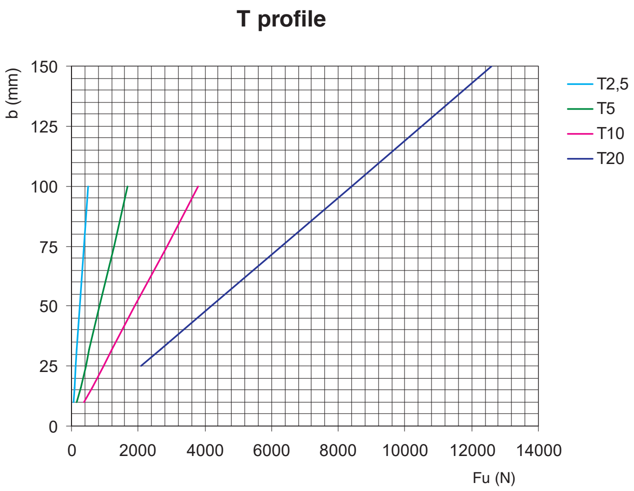
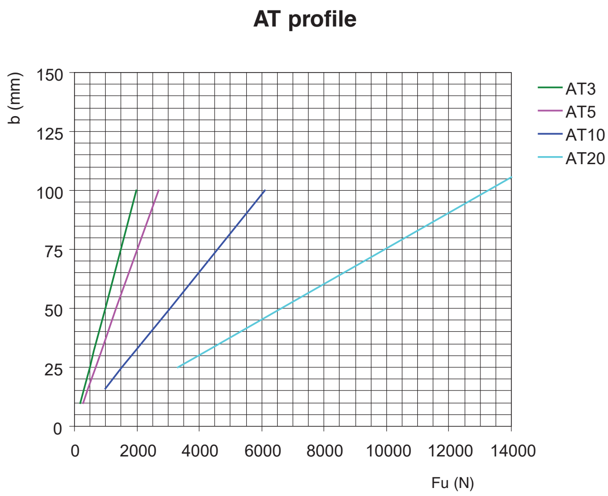
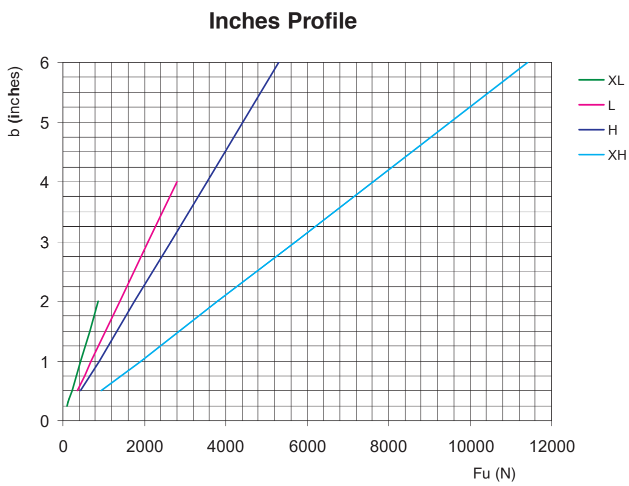
Selection graphs corrected peripheral force / belt width

LINEAR drives

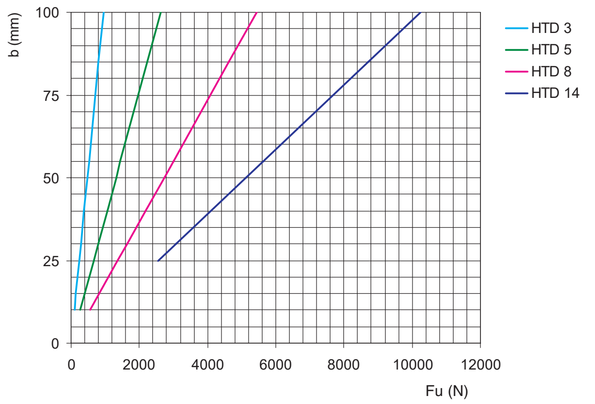
The selection graphs **corrected peripheral force / belt width** provide a quick indication on the belt width needed for each belt profile when a specific corrected load is applied. The graphs have been designed considering the maximum speed (rpm) generally used in the applications for every belt profile and pitch. No safety factor is included as safety factor usually depends on acceleration. Therefore, depending on the specific values of the application, it might be necessary to change the belt width upon calculation.



