Technical information for toothed belts 22062

General:

The HTD profile belts have ISO 13050 tooth form. Compared to classic V belts, the running noise of belts with this type of tooth is significantly reduced. Toothed belt drives are also low-maintenance, resistant to a wide range of environmental influences and, when correctly dimensioned have an extremely long service life.

Parameter	Belt design
Belt speed perm. vmax [m/s]	50
Ambient temperature t min [°C]/ t max [°C]	-20 +100
Electrically conductive as per ISO 9563	No
Oil resistance	+
Ozone resistance	++

Expect increased wear if the recommended belt speed is exceeded.

Drive torques:

The power transfer is significantly higher compared to conventional imperial sized V belts. The arc shaped tooth contour provides high resistance to tooth slippage. Performance tables are available to help by size selection. The axles must be parallel to one another. The toothed pulleys can be aligned very precisely using a straight edge or laser. Use the largest possible pulley diameter. At least one toothed belt pulley must have rim flanges. During installation never use force to lever the toothed belt over the rim flange. Adjustment options must be provided to allow for mounting and setting the correct belt tension.

Belt tension:

For a long service life and low-noise operation, the correct alignment and tensioning of the drive is extremely important. Idler pulleys are often used to adjust the belt tension in drives with fixed axles. A toothed idler in the slack strand of the belt is preferable to a smooth back belt idler. Smooth back belt idlers generate a contra-flexion of the belt which leads to a shorter service life of the drive. If it cannot be avoided, the smooth idler should be at least 1.25 times as large as the smaller toothed belt pulley of the drive and it should be situated as close as possible to the smaller toothed pulley to maximise the number of teeth in engagement.

Assembly:

The belt should be fitted by hand without using tools such as levers, screwdrivers etc. This is to prevents damage to the belt, the toothed pulleys or the rim flanges. The toothed pulleys must be precisely aligned. After setting the calculated tension, run the drive for a short while then re-check the tension and alignment again, make any necessary adjustments.

Repeat this check after roughly one hours operation. A slight drop in frequency is normal. Check all fastenings of the drive and tighten if necessary to prevent loosening through operating vibrations etc.

If a belt is removed for maintenance work at a later date, the current resonant frequency should be determined first. The belt should be refitted with this frequency unless it is replaced by a new belt. If a new belt is fitted the initial installation value applies.

Belt storage:

Never kink the belts. Prevent small bending radii. Prevent direct sunlight and chemical influences.

The storeroom should be 15° to 20° C and dry and dust-free.

Specific toothed belts – weight per meter ms [kg/m · mm]:

Types	3M	5M	8M
HTD	$3{,}6 \times 10^{-3}$	$3{,}6 \times 10^{-3}$	$5{,}5 \times 10^{-3}$

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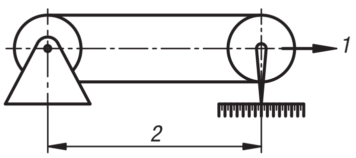
Tolerances:

Length and width tolerances are specified in ISO 13050.

Division	Belt width [mm]	Width tolerances according to belt length		
		up to 840 mm	> 840 mm to 1680 mm	> 1680 mm
3 mm	9	+0,6 -0,6	+0,6 -0,6	+0,8 -0,8
	15	+0,8 -0,8	+0,8 -0,8	+0,8 -0,8
5 mm	15	+0,8	+0,8	+0,8
	25	-0,8	-0,8	-0,8
8 mm	20	+0,8	+0,8	+0,8
	30	-0,8	-1,3	-1,3
	50	+1,3	+1,3	+1,3
		-1,3	-1,3	-1,5



1) Test force (N)

2) Centre distance (mm)

Length [mm]	Tolerance +/- [mm]
< 150	0,15
151-250	0,2
252-400	0,23
401-550	0,25
551-800	0,3
801-1000	0,33
1001-1250	0,38
1251-1500	0,4
1501-1750	0,43
1751-2000	0,45
2001-2250	0,48
> 2250	+ 0,10 mm/m

Test pulleys for length measurement as per ISO 13050			Test force [N] by belt width [mm]					
Pitch [mm]	**No. of teeth**	**Girth [mm]**	**9**	**15**	**20**	**25**	**30**	**50**
3	30	90	76	138				
5	30	150		214		379		
8	34	272			470		750	1320

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Performance tables for HTD 3M9 and 3M15

