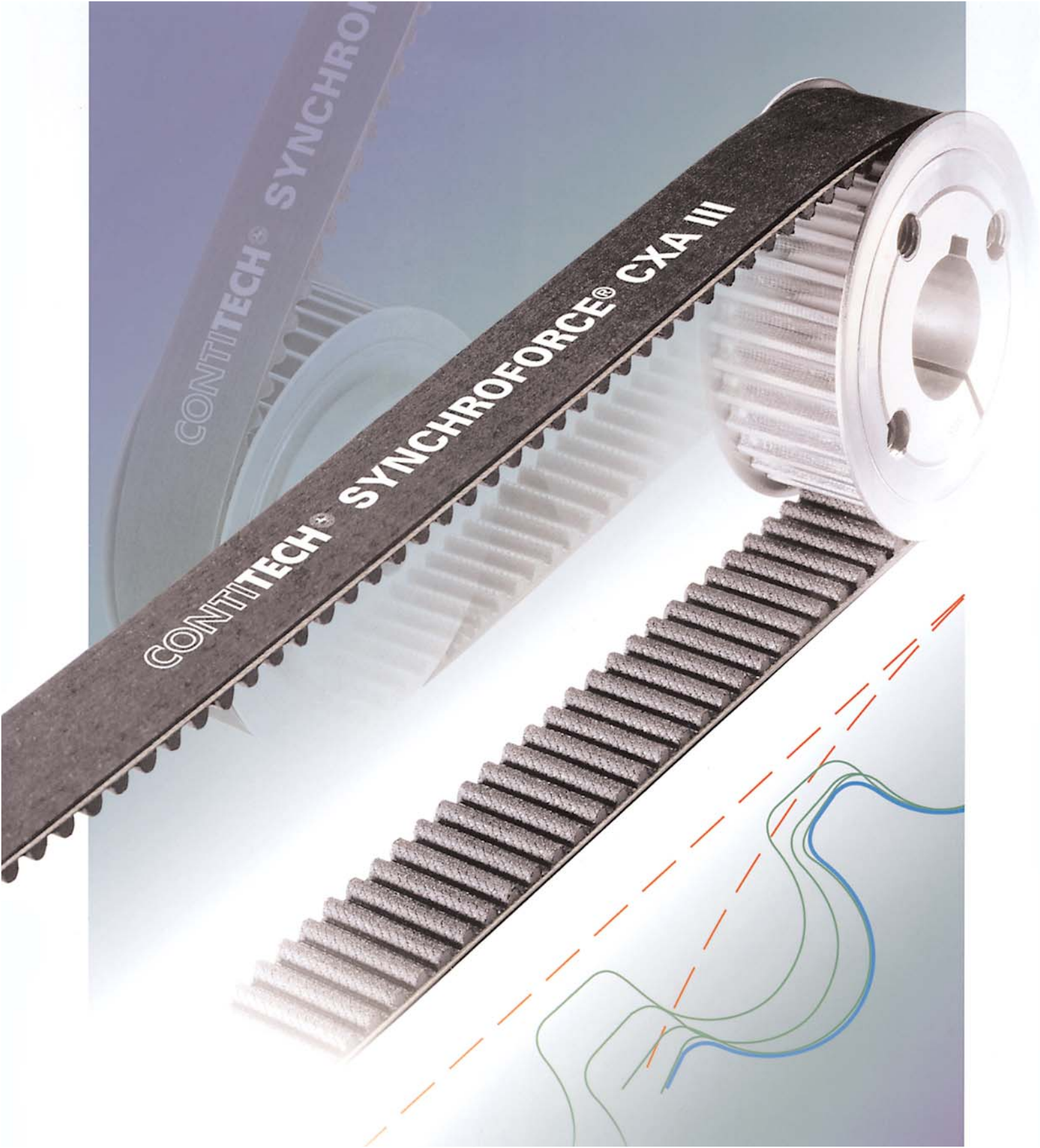


# CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts



**ContiTech**  
Specialist in rubber  
and plastics technology

The ContiTech Division is a development partner and original equipment manufacturer for many branches of industry: with high-grade functional parts, components and systems. It is part of the Continental AG with 8 business units specialising in rubber and plastics technology and utilising their common know-how.

That's what the ContiTech brand is all about.