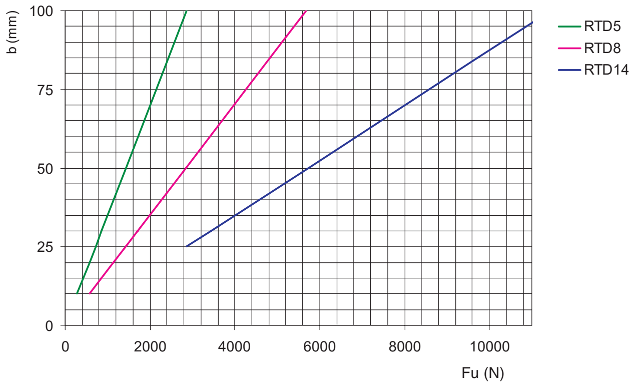




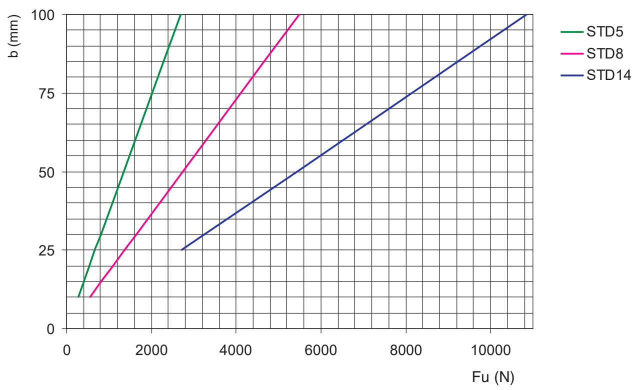
HTD profile



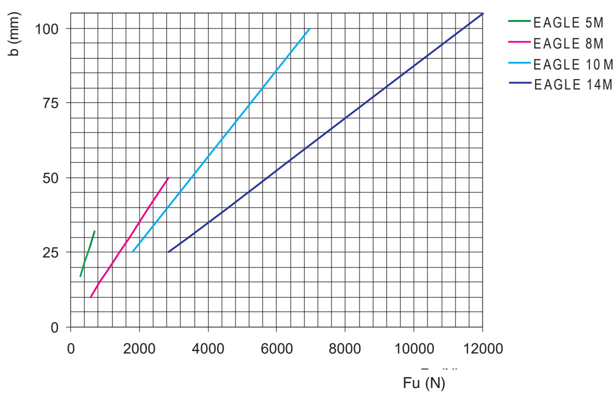
RTD profile



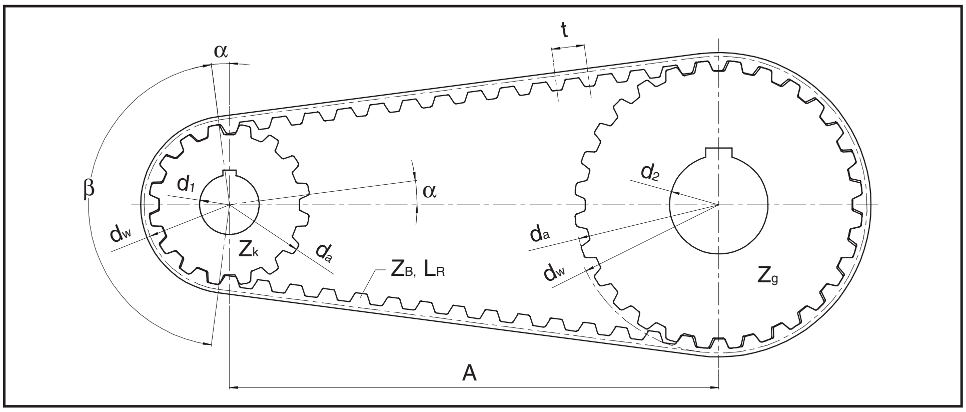
STD profile



EAGLE profile



Power transmission drives ELA-flex SD® and iSync®



Definitions

b	[cm]	Belt width
L_R	[mm]	Belt length
z_R	-	Number of teeth of the belt
B	[mm]	Pulley width
A	[mm]	Center distance
A_{eff}	[mm]	Effective center distance
d	[mm]	Pulley bore diameter
d_a	[mm]	Pulley outside diameter
d_{ak}	[mm]	Small pulley outside diameter
d_{ag}	[mm]	Large pulley outside diameter
d_w	[mm]	Pulley pitch diameter
d_{wk}	[mm]	Small pulley pitch circle diameter
d_{wg}	[mm]	Large pulley pitch circle diameter
F_{Wsta}	[N]	Static Shafts load
F_{TV}	[N]	Pretension force per belt side
F_{Tzul}	[N]	Allowable tensile load
F_U	[N]	Peripheral force

M	[Nm]	Torque
P	[kW]	Power
t_{ab}	[s]	Acceleration time
t_{av}	[s]	Deceleration time
v	[m/s]	Peripheral speed
z_e	-	N. of teeth in mesh
z_k	-	Number of teeth of the small pulley
z_g	-	Number of teeth of the large pulley
i	-	Drive ratio [$n_1 : n_2$]
ρ	[kg/dm³]	Specific weight
J	[kgm²]	Moment of inertia
t	[mm]	Pitch
n	[min⁻¹]	Rpm
n_1	[min⁻¹]	Rpm of driver pulley
ω	[s⁻¹]	Angular speed
β	[°]	Wrap angle

Calculation formula

Power

$$P = \frac{M \cdot n}{9550}$$

$$P = \frac{F_u \cdot d_w \cdot n}{19100 \cdot 10^3}$$

Peripheral force

$$F_u = \frac{19100 \cdot P \cdot 10^3}{n \cdot d_w}$$