toothed belt HTD3M- transferable belt power in kW for a width of 9 mm on the smaller toothed pulley																
No. of teeth		10	12	14	16	18	20	24	28	32	40	48	56	64	72	80
Effective diameter [mm]		9,55	11,46	13,37	15,28	17,19	19,10	22,92	26,74	30,56	38,20	45,84	53,48	61,12	68,75	76,39
Speed n_k (rpm)	20	0,002	0,002	0,002	0,002	0,003	0,003	0,003	0,005	0,005	0,007	0,008	0,012	0,013	0,013	0,015
	40	0,003	0,003	0,003	0,005	0,005	0,005	0,007	0,008	0,010	0,015	0,018	0,021	0,025	0,028	0,031
	60	0,003	0,005	0,005	0,007	0,008	0,008	0,012	0,013	0,015	0,021	0,026	0,033	0,038	0,041	0,046
	100	0,007	0,008	0,010	0,012	0,013	0,015	0,018	0,021	0,026	0,035	0,044	0,054	0,063	0,063	0,077
	200	0,010	0,016	0,018	0,021	0,025	0,028	0,036	0,044	0,053	0,071	0,091	0,11	0,12	0,14	0,15
	300	0,018	0,021	0,026	0,030	0,035	0,040	0,049	0,059	0,071	0,094	0,12	0,14	0,16	0,18	0,21
	400	0,021	0,026	0,031	0,038	0,043	0,048	0,061	0,074	0,087	0,12	0,15	0,18	0,20	0,23	0,25
	500	0,026	0,031	0,038	0,044	0,051	0,058	0,071	0,087	0,102	0,14	0,17	0,21	0,24	0,27	0,29
	600	0,030	0,036	0,043	0,051	0,058	0,066	0,082	0,099	0,12	0,15	0,20	0,23	0,27	0,30	0,33
	700	0,033	0,041	0,049	0,058	0,066	0,074	0,092	0,11	0,13	0,17	0,22	0,26	0,30	0,34	0,37
	800	0,038	0,046	0,054	0,063	0,072	0,082	0,10	0,12	0,14	0,19	0,24	0,29	0,33	0,37	0,41
	950	0,043	0,053	0,063	0,072	0,082	0,094	0,12	0,14	0,16	0,22	0,27	0,32	0,37	0,42	0,46
	1000	0,044	0,054	0,064	0,076	0,086	0,097	0,12	0,14	0,17	0,22	0,28	0,34	0,38	0,43	0,48
	1200	0,051	0,063	0,074	0,086	0,099	0,11	0,14	0,17	0,19	0,26	0,32	0,38	0,43	0,49	0,54
	1450	0,059	0,072	0,086	0,10	0,11	0,13	0,16	0,19	0,22	0,29	0,37	0,43	0,50	0,56	0,62
	1600	0,064	0,077	0,092	0,11	0,12	0,14	0,17	0,21	0,24	0,31	0,39	0,47	0,53	0,60	0,66
	1800	0,069	0,086	0,10	0,12	0,13	0,15	0,19	0,22	0,26	0,34	0,43	0,51	0,58	0,65	0,72
	2000	0,076	0,092	0,11	0,13	0,14	0,02	0,20	0,24	0,28	0,37	0,46	0,54	0,62	0,69	0,77
	2400	0,087	0,11	0,13	0,15	0,17	0,19	0,23	0,28	0,32	0,42	0,52	0,62	0,70	0,79	0,87
	2850	0,10	0,12	0,14	0,16	0,19	0,21	0,26	0,31	0,37	0,48	0,59	0,69	0,79	0,88	0,97
	3200	0,11	0,13	0,16	0,18	0,21	0,23	0,29	0,34	0,40	0,52	0,64	0,74	0,84	0,94	1,04
	3600	0,12	0,14	0,17	0,20	0,23	0,26	0,31	0,37	0,43	0,56	0,69	0,80	0,91	1,01	1,11
	4000	0,13	0,16	0,19	0,22	0,25	0,28	0,34	0,40	0,47	0,60	0,74	0,86	0,97	1,07	1,17
	5000	0,15	0,19	0,22	0,26	0,29	0,33	0,40	0,47	0,54	0,70	0,84	0,98	1,09	1,20	1,29
	6000	0,17	0,22	0,25	0,29	0,33	0,37	0,45	0,54	0,62	0,78	0,94	1,07	1,18	1,28	1,35
	7000	0,20	0,24	0,28	0,33	0,37	0,41	0,50	0,59	0,68	0,85	1,01	1,14	1,24	1,31	1,35
	8000	0,22	0,27	0,31	0,36	0,41	0,46	0,55	0,65	0,74	0,91	1,06	1,18	1,25	1,28	1,27
	10000	0,26	0,31	0,37	0,42	0,48	0,53	0,64	0,74	0,83	0,99	1,11	1,16	1,14	1,04	0,85
	12000	0,30	0,36	0,42	0,48	0,54	0,60	0,70	0,80	0,89	1,02	1,06	1,00	0,81		
	14000	0,33	0,40	0,47	0,53	0,59	0,65	0,76	0,85	0,92	0,97	0,91	0,67			

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Performance tables for HTD 5M15 and 5M20

toothed belt HTD5M- transferable belt power in kW for a width of 15 mm on the smaller toothed pulley															
No. of teeth	**14**	**16**	**18**	**20**	**24**	**28**	**32**	**36**	**40**	**44**	**48**	**56**	**64**	**72**	**80**
Effective diameter [mm]	22,28	25,46	28,65	31,83	38,20	44,56	50,93	57,30	63,66	70,03	76,39	89,13	101,86	114,59	127,32
Speed n_k (rpm)															
20	0,007	0,011	0,011	0,013	0,017	0,021	0,024	0,028	0,032	0,037	0,041	0,05	0,058	0,064	0,071
40	0,017	0,021	0,022	0,026	0,032	0,039	0,047	0,056	0,065	0,075	0,084	0,1	0,11	0,13	0,14
60	0,024	0,03	0,034	0,039	0,049	0,06	0,071	0,084	0,097	0,11	0,13	0,15	0,17	0,19	0,21
100	0,041	0,049	0,056	0,065	0,082	0,12	0,12	0,14	0,16	0,18	0,21	0,25	0,29	0,32	0,36
200	0,084	0,099	0,11	0,13	0,16	0,21	0,24	0,28	0,32	0,37	0,42	0,54	0,57	0,64	0,72
300	0,11	0,13	0,16	0,18	0,22	0,26	0,32	0,38	0,43	0,49	0,56	0,67	0,76	0,86	0,95
400	0,14	0,17	0,19	0,22	0,28	0,34	0,39	0,46	0,53	0,61	0,68	0,81	0,93	1,05	1,16
500	0,17	0,21	0,22	0,26	0,32	0,39	0,47	0,54	0,63	0,71	0,8	0,95	1,09	1,23	1,36
600	0,19	0,22	0,26	0,3	0,37	0,45	0,54	0,62	0,71	0,81	0,91	1,08	1,24	1,39	1,55
700	0,22	0,26	0,3	0,34	0,41	0,5	0,6	0,7	0,8	0,9	1,01	1,21	1,38	1,55	1,72
800	0,24	0,28	0,32	0,37	0,47	0,56	0,65	0,77	0,88	0,99	1,11	1,32	1,51	1,7	1,89
950	0,28	0,32	0,37	0,41	0,52	0,64	0,75	0,87	0,99	1,12	1,26	1,49	1,7	1,92	2,12
1000	0,28	0,34	0,39	0,43	0,54	0,65	0,78	0,9	1,03	1,16	1,3	1,55	1,77	1,98	2,2
1200	0,34	0,39	0,45	0,5	0,62	0,75	0,88	1,03	1,17	1,32	1,48	1,75	2	2,25	2,49
1450	0,37	0,45	0,5	0,58	0,71	0,86	1,01	1,18	1,34	1,51	1,69	2	2,38	2,55	2,83
1600	0,41	0,49	0,54	0,62	0,77	0,93	1,08	1,26	1,44	1,64	1,81	2,14	2,43	2,73	3,02
1800	0,45	0,52	0,6	0,67	0,84	1,01	1,2	1,37	1,56	1,76	1,96	2,31	2,63	2,94	3,25
2000	0,49	0,56	0,65	0,73	0,92	1,1	1,29	1,48	1,68	1,91	2,1	2,48	2,82	3,15	3,47
2400	0,56	0,65	0,75	0,84	1,05	1,25	1,46	1,68	1,91	2,14	2,38	2,79	3,16	3,52	3,87
2850	0,64	0,75	0,84	0,95	1,18	1,42	1,64	1,9	2,15	2,4	2,66	3,11	3,5	3,88	4,24
3200	0,69	0,8	0,93	1,05	1,29	1,53	1,79	2,05	2,32	2,58	2,86	3,33	3,73	4,12	4,47
3600	0,77	0,88	1,01	1,14	1,4	1,66	1,94	2,22	2,5	2,78	3,06	3,55	3,96	4,33	4,67
4000	0,82	0,95	1,08	1,23	1,51	1,79	2,07	2,37	2,67	2,96	3,25	3,74	4,14	4,5	4,79
5000	0,97	1,12	1,29	1,44	1,76	2,07	2,39	2,72	3,03	3,33	3,62	4,08	4,41	4,64	4,76
6000	1,12	1,29	1,46	1,64	1,98	2,34	2,67	2,99	3,3	3,59	3,85	4,21	4,38	4,36	4,15
7000	1,25	1,44	1,63	1,81	2,19	2,99	2,88	3,19	3,47	3,72	3,92	4,1	3,99		
8000	1,36	1,57	1,78	1,96	2,35	2,71	3,03	3,31	3,54	3,71	3,82	3,72			
10000	1,59	1,81	2,02	2,22	2,6	2,9	3,14	3,28	3,31	3,23	3				
12000	1,78	2	2,2	2,39	2,71	2,9	2,95	2,84	2,53						
14000	1,92	2,15	2,34	2,49	2,67	2,67	2,73								