**CONTITECH** 

3–12 \_\_\_ **1 CONTI SYNCHROFORCE® CXA III  
Heavy-Duty Timing Belts**

4 \_\_\_ Construction

5 \_\_\_ Properties

6 \_\_\_ Designation

6–10 \_\_\_ Product range and applications

11/12 \_\_\_ Tolerances

13–20 \_\_\_ **2 HTD/STD Toothed Pulleys**

14 \_\_\_ Material

14 \_\_\_ Flanged pulleys

15 \_\_\_ Designation

15–19 \_\_\_ Pulley diameters

18/19 \_\_\_ Standard toothed pulleys

20 \_\_\_ Tolerances

21–39 \_\_\_ **3 Design of Timing Belt Drives**

22/23 \_\_\_ Glossary of symbols and terms

24–26 \_\_\_ Design data

27–29 \_\_\_ Calculation example

30–35 \_\_\_ Calculation documentation

36–38 \_\_\_ Power ratings

39 \_\_\_ ContiTech drive design service

40 \_\_\_ Useful formulas

41–43 \_\_\_ **4 Installation instructions**

45 \_\_\_ Index



---

Construction

---

Properties

---

Designation

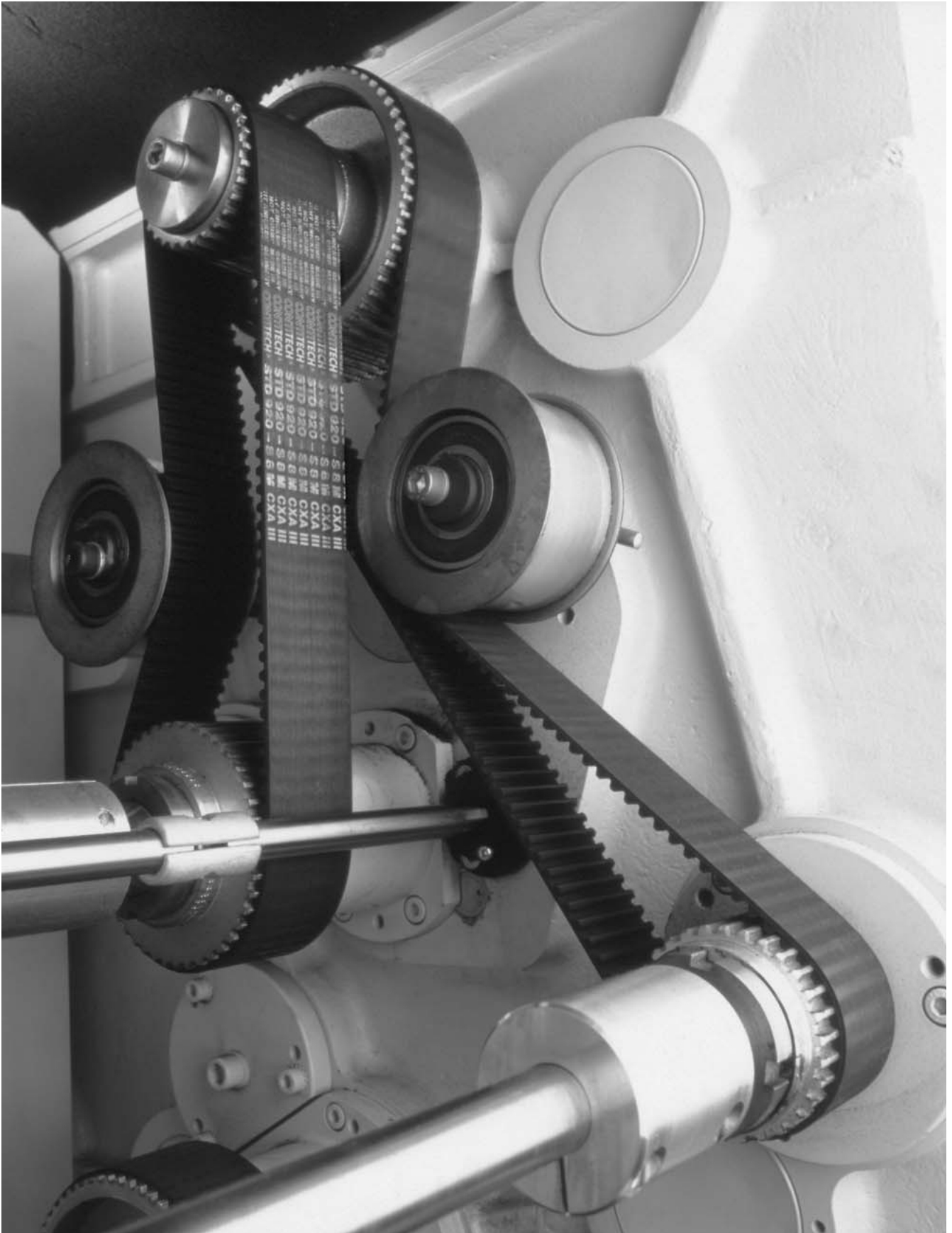
---

Product Range

---

Tolerances

## CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts



CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts  
in an assembly unit

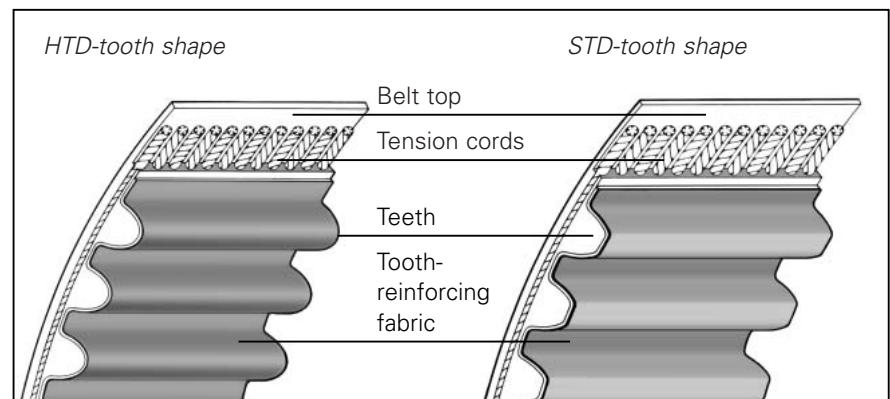
## High-performance, compact and economic

CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts are developed for transmitting high torque values and for drives with exacting demands on tensile strength and length stability. The optimised belt design made of high-strength materials is the basis for the very high power transmission capacity.

CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts with HTD or STD tooth profile are successfully used in roller and lifting drives of material handling systems, in mounting and positioning systems, grinding and crushing plants as well as in various mechanical engineering applications.

Drives with CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts are space saving, economic and maintenance-free. With their very high power transmission capacity, the belts are also suitable for powerful chain drives.

### Construction



CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts are made of the following materials:

#### Belt top and teeth

Both the belt top and teeth are made of an aramid-reinforced polychloroprene material. By aligning the aramid fibres parallel to the direction of belt motion, the teeth are given extra strength to withstand shear and deformation forces.

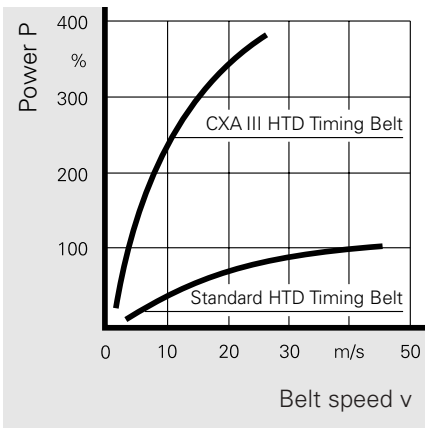
The optimised material combination and the good bonding to the other components are further factors contributing to the high strength and the long service life of these timing belts.

#### Tension cords

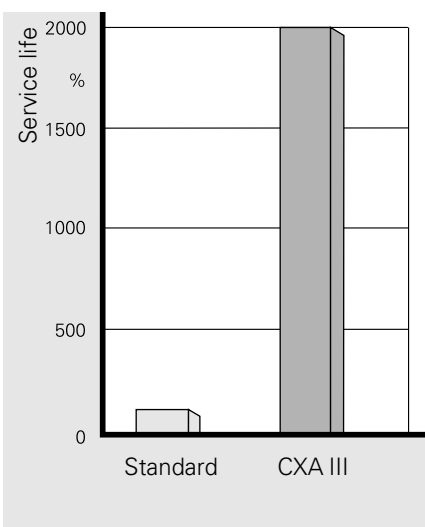
Long-life, high-strength aramid tension cords allow high power transmission capacity. The precise spooling of tensile cords – twined in reversed lay in pairs – ensures the operational reliability of the timing belts.

#### Tooth-reinforcing fabric

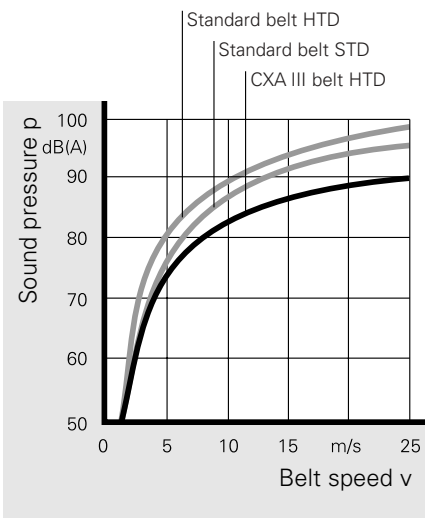
The multi layer calendered polyamide fabric on the toothed side of the belt prevents both premature wear and shearing at the tooth base. The fabric used has a low coefficient of friction. This property, enhanced by the fabric design, allows the teeth to correctly mesh in the grooves and reduces noise emission.



Comparison of power transmitted by standard and CXA III Timing Belts as a function of belt speed



Comparison of service life achieved by standard and CXA III Timing Belts at room temperature and under constant load



The sound pressure of three belt constructions of equal wide timing belts in 8 mm pitch as a function of belt speed

## Properties

### Synchronous transmission

CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts transmit both linear and rotary motion with great precision and angular accuracy. The optimally matched tooth shapes of belt and pulley are designed to prevent belt teeth from jumping over pulley teeth.

### High power transmission capacity

The aramid-reinforced polychloroprene teeth have high resistance to deformation and in combination with aramid tension cords – with their high tear resistance and high modulus of elasticity they allow for the transmission of large forces, even under intermittent or shock loading.

CONTI SYNCHROFORCE® Heavy-Duty Timing Belts of the CXP III type are recommended for fast-running dynamically stressed drives moving at speeds up to 50 m/s.

### Long service life and operational reliability

Belt life research on test stands with alternating loading as well as findings from commercial applications have shown that CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts achieve service lives up to eight times those of conventional belts.

### Compact and economic

The high dynamic strength of CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts allows synchronous drives to be installed in confined spaces.

CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts with HTD and STD tooth profiles have been developed for use on standard toothed pulleys. It is not necessary to replace pulleys if a changeover is made from standard to heavy-duty timing belts.

### High transmission ratios

The positive engagement between belt and pulley and the high specific load carrying capacity of the teeth allow singlestage transmission ratios of up to 1:10 even for short centre distances and for small pulley diameters.

### No lubrication or maintenance

CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts are maintenance-free. No lubrication and retensioning are required.

### Quiet running

The optimised matching between profiles of belt and pulley, and the special belt design with the multi-layer calendered polyamide fabric combine to give perceptibly lower noise levels than those generated by standard timing belts.

### High efficiency

The precise profiling with virtually friction-free meshing as well as belt flexibility and bending capacity ensure a constantly high efficiency of up to 98%.

### Resistance to external influences

- All standard CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts are
- temperature range from +100°C to –20°C according to application
  - suitable for tropical climates
  - resistant to ozone
  - moderately oil-resistant
  - electrically conductive according to ISO 9563
  - insensitive to moisture and weathering

**Designation**

CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts are designated on the basis of the following features:

- tooth shape
- pitch length
- tooth pitch
- belt width
- type

**Example**

CONTI SYNCHROFORCE® Heavy-Duty Timing Belt HTD 1280 – 8M – 30 CXA III

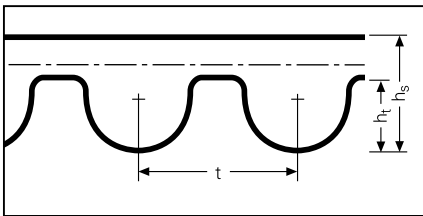
- 1280 \_\_\_\_\_ 1280mm pitch length
- 8M \_\_\_\_\_ 8mm tooth pitch, HTD tooth profile
- 30 \_\_\_\_\_ 30mm belt width
- CXA III \_\_\_\_\_ CXA III type

CONTI SYNCHROFORCE® Heavy-Duty Timing Belt STD 1280 – S8M – 30 CXA III

- 1280 \_\_\_\_\_ 1280mm pitch length
- S8M \_\_\_\_\_ 8mm tooth pitch STD tooth profile
- 30 \_\_\_\_\_ 30mm belt width
- CXA III \_\_\_\_\_ CXA III type

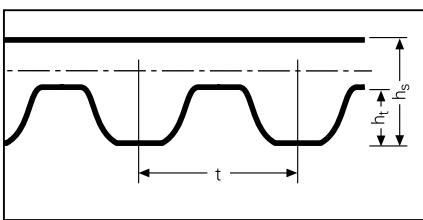
**Product Range**

CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts are manufactured in HTD and STD tooth profiles. The tooth shape with rounded flanks ensures uniform power transmission as the teeth mesh and an even distribution of load within each tooth.



