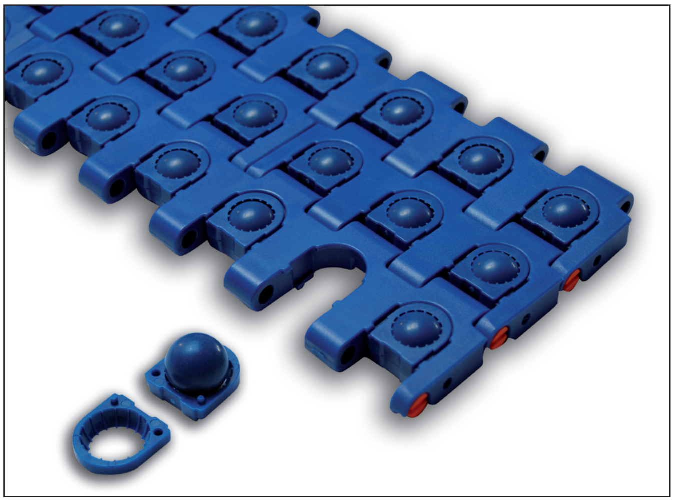




2) Procedure for changing the balls or the retainers



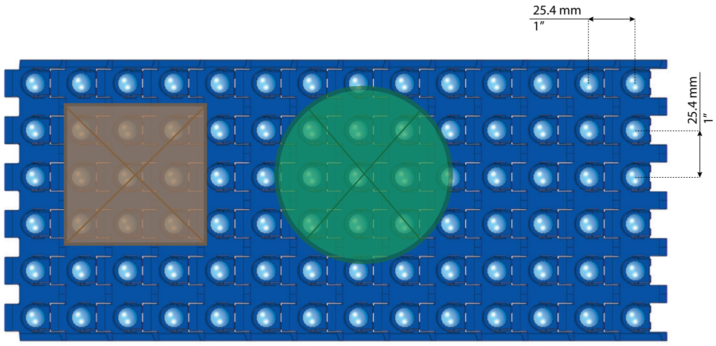




Products that can be handled

General recommendations:

- Contact surface belt/product ≥ 3 x 3 balls



- For a proper controlled rotation we advice a length/width ratio of contact surface between belt and product ≤ 2, see page 10.

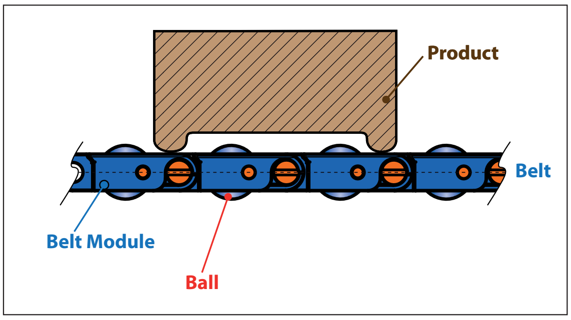
- Product contact surface must be:
    + As smooth and closed as possible.
        - No protruding edges/areas.
    + As flat as possible.
        - No wave pattern.
        - Not bent.
    + Rigid enough.
        - Elastic areas must not contact the modules of the belt.
- Product contact surface must offer enough grip.

$F_a = m * a$, $\quad F_F = m * \mu * g \quad F_F \overset{!}{>} F_a \quad \mu > \frac{a}{g}$

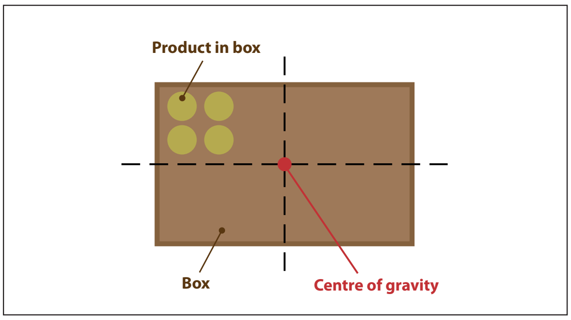
Friction factor µ between product on balls must be bigger than the ratio of acceleration – which is applied by the drive- and gravitational acceleration.

Note:
Consider product stability (ref. to corresponding chapter in the Engineering Manual)

- Centre of gravity of the product should be as close to the centre of the product contact surface as possible.



Such products cannot be driven by the balls



Not recommended

Maximum possible acceleration of the balls of the belt

$a \overset{!}{<} \mu * g$ Attention: Check µ between product and balls as well as between balls and auxiliary belt.

Friction product/belt

We recommend conducting tests with your original product before finishing the design of your RT2253 conveyor. We have small test conveyors that could contribute in this testing process.
Please contact your local System Plast Application Engineering contact to discuss this.

Operating conditions

Ball retainers are designed with internal ribs in order to offer low friction against the balls. A certain quantity of debris can be collected in the pockets between the ribs without affecting the rotation of the balls. If one or more balls do not rotate freely, conveyed goods move uncontrolled and can no longer be positioned precisely. Blocked balls wear out unevenly and have to be replaced. Same happens with the sliding panels respectively auxiliary belts.

Wet or half-wet conditions increase the danger of flushing debris into the retainers, forming a sticky paste that blocks the balls.
Dry operation is recommended.

Balls blocked by foreign particles or sticky labels have the same effect.

The system with auxiliary belt is based on constant and sufficient friction respectively grip. Any grip-reducing conditions, e.g. lubrication, water carry over, affect the performance of the conveyor in an unpredictable way. In case of auxiliary conveyor design with PVC belt and friction drive, no lube or any other friction reducing conditions may occur.

Conveyors have to be set-up level to avoid products from rolling off just by gravitational forces. Only if the balls have contact with either the auxiliary belt or the sliding panel, inclines/declines are possible.

Conveyors have to be kept clean. Carry-over of dirt/debris/abrasives/…by the product has to be avoided. Environmental conditions have to be clean, as well.

Cleaning is necessary, if products do not move as they are supposed to do.

Intermediate cleaning can be done by means of compressed air blowing devices without dismantling the conveyor.

For a full cleaning the belt has to be taken off and dismantled. All parts have to be washed and dried. The conveyor bed has to be washed and dried.
For washing and drying regard chemical and thermal compatibility of all components. Regard the protection class of the drives. When reassembling the belt into the conveyor make sure the sprockets are in the correct position and aligned with the corresponding pocket of the belt. While the conveyor and belts are disassembled, check all parts for wear and replace, if necessary.

Catalogues available on request

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all your productive needs

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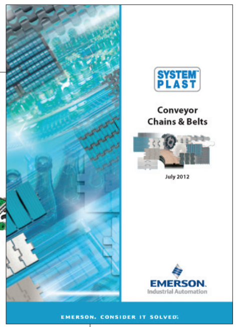
Supports

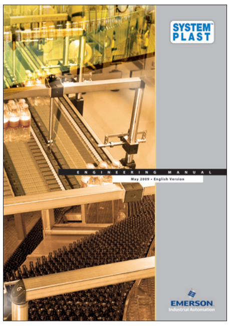
Leveling
Pads

Conveyor
Components

Conveyor
Chains / Belts



Engineering
Manual



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