Performance tables for HTD 8M20

toothed belt HTD8M- transferable belt power in kW for a width of 20 mm on the smaller toothed pulley																
No. of teeth	**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**	**38**	**40**	**44**	**48**	**52**	**56**	**64**	**72**
Effective diameter [mm]	56,02	61,12	66,12	71,30	76,39	81,49	86,58	91,67	96,77	101,86	112,05	122,23	132,42	142,60	162,97	183,35
Speed n_k (rpm)																
10	0,03	0,03	0,04	0,04	0,05	0,06	0,06	0,07	0,08	0,09	0,1	0,11	0,11	0,12	0,14	0,15
20	0,05	0,06	0,07	0,08	0,1	0,11	0,13	0,15	0,17	0,18	0,19	0,21	0,23	0,14	0,27	0,3
50	0,13	0,15	0,18	0,21	0,24	0,28	0,32	0,37	0,41	0,44	0,49	0,53	0,57	0,61	0,68	0,76
100	0,26	0,29	0,35	0,42	0,49	0,57	0,65	0,73	0,83	0,89	0,97	1,05	1,13	1,21	1,37	1,52
200	0,51	0,58	0,7	0,84	0,98	1,13	1,3	1,47	1,65	1,78	1,95	2,11	2,27	2,42	2,73	3,04
300	0,77	0,84	1,02	1,21	1,41	1,64	1,87	2,12	2,38	2,58	2,81	3,04	3,27	3,49	3,94	4,38
400	1,03	1,12	1,32	1,57	1,83	2,12	2,42	2,75	3,09	3,34	3,64	3,94	4,23	4,52	5,1	5,66
500	1,28	1,4	1,61	1,92	2,24	2,59	2,96	3,36	3,78	4,09	4,45	4,81	5,17	5,52	6,22	6,9
600	1,54	1,68	1,9	2,26	2,64	3,05	3,49	3,95	4,45	4,81	5,24	5,66	6,08	6,49	7,31	8,11
700	1,8	1,96	2,19	2,59	3,03	3,5	4,01	4,54	5,1	5,52	6,01	6,49	6,97	7,44	8,38	9,29
800	2,05	2,24	2,46	2,92	3,42	3,95	4,51	5,11	5,75	6,22	6,77	7,31	7,84	8,38	9,42	10,4
950	2,44	2,66	2,89	3,41	3,98	4,6	5,26	5,96	6,7	7,24	7,88	8,51	9,13	9,74	11	12,1

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	No. of teeth	22	24	26	28	30	32	34	36	38	40	44	48	52	56	64	72
	Effective diameter [mm]	56,02	61,12	66,12	71,30	76,39	81,49	86,58	91,67	96,77	101,86	112,05	122,23	132,42	142,60	162,97	183,35
Speed n_k (rpm)	1000	2,57	2,8	3,04	3,57	4,17	4,82	5,5	6,23	7,01	7,58	8,24	8,9	9,55	10,2	11,5	12,7
	1200	3,08	3,36	3,65	4,19	4,9	5,66	6,47	7,33	8,23	8,9	9,68	10,4	11,2	12	13,4	14,8
	1450	3,72	4,05	4,4	4,96	5,79	6,69	7,64	8,65	9,72	10,5	11,4	12,3	13,2	14,1	15,8	17,4
	1600	4,1	4,47	4,86	5,41	6,32	7,29	8,33	9,43	10,6	11,5	12,4	13,4	14,4	15,3	17,1	18,9
	1800	4,61	5,03	5,46	5,99	7	8,08	9,23	10,5	11,7	12,7	13,8	14,8	15,9	16,9	18,9	20,8
	2000	5,12	5,58	6,06	6,63	7,67	8,86	10,1	11,5	12,9	13,9	15,1	16,2	17,4	18,5	20,6	22,7
	2200	5,62	6,13	6,65	7,28	8,33	9,62	11	12,4	14	15,1	16,3	17,6	18,8	20	22,3	24,4
	2500	6,38	6,95	7,54	8,25	9,3	10,7	12,3	13,9	15,6	16,8	18,2	19,6	20,9	22,2	24,6	26,9
	2850	7,26	7,9	8,57	9,38	10,4	12	13,7	15,5	17,4	18,7	20,3	21,8	23,2	24,6	27,2	27,7
	3000	7,63	8,31	9,01	9,85	10,9	12,5	14,3	16,2	18,1	19,6	21,1	22,7	24,1	25,6	28,2	29,6
	3500	8,87	9,65	10,5	11,4	12,4	14,2	16,2	18,3	20,6	22,2	23,9	25,6	27,1	28,6	31,4	30,6
	4000	10,1	11	11,9	13	14,1	15,8	18,1	20,4	25	24,6	26,5	28,2	29,9	31,4	34,1	33,8
	4500	11,3	12,3	13,3	14,5	15,7	17,4	19,8	22,3	25	26,9	28,9	30,6	32,3	33,8	36,3	
	5000	12,5	13,6	14,6	16	17,3	18,8	21,4	24,2	27	29,1	31	32,8	34,4	35,8		
	5500	13,7	14,8	16	17,4	18,8	20,2	23	25,9	28,9	31	33	34,7	36,2			
	6000	14,8	16	17,3	18,8	20,2	21,8	24,4	27,4	30,6	32,8	34,7	36,3				