$$F_u = \frac{2000 \cdot M}{d_w}$$

Torque

$$M = \frac{F_U \cdot d_W}{2000}$$

$$M = \frac{9550 \cdot P}{n}$$

Moment of inertia

$$J = 98{,}2 \cdot 10^{-15} \cdot B \cdot \rho \cdot \left(d_a^4 - d^4\right)$$

Angular speed

$$\omega = \frac{\pi \cdot n}{30}$$

Peripheral speed

$$v = \frac{d_W \cdot n}{19100}$$

Acceleration torque

$$M_{ab} = \frac{J \cdot \Delta n}{9{,}55 \cdot t_{ab}}$$

rpm

$$n = \frac{19100 \cdot v}{d_w}$$

Safety factors

Belt selection is made according to a constant working load. For start up torque and in case of peak loads and vibrations a safety factor c_1 must be considered.

Transmission with steady load $c_1 = 1,0$

Transmission with peak or fluctuating loads:

Light	$c_1 = 1,4$
Medium	$c_1 = 1,7$
Heavy	$c_1 = 2,0$

For speed up driver factor c_2 must be considered:

i = from 0,66 to 1	$c_2 = 1,1$
i = from 0,40 to 0,66	$c_2 = 1,2$
i < 0,40	$c_2 = 1,3$

The resulting total safety factor is:

$c_0 = c_1 \cdot c_2$

Drive calculation

The necessary data for drive calculation are:

• Power to be transmitted	P	[kW]
• Driver rpm	n_1	[min^{-1}]
• Motor starting torque	M_{ab}	[Nm]
• Required center distance	A	[mm]
• Maximum driver pulley diameter	d_{w1}	[mm]

Select type of belt

For the initial drive selection, use the selection graphs illustrated in the relative ELA-flex SD® catalog section. For initial pulley choice, it is recommended to use the driver pulley with maximum diameter allowable in the application.

