

Technischer Hinweis für Zahnriemen 22052 und 22057

General

Polyurethane toothed belts are made of abrasion-resistant polyurethane and high-tensile reinforced steel cording. They allow for a smooth and synchronous transmission of power. They are maintenance-free and extremely cost-efficient.

Drive installation

Diagrams and performance tables are available on these pages for selecting the size. The axes must be parallel to one another. It is possible to align the toothed pulleys very precisely using a straight edge or laser. Use the largest possible toothed pulleys. Make sure that at least one toothed pulley has rim flanges. When installing the toothed belts, never forcefully lever over the rim flange. Adjustment possibilities should be pre-planned for mounting and setting the correct belt tension.

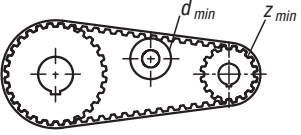
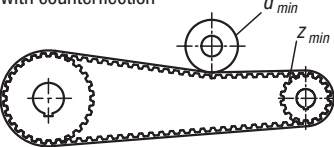
Belt tension

In order to guarantee a long service life and low-noise operation, correct alignment and pre-tensioning of the drive are absolutely necessary. Idlers are often used on drives with fixed centre distances in order to be able to set the belt tension accurately. A smooth roller is the preferred idler to use on the slack side of the belt. Smooth idlers produce counter-flection which reduces the service life of the drive. If it is not possible to do without them, the idler should be at least 1.25 times as large as the drive's small toothed pulley and fitted as close as possible to the small pulley in order to maximise the number of teeth in mesh.

Belt storage

Never bend the toothed belt. When storing, prevent bending, direct solar radiation and chemical influences.

Minimum number of teeth and minimum diameter

	Profile	T2,5	T5	T10	AT5	AT10
without counterflexion 	Synchronising wheel z_{min}	10	10	12	15	15
	Inner idler on teeth $d_{min} [mm]$	15	30	60	30	50
with counterflexion 	Synchronising wheel z_{min}	18	15	20	25	25
	Outer idler on belt back $d_{min} [mm]$	15	30	60	60	120

Technical information for toothed belts 22052 and 22057

Specific tooth force

Output „P“ and torque „M“ to be transferred via the belt are calculated using the following formulas:

P = Power [kW]

M = Torque [Nm]

P_{spez} = Specific power

M_{spez} = Specific torque

Z_e = Engaging teeth of small gear wheel

Z_{emax} = 12 for calculating max. permissible engaging teeth

Z_k = Nr. of teeth of small gear wheel

b = Belt width [cm]

A = Centre distance [mm]

$$P \text{ [kW]} = P_{\text{spez}}$$

$$M \text{ [Nm]} = M_{\text{spez}}$$

Pitch T 2,5

Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]	Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]	Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]
0	0,47	0,000	1200	0,29	0,361	3400	0,23	0,810
20	0,45	0,010	1300	0,28	0,385	3600	0,22	0,845
40	0,44	0,018	1400	0,28	0,408	3800	0,22	0,880
60	0,43	0,027	1440	0,28	0,417	4000	0,22	0,914
80	0,42	0,035	1500	0,27	0,431	4500	0,21	0,996
100	0,41	0,043	1600	0,27	0,454	5000	0,21	1,074
200	0,38	0,080	1700	0,27	0,476	5500	0,20	1,150
300	0,36	0,114	1800	0,26	0,498	6000	0,19	1,223
400	0,35	0,145	1900	0,26	0,519	6500	0,19	1,293
500	0,34	0,175	2000	0,26	0,541	7000	0,19	1,360
600	0,33	0,204	2200	0,25	0,582	7500	0,18	1,426
700	0,32	0,232	2400	0,25	0,622	8000	0,18	1,489
800	0,31	0,259	2600	0,24	0,662	8500	0,17	1,551
900	0,30	0,286	2800	0,24	0,700	9000	0,17	1,611
1000	0,30	0,311	3000	0,24	0,715	9500	0,17	1,668
1100	0,29	0,336	3200	0,23	0,780	10000	0,16	1,725

Pitch T 5

Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]	Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]	Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]
0	2,523	0,000	1200	1,607	2,019	3400	1,248	4,444
20	2,458	0,051	1300	1,580	2,151	3600	1,229	4,632
40	2,403	0,101	1400	1,555	2,279	3800	1,209	4,812
60	2,354	0,148	1440	1,545	2,330	4000	1,191	4,988
80	2,312	0,194	1500	1,532	2,406	4500	1,149	5,414
100	2,276	0,238	1600	1,510	2,529	5000	1,111	5,818
200	2,135	0,447	1700	1,489	2,651	5500	1,078	6,206
300	2,032	0,638	1800	1,470	2,770	6000	1,046	6,571
400	1,951	0,817	1900	1,451	2,888	6500	1,017	6,924
500	1,884	0,987	2000	1,433	3,001	7000	0,991	7,262
600	1,829	1,149	2200	1,400	3,226	7500	0,966	7,588
700	1,781	1,306	2400	1,371	3,445	8000	0,943	7,897
800	1,738	1,456	2600	1,342	3,654	8500	0,920	8,191
900	1,701	1,603	2800	1,317	3,860	9000	0,900	8,480
1000	1,667	1,745	3000	1,306	3,940	9500	0,880	8,758
1100	1,635	1,884	3200	1,292	4,059	10000	0,862	9,027

