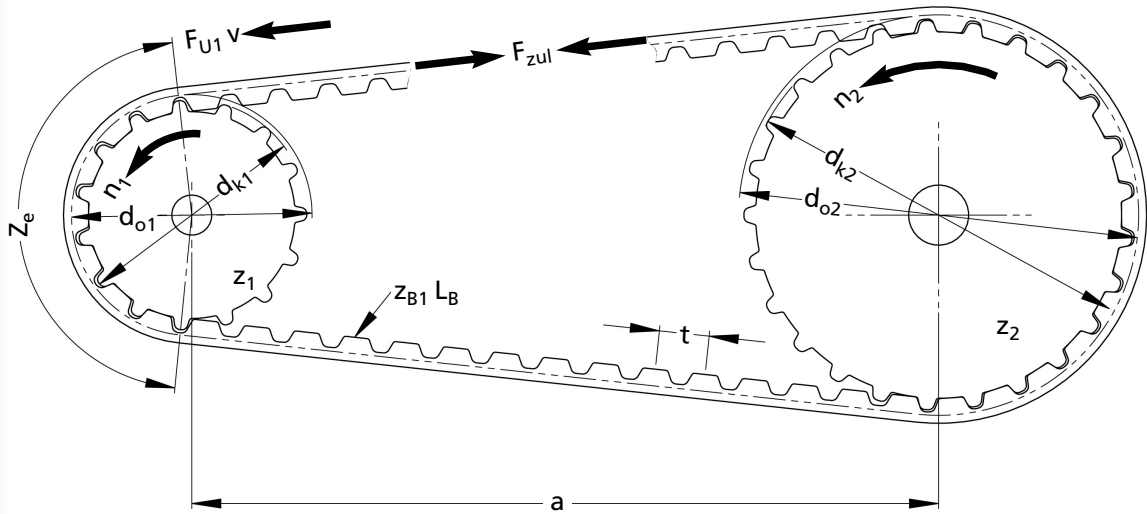


TECHNICAL

Timing Belts and Pulleys

TECHNICAL



a = Centre distance (mm)
 M_B = Acceleration torque (Nm)
 t_b = Acceleration time (s)
 d = Bore (mm)
 ρ = Density (kg/dm³)
 M = Torque (Nm)
 n = RPM (min⁻¹)
 d_k = Outside diameter (mm)

P = Power (kW)
 J = Moment of Inertia (kgm²)
 L_B = Belt length (mm)
 i = Ratio
 F_{zul} = Allowable tensile load (N)
 B = Pulley width (mm)
 t = Pitch (mm)
 v = Velocity (m/s)

F_U = Peripheral force (N)
 w = Angular velocity (s⁻¹)
 d_0 = Pitch circle diameter (mm)
 z = No. of teeth when $i = 1$
 z_1 = No. of teeth of small pulley
 z_2 = No. of teeth of large pulley
 z_B = No. of teeth in the belt
 z_e = No. of teeth in mesh

Belt length when $i \neq 1$

$$L_B \approx \frac{t}{2} (z_2 + z_1) + 2a + \frac{1}{4a} \left[\frac{(z_2 - z_1)^2}{\pi} \right]$$

