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]

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

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

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

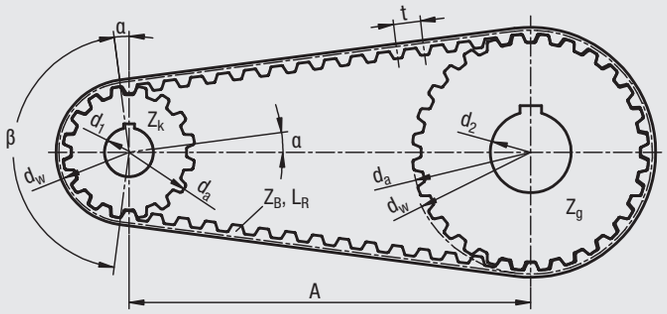
Speed [min^{-1}]	M_{spez} [Ncm/cm]	P_{spez} [W/cm]	Speed [min^{-1}]	M_{spez} [Ncm/cm]	P_{spez} [W/cm]	Speed [min^{-1}]	M_{spez} [Ncm/cm]	P_{spez} [W/cm]
0	3,813	0,000	**1200**	2,668	3,352	**3400**	1,993	7,096
20	3,758	0,079	**1300**	2,620	3,566	**3600**	1,954	7,368
40	3,708	0,155	**1400**	2,574	3,773	**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 n1 : n2
ρ	(kg/dm3)	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 ≠ 1
(simplified)

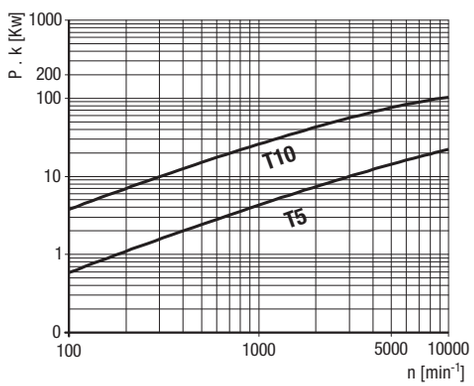
$$L_R \approx \frac{t}{2} \cdot (z_g + z_k) + 2A + \frac{1}{4A} \cdot \left[\frac{(z_g - z_k) \cdot t}{\pi}\right]^2$$

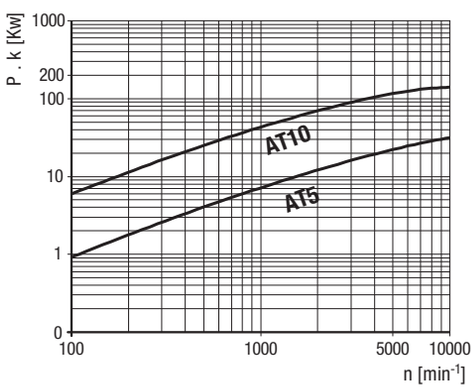
Belt length for i ≠ 1
(for greater accuracy)

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

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

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

Calculating the number of teeth in mesh

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

with β [°] = wrap angle

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

Determining the belt width

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

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

FWsta = 2 x FTV x cos x β

FWsta = 2 x FTV (for i = 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

$z_R < 75$	$F_{TV} = 1/3\ F_U$
$75 < z_R < 150$	$F_{TV} = 1/2\ F_U$
$z_R > 150$	$F_{TV} = 2/3\ F_U$
multi-shaft drives	$F_{TV} > F_U$

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

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

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

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

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 permissable 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