Pitch T 10

Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]	Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]	Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]
0	8,244	0,000	1200	4,808	6,042	3400	3,460	12,318
20	8,009	0,168	1300	4,708	6,409	3600	3,385	12,761
40	7,805	0,327	1400	4,614	6,764	3800	3,312	13,179
60	7,627	0,479	1440	4,577	6,902	4000	3,245	13,592
80	7,472	0,626	1500	4,526	7,109	4500	3,088	14,549
100	7,339	0,768	1600	4,444	7,445	5000	2,946	15,424
200	6,804	1,425	1700	4,366	7,771	5500	2,817	16,224
300	6,411	2,014	1800	4,292	8,090	6000	2,701	16,969
400	6,105	2,557	1900	4,222	8,401	6500	2,593	17,646
500	5,857	3,066	2000	4,157	8,706	7000	2,492	18,269
600	5,648	3,549	2200	4,033	9,291	7500	2,398	18,836
700	5,467	4,007	2400	3,920	9,851	8000	2,311	19,359
800	5,306	4,445	2600	3,815	10,386	8500	2,228	19,832
900	5,163	4,866	2800	3,718	10,901	9000	2,150	20,264
1000	5,034	5,271	3000	3,680	11,097	9500	2,077	20,661
1100	4,916	5,663	3200	3,626	11,389	10000	2,007	21,015

Pitch AT 5

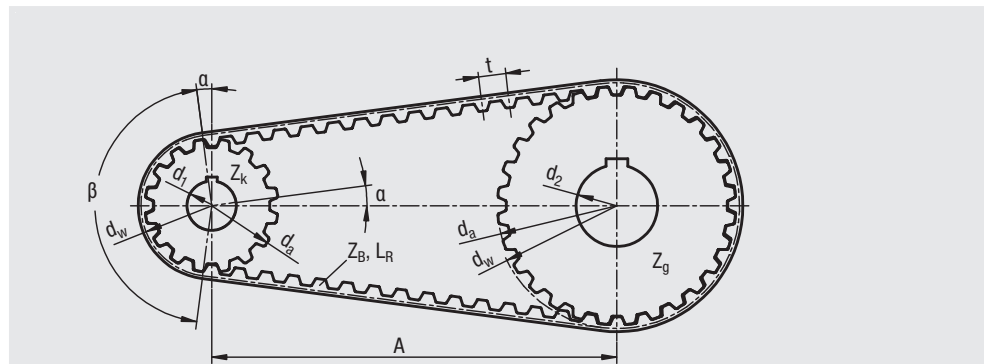
Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]	Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]	Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]
0	3,813	0,000	1200	2,668	3,352	3400	1,993	7,096
20	3,758	0,079	1300	2,620	3,566	3600	1,954	7,368
40	3,708	0,155	1400	2,574	3,773	3800	1,917	7,627
60	3,663	0,230	1440	2,557	3,855	4000	1,881	7,879
80	3,623	0,304	1500	2,531	3,975	4500	1,799	8,479
100	3,586	0,376	1600	2,491	4,173	5000	1,725	9,032
200	3,448	0,722	1700	2,452	4,365	5500	1,658	9,549
300	3,343	1,050	1800	2,416	4,554	6000	1,596	10,029
400	3,235	1,355	1900	2,381	4,737	6500	1,539	10,473
500	3,137	1,642	2000	2,348	4,918	7000	1,485	10,887
600	3,050	1,916	2200	2,285	5,265	7500	1,436	11,278
700	2,972	2,178	2400	2,229	5,601	8000	1,389	11,635
800	2,900	2,430	2600	2,175	5,923	8500	1,346	11,980
900	2,834	2,671	2800	2,125	6,231	9000	1,304	12,289
1000	2,775	2,905	3000	2,106	6,352	9500	1,264	12,576
1100	2,719	3,132	3200	2,079	6,531	10000	1,228	12,854