Performance tables for HTD 8M30

toothed belt HTD8M- transferable belt power in kW for a width of 30 mm on the smaller toothed pulley																	
	No. of teeth	22	24	26	28	30	32	34	36	38	40	44	48	52	56	64	72
	Effective diameter [mm]	56,02	61,12	66,12	71,30	76,39	81,49	86,58	91,67	96,77	101,86	112,05	122,23	132,42	142,60	162,97	183,35
Speed n_k (rpm)	10	0,05	0,05	0,06	0,06	0,08	0,09	0,09	0,11	0,13	0,14	0,16	0,17	0,17	0,19	0,22	0,24
	20	0,08	0,09	0,11	0,13	0,16	0,17	0,21	0,24	0,27	0,28	0,3	0,33	0,36	0,38	0,43	0,47
	50	0,21	0,24	0,28	0,33	0,38	0,44	0,51	0,58	0,65	0,7	0,77	0,84	0,9	0,96	1,07	1,2
	100	0,41	0,46	0,55	0,66	0,77	0,9	1,03	1,15	1,31	1,41	1,53	1,66	1,79	1,91	2,16	2,4
	200	0,81	0,92	1,11	1,33	1,55	1,79	2,05	2,32	2,61	2,81	3,08	3,33	3,59	3,82	4,31	4,8
	300	1,22	1,33	1,61	1,91	2,23	2,59	2,95	3,35	3,76	4,08	4,44	4,8	5,17	5,51	6,23	6,92
	400	1,63	1,77	2,09	2,48	2,89	3,35	3,82	4,35	4,88	5,28	5,75	6,23	6,68	7,14	8,06	8,94
	500	2,02	2,21	2,54	3,03	3,54	4,09	4,68	5,31	5,97	6,46	7,03	7,6	8,17	8,72	9,83	10,9
	600	2,43	2,65	3	3,57	4,17	4,82	5,51	6,24	7,03	7,6	8,28	8,94	9,61	10,3	11,5	12,8
	700	2,84	3,1	3,46	4,09	4,79	5,53	6,34	7,17	8,06	8,72	9,5	10,3	11	11,8	13,2	14,7
	800	3,24	3,54	3,89	4,61	5,4	6,24	7,13	8,07	9,09	9,83	10,7	11,5	12,4	13,2	14,9	16,5
	950	3,86	4,2	4,57	5,39	6,29	7,27	8,31	9,42	10,6	11,4	12,5	13,4	14,4	15,4	17,3	19,2
	1000	4,06	4,42	4,8	5,64	6,59	7,62	8,69	9,84	11,1	12	13	14,1	15,1	16,1	18,1	20
	1200	4,87	5,31	5,77	6,62	7,74	8,94	10,2	11,6	13	14,1	15,3	16,5	17,7	18,9	21,2	23,4
	1450	5,88	6,4	6,95	7,84	9,15	10,6	12,1	13,7	15,4	16,6	18	19,4	20,9	22,2	24,9	27,5
	1600	6,48	7,06	7,68	8,55	10	11,5	13,2	14,9	16,7	18,1	19,7	21,2	22,7	24,2	27,1	29,9
	1800	7,28	7,95	8,63	9,46	11,1	12,8	14,6	16,5	18,5	20	21,8	23,4	25,1	26,7	29,9	32,9
	2000	8,09	8,82	9,57	10,5	12,1	14	16	18,1	20,3	21,9	23,8	25,6	27,4	29,2	32,6	35,8
	2200	8,88	9,69	10,5	11,5	13,2	15,2	17,3	19,6	22	23,8	25,8	27,8	29,7	31,6	35,2	38,6
	2500	10,1	11	11,9	13	14,7	17	19,4	21,9	24,6	26,5	28,7	30,9	33	35	38,9	42,5
	2850	11,5	12,5	13,5	14,8	16,4	18,9	21,6	24,4	27,4	29,6	32	34,4	36,6	38,8	42,9	43,8
	3000	12,1	13,1	14,2	15,6	17,2	19,8	22,6	25,5	28,6	30,9	33,4	35,8	38,1	40,4	44,6	46,7
	3500	14	15,2	16,5	18,1	19,6	22,5	25,6	29	32,5	35	37,7	40,4	42,9	45,3	49,6	48,4
	4000	16	17,3	18,8	20,5	22,2	25	28,5	32,2	39,5	38,9	41,8	44,6	47,2	49,6	53,9	53,4
	4500	17,9	19,4	21	22,9	24,8	27,5	31,3	35,3	39,5	42,5	45,6	48,4	51	53,4	57,3	
	5000	19,7	21,4	23,1	25,2	27,3	29,8	33,9	38,2	42,7	45,9	49	51,8	54,4	56,5		
	5500	21,6	23,4	25,2	27,4	29,7	31,9	36,3	40,9	45,7	49	52,1	54,8	57,1			
	6000	23,4	25,3	27,3	29,6	32	34,4	38,5	43,3	48,4	51,8	54,8	57,3				