**HTD tooth profile**

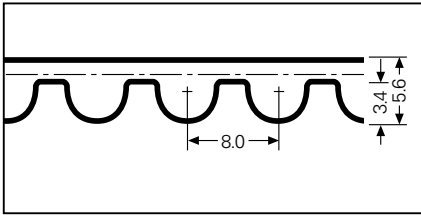
CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts with HTD (high torque drive) profile have a large power transmission capacity and prevent the belt from jumping over the pulley teeth. These timing belts are insensitive to external influences and can be used for a wide range of applications.



**STD tooth profile**

CONTI SYNCHROFORCE® CXA III Heavy Duty Timing Belts with STD (super torque drive) profile can withstand considerable stressing. The arched shape allows precise matching of belt and pulley teeth, thereby giving optimum meshing as well as smooth and quiet running.

The pitch lengths, belt lengths and standard widths that can be supplied for belts with HTD and STD profiles are shown in Tables 1 to 3 (pages 7 to 10).



## Toothed profile HTD 8M

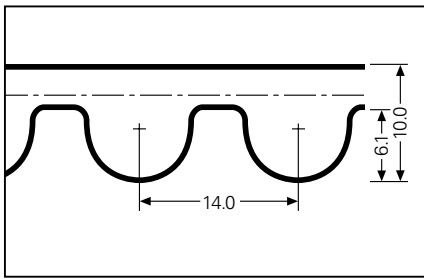
### Standard lengths

Table 1

Designation	Pitch length $L_W$ (mm)	Number of teeth $z$
288 – 8M*	288	36
352 – 8M*	352	44
376 – 8M	376	47
416 – 8M*	416	52
424 – 8M*	424	53
472 – 8M	472	59
480 – 8M	480	60
560 – 8M	560	70
600 – 8M	600	75
624 – 8M	624	78
640 – 8M	640	80
656 – 8M	656	82
720 – 8M	720	90
776 – 8M	776	97
784 – 8M	784	98
800 – 8M	800	100
880 – 8M	880	110
912 – 8M	912	114
920 – 8M	920	115
960 – 8M	960	120
1040 – 8M	1040	130
1120 – 8M	1120	140
1200 – 8M	1200	150
1280 – 8M	1280	160
1304 – 8M	1304	163
1328 – 8M	1328	166
1360 – 8M	1360	170
1424 – 8M	1424	178
1440 – 8M	1440	180
1600 – 8M	1600	200
1760 – 8M	1760	220
1800 – 8M	1800	225
2000 – 8M	2000	250
2248 – 8M	2248	281
2400 – 8M	2400	300
2800 – 8M	2800	350
3008 – 8M*	3008	376
3408 – 8M*	3408	426
3808 – 8M*	3808	476

\*Non-stock items, delivery on request.

Standard widths: 20, 30, 50, 85 mm, intermediate widths on request.



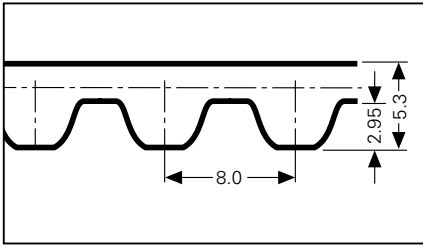
### Toothed profile HTD 14M

Standard lengths

Table 2

Designation	Pitch length $L_W$ (mm)	Number of teeth $z$
966 – 14M	966	69
1190 – 14M	1190	85
1400 – 14M	1400	100
1610 – 14M	1610	115
1778 – 14M	1778	127
1890 – 14M	1890	135
2100 – 14M	2100	150
2310 – 14M	2310	165
2450 – 14M	2450	175
2590 – 14M	2590	185
2800 – 14M	2800	200
3150 – 14M	3150	225
3500 – 14M	3500	250
3850 – 14M	3850	275
4326 – 14M	4326	309
4578 – 14M	4578	327

Standard widths: 40, 55, 85, 115, 170 mm, intermediate widths on request.

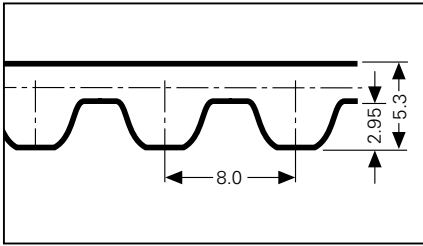

**Toothed profile STD S 8M\***

Standard lengths

Table 3

Designation	Pitch length $L_W$ (mm)	Number of teeth $z$
440 – S 8M	440	55
480 – S 8M	480	60
528 – S 8M	528	66
560 – S 8M	560	70
600 – S 8M	600	75
632 – S 8M	632	79
640 – S 8M	640	80
656 – S 8M	656	82
672 – S 8M	672	84
688 – S 8M	688	86
696 – S 8M	696	87
712 – S 8M	712	89
720 – S 8M	720	90
728 – S 8M	728	91
736 – S 8M	736	92
760 – S 8M	760	95
768 – S 8M	768	96
784 – S 8M	784	98
792 – S 8M	792	99
800 – S 8M	800	100
824 – S 8M	824	103
848 – S 8M	848	106
864 – S 8M	864	108
880 – S 8M	880	110
912 – S 8M	912	114
920 – S 8M	920	115
944 – S 8M	944	118
960 – S 8M	960	120
992 – S 8M	992	124
1000 – S 8M	1000	125
1056 – S 8M	1056	132
1064 – S 8M	1064	133
1072 – S 8M	1072	134
1120 – S 8M	1120	140
1136 – S 8M	1136	142
1160 – S 8M	1160	145
1168 – S 8M	1168	146
1176 – S 8M	1176	147
1184 – S 8M	1184	148
1200 – S 8M	1200	150
1216 – S 8M	1216	152
1240 – S 8M	1240	155
1256 – S 8M	1256	157
1264 – S 8M	1264	158

\*Non-stock items, delivery on request.



**Toothed profile STD S8M\***

Standard lengths

Table 3

Designation	Pitch length $L_W$ (mm)	Number of teeth $z$
1280 – S8M	1280	160
1296 – S8M	1296	162
1304 – S8M	1304	163
1312 – S8M	1312	164
1344 – S8M	1344	168
1368 – S8M	1368	171
1400 – S8M	1400	175
1408 – S8M	1408	176
1440 – S8M	1440	180
1480 – S8M	1480	185
1512 – S8M	1512	189
1552 – S8M	1552	194
1600 – S8M	1600	200
1624 – S8M	1624	203
1760 – S8M	1760	220
1776 – S8M	1776	222
1800 – S8M	1800	225
1816 – S8M	1816	227
1912 – S8M	1912	239
2240 – S8M	2240	280
2392 – S8M	2392	299
2800 – S8M	2800	350
2848 – S8M	2848	356

Standard widths: 20, 30, 50, 85 mm, intermediate widths on request.

\*Non-stock items, delivery on request.

## Tolerances

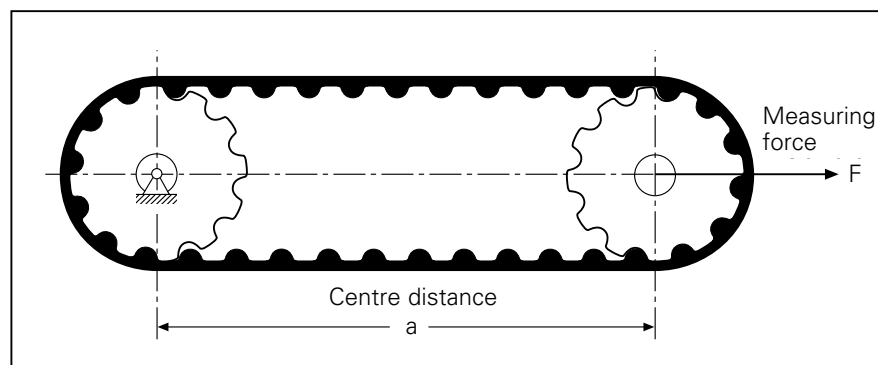
CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts are precision products. They are manufactured with great care and accuracy. The tolerances for length, width and thickness are listed in the following tables.

### Length tolerances for timing belts

Table 4

Pitch length $L_W$ mm	Tolerance as centre distance deviation in mm
> 255 – 400	$\pm 0.23$
> 400 – 560	$\pm 0.25$
> 560 – 800	$\pm 0.30$
> 800 – 1000	$\pm 0.33$
> 1000 – 1270	$\pm 0.38$
> 1270 – 1500	$\pm 0.40$
> 1500 – 1800	$\pm 0.43$
> 1800 – 2000	$\pm 0.45$
> 2000 – 2250	$\pm 0.48$
> 2250	The tolerance value increases by further 0.05 mm for every 500 mm increase in length.

The test setup is shown in Fig. 1. The measuring forces for the length measurements are given in Table 5.



Test setup

Fig. 1

### Measuring forces for length measurements

Table 5

Tooth profile		HTD 8M	HTD 14M	STD S8M
Tooth pitch t	mm	8	14	8
Measuring force F for width b = 20 mm	N	750	1000	750

For timing belts of other widths the measuring forces are available on request.