Calculate drive ratio

$$i = \frac{n_{driver}}{n_{driven}}$$

Calculate belt length

Belt length for drive with ratio i ≠ 1

$$L_R \approx \frac{t}{2} \cdot (z_g + z_k) + 2A + \frac{1}{4A} \cdot \left[\frac{(z_g - z_k) \cdot t}{\pi}\right]^2$$

and more precisely:

$$L_R = 2A \cdot \sin \cdot \frac{\beta}{2} + \frac{t}{2} \cdot \left[z_g + z_k + \left(1 - \frac{\beta}{180}\right) \cdot (z_g - z_k)\right]$$

Belt length for drive with ratio i = 1

$$L_R = 2 \cdot A + \pi \cdot d_w = 2 \cdot A + z \cdot t$$

Calculate teeth in mesh

$$z_e = \frac{\beta}{360} \cdot z_k$$

with $\beta\,[°] =$ wrap angle

$$\beta = 2 \cdot \arccos \cdot \left[\frac{t \cdot (z_g - z_k)}{2 \cdot \pi \cdot A}\right]$$

Determine belt width

$$b = \frac{P \cdot 1000 \cdot c_0}{z_k \cdot z_e \cdot P_{spez}} \qquad b = \frac{100 \cdot M \cdot c_0}{z_k \cdot z_e \cdot M_{spez}}$$

Verify allowable tensile load

The allowable tensile load of the belt must be higher than the total corrected peripheral force.

$F_{Tzul} > c_0 \cdot F_U$ with $F_u = \frac{2000 \cdot M}{d_w}$

Calculate shaft load

$$F_{Wsta} = 2 \cdot F_{Tv} \cdot \cos \cdot \beta$$
$$F_{Wsta} = 2 \cdot F_{Tv} \; (\text{for } i = 1)$$

Determine installation tension

A drive is correctly tensioned when the belt slack side is tensioned in all working conditions. It is also important to use the minimum necessary tension to minimize shaft loads. Belt tension is dependent also on belt length L_R and its number of teeth Z_R. According to belt number of teeth, following tension is suggested:

2 shafts drive

$Z_R < 75$	$F_{TV} = 1/3\ F_U$
$75 < Z_R < 150$	$F_{TV} = 1/2\ F_U$
$Z_R > 150$	$F_{TV} = 2/3\ F_U$

More than 2 shafts drive

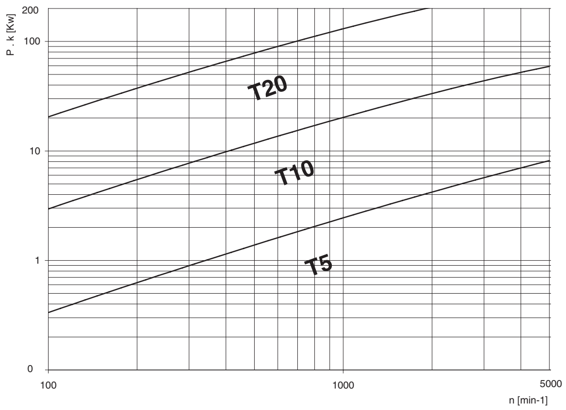
$F_{TV} > F_U$

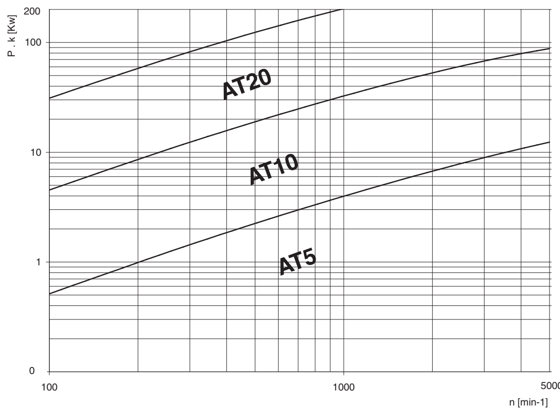
In order to ensure the correct drive installation tension, it is recommended to use the special belt tension meter available from ELATECH®.