Belt length when $i = 1$

$$L_B = 2a + \pi \cdot d_0$$

$$L_B = 2a + z \cdot t$$

Peripheral Force

$$F_U = \frac{2 \cdot 10^3 \cdot M}{d_0}$$

$$F_U = \frac{19.1 \cdot 10^6 \cdot P}{n \cdot d_0}$$

$$F_U = \frac{10^3 \cdot P}{v}$$

Torque

$$M = \frac{d_0 \cdot F_U}{2 \cdot 10^3}$$

$$M = \frac{9.55 \cdot 10^3 \cdot P}{n}$$

$$M = \frac{d_0 \cdot P}{2 \cdot v}$$

Power

$$P = \frac{M \cdot n}{9.55 \cdot 10^3}$$

$$P = \frac{F_U \cdot d_0 \cdot n}{19.1 \cdot 10^6}$$

$$P = \frac{F_U \cdot v}{10^3}$$

Angular velocity

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

Rpm

$$n = \frac{19.1 \cdot 10^3 \cdot v}{d_0}$$

Velocity

$$v = \frac{d_0 \cdot n}{19.1 \cdot 10^3}$$

Pitch circle diameter

$$d_0 = \frac{z \cdot t}{\pi}$$

Mass moment of inertia

$$J = 98.2 \cdot 10^{-15} \cdot B \cdot \rho \cdot (d_k^4 - d^4)$$

Acceleration torque

$$M_B = \frac{J \cdot \Delta n}{9.55 \cdot t_b}$$

Centre distance (approx.) for $i = 1$

$$a \approx \frac{z_B \cdot z_1}{2} \cdot t$$

Centre distance (approx.) for $i \neq 1$

$$a \approx \frac{L_B - (\pi/2)(d_{o1} + d_{o2})}{4} + \sqrt{\left(\frac{L_B - (\pi/2)(d_{o1} + d_{o2})}{4} \right)^2 - \frac{(d_{o2} + d_{o1})^2}{8}}$$

TECHNICAL

Synchronous and Breco® Timing Belts and Pulleys

Pulley Tooth Versions

All Ondrives pulleys are supplied with normal backlash tooth gap form. SE and zero backlash are available on request. Please contact our Technical department.

Flexibility

The minimum number of teeth on the pulley / minimum diameter recommended for trouble free operation is based on the belt type selected. When considering drives with reverse bending (contraflexure), it is especially important to remember that the minimum number of teeth on the pulley / minimum diameter must be increased. Values are given at the end of each belt type section.

Pre-tension

The pre-tension F_V is determined by the maximum operating peripheral force F_U . The purpose of pre-tension is to allow both sides of the belt between the pulleys to run without sagging. It is important to recognise the difference between the loaded (tight) and unloaded (slack) side of a drive as when power is applied, the tension increases in the loaded (tight) side and decreases proportionately in the slack side.

The pre-tension is correctly set when the unloaded (slack) side of the belt always remains taut under the maximum operating loads. Any sag or flap indicates too low a pre-tension.

For two pulley drives:

Pre-tension $\geq 0.5 \cdot$ Peripheral force
 $F_V \geq 0.5 \cdot F_U$

For multiple pulley and linear drives:

Pre-tension $\geq 1.0 \cdot$ Peripheral force
 $F_V \geq 1.0 \cdot F_U$

Tension Member Tensile Loading F_{zul}

The timing belt is designed correctly when the tension member loading value is not exceeded. Values for each belt can be found on the product page. $F_u < F_{zul}$

Tooth Shear Strength

The belt width (in cm) required to transmit known peripheral force F_U , torque M or power P without exceeding the maximum allowable tooth shear strength is calculated using any of the following formulae and the values from the tables:

$$b = \frac{F_U}{z_e \cdot F_{U\text{spez}}}$$

$$b = \frac{100 \cdot M}{z_1 \cdot z_e \cdot M_{\text{spez}}}$$

$$b = \frac{1000 \cdot P}{z_1 \cdot z_e \cdot P_{\text{spez}}}$$

b = belt width (in cm)

$F_{U\text{spez}}$ = specific peripheral force (N/cm)

M_{spez} = specific torque (N/cm)

P_{spez} = specific power (W/cm)

z_1 = No. of teeth on the small pulley

z_2 = No. of teeth on the large pulley

t = pitch in mm

a = centre distance in mm

z_e = No. of teeth in mesh (see below)

$z_{e\text{max}} = 12$ for T, AT, AT-G3 and Breco® M

To calculate the number of teeth in mesh, z_e :