Width tolerances for timing belts

Table 6

Belt width b mm	Width tolerance for pitch length $L_W$ mm		
	up to 880 mm	> 880 up to 1760 mm	> 1760 mm
20– 40	+ 0.8 – 0.8	+ 0.8 – 1.2	+ 0.8 – 1.2
> 40– 50	+ 0.8 – 1.2	+ 1.2 – 1.2	+ 1.2 – 1.5
> 50– 85	+ 1.2 – 1.2	+ 1.5 – 1.5	+ 1.5 – 2.0
> 85–170	+ 1.5 – 1.5	+ 1.5 – 2.0	+ 2.0 – 2.0
> 170		+ 4.8 – 4.8	+ 4.8 – 4.8

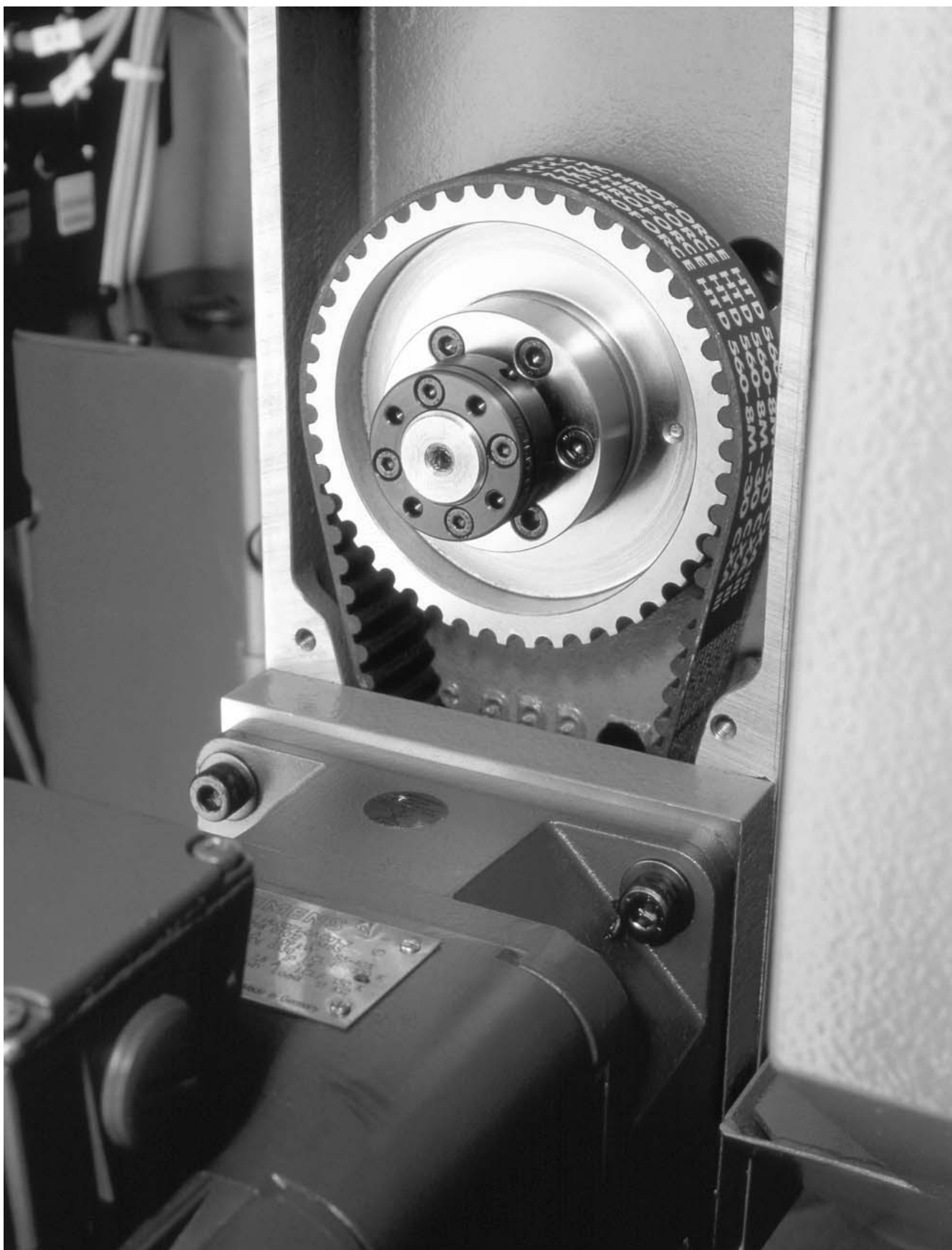
Thickness tolerances for timing belts

Table 7

Tooth profile	HTD 8M	HTD 14M	STD S 8M
Belt thickness $h_s$ mm	5.6	10.0	5.3
Thickness tolerance Standard construction mm	± 0.40	± 0.60	± 0.40
Thickness tolerance Special construction mm	± 0.20	± 0.25	± 0.20

Material	Pulley Diameters
Flanged Pulleys	Standard Toothed Pulleys
Designation	Tolerances

## HTD/STD Toothed Pulleys



CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belt  
in a machine tool

## HTD/STD Toothed Pulleys

The service lives and smooth-running properties of timing belts are determined to a large extent by the quality of the toothed pulleys they run on.

CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts of HTD or STD profile have been developed for use on standard pulleys of the profile concerned.

### Material

The material selected depends on the size of the pulley and on the power to be transmitted.

– Aluminium alloy	AlCuMgPb F 35 bis F 38 in hard anodised type for tooth pitch 8 mm
– Steel or gray cast iron	9 SMn 28K, 9 SMnPb 28K, Ck45 GG-22 bis GG-25 for tooth pitches 8 and 14 mm

### Flanged Pulleys

Flanged pulleys prevent belts from slipping off. In general, the smaller pulleys of a drive are provided with flanges on both sides. It may be beneficial to fit single flanges on alternate sides of consecutive pulleys.

Flanged pulleys may, at the discretion of the pulley manufacturers, be angled, chamfered or of a radius-matching design.

**Designation**

Toothed pulleys for CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts are designated on the basis of the following features:

- tooth shape
- toothed pulley fastening
- number of teeth
- tooth pitch
- toothed pulley width
- pulley type

**Example**

HTD pulley PT 40 – 8M – 50 – 3F

PT \_\_\_\_\_ Pulley for taper bush  
 40 \_\_\_\_\_ 40 teeth  
 8M \_\_\_\_\_ 8 mm tooth pitch, HTD profile  
 50 \_\_\_\_\_ Pulley for 50 mm wide belts  
 3F \_\_\_\_\_ Type of pulley

STD pulley PT 40 – S8M – 50 – 3F

PT \_\_\_\_\_ Pulley for taper bush  
 40 \_\_\_\_\_ 40 teeth  
 S8M \_\_\_\_\_ 8 mm tooth pitch, STD profile  
 50 \_\_\_\_\_ Pulley for 50 mm wide belts  
 3F \_\_\_\_\_ Type of pulley

**Pulley diameters**

Tables 8 and 9 (pages 16 and 17) contain technical data on number of teeth, pitch diameter and outside diameter of HTD and STD toothed pulleys.

Specialist suppliers keep a stock of the most popular sizes of toothed pulleys. The dimensions of standard toothed pulleys for HTD 8M and 14M as well as for STD S8M are shown in Tables 10 and 12 (pages 18 and 19).

Data on the widths of matching belts and toothed pulleys are shown in Tables 11 and 13 (pages 18 and 19).

HTD/STD Toothed Pulleys  
Tooth Pitch 8 mm

(Dimensions in mm)