Technical information for toothed belts 22062

Performance tables for HTD 8M50

toothed belt HTD8M- transferable belt power in kW for a width of 50 mm on the smaller toothed pulley																	
No. of teeth		**22**	**24**	**26**	**28**	**30**	**32**	**34**	**36**	**38**	**40**	**44**	**48**	**52**	**56**	**64**	**72**
Effective diameter [mm]		56,02	61,12	66,12	71,30	76,39	81,49	86,58	91,67	96,77	101,86	112,05	122,23	132,42	142,60	162,97	183,35
Speed n_k (rpm)	**10**	0,08	0,08	0,11	0,11	0,14	0,16	0,16	0,19	0,22	0,25	0,27	0,3	0,3	0,33	0,38	0,41
	20	0,14	0,16	0,19	0,22	0,27	0,3	0,35	0,41	0,46	0,49	0,52	0,57	0,63	0,66	0,74	0,82
	50	0,35	0,41	0,49	0,57	0,66	0,76	0,87	1,01	1,12	1,2	1,34	1,45	1,56	1,67	1,86	1,07
	100	0,71	0,79	0,96	1,15	1,34	1,56	1,77	1,99	2,27	2,43	2,65	2,87	3,08	3,3	3,74	4,15
	200	1,39	1,58	1,91	2,29	2,68	3,08	3,55	4,01	4,5	4,86	5,32	5,76	6,2	6,61	7,45	8,3
	300	2,1	2,29	2,78	3,3	3,85	4,48	5,11	5,79	6,5	7,04	7,67	8,3	8,93	9,53	10,8	12
	400	2,81	3,06	3,6	4,29	5	5,79	6,61	7,51	8,44	9,12	9,94	10,8	11,5	12,3	13,9	15,5
	500	3,49	3,82	4,4	5,24	6,12	7,07	8,08	9,17	10,3	11,2	12,1	13,1	14,1	15,1	17	18,8
	600	4,2	4,59	5,19	6,17	7,21	8,33	9,53	10,8	12,1	13,1	14,3	15,5	16,6	17,7	20	22,1
	700	4,91	5,35	5,98	7,07	8,27	9,56	10,9	12,4	13,9	15,1	16,4	17,7	19	20,3	22,9	25,4
	800	5,6	6,12	6,72	7,97	9,34	10,8	12,3	14	15,7	17	18,5	20	21,4	22,9	25,7	28,5
	950	6,66	7,26	7,89	9,31	10,9	12,6	14,4	16,3	18,3	19,8	21,5	23,2	24,9	26,6	29,9	33,1
	1000	7,02	7,64	8,3	9,75	11,4	13,2	15	17	19,1	20,7	22,5	24,3	26,1	27,8	31,3	34,6
	1200	8,41	9,17	10	11,4	13,4	15,5	17,7	20	22,5	24,3	26,4	28,5	30,6	32,6	36,6	40,5
	1450	10,2	11,1	12	13,5	15,8	18,3	20,9	23,6	26,5	28,7	31,2	33,6	36	38,4	43	47,5
	1600	11,2	12,2	13,3	14,8	17,3	19,9	22,7	25,7	28,9	31,3	34	36,6	39,2	41,8	46,8	51,6
	1800	12,6	13,7	14,9	16,4	19,1	22,1	25,2	28,5	32,1	34,6	37,6	40,5	43,4	46,2	51,6	56,8
	2000	14	15,2	16,5	18,1	20,9	24,2	27,6	31,3	35,1	37,9	41,1	44,3	47,4	50,4	56,3	61,9
	2200	15,3	16,7	18,2	19,9	22,7	26,3	30	33,9	38,1	41,1	44,6	48	51,3	54,5	60,8	66,7
	2500	17,4	19	20,6	22,5	25,4	29,3	33,4	37,8	42,5	45,8	49,7	53,4	57	60,5	67,2	73,5
	2850	19,8	21,6	23,4	25,6	28,4	32,7	37,3	42,2	47,4	51,2	55,3	59,4	63,3	67,1	74,2	75,6
	3000	20,8	22,7	24,6	26,9	29,6	34,2	39	44,1	49,5	53,4	57,7	61,9	65,9	69,8	77	80,8
	3500	24,2	26,3	28,6	31,2	33,9	38,8	44,3	50	56,1	60,5	65,2	69,8	74,1	78,2	85,7	83,6
	4000	27,6	30	32,4	35,4	38,4	43,2	49,3	55,7	68,3	67,2	72,3	77	81,5	85,7	93,1	92,2
	4500	30,8	33,5	36,3	39,5	42,9	47,4	54	61	68,3	73,5	78,8	83,6	88,2	92,2	99,1	
	5000	34,1	37	40	43,5	47,1	51,4	58,5	66	73,8	79,3	84,7	89,6	93,9	97,7		
	5500	37,3	40,4	43,6	47,4	53,3	55,2	62,7	70,6	78,9	84,7	90	94,7	98,7			
	6000	40,4	43,7	47,1	51,2	55,3	59,4	66,5	74,9	83,6	89,6	94,7	99,1				

Toothed pulley tolerances:

Pulley diameter tolerances

Outside diameter [mm]	Diameter tolerance [mm]	Permissible pitch error over:	
		2 tooth gaps	90° arc
from 50,8 to 101,6	0,1 -0	± 0,03	± 0,13
from 101,6 to 177,8	0,13 -0	± 0,03	± 0,13
from 177,8 to 304,8	0,15 -0	± 0,03	± 0,15
from 304,8 to 508	0,18 -0	± 0,03	± 0,18
from 508 to 762	0,2 -0	± 0,03	± 0,20
from 762 to 1016	0,23	± 0,03	
over 1016	0,25 -0	± 0,03	± 0,25

The parallelism tolerance of the pulley toothing to the hole is 0.03 mm per 25 mm pulley width.