$$z_e = \frac{z_1}{180} \cdot \arccos \frac{(z_2 - z_1) \cdot t}{2\pi a}$$

T2.5 Specific Tooth Shear Strength

Rpm, n (min ⁻¹)	$F_{U\text{spez}}$ (N/cm)	M_{spez} (Ncm/cm)	P_{spez} (W/cm)	Rpm, n (min ⁻¹)	$F_{U\text{spez}}$ (N/cm)	M_{spez} (Ncm/cm)	P_{spez} (W/cm)	Rpm, n (min ⁻¹)	$F_{U\text{spez}}$ (N/cm)	M_{spez} (Ncm/cm)	P_{spez} (W/cm)
0	9.03	0.359	0.000	1200	5.51	0.219	0.275	3600	4.22	0.168	0.632
20	8.72	0.347	0.007	1300	5.41	0.215	0.293	3800	4.15	0.165	0.657
40	8.48	0.337	0.014	1400	5.33	0.212	0.311	4000	4.09	0.163	0.682
60	8.28	0.329	0.021	1460	5.28	0.210	0.321	4500	3.95	0.157	0.740
80	8.10	0.322	0.027	1500	5.25	0.209	0.328	5000	3.82	0.152	0.796
100	7.95	0.316	0.033	1600	5.17	0.206	0.345	5500	3.71	0.148	0.850
150	7.64	0.304	0.048	1700	5.10	0.203	0.361	6000	3.60	0.143	0.901
200	7.39	0.294	0.062	1800	5.04	0.200	0.378	6500	3.51	0.140	0.950
300	7.01	0.279	0.088	1900	4.97	0.198	0.394	7000	3.42	0.136	0.997
400	6.71	0.267	0.112	2000	4.91	0.195	0.409	7500	3.33	0.133	1.042
500	6.48	0.258	0.135	2200	4.80	0.191	0.440	8000	3.26	0.130	1.086
600	6.28	0.250	0.157	2400	4.70	0.187	0.470	8500	3.18	0.127	1.128
700	6.11	0.243	0.178	2500	4.65	0.185	0.484	9000	3.11	0.124	1.168
730	6.07	0.241	0.185	2600	4.60	0.183	0.499	9500	3.05	0.121	1.207
800	5.97	0.237	0.199	2800	4.51	0.180	0.527	10000	2.99	0.119	1.245
900	5.83	0.232	0.219	3000	4.43	0.176	0.554	12000	2.77	0.110	1.384
1000	5.71	0.227	0.238	3200	4.36	0.173	0.581	15000	2.50	0.099	1.561
1100	5.61	0.223	0.257	3400	4.28	0.170	0.607	18000	2.28	0.091	1.708

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TECHNICAL

Synchronous and Breco® Timing Belts and Pulleys

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T5 Specific Tooth Shear Strength

Rpm, n (min ⁻¹)	F _{U Spez} (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _{U Spez} (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _{U Spez} (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)
0	24.00	1.910	0.000	1200	15.31	1.218	1.531	3600	11.77	0.936	3.530
20	23.38	1.861	0.039	1300	15.06	1.198	1.632	3800	11.59	0.922	3.670
40	22.86	1.819	0.076	1400	14.83	1.180	1.730	4000	11.42	0.909	3.807
60	22.41	1.783	0.112	1500	14.61	1.162	1.826	4500	11.03	0.878	4.136
80	22.01	1.751	0.147	1600	14.40	1.146	1.920	5000	10.68	0.850	4.450
100	21.65	1.723	0.180	1700	14.21	1.131	2.013	5500	10.36	0.825	4.750
200	20.28	1.614	0.338	1800	14.03	1.116	2.104	6000	10.07	0.802	5.037
300	19.30	1.536	0.483	1900	13.85	1.102	2.193	6500	9.81	0.780	5.312
400	18.55	1.476	0.618	2000	13.69	1.089	2.210	7000	9.56	0.761	5.577
500	17.93	1.427	0.747	2200	13.38	1.065	2.453	7500	9.33	0.742	5.831
600	17.41	1.385	0.870	2400	13.10	1.042	2.619	8000	9.11	0.725	6.076
700	16.96	1.349	0.989	2600	12.84	1.021	2.781	8500	8.91	0.709	6.310
800	16.56	1.318	1.104	2800	12.59	1.002	2.938	9000	8.72	0.694	6.540
900	16.20	1.289	1.215	3000	12.37	0.984	3.092	9500	8.54	0.679	6.760
1000	15.88	1.263	1.323	3200	12.16	0.967	3.241	10000	8.37	0.666	6.970
1100	15.58	1.240	1.428	3400	11.96	0.951	3.338				