Table 8

Number of teeth z	Pitch diameter d <sub>w</sub>	Outside diameter d <sub>a</sub>	Number of teeth z	Pitch diameter d <sub>w</sub>	Outside diameter d <sub>a</sub>	Number of teeth z	Pitch diameter d <sub>w</sub>	Outside diameter d <sub>a</sub>	Number of teeth z	Pitch diameter d <sub>w</sub>	Outside diameter d <sub>a</sub>
22	56.02	54.65	65	165.52	164.15	108	275.02	273.65	151	384.52	383.15
23	58.57	57.20	66	168.07	166.70	109	277.57	276.20	152	387.06	385.69
24	61.12	59.75	67	170.61	169.24	110	280.11	278.74	153	389.61	388.24
25	63.66	62.29	68	173.16	171.79	111	282.66	281.29	154	392.16	390.79
26	66.21	64.84	69	175.71	174.34	112	285.21	283.84	155	394.70	393.33
27	68.75	67.38	70	178.25	176.88	113	287.75	286.38	156	397.25	395.88
28	71.30	69.93	71	180.80	179.43	114	290.30	288.93	157	399.80	398.43
29	73.85	72.48	72	183.35	181.98	115	292.84	291.47	158	402.34	400.97
30	76.39	75.02	73	185.89	184.52	116	295.39	294.02	159	404.89	403.52
31	78.94	77.57	74	188.44	187.07	117	297.94	296.57	160	407.44	406.07
32	81.49	80.12	75	190.99	189.62	118	300.48	299.11	161	409.98	408.61
33	84.03	82.66	76	193.53	192.16	119	303.03	301.66	162	412.53	411.16
34	86.58	85.21	77	196.08	194.71	120	305.58	304.21	163	415.08	413.71
35	89.13	87.76	78	198.63	197.26	121	308.12	306.75	164	417.62	416.25
36	91.67	90.30	79	201.17	199.80	122	310.67	309.30	165	420.17	418.80
37	94.22	92.85	80	203.72	202.35	123	313.22	311.85	166	422.72	421.35
38	96.77	95.40	81	206.26	204.89	124	315.76	314.39	167	425.26	423.89
39	99.31	97.94	82	208.81	207.44	125	318.31	316.94	168	427.81	426.44
40	101.86	100.49	83	211.36	209.99	126	320.86	319.49	169	430.35	428.98
41	104.41	103.04	84	213.90	212.53	127	323.40	322.03	170	432.90	431.53
42	106.95	105.58	85	216.45	215.08	128	325.95	324.58	171	435.45	434.08
43	109.50	108.13	86	219.00	217.63	129	328.50	327.13	172	437.99	436.62
44	112.05	110.68	87	221.54	220.17	130	331.04	329.67	173	440.54	439.17
45	114.59	113.22	88	224.09	222.72	131	333.59	332.22	174	443.09	441.72
46	117.14	115.77	89	226.64	225.27	132	336.14	334.76	175	445.63	444.26
47	119.68	118.31	90	229.18	227.81	133	338.68	337.31	176	448.18	446.81
48	122.23	120.86	91	231.73	230.36	134	341.23	339.86	177	450.73	449.36
49	124.78	123.41	92	234.28	232.91	135	343.77	342.40	178	453.27	451.90
50	127.32	125.95	93	236.82	235.45	136	346.32	344.95	179	455.82	454.45
51	129.87	128.50	94	239.37	238.00	137	348.87	347.50	180	458.37	457.00
52	132.42	131.05	95	241.92	240.55	138	351.41	350.04	181	460.91	459.54
53	134.96	133.59	96	244.46	243.09	139	353.96	352.55	182	463.46	462.09
54	137.51	136.14	97	247.01	245.64	140	356.51	355.14	183	466.01	464.64
55	140.06	138.69	98	249.55	248.18	141	359.05	357.58	184	468.55	467.18
56	142.60	141.23	99	252.10	250.73	142	361.60	360.23	185	471.10	469.73
57	145.15	143.78	100	254.65	253.28	143	364.15	362.78	186	473.65	472.27
58	147.70	146.33	101	257.19	255.82	144	366.69	365.32	187	475.19	474.82
59	150.24	148.87	102	259.74	258.37	145	369.24	367.87	188	478.74	477.37
60	152.79	151.42	103	262.29	260.92	146	371.79	370.42	189	481.28	479.91
61	155.34	153.97	104	264.83	263.46	147	374.33	372.96	190	483.83	482.46
62	157.88	156.51	105	267.38	266.01	148	376.88	375.51	191	486.38	485.01
63	160.43	159.06	106	269.93	268.56	149	379.43	378.06	192	488.92	487.55
64	162.97	161.60	107	272.47	271.10	150	381.97	380.60			

HTD Toothed Pulleys  
Tooth Pitch 14 mm

(Dimensions in mm)

Table 9

Number of teeth z	Pitch diameter $d_w$	Outside diameter $d_a$	Number of teeth z	Pitch diameter $d_w$	Outside diameter $d_a$	Number of teeth z	Pitch diameter $d_w$	Outside diameter $d_a$	Number of teeth z	Pitch diameter $d_w$	Outside diameter $d_a$
28	124.78	121.98	72	320.86	318.06	116	516.94	514.14	160	713.01	710.21
29	129.23	126.43	73	325.31	322.51	117	521.39	518.59	161	717.47	714.67
30	133.69	130.89	74	329.77	326.97	118	525.85	523.05	162	721.93	719.13
31	138.15	135.35	75	334.23	331.43	119	530.30	527.50	163	726.38	723.58
32	142.60	139.80	76	338.68	335.88	120	534.76	531.96	164	730.84	728.04
33	147.06	144.26	77	343.14	340.34	121	539.22	536.42	165	735.30	732.50
34	151.52	148.72	78	347.59	344.79	122	543.67	540.87	166	739.75	736.95
35	155.97	153.17	79	352.05	349.25	123	548.13	545.33	167	744.21	741.41
36	160.43	157.63	80	356.51	353.71	124	552.59	549.79	168	748.66	745.86
37	164.88	162.08	81	360.96	358.16	125	557.04	554.24	169	753.12	750.32
38	169.34	166.54	82	365.42	362.62	126	561.50	558.70	170	757.58	754.78
39	173.80	171.00	83	369.88	367.08	127	565.95	563.15	171	762.03	759.23
40	178.25	175.45	84	374.33	371.53	128	570.41	567.51	172	756.49	763.69
41	182.71	179.91	85	378.79	375.99	129	574.87	572.07	173	770.95	768.15
42	187.17	184.37	86	383.24	380.44	130	579.32	576.52	174	775.40	772.60
43	191.62	188.82	87	387.70	384.90	131	583.78	580.98	175	779.86	777.05
44	196.08	193.28	88	392.16	389.36	132	588.24	585.44	176	784.32	781.52
45	200.54	197.74	89	396.51	393.81	133	592.69	589.89	177	788.77	785.97
46	204.99	202.19	90	401.07	398.27	134	597.15	594.35	178	793.23	790.43
47	209.45	206.65	91	405.53	402.73	135	601.61	598.81	179	797.68	794.88
48	213.90	211.10	92	409.98	407.18	136	606.06	603.26	180	802.14	799.34
49	218.36	215.56	93	414.44	411.64	137	610.52	607.72	181	806.60	803.80
50	222.82	220.02	94	418.90	416.10	138	614.97	612.17	182	811.05	808.25
51	227.27	224.47	95	423.35	420.55	139	619.43	616.63	183	815.51	812.71
52	231.73	228.93	96	427.81	425.01	140	623.89	621.09	184	819.97	817.17
53	236.19	233.39	97	432.26	429.46	141	628.34	625.54	185	824.42	821.62
54	240.64	237.84	98	436.72	433.92	142	632.80	630.00	186	828.88	826.08
55	245.10	242.30	99	441.18	438.38	143	637.26	634.46	187	833.33	830.53
56	249.55	246.75	100	445.63	442.83	144	641.71	638.91	188	837.79	834.99
57	254.01	251.21	101	450.09	447.29	145	646.17	643.37	189	342.25	839.45
58	258.47	255.67	102	454.55	451.75	146	650.63	647.83	190	846.70	843.90
59	262.92	260.12	103	459.00	456.20	147	655.08	652.28	191	851.16	848.36
60	267.38	264.58	104	463.46	460.66	148	659.54	656.74	192	855.62	852.82
61	271.84	269.04	105	467.92	465.12	149	663.99	661.19	193	860.07	857.27
62	276.29	273.49	106	472.37	469.57	150	668.45	665.65	194	864.53	861.73
63	280.75	277.95	107	476.83	474.03	151	672.91	570.11	195	868.99	866.19
64	285.21	282.41	108	481.28	478.48	152	677.36	674.56	196	873.44	870.64
65	289.66	286.86	109	485.74	492.94	153	681.82	679.02	197	877.90	875.10
66	294.12	291.32	110	490.20	487.40	154	685.28	683.48	198	882.36	879.56
67	298.57	295.77	111	494.65	491.85	155	690.73	687.93	199	886.81	884.01
68	303.03	300.23	112	499.11	496.31	156	695.19	692.39	200	891.27	888.47
69	307.49	304.69	113	503.57	500.77	157	699.65	696.84	201	895.72	892.92
70	311.94	309.14	114	508.02	505.22	158	704.10	701.30	202	900.18	897.38
71	316.40	313.60	115	512.48	509.68	159	708.56	705.76	203	904.64	901.84

HTD/STD Standard Toothed Pulleys  
Tooth Pitch 8 mm

(Dimensions in mm)

Table 10

Number of teeth $z$	Pitch diameter $d_w$	Outside diameter $d_a$	Flanged pulley diameter $d_b \approx$	Pilot bore diameter $d_v$	Finished bore diameter $d_{F \max}$
22	56.02	54.65	60	12	25
24	61.12	59.74	66	12	28
26	66.21	64.84	70	12	30
28	71.30	69.93	75	15	30
30	76.39	75.12	82	15	32
32	81.49	80.16	87	15	35
34	86.58	85.22	91	15	42
36	91.67	90.30	97	15	42
38	96.77	95.39	102	15	45
40	101.86	100.49	106	15	45
44	112.05	110.67	120	15	45
48	122.23	120.86	128	15	45
56	142.60	141.23	150	15	50
64	162.97	161.60	168	15	50
72	183.35	181.97	192	15	55
80	203.72	202.35	–	15	60
90	229.18	227.81	–	15	60
112	285.21	283.83	–	18	60
144	366.69	365.32	–	20	60
168	427.81	426.44	–	20	60
192	488.92	487.55	–	20	60

Standard widths

(Dimensions in mm)

Table 11

Timing belt width $b$	Toothed pulleys Intermeshing width for pulleys	
	with 2 flanges	without flanges
20	24	28
30	34	38
50	56	60
85	91	95

The standard toothed pulleys listed in these tables are available from the specialist trade with pilot bores or taper bushes.