Pitch AT 10

Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]	Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]	Speed [min ⁻¹]	M _{spez} [Ncm/cm]	P _{spez} [W/cm]
0	15,903	0,000	1200	10,174	12,785	3400	7,019	24,898
20	15,670	0,328	1300	9,945	13,538	3600	6,838	25,778
40	15,452	0,647	1400	9,731	14,266	3800	6,664	26,516
60	15,246	0,958	1440	9,649	14,550	4000	6,500	27,225
80	15,053	1,261	1500	9,529	14,968	4500	6,120	28,837
100	14,870	1,557	1600	9,340	15,649	5000	5,777	30,248
200	14,103	2,954	1700	9,160	16,305	5500	5,464	31,470
300	13,483	4,236	1800	8,990	16,944	6000	5,179	32,536
400	12,927	5,414	1900	8,828	17,563	6500	4,916	33,460
500	12,439	6,513	2000	8,672	18,162	7000	4,670	34,232
600	12,008	7,545	2200	8,380	19,305	7500	4,441	34,878
700	11,626	8,522	2400	8,113	20,390	8000	4,227	35,409
800	11,282	9,451	2600	7,866	21,414	8500	4,023	35,808
900	10,969	10,337	2800	7,632	22,378	9000	3,832	36,113
1000	10,683	11,186	3000	7,544	22,751	9500	3,651	36,322
1100	10,418	12,000	3200	7,416	23,296	10000	3,479	36,429

Technical information for toothed belts 22052 and 22057

b	(cm)	Belt width
L_R	(mm)	Belt length
Z_R	-	Number of belt teeth
B	(mm)	Pulley width
A	(mm)	Centre distance
A_{eff}	(mm)	Effective centre distance
d	(mm)	Diameter of bore
d_a	(mm)	Outer diameter
d_{ak}	(mm)	Outer diameter of small pulley
d_{ag}	(mm)	Outer diameter of large pulley
d_w	(mm)	Effective diameter
d_{wk}	(mm)	Effective diameter of small pulley
d_{wg}	(mm)	Effective diameter of large pulley
F_{wsta}	(N)	Static shaft power
F_{TV}	(N)	Pre-tensioning force per belt
F_{Tzul}	(N)	Maximum permissible belt tension
F_U	(N)	Peripheral force
M	(Nm)	Torque
P	(kW)	Output
t_{ab}	(s)	Acceleration time
t_{av}	(s)	Deceleration time
v	(m/s)	Speed / peripheral speed
Z_e	-	Number of teeth in mesh
Z_k	-	Number of teeth on small pulley
Z_g	-	Number of teeth on large pulley
i	-	Speed ratio $n_1 : n_2$
ρ	(kg/dm ³)	Density
J	(kgm ²)	Mass moment of inertia
t	(mm)	Pitch
n	(min ⁻¹)	Speed
n_1	(min ⁻¹)	Drive pulley speed
ω	(s ⁻¹)	Angular speed
β	(°)	Wrap angle



Formula's

Power

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

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

Circumferential force

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

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

Torque

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

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

Angular velocity

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

Circumferential speed

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

Acceleration torque

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

Moment of inertia

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

Speed

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

Effective diameter

$$d_w = \frac{z \cdot t}{\pi}$$

Belt length for $i=1$

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

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

Belt length for $i \neq 1$ (simplified)

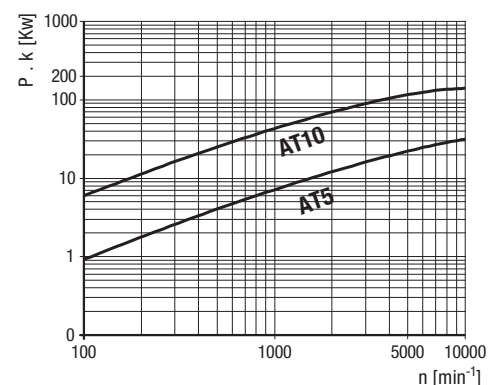
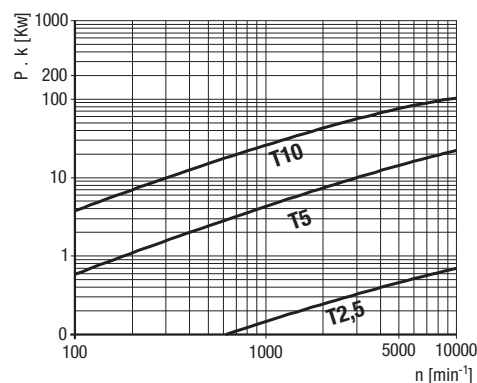
$$L_R \approx \frac{t}{2} \cdot (z_g + z_k) + 2A + \frac{1}{4A} \cdot \left[\frac{(z_g - z_k) \cdot t}{\pi} \right]^2$$

Belt length for $i \neq 1$ (for greater accuracy)

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

Selection diagram

The selection diagrams enables the selection of the belt profile for the drive task in advance. The application c safety factors and the speed of the small pulley must be taken into account.