T10 Specific Tooth Shear Strength

Rpm, n (min ⁻¹)	F _{U Spez} (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _{U Spez} (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _{U Spez} (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)
0	50.50	8.040	0.000	1200	29.30	4.670	5.870	3600	20.70	3.300	12.420
20	49.00	7.800	0.163	1300	28.70	4.570	6.220	3800	20.30	3.230	12.840
40	47.70	7.600	0.318	1400	28.20	4.480	6.570	4000	19.86	3.160	13.240
60	46.60	7.420	0.466	1500	27.60	4.400	6.910	4500	18.91	3.010	14.180
80	45.70	7.270	0.609	1600	27.10	4.320	7.230	5000	18.06	2.870	15.050
100	44.80	7.130	0.746	1700	26.70	4.240	7.550	5500	17.28	2.750	15.840
200	41.40	6.600	1.381	1800	26.20	4.170	7.860	6000	16.58	2.640	16.580
300	39.10	6.220	1.953	1900	25.80	4.100	8.160	6500	15.93	2.540	17.260
400	37.20	5.920	2.480	2000	25.40	4.040	8.460	7000	15.33	2.440	17.880
500	35.70	5.680	2.980	2200	24.60	3.920	9.030	7500	14.76	2.350	18.460
600	34.40	5.480	3.440	2400	23.90	3.810	9.580	8000	14.24	2.270	18.990
700	33.30	5.310	3.890	2600	23.30	3.710	10.100	8500	13.74	2.180	19.470
800	32.40	5.150	4.320	2800	22.70	3.620	10.600	9000	13.28	2.110	19.920
900	31.50	5.010	4.730	3000	22.20	3.530	11.080	9500	12.84	2.040	20.300
1000	30.70	4.890	5.120	3200	21.70	3.450	11.550	10000	12.42	1.980	20.700
1100	30.00	4.770	5.500	3400	21.20	3.360	11.990				

AT5 Specific Tooth Shear Strength

Rpm, n (min ⁻¹)	F _{U Spez} (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _{U Spez} (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _{U Spez} (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)
0	35.30	2.810	0.000	1200	24.80	1.970	2.480	3600	18.28	1.454	5.480
20	34.90	2.780	0.058	1300	24.30	1.936	2.640	3800	17.93	1.427	5.680
40	34.50	2.750	0.115	1400	23.90	1.903	2.790	4000	17.61	1.401	5.870
60	34.10	2.720	0.171	1500	23.50	1.872	2.940	4500	16.86	1.342	6.320
80	33.80	2.690	0.225	1600	23.20	1.843	3.090	5000	16.18	1.288	6.740
100	33.50	2.660	0.279	1700	22.80	1.816	3.230	5500	15.56	1.239	7.130
200	32.00	2.550	0.534	1800	22.50	1.789	3.370	6000	15.00	1.194	7.500
300	30.90	2.460	0.771	1900	22.20	1.764	3.510	6500	14.48	1.152	7.840
400	29.80	2.370	0.995	2000	21.90	1.740	3.650	7000	13.99	1.113	8.160
500	29.00	2.300	1.207	2200	21.30	1.695	3.910	7500	13.54	1.077	8.460
600	28.20	2.240	1.409	2400	20.80	1.654	4.160	8000	13.11	1.043	8.740
700	27.50	2.190	1.603	2600	20.30	1.615	4.400	8500	12.71	1.011	9.000
800	26.80	2.140	1.789	2800	19.84	1.579	4.630	9000	12.33	0.981	9.240
900	26.30	2.090	1.969	3000	19.42	1.545	4.850	9500	11.97	0.953	9.470
1000	25.70	2.050	2.140	3200	19.01	1.513	5.070	10000	11.63	0.925	9.690
1100	25.20	2.010	2.310	3400	18.64	1.483	5.280				

For designs over the quoted speed, please contact our Technical Department

TECHNICAL

Synchronous and Breco® Timing Belts and Pulleys

AT10 Specific Tooth Shear Strength

Rpm, n (min ⁻¹)	F _U Spez (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _U Spez (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _U Spez (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)
0	73.50	11.700	0.000	1200	47.20	7.510	9.440	3600	31.900	5.070	19.110
20	72.40	11.530	0.241	1300	46.20	7.350	10.000	3800	31.100	4.940	19.670
40	71.40	11.370	0.476	1400	45.20	7.190	10.540	4000	30.300	4.820	20.200
60	70.50	11.210	0.705	1500	44.30	7.040	11.070	4500	28.500	4.540	21.400
80	69.60	11.070	0.928	1600	43.40	6.910	11.570	5000	26.900	4.290	22.500
100	68.70	10.940	1.145	1700	42.60	6.780	12.060	5500	25.500	4.060	23.400
200	65.00	10.350	2.170	1800	41.80	6.650	12.540	6000	24.200	3.850	24.200
300	62.10	9.880	3.100	1900	41.00	6.530	13.000	6500	23.000	3.650	24.900
400	59.50	9.480	3.970	2000	40.300	6.420	13.440	7000	21.800	3.470	25.500
500	57.40	9.130	4.780	2200	39.000	6.200	14.300	7500	20.800	3.300	26.000
600	55.50	8.830	5.550	2400	37.800	6.010	15.100	8000	19.770	3.150	26.400
700	53.70	8.550	6.270	2600	36.600	5.830	15.860	8500	18.840	3.000	26.700
800	52.20	8.310	6.960	2800	35.500	5.660	16.580	9000	17.950	2.860	26.900
900	50.80	8.080	7.620	3000	34.500	5.500	17.270	9500	17.120	2.720	27.100
1000	49.50	7.880	8.250	3200	33.600	5.350	17.920	10000	16.320	2.600	27.200
1100	48.30	7.690	8.860	3400	32.700	5.200	18.530				