## HTD Standard Toothed Pulleys Tooth Pitch 14 mm

(Dimensions in mm)

Table 12

Number of teeth $z$	Pitch diameter $d_w$	Outside diameter $d_a$	Flanged pulley diameter $d_b \approx$	Pilot bore diameter $d_v$	Finished bore diameter $d_{F \max}$
28	124.78	121.98	130	24	60
29	129.23	126.43	134	24	60
30	133.69	130.89	138	24	60
32	142.60	139.80	148	24	60
34	151.52	148.72	156	24	60
36	160.43	157.63	166	24	60
38	169.34	166.54	183	24	70
40	178.25	175.45	184	24	70
44	196.08	193.28	202	24	70
48	213.90	211.10	220	24	75
56	249.55	246.75	254	28	75
64	285.21	282.41	290	28	75
72	320.86	318.06	–	28	75
80	356.51	353.71	–	28	75
90	401.07	398.27	–	28	75
112	499.11	496.31	–	28	75
144	641.71	638.91	–	28	75
168	748.66	745.86	–	28	75
192	855.62	852.82	–	28	75
216	962.57	959.77	–	28	85

## Standard widths

(Dimensions in mm)

Table 13

Timing belt width $b$	Toothed pulleys Intermeshing width for pulleys	
	with 2 flanges	without flanges
40	48	54
55	64	70
85	94	102
115	125	133
170	180	187

The standard toothed pulleys listed in these tables are available from the specialist trade with pilot bores or clamping bushes.

**Tolerances**

Outside Diameter Tolerance

Table 14

outside diameter $d_a$ mm	Tolerance mm
$\leq 25$	+ 0.05 0
> 25– 50	+ 0.08 0
> 50–100	+ 0.10 0
> 100–175	+ 0.13 0
> 175–300	+ 0.15 0
> 300–500	+ 0.18 0
> 500	+ 0.20 0

Lateral Runout Tolerance

Table 15

outside diameter $d_a$ mm	Tolerance mm
$\leq 100$	0.1
> 100–250	0.001 per mm outside diameter
> 250	0.25 + 0.0005 per mm outside diameter

Radial Runout Tolerance

Table 16

outside diameter $d_a$ mm	Tolerance mm
$\leq 200$	0.13
> 200	0.13 + 0.0005 per mm outside diameter

**Parallelism**

Parallelism between the bore and teeth may not exceed a maximum deviation of 1  $\mu\text{m}$  per millimetre of toothed pulley width.

**Taper**

The taper may amount to maximum of 1  $\mu\text{m}$  per millimetre over the width of the tooth and, at the same time, may not exceed the permissible diameter tolerance.

---

Symbols, Units, Terms

Calculation Documentation

---

Design Data

Power Ratings

---

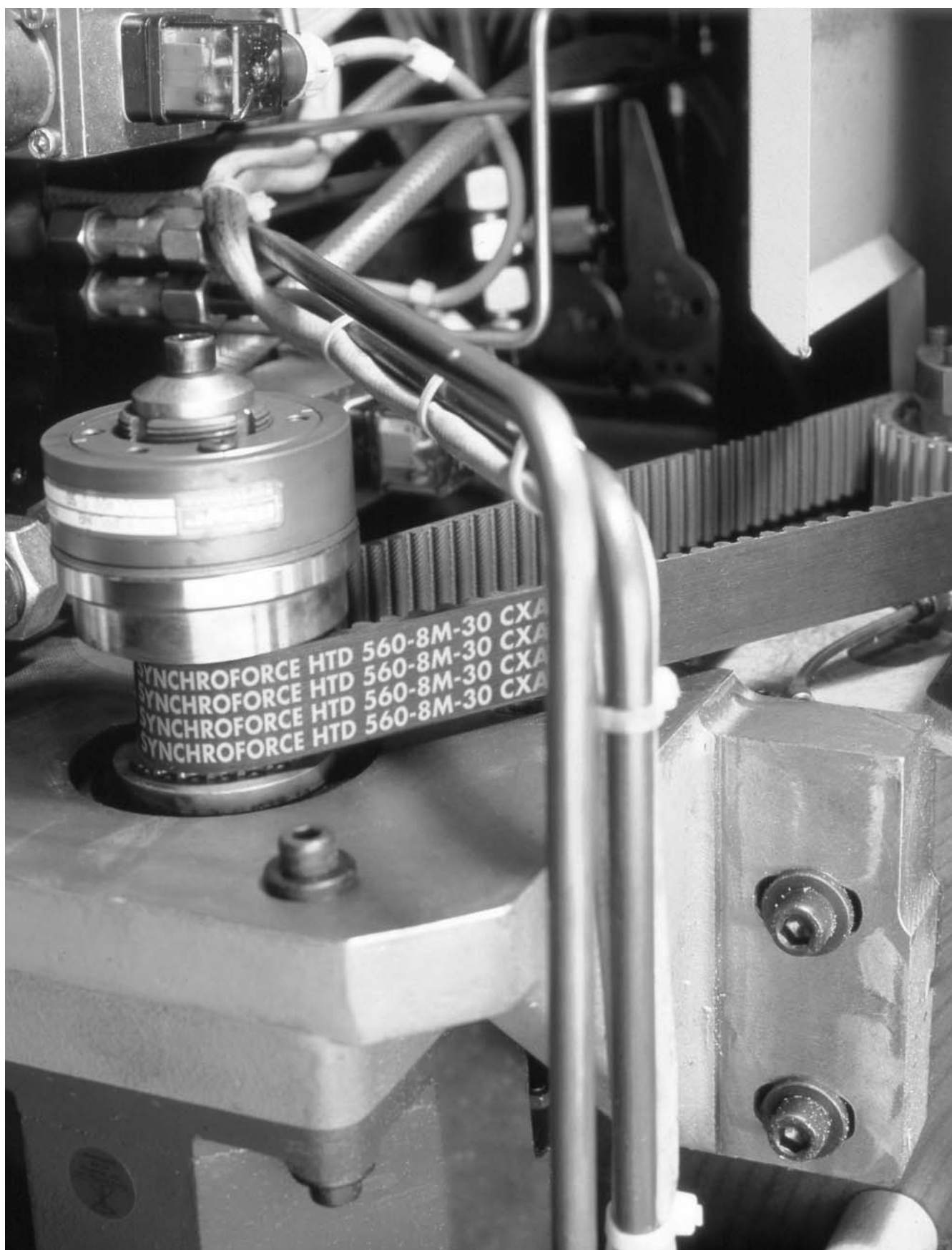
Calculation Example

ContiTech Drive Design Service

---

Usefull Formulas

## Design of Timing Belt Drives

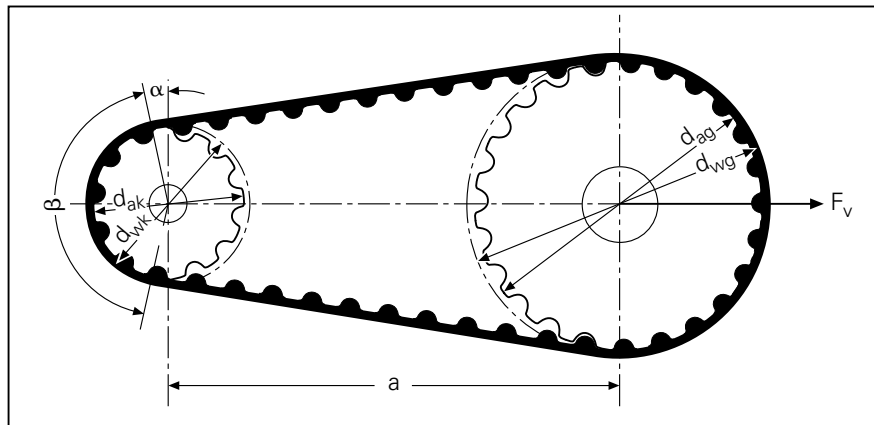


CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belt  
in a pump drive

## Design of Timing Belt Drives

The worked examples of calculations apply to drives equipped with CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts. The values needed for the drive design are given in the following tables and diagrams.

It is recommended that operators of complex drives consult ContiTech's application engineers without obligation for advise on specific design problems.