Concentricity tolerance of the hole relative to the OD

Outside diameter [mm]	Tolerance [mm]
up to 203.2	0,13
over 203.2	0.13 plus 0.013 for every additional 25.4 mm OD over 203.2 mm

Eccentricity tolerance of the hole relative to the OD

Outside diameter [mm]	Tolerance [mm]
from 50,8 to 203,2	0.05 plus 0.01 for every additional 10 mm OD over 50.8 mm
over 254.0	0.13 plus 0.013 for every additional 10 mm OD over 254 mm

Cylindricity tolerance:

0.1 mm per 100 mm pulley width, where the OD tolerance must not be exceeded.

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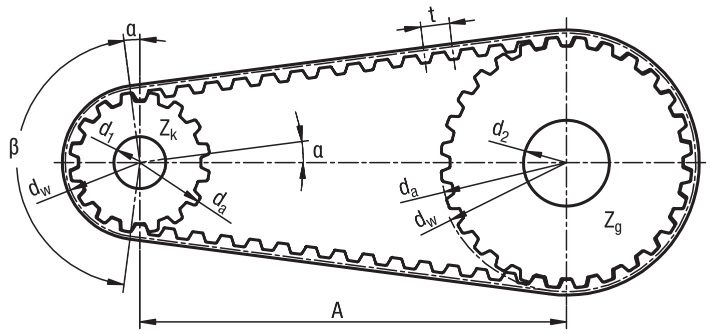
Calculation of toothed belt drives

Toothed belt drives are high-quality technical systems that with careful calculation and alignment are highly efficient and have a long service life. Due to the synchronous rotation transmission, belt slippage is prevented.
The required calculation equations and factors, and the required calculation steps are described below.

Required information for the correct configuration of a toothed belt drive:
- Type of machine
- Type of drive motor
- Motor power and/or required drive power
- Operating factors
- Rotational speed of the motor shaft
- Rotational speed of the powered shaft
- Transmission ratio



a	(mm)	Centre distance
b	(mm)	Belt width
c_0	-	Predefined total operating factor
c_{0err}	-	Calculated total operating factor
c_1	-	Tooth mesh factor
c_2	-	Load factor
c_3	-	Acceleration factor
c_4	-	Fatigue factor
c_5	-	Length factor
d_a	(mm)	Pulley OD
d_{ag}	(mm)	Larger pulley OD
d_{ak}	(mm)	Smaller pulley OD
d_w	(mm)	Pulley effective diameter
d_{w1}	(mm)	Driving pulley effective diameter
d_{w2}	(mm)	Driven pulley effective diameter
d_{wg}	(mm)	Larger pulley effective diameter
d_{wk}	(mm)	Smaller pulley effective diameter
f	(Hz)	Resonant frequency
F_e	(N)	Test force
F_{stat}	(N)	Static strand force
F_u	(N)	Tangential force
F_v	(N)	Total tension force
i	-	Ratio
k_1	-	Tension factor
k_2	-	Tension operating factor
L_f	(mm)	Free strand length
L_w	(mm)	Belt effective length
m	(kg/m)	Belt weight, per m belt length
m_s	(kg/m·mm)	Specific belt weight, per m length and mm width
n_1	(rpm)	Rotational speed of driving pulley
n_2	(rpm)	Rotational speed of driven pulley
n_g	(rpm)	Larger pulley rotational speed
n_k	(rpm)	Smaller pulley rotational speed
P	(kW)	Power transferred
P_N	(kW)	Power value for belt in reference width
P_R	(kW)	Power value for selected belts
t	(mm)	Tooth pitch
t_e	(mm)	Indentation depth
v	(m/s)	Belt speed
z	-	No. of teeth on toothed belt
z_1	-	No. of teeth on driving pulley
z_2	-	No. of teeth on driven pulley
z_g	-	No. of teeth on larger pulley
z_k	-	No. of teeth on smaller pulley
α	°	Strand inclination angle
β	°	Wrap angle of smaller toothed pulley

Ratio 1/i	Acceleration factor c_3
1-1,25	-
> 1,25-1,75	0,1
> 1,75-2,5	0,2
> 2,5-3,5	0,3
> 3,5	0,4

Total operating factor c_0

The total operating factor c0 is calculated from the sum of factors c2, c3 and c4:
Factorul total operațional c0 este determinat prin adăugarea factorilor c2, c3 și c4:

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Load factors c_2	Drive machines		
Processing machines	- Electric motors with low initial torque (up to 1.5 x nominal torque) - Water and steam turbines - Combustion motors with 8 or more cylinders	- Electric motors with average initial torque (1.5 to 2.5 x nominal torque) - Combustion motors with 4 to 6 cylinders	- Electric motors with high initial and brake torque (over 2.5 x nominal torque) - Hydraulic motors - Combustion motors with 4 cylinders
Office equipment, scanners, printers, photocopiers	1,1	1,2	1,3
Precision instruments, micro-mechanics and measuring instru-ments	1	1,1	1,2
Domestic machinery, centrifugal‘s	1	1,1	1,2
Food processors, slicers	1,1	1,2	1,3
Domestic sewing machines	1,1	1,2	1,3
Industrial sewing machines	1,2	1,3	1,4
Laundry equipment, tumble dryers	1,2	1,4	1,6
Washing machines	1,4	1,6	
Conveyor system, conveyor belts for light goods	1,1	1,2	1,3
Belt and roller conveyors for moderate loads	1,2	1,4	1,6
Conveyor systems for heavy goods, elevators	1,4	1,6	1,8
Auger conveyors, bucket elevators	1,4	1,6	1,8
CSTR‘s, mixing machines for liquid media	1,2	1,4	1,6
Mixing machines for semi-liquid media	1,3	1,5	1,7
Bakery and pasta machines	1,4	1,6	1,8
Machine tools, lathes	1,2	1,4	1,6
Borers, grinders, milling machines, shapers	1,3	1,5	1,7
Woodworking machines, wood turning lathes and band saws	1,2	1,3	1,5
Sawmill machinery	1,4	1,6	1,8
Brick making machines, mixing machines, dough kneaders	1,4	1,6	1,8
Clay mills	1,6	1,8	2
Textile machinery, winding and warping looms	1,2	1,4	1,6
Spinning and plying machines, power loom weavers	1,3	1,5	1,7
Paper production, agitators, calenders, drying machines	1,2	1,4	1,6
Pumps, wood sanders	1,4	1,6	1,8
Printing machines, cutting and folding machines	1,2	1,4	1,6
Rotary printing presses	1,3	1,5	1,7
Screening machines, trommel screens	1,2	1,4	1,6
Vibrating screens	1,3	1,5	1,7
Ventilators, blowers, radial fans	1,4	1,6	1,8
Flow-through ventilators, axial-flow fans	1,6	1,8	2
Compressors, rotary screw compressors	1,4	1,5	1,6
Reciprocating compressors	1,6	1,8	2
Pumps, centrifugal and gear pumps	1,2	1,4	1,6
Reciprocating pumps	1,7	1,9	2,1
Generators and excitation machines	1,4	1,6	1,8
Lifts and hoists	1,4	1,6	1,8
Centrifugal‘s	1,5	1,7	1,9
Rubber industry, rubber processing machines	1,5	1,7	1,9
Mills, hammer mills	1,5	1,7	1,9
Ball, roller and pebble mills	1,7	1,9	2,1