AT5-G3 Specific Tooth Shear Strength

Rpm, n (min ⁻¹)	F _U Spez (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _U Spez (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _U Spez (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)
0	44.125	3.513	0.000	1200	31.000	2.463	3.100	3600	22.850	1.818	6.850
20	43.625	3.475	0.073	1300	30.375	2.420	3.300	3800	22.413	1.784	7.100
40	43.125	3.438	0.144	1400	29.875	2.379	3.488	4000	22.013	1.751	7.338
60	42.625	3.400	0.214	1500	29.375	2.340	3.675	4500	21.075	1.678	7.900
80	42.250	3.363	0.281	1600	29.000	2.304	3.863	5000	20.225	1.610	8.425
100	41.875	3.325	0.349	1700	28.500	2.270	4.038	5500	19.450	1.549	8.913
200	40.000	3.188	0.668	1800	28.125	2.236	4.213	6000	18.750	1.493	9.375
300	38.625	3.075	0.964	1900	27.750	2.205	4.388	6500	18.100	1.440	9.800
400	37.250	2.963	1.244	2000	27.375	2.175	4.563	7000	17.488	1.391	10.200
500	36.250	2.875	1.509	2200	26.625	2.119	4.888	7500	16.925	1.346	10.575
600	35.250	2.800	1.761	2400	26.000	2.068	5.200	8000	16.388	1.304	10.925
700	34.375	2.738	2.004	2600	25.375	2.019	5.500	8500	15.888	1.264	11.250
800	33.500	2.675	2.236	2800	24.800	1.974	5.788	9000	15.413	1.226	11.550
900	32.875	2.613	2.461	3000	24.275	1.931	6.063	9500	14.963	1.191	11.838
1000	32.125	2.563	2.675	3200	23.763	1.891	6.338	10000	14.538	1.156	12.113
1100	31.500	2.513	2.888	3400	23.300	1.854	6.600				

AT10-G3 Specific Tooth Shear Strength

Rpm, n (min ⁻¹)	F _U Spez (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _U Spez (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)	Rpm, n (min ⁻¹)	F _U Spez (N/cm)	M _{Spez} (Ncm/cm)	P _{Spez} (W/cm)
0	91.880	14.630	0.000	1200	59.000	9.390	11.800	3600	39.880	6.340	23.890
20	90.500	14.410	0.300	1300	57.750	9.190	12.500	3800	38.880	6.180	24.590
40	89.250	14.210	0.600	1400	56.500	8.990	13.180	4000	37.880	6.030	25.250
60	88.130	14.010	0.880	1500	55.380	8.800	13.840	4500	35.630	5.680	26.750
80	87.000	13.840	1.160	1600	54.250	8.640	14.460	5000	33.630	5.360	28.130
100	85.880	13.680	1.430	1700	53.250	8.480	15.080	5500	31.880	5.080	29.250
200	81.250	12.940	2.710	1800	52.250	8.310	15.680	6000	30.250	4.810	30.250
300	77.630	12.350	3.880	1900	51.250	8.160	16.250	6500	28.750	4.560	31.130
400	74.380	11.850	4.960	2000	50.380	8.030	16.800	7000	27.250	4.340	31.880
500	71.750	11.410	5.980	2200	48.750	7.750	17.880	7500	26.000	4.130	32.500
600	69.380	11.040	6.940	2400	47.250	7.510	18.880	8000	24.710	3.940	33.000
700	67.130	10.690	7.840	2600	45.750	7.290	19.830	8500	23.550	3.750	33.380
800	65.250	10.390	8.700	2800	44.380	7.080	20.730	9000	22.440	3.580	33.630
900	63.500	10.100	9.530	3000	43.130	6.880	21.590	9500	21.400	3.400	33.880
1000	61.880	9.850	10.310	3200	42.000	6.690	22.400	10000	20.400	3.250	34.000
1100	60.380	9.610	11.080	3400	40.880	6.500	23.160				

For designs over the quoted speed, please contact our Technical Department

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