### Glossary of symbols and terms

Symbol	Unit	Definition
$a$	mm	Centre distance
$b$	mm	Width of timing belt
$c_0$		Predefined total service factor
$c_{0\text{ err}}$		Calculated total service factor
$c_1$		Teeth in mesh factor
$c_2$		Load factor
$c_3$		Acceleration factor
$c_4$		Fatigue factor
$c_5$		Length factor
$c_6$		Width factor
$c_{6\text{ err}}$		Calculated width factor
$d_a$	mm	Outside diameter of toothed pulley
$d_{ag}$	mm	Outside diameter of large toothed pulley
$d_{ak}$	mm	Outside diameter of small toothed pulley
$d_w$	mm	Pitch diameter of toothed pulley
$d_{w1}$	mm	Pitch diameter of driving toothed pulley
$d_{w2}$	mm	Pitch diameter of driven toothed pulley
$d_{wg}$	mm	Pitch diameter of large toothed pulley
$d_{wk}$	mm	Pitch diameter of small toothed pulley
$f$	Hz	Natural frequency
$F_{\text{stat}}$	N	Static belt tension
$F_u$	N	Effective pull
$F_v$	N	Total axle load

Symbol	Unit	Definition
$i$		Transmission ratio
$k_1$		Belt tension load factor
$k_2$		Belt tension service factor
$L_f$	mm	Free span length
$L_w$	mm	Pitch length of belt
$m$	kg/m	Belt weight per m length
$m_s$	kg/m · mm	Specific belt weight per m length and mm width
$n_1$	min <sup>-1</sup>	Speed of driving toothed pulley
$n_2$	min <sup>-1</sup>	Speed of driven toothed pulley
$n_g$	min <sup>-1</sup>	Speed of large toothed pulley
$n_k$	min <sup>-1</sup>	Speed of small toothed pulley
$P$	kW	Power to be transmitted
$P_N$	kW	Power rating for effective width of belt
$P_R$	kW	Power rating for selected width of belt
$t$	mm	Tooth pitch
$v$	m/s	Belt speed
$z$		No of teeth of the timing belt
$z_1$		No of teeth of the driving toothed pulley
$z_2$		No of teeth of the driven toothed pulley
$z_g$		No of teeth of the large toothed pulley
$z_k$		No of teeth of the small toothed pulley
$\alpha$	° (degrees)	Belt side inclination angle $\alpha = 90 - \frac{\beta}{2}$
$\beta$	° (degrees)	Angle of belt wrap around the small toothed pulley

## Design Data

Timing belt drives are calculated in several stages. The following section contains all the formulas needed for this calculation:

### Drive Data required

For calculating timing belt drives the following data is required:

- Power and type of prime mover
- Type of loading for driven machine
- Operating conditions
- Speeds of prime mover and driven machines
- Transmission ratio
- Number of teeth or toothed pulley diameter of driving and driven machines
- Centre distance range

### Calculation steps

#### 1. Determining the total service factor $c_0$

The total service factor  $c_0$  is determined by adding together

- Acceleration factor  $c_2$  from Table 18 on page 31
- Acceleration factor  $c_3$  from Table 19 on page 32
- Fatigue factor  $c_4$  from Table 20 on page 32

$$c_0 = c_2 + c_3 + c_4$$

#### 2. Selecting the pitch $t$ of the timing belt

The pitch  $t$  of the timing belt is determined on the basis of

- The power to be transmitted,  $P$
- The total service factor,  $c_0$
- The speed of the small toothed pulley,  $n_k$

Relevant data is contained in the selection diagram figure 2 for HTD 8M and 14M as well as for STD S8M timing belts on page 34.

#### 3. Determining the pitch diameters $d_w$ and the numbers of teeth $z$ of toothed pulleys

The pitch diameters  $d_w$  are calculated on the basis of design data of min. and max. values as well as in accordance with the power transmission required.

$$i = \frac{n_1}{n_2} = \frac{d_{w2}}{d_{w1}} = \frac{z_2}{z_1}$$

Diameters and numbers of teeth for HTD and STD toothed pulleys are given in Tables 8 and 9 on pages 16 and 17.

**4. Calculating the pitch length  $L_w$  and the centre distance  $a$** 

The pitch length  $L_w$  of the timing belt can be calculated approximately using the following formula:

$$L_w \approx 2 \cdot a + \frac{t}{2} \cdot (z_g + z_k) + \frac{\left[ \frac{t}{\pi} \cdot (z_g - z_k) \right]^2}{4 \cdot a} \quad \text{mm}$$

The standard lengths of the timing belts we supply are given in Tables 1 to 3 on pages 7 to 10.

The centre distance  $a$ , taking the selected belt length and the specified number of teeth of toothed pulleys, may be calculated using the following formula:

$$a \approx \frac{1}{4} \cdot \left[ L_w - \frac{t}{2} \cdot (z_g + z_k) + \sqrt{\left[ L_w - \frac{t}{2} \cdot (z_g + z_k) \right]^2 - 2 \cdot \left[ \frac{t}{\pi} \cdot (z_g - z_k) \right]^2} \right] \quad \text{mm}$$

For a transmission of  $i = 1$ , the following formulas apply:

$$a = \frac{t}{2} (z - z_1) \quad \text{oder} \quad a = \frac{L_w - \pi \cdot d_w}{2} \quad \text{mm}$$

**5. Determining the teeth in mesh factor  $c_1$  and the length factor  $c_5$** 

The number of meshing teeth and the belt length are taken into consideration by the factors:

- Teeth in mesh factor  $c_1$  from Table 17 on page 30
- Length factor  $c_5$  from Table 21 on page 33.

**6. Determining the width  $b$  of a timing belt**

The necessary width  $b$  of the timing belt is determined giving due consideration to the service factor, the teeth in mesh factor and the length factor. They in turn are all dependent upon

- the power to be transmitted,  $P$  and
- the power rating  $P_N$  for the effective width of the belt.

The power ratings  $P_N$  for CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts with HTD and STD profiles are listed in Tables 25, 27 and 29 on pages 36 to 38 for defined effective widths.

The power ratings  $P_R$  for widths other than standard and intermediate widths may be calculated by multiplying the above power ratings by the width factors  $c_6$  listed in Tables 26, 28 and 30 on pages 36 to 38.

$$P_R = P_N \cdot c_6 \quad \text{kW}$$

The width  $b$  of the timing belt is selected in accordance with the power rating if the  $c_6$  factor corresponding to this width is greater than the calculated width factor  $c_{6\text{ err}}$ .

$$c_{6\text{ belt}} \geq c_{6\text{ err}} = \frac{P \cdot c_0}{P_N \cdot c_1 \cdot c_5}$$

The total service factor, calculated after the belt width has been established, is

$$c_{0\text{ err}} = \frac{P_R \cdot c_1 \cdot c_5}{P}$$

#### 7. Calculating the total axle load $F_v$

The required axle load of the timing belt,  $F_v$ , is calculated, allowing for the output speed or the belt speed and the power to be transmitted. The belt tension load factor  $k_1$  takes account of the different operating conditions.

If a belt width is selected that is considerably greater than the calculated width, the axle load must be increased by the belt tension service factor  $k_2$ . The values for the factors  $k_1$  and  $k_2$  are shown in Tables 22a and 22b on page 33.

$$F_v = k_1 \cdot k_2 \frac{60 \cdot 10^6 \cdot P \cdot \sin \frac{\beta}{2}}{t \cdot z_k \cdot n_k} = k_1 \cdot k_2 \frac{10^3 \cdot P \cdot \sin \frac{\beta}{2}}{v} \text{ N}$$

The ensuing static belt tension  $F_{\text{stat}}$  is:

$$F_{\text{stat}} = \frac{F_v}{2 \cdot \sin \frac{\beta}{2}} = k_1 \cdot k_2 \frac{10^3 \cdot P}{2 \cdot v} \text{ N}$$

#### 8. Checking the initial tension

It is recommended that the initial tension of a timing belt is checked using the frequency measuring method. This method involves the measuring of the natural frequency of the strand of the belt which is set vibrating by striking the belt lightly.

The calculation formulas and specific timing belt values are given on page 35.