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Fatigue factor c4

This factor takes into account the daily operating time and special stress on the belt, e.g. from belt back idlers.

Daily operating time and conditions	Fatigue factor c4
no permanent operation	-0,2
10 to 16 hours	+0,2
> 16 hours	+0,4
with back belt idler	+0,2

Length factor c5

The contra-flex stress subject to the belt length is taken into account here.

Pitch [mm]	Belt length [mm]	c_5
3	< 190	0,8
	190-260	0,9
	260-400	1
	400-600	1,1
	> 600	1,2

Pitch [mm]	Belt length [mm]	c_5
5	< 440	0,8
	440-500	0,9
	500-800	1
	800-1100	1,1
	> 1100	1,2

Pitch [mm]	Belt length [mm]	c_5
8	< 640	0,8
	640-950	0,9
	950-1280	1
	1280-1800	1,1
	> 1800	1,2

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Drive configuration

1. Determining the power to be transmitted

The power to be transmitted P [kW] is determined by multiplying the nominal power of the drive machine PM [kW] with the total operating factor c0.

P = PM · c0 [kW]; here c0 = c2 + c3 + c4

2. Selecting the belt pitch

The belt pitch can be selected in advance taking into account the diameter desired for the application. The required minimum number of teeth on the pulleys for the different pitches is decisive.

Pitch [mm]	**3**	**5**	**8**
Minimum No. of teeth	10	14	22
Diameter [mm]	9,55	22,28	56,02
dmin [mm] back belt idler	14	27	85

Note:

The larger the selected toothed pulley diameter, the smaller the drive will ultimately be. However, the larger the pulley diameter, the higher the belt speed and therefore the louder the operating noise. Here the best compromise must be sought. For every problem there are generally multiple solutions.

3. Determining the number of teeth

Taking into account the specifications of the drive and the minimum numbers of teeth, the number of teeth on the drive pulley and driven pulley are determined with the aid of the required ratio. The appropriate equation is:

$$i = \frac{n_1}{n_2} = \frac{d_{w2}}{d_{w1}} = \frac{Z_2}{Z_1}$$

4. Determining the belt length

The theoretically required effective belt length is determined by taking into account the selected drive pulleys and the desired centre distance, .

The standard belt length that comes closest to the calculated length should be chosen. The centre distance is then calculated from the converted equation using the standard length.

The appropriate equations are:

$$L_w = 2 \cdot a + \frac{\pi}{2} \cdot \left(d_{wg} + d_{wk}\right) + \frac{\left(d_{wg} - d_{wk}\right)^2}{4 \cdot a}$$ with predefined centre distance a

$$a = \frac{b + \sqrt{(b^2 - 32 \cdot \left(d_{wg} - d_{wk}\right)^2}}{16}$$ with standard belt length Lw

therein is $b = 4 \cdot L_w - 2 \cdot \pi \cdot (d_{wg} + d_{wk})$

5. Determining the belt width

The performance tables contain the transferable belt performances for standard belt widths according to the number of teeth on the smaller pulley and its rotational speed, whereby at least 6 teeth need to be engaged for these performances.

If the number of engaged teeth ze is less, the factor c1 must be deducted.

Teeth engaged	> 6	5	4	3	2
Factor C1	1	0,8	0,6	0,4	0,2

Number of engaged teeth ze

The number of engaged teeth on the smaller pulley is calculated using the following equation:

$$z_e = 0{,}5 - \left(\frac{\left(d_{wg} - d_{wk}\right)}{6 \cdot \alpha}\right) \cdot z_k$$

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6. Performance value for the selected belts PR

The respective table value multiplied by the factors c_1 and c_5 corresponds to the transferable belt performance PR of the selected belt.

Example: Performance table HTD 8M, width 30
selected belt length = 2800 mm, giving a length factor $c_5 = 1.2$;
No. of teeth on the smaller pulley $z_k = 24$ at rotational speed nk = 2850 rpm
table value P = 12.5 kW.
No. of engaged teeth ze = 5, therefore c1 = 0.8
Result: $P_R = 12.5 \times 0.8 \times 1.2 = P_R = 12$ kW for the transferable belt performance.

The transferable belt performance must be greater than the transferred performance P (see 1.).
If this is not the case, the next largest belt width must be chosen. If this is not possible, a thicker belt must be used.

7. Permissible peripheral force Fu allowed for the selected belt

For the chosen belt, the maximum peripheral force in N occurring during operation must be determined and compared with the maximum permissible peripheral force.
This is done using the equation for performance P or torque M.

$$F_u = \frac{10^3 \cdot P}{v} \qquad F_u = \frac{2 \cdot 10^3 \cdot M}{d_w}$$

This force must not exceed the maximum permissible values and therefore a belt stretching of ca. 0.2%. Otherwise, a larger belt width must be chosen.