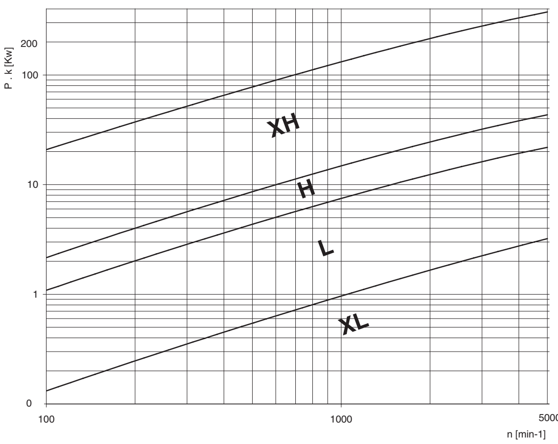
Selection graphs

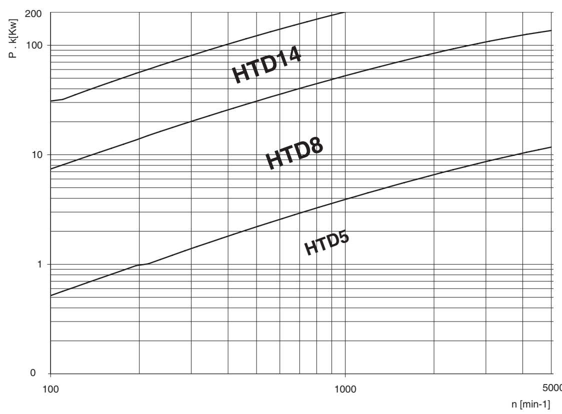
ELA-flex SD®

The selection graphs allows the customer to select the most suitable timing belt pitch for each belt profile and for the power to be transmitted. The rpm on the horizontal axis refers to the small pulley. The corrected power (safety factor x nominal power) is read on the vertical axis.









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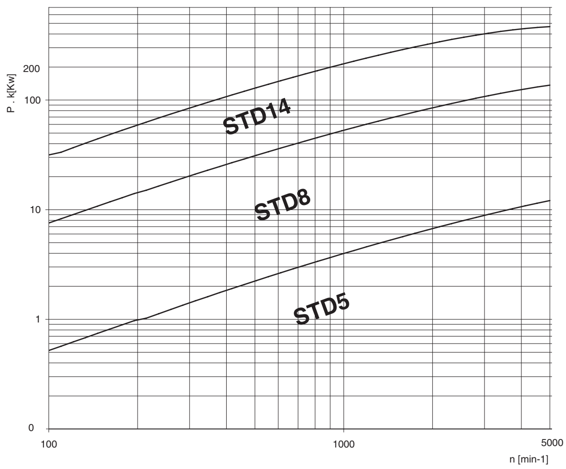
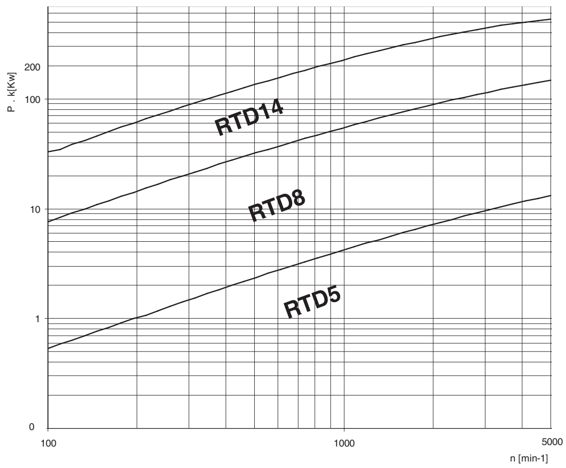
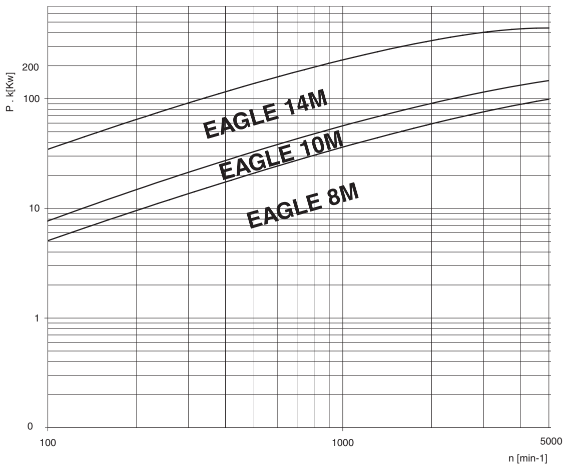