Technical information for toothed belts 22052 and 22057

Drive calculation

The following data are required for the calculation:

- drive output to be transferred $= P$ [kW]
- drive speed $= n_1$ [min⁻¹]
- motor starting torque $= M_{ab}$ [Nm]
- centre distance required $= A$ [mm]
- max. permissible drive pulley diameter $= d_{w1}$ [mm]

Safety factor

Belts are selected for uniform loads. A c1 safety factor must be anticipated for peak and dynamic loads.

drive with uniform load c1 = 1.0

drive with peak or dynamic load:

light c1	=	1.4
medium c1	=	1.7
heavy c1	=	2.0

For speed step-up ratios a c2 acceleration factor must be anticipated:

i = from 0.66 to 1.0	c2	=	1.1
i = from 0.40 to 0.66	c2	=	1.2
i < 0.40	c2	=	1.3

The overall service factor is:

$$C_0 = C_1 \times C_2$$

Belt and washer selection

Use the selection diagram for belt pre-selection. Selecting the largest permissible pulley is recommended.

Calculating speed ratio i

$$i = \frac{n_1}{n_2}$$

Calculation example

- motor output to be transferred	10 kW
- drive speed n1	2600 1/min
- drive speed n2	2600 1/min
- motor starting torque	50 Nm
- centre distance required A	400 mm
- max. permissible drive pulley diameter dw	130 mm
- safety factor c1	1.4

Calculating the speed ratio

$$\frac{n_1}{n_2} = 1$$

Belt selection:

Belt pitch T10 is selected from the selection diagram taking into account safety factor 1.4 for calculated output PB of 14 kW corrected as a result.

Calculating the number of washer teeth z:

The number of teeth is calculated from the maximum permissible pulley diameter and the selected belt pitch T10. On the basis of speed ratio i = 1, driving and driven pulley are the same size.

$$z = \frac{130 \cdot \pi}{10} = 40.84 - \text{selected } z = 40 \text{ with } d_w = 127.32 \text{ mm.}$$

The maximum permissible diameter was selected in order to minimise the belt width.

$$z_1 = 40, z_2 = 40$$

Calculating the belt length

$$L_R = 2 \cdot A + \pi \cdot d \cdot w = 2 \cdot A + z \cdot t$$

$$L_R = 2 \cdot 400 + 40 \cdot 10 = 1200 \text{ mm}$$

Calculating the number of teeth in mesh

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

with β [°] = wrap angle

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

Determining the belt width

$$b = \frac{P \cdot 1000 \cdot C_0}{z_k \cdot z_e \cdot P_{spez}} \quad b = \frac{100 \cdot M \cdot C_0}{z_k \cdot z_e \cdot M_{spez}}$$

Checking the permissible belt tension

The permissible belt tension must be greater than the maximum peripheral force anticipated.

$$F_{Tzul} > C_0 \cdot F_U \quad \text{with} \quad F_U = \frac{2000 \cdot M}{d_w}$$

Static shaft power

$$FW_{sta} = 2 \times FTV \times \cos \alpha \times \beta$$

$$FW_{sta} = 2 \times FTV \text{ (for } \alpha = 1)$$

Determining the pretension

The belt is pretensioned correctly if the slack side remains tensioned under every operating condition that occurs. In order to achieve the lowest shaft load possible, care must be taken, though, not to tension more than is required. The correct belt tension also depends on the belt length LR (number of belt teeth zR).

The following pretensioning forces per side are recommended:

2 shaft drives

$$z_R < 75 \quad F_{TV} = 1/3 F_U$$

$$75 < z_R < 150 \quad F_{TV} = 1/2 F_U$$

$$z_R > 150 \quad F_{TV} = 2/3 F_U$$

$$\text{multi-shaft drives} \quad F_{TV} > F_U$$

Use of an applicable measurement device is recommended to set the pretension correctly.

Number of teeth in mesh

When i = 1 the number of teeth in mesh on both pulleys is z e = 20.

Determining belt width b:

$$b = \frac{1000 \cdot 10 \cdot 1.4}{40 \cdot 12 \cdot 10.386} = 2.81 \text{ cm} = 28.1 \text{ mm}$$

The next largest standard belt width of 32 mm is selected. The belt width selected is checked based on the motor starting torque for speed n = 0.

$$b = \frac{100 \cdot 50}{40 \cdot 12 \cdot 3.815} = 2.73 \text{ cm} = 27.3 \text{ mm}$$

The next largest standard width of 32 mm is selected.

Checking the permissible belt tension FTzul:

$$F_U = \frac{2000 \cdot 50}{127.32} = 785.4 \text{ N}$$

Tensioning force via No. of belt teeth

$$z_R = \frac{1200}{10} = 120 \text{ teeth}$$

Belt tensioning force FTV per side is:

$$F_{TV} = \frac{1}{2} \cdot F_U = 392.7 \text{ N with } z_R = 120$$

Flexibility:

The requisite minimum diameters are maintained.

Belt selected:

32 T10 - 1200