Permissible peripheral force Fuzul

Width [mm]	3M HTD	5M HTD	8M HTD
9	170		
15	290	535	
25		905	
20			1400
30			2100
50			3500

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Calculation example

A fan should be upgraded from using V belts to a timing belt drive.

Available drive data:

Motor power:	PM = 15 kW at 1430 rpm
Drive machine:	Electric motor with average initial torque
Motor pulley diameter:	ca. 140 mm
Transmission ratio:	1:1
Centre distance:	1150 to 1250 mm
Operating time:	10 to 16 hours per day

1. Determining performance to be transferred P

With P = PM x c_0 [kW] and $c_0 = c_2 + c_3 + c_4$

$c_2 = 1.6$

$c_3 = 0$

$c_4 = 0.2$

Result: $c_0 = 1.6 + 0 + 0.2 = 1.8$ therefore P = 15 kW x 1.8 = 27 kW

2. Determining the belt pitch

Due to the size of the pulley Ø140 mm and taking into account the minimum number of teeth, a belt pitch of 8 mm = 8M is selected.

3. Determining the number of teeth

As the transmission ratio is 1:1, only the number of teeth must be determined. With the equation for the circumference, the circumferential length of the toothed pulley is found to be ca. 439.8 mm.

This measurement divided by the tooth pitch 8 equals theoretically 55 teeth.

The chosen number of teeth is 56. The effective diameter is

$$d_w = \frac{z_1 \cdot t}{\pi} = 142{,}60 \text{ mm}$$

4. Determining the belt length

With the centre distance of 1200 mm and the equation the theoretical belt length is calculated to be 2844 mm.

The next suitable belt length is **L_w = 2800 mm; length factor c_5 = 1.2**

With the converted equation the centre distance α = 1178 within the specified limits.

$$L_w = 2 \cdot \alpha + \frac{\pi}{2} \cdot (d_{wg} + d_{wk}) + \frac{(d_{wg} + d_{wk})^2}{4 \cdot \alpha}$$

5. Determining the belt width

The number of engaged teeth is immediately clear in this case as both pulleys are wrapped at 180°, i.e. both pulleys have **28 teeth each > 6** and therefore **c_1 = 1.0**.

A glance in the performance tables for the pitch 8M gives a transferable belt performance of:

38.4 kW for the toothed belt **HTD 2800 - 8M - 50**

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6. Performance value for selected belt PR

The standard HTD toothed belt generates P x c_5 = 38.4 x 1.20 = 41.28 kW. This value is sufficient for the required factor c_0 of 1.8 and P = 15 kW.

$$c_{oerr} = \frac{P_R}{P_M} = 2,75$$

7. Permissible peripheral force F_{uzul} of the selected belt

F_{uzul} is 1880 N for the chosen belt. Using the equation, this gives:

$$F_u = \frac{P_M \cdot 10^3}{v} = \frac{15 \cdot 1000}{10,68} = 1.404,49 \text{ N as peripheral force}$$

This sets the belt speed at v = 10.68 m/s,
calculated from

$$v = \frac{n \cdot t \cdot z_1}{60000} = \frac{1.430 \cdot 8 \cdot 56}{60000} \text{ in m/s}$$

The chosen belt therefore fulfils all conditions.

Belt tension

The belt tension is based on the operating conditions of the drive. The total tension force F_v acts on the shaft bearing and is also referred to as shaft force. The associated equation is:

$$F_v = k_1 \cdot k_2 \cdot \frac{P_M \cdot 10^3 \cdot \sin\frac{\beta}{2}}{v}$$

and gives in this case:
1404.49 x k_1 x k_2 = 1404.49 x 1.0 x 1.3 = 1825.84
as the transmission ratio is 1:1.
The value $\sin\frac{\beta}{2}$ refers to the wrap angle of the smaller toothed pulley if the pulley diameters are unequal.

Operating mode	Pre-tension factor k_1
light constant drive	0,85
medium loading	1
high alternating load	1,25
strong impact load	1,4

Calculated operating factor c_{oerr}	Pre-tension factor k_2
<1,5	1,12
1,50-1,75	1,13-1,16
1,75-2	1,17-1,2
>2	1,2-1,6

In the case under consideration, the static shaft force is set to 1825.84 N.
As both pulleys are the same size, the force is distributed to 50% in both belt strands evenly as static strand force Fstat.
This force is ca. 913 N.
For different diameters, the following equation applies: $F_{stat} = \frac{F_v}{2 \cdot \sin\frac{\beta}{2}}$

The wrap angle β of the smaller toothed pulley can be calculated from the equation:

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

Calculation of ze under point 5.

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8. Adjusting the belt tension

The belt tension meter is recommended for measuring the resonant frequency of the slack belt strand.

If the belt strand is made to vibrate e.g. by a gentle knock with a screwdriver handle, it vibrates with a characteristic frequency dependent on the strand force, strand length and dead weight.

This frequency can be calculated once the other values are known.

The strand length is calculated with

$$L_w = a \cdot \sin \frac{\beta}{2}$$

In this example the strand length is equal to the centre distance a = Lf = 1178 mm.

The belt weight per metre is 5.5 x 10-3 kg/m x mm.

This gives m = 1.178 x 5.5 x 10-3 x 50 = 0.324 kg.

The static strand force is 913 N.

The equation for calculating the frequency is $f = \sqrt{\left(\frac{10^6 \cdot F_{stat}}{4 \cdot m \cdot L_f^2} \right)}$ and gives 22.5 Hz.

Guidelines for adjustment ranges

Length [mm]	Adjustment range for installation in mm by						Adjustment range for belt tensioning
	a pulley with rim flange			two pulleys with rim flanges			
	3M	5M	8M	3M	5M	8M	5M/8M
< 1525	8	15	23	14	21	35	3
1525-3050	12	17	25	18	23	37	5
> 3050			28			40	8

Aligning the drives

Belt drives must be aligned as precisely as possible to ensure reliable long-term power transmission and a long service life.

Axial offset and angle error should therefore be kept within narrow limits.

The axial offset, left image, should not exceed 0.5% of the centre distance.

The angle error, right image, should not exceed 0.25% per 1 m of the centre distance. To achieve this the Line Laser is a setup aid.