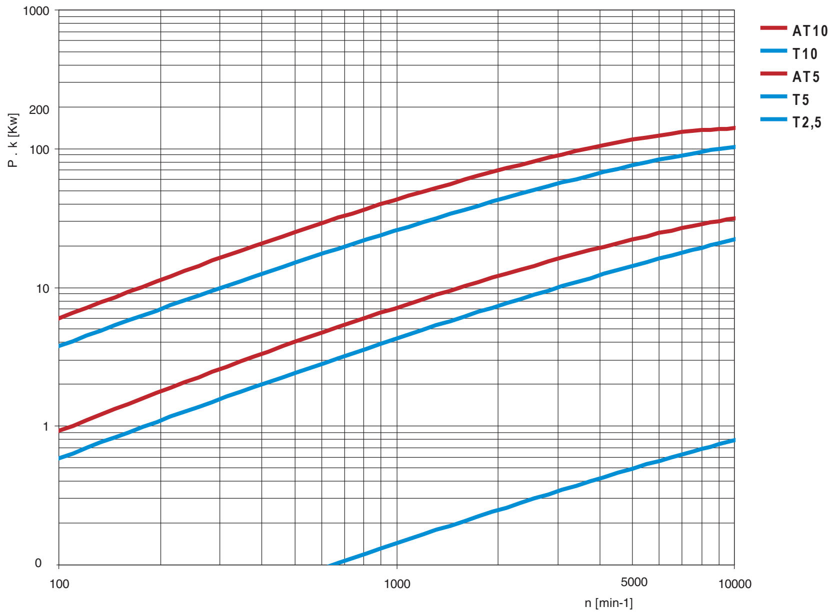




Drive Calculation

Selection graphs

iSync® high performance timing belts



Troubleshooting

DAMAGE	CAUSE	REMEDY
Belt tooth jumping	Over load (shock on the machine)	Increase belt size/modify design
	Overload due to machine accident	Prevent recurrence of the accident
	Shortage of teeth in mesh	Increase teeth in mesh by using an idler
	Lack of initial tension	Correct initial tension
	Pulley diameter too small	Change design
	Moment of inertia for start and stop is not considered	Change design
Abnormal noise level	Bad pulley alignment	Adjust alignment
	Incorrect pulley tooth shape	Change pulley
	Belt wider than pulley diameter	Change design
	Over load	Change design
	Belt over-tension	Correct initial tension
Belt side abrasion	Bad pulley alignment	Adjust alignment
	Poor flange shape	Correct flange shape or change flange
	Pulley flange roughness	Change flange to an appropriate one
Belt tooth abrasion	Presence of particles between belt and pulley	Improve environment or apply a protective cover
	Over load	Change design (increase belt size)
	Over tension	Correct initial tension
	Belt tooth jumping due to lack of initial tension	Correct initial tension
Belt tooth bottom abrasion	Bad pulley profile	Use correct pulley
	Over tension	Correct initial tension
Belt back abrasion	Contact with undesired element (i.e. machine frame)	Eliminate contact
Belt back cracking	Running under too low temperature	Increase environment temperature or ask for special compound
	Pulleys too small	Observe minimum pulley diameter recommendations
Belt breakage	Over load (shock on the machine)	Increase belt size/modify design
	Undesired particles in mesh	Improve environment or apply a protective cover
	Tension member corrosion	Improve environment or use aramid/stainless steel cords
	Belt run off over pulley flange	Adjust alignment and change pulley flange
	Not enough belt teeth in clamping plate	Use larger clamping plate
	Clamping plate screws tightened incorrectly	Apply optimum torque to clamp plate screws
Tension member partial tear	Presence of undesired particles in mesh	Improve environment or apply a protective cover
	Improper installation	Exercise care when installing
	Belt folded or twisted	Exercise care in handling
	Fatigue on side due to bad alignment	Correct alignment
Back covering abnormal abrasion	Aggressive environment	Change belt back cover or improve environment conditions
Pulley tooth abrasion	Presence of undesired particles in mesh	Improve environment or apply a protective cover
	Over load	Change design
	Belt over tension	Correct initial tension
	Pulley material not adequate (too soft)	Change pulley material or adopt surface treatment

Notes:

The data contained in this publication are for information purposes only and do not enlarge, amend or imply any warranty other than provided by the manufacturer with the product. In the spirit of continuos technical improvement, the specifications in this catalogue are subject to change without notice.