CONTI® tension gauge VSM-1

**Calculation example**

Doubling the power of an existing STD drive with uneven loading and frequent gear changes

Prime mover:	Electric motor with high starting torque	$P = 6 \text{ kW}$ $n_1 = 1450 \text{ min}^{-1}$
Driven machine:	Packaging machine	$n_2 = 1050 \text{ min}^{-1}$
Operating conditions:	Diameter of large pulley	$\leq 105 \text{ mm}$
	Centre distance	$a = 460 \text{ mm} \pm 5 \text{ mm}$
	Daily operating period	16–24 hours

**Load Factor**

$c_2$  from Table 18 on page 31

$$c_2 = 1.6$$

**Acceleration Factor**

$c_3$  from Table 19 on page 32

$$c_3 = 0$$

**Fatigue Factor**

$c_4$  from Table 20 on page 34

$$c_4 = 0.4$$

**Total Service Factor**

$$c_0 = c_2 + c_3 + c_4$$

$$c_0 = 1.6 + 0 + 0.4 = 2.0$$

**Selection of Timing Belt Pitch**

Diagram Fig. 2 on page 33

Selected: CONTI SYNCHROFORCE® CXA III  
Heavy-Duty Timing Belt STD S8M

**Transmission Ratio**

$$i = \frac{n_1}{n_2} = \frac{z_2}{z_1}$$

$$i = \frac{1450}{1050} = 1.38$$

**No. of Teeth and Pitch Diameter of the Toothed Pulleys**

$z_g$  from Table 8 on page 16

$$z_2 = z_g$$

$$z_1 = z_k = \frac{z_g}{i}$$

$d_{wk}$  from Table 8 on page 16

Condition:  $d_{wg} \leq 105 \text{ mm}$

Selected:

$$z_g = 40 \quad d_{wg} = 101.86 \text{ mm}$$

$$z_k = \frac{40}{1.38} = 28.98$$

Selected:

$$z_k = 29 \quad d_{wk} = 73.85 \text{ mm}$$

**Pitch Length**

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

$$L_w \approx 2 \cdot 460 + \frac{8}{2} \cdot (40 + 29) + \frac{\left[ \frac{8}{\pi} \cdot (40 - 29) \right]^2}{4 \cdot 460}$$

$$L_w \approx 1197.55 \text{ mm}$$

**Selection of a Standard Length**

$L_w$  from Table 3 on page 10

$$L_w = 1200 \text{ mm} \quad z = 150$$

#### Centre Distance

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

$$a \approx \frac{1}{4} \cdot \left[ 1200 - \frac{8}{2} \cdot (40 + 29) + \sqrt{\left[ 1200 - \frac{8}{2} \cdot (40 + 29) \right]^2 - 2 \cdot \left[ \frac{8}{\pi} \cdot (40 - 29) \right]^2} \right]$$

$$= 461.79 \text{ mm}$$

#### Anle of Belt Wrap around the Small Toothed Pulley

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

$$\beta = 2 \cdot \arccos \left[ \frac{8 \cdot (40 - 29)}{2 \cdot \pi \cdot 461.79} \right]$$

$$\beta = 176.52^\circ$$

#### Teeth in Mesh Factor

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

$c_1$  from Table 17 on page 30

$$z_e = 29 \cdot \frac{176.52}{360} = 14.22$$

$c_1 = 1.0$

#### Length Factor

$c_5$  from Table 21 on page 33

$c_5 = 1.0$

#### Timing Belt Width

Power rating  $P_N$   
for effective width of timing belt  
from Table 29 on page 38

Requirement

$$c_6 \text{ belt} \geq c_{6 \text{ err}}$$

$$c_{6 \text{ err}} = \frac{P \cdot c_0}{P_N \cdot c_1 \cdot c_5}$$

$c_6$  belt from Table 30 on page 38

Power rating  $P_R$

for selected width of timing belt

$$P_R = P_N \cdot c_6$$

Calculated service factor  $c_{0 \text{ err}}$   
for selected width of timing belt

$$c_{0 \text{ err}} = \frac{P_R \cdot c_1 \cdot c_5}{P}$$

$$P_N = 12.22 \text{ kW}$$

$$c_{6 \text{ err}} = \frac{6.0 \cdot 2.0}{12.22 \cdot 1.0 \cdot 1.0} = 0.98$$

Selected: Belt width 20 mm  
with  $c_6 = 1.0$   
hence requirement  $c_6 \text{ belt} \geq c_{6 \text{ err}}$  is met

$$P_R = 12.22 \cdot 1.0 = 12.22 \text{ kW}$$

$$c_{0 \text{ err}} = \frac{12.22 \cdot 1.0 \cdot 1.0}{6.0} = 2.04$$

#### Timing Belt Tension

Total axle load

$$F_v = k_1 \cdot k_2 \cdot \frac{60 \cdot 10^6 \cdot P \cdot \sin \frac{\beta}{2}}{t \cdot z_k \cdot n_k}$$

Static belt tension

$$F_{\text{stat}} = \frac{F_v}{2 \cdot \sin \frac{\beta}{2}}$$

$$F_v = 1.0 \cdot 1.6 \cdot \frac{60 \cdot 10^6 \cdot 6.0 \cdot \sin \frac{176.52}{2}}{8 \cdot 29 \cdot 1450} = 1711.46 \text{ N}$$

$$F_{\text{stat}} = \frac{1711.46}{2 \cdot \sin \frac{176.52}{2}} = 855.37 \text{ N}$$

**Checking the Initial Tension using the Frequency Measuring Method**

$m_s$  — specific weight of timing belt  
per m length and mm width  
from Table 23 on page 35

$b$  — width of timing belt

$m$  — weight of timing belt per m length

$L_f$  — free span length

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

$F_{stat}$  — predefined static belt tension

the desired frequency derived from  
calculation of total axle load, on page 35

$$f = \sqrt{\frac{F_{stat}}{4 \cdot m \cdot L_f^2}}$$

$$m_s = 4.70 \cdot 10^{-3} \text{ kg/m} \cdot \text{mm}$$

$$b = 20 \text{ mm}$$

$$m = 4.70 \cdot 10^{-3} \cdot 20$$

$$m = 0.094 \text{ kg/m}$$

$$L_f = 461.79 \cdot \sin \frac{176.52}{2}$$

$$L_f = 461.58 \text{ mm} = 0.46158 \text{ m}$$

$$F_{stat} = 1070.15 \text{ N}$$

$$f = \sqrt{\frac{855.73}{4 \cdot 0.094 \cdot 0.46158^2}} = 103.35 \text{ Hz}$$

The belt is properly tensioned when the desired frequency  $f$  coincides with the actual measured frequency.

**Result of Drive Calculation**

1 CONTI SYNCHROFORCE® CXA III  
Heavy-Duty Timing Belt    STD 1200 – S 8M – 20  
1 STD toothed pulley        PT29 – S 8M – 20F  
1 STD toothed pulley        PT40 – S 8M – 20

### Calculation Documentation

The calculation documentation contains all the data, formulas and tables needed for the calculation of drives operating with CONTI SYNCHROFORCE® CXA III Heavy Duty Timing Belts. We have not included any tables whose values can easily be calculated using the formulas we have quoted.

#### Total Service Factor $c_0$

The total service factor  $c_0$  takes account of safety factors for special operating conditions in respect of loading, acceleration and fatigue. It is calculated from the individual factors:

$$c_0 = c_2 + c_3 + c_4$$

#### Teeth in Mesh Factor $c_1$

The teeth in mesh factor  $c_1$  takes account of the number of teeth  $z_e$  of the small toothed pulley  $z_k$  that mesh in the belt:

$$z_e = z_k \cdot \frac{\beta}{360} \quad \beta = 2 \cdot \arccos \left[ \frac{t \cdot (z_g - z_k)}{2 \cdot \pi \cdot a} \right] \text{°(degrees)}$$

The Teeth in mesh factors are given in the following table.

#### Teeth in Mesh Factor $c_1$

Table 17

Meshing number of teeth $z_e$	Teeth in mesh factor $c_1$
3	0.4
4	0.6
5	0.8
$\geq 6$	1.0

**Load Factor  $c_2$** 

The load factor  $c_2$  takes account of the type of prime mover and of the driven machine. These values do not take account of any non-standard operating conditions. The cited factors are only intended as reference values for guidance purposes. In cases of doubt, ContiTech application engineers are pleased to provide advice.

Load Factor  $c_2$ 

Table 18

Driven machines		Prime movers		
		Electric motors with a low starting torque (up to 1.5 times the rated torque) Water and steam turbines Internal combustion engines with 8 or more cylinders	Electric motors with a medium starting torque (1.5 to 2.5 times the rated torque) Internal combustion engines with 4 to 6 cylinders	Electric motors with a high starting and braking torque (more than 2.5 times the rated torque) Hydraulic motors Internal combustion engines with up to 4 cylinders
Conveyors	Belt & roller conveyors for lightweight goods	1.1	1.2	1.3
	for moderately heavy loads	1.2	1.4	1.6
	Conveyors for heavy goods, elevators, feed screws, bucket elevators	1.4	1.6	1.8
Mixers	Mechanical stirrers, Mixers, liquid	1.2	1.4	1.6
	Mechanical stirrers, Mixers, semiliquid	1.3	1.5	1.7
Bakery machines	Bakery dough mixers	1.4	1.6	1.8
Machine tools	Lathes	1.2	1.4	1.6
	Drilling & grinding, milling & planing machines	1.3	1.5	1.7
Wood working machines	Wood turning lathes & band saws	1.2	1.3	1.5
	Planing machines & circular saws	1.2	1.4	1.6
Sawing-mill machines		1.4	1.6	1.8
Brickworks machinery	Mixing machines	1.4	1.6	1.8
	Loam mills	1.6	1.8	2.0
Textile machinery	Bobbin winding and warping machines	1.2	1.4	1.6
	Spinning, twisting & weaving machines	1.3	1.5	1.7
Paper making machines	Agitators, calenders, driers	1.2	1.4	1.6
	Pumps, beating machines, stuff grinders	1.4	1.6	1.8
Printing machines	Slitting & folding machines	1.2	1.4	1.6
	Rotary presses	1.3	1.5	1.7
Screen machines	Drum screens	1.2	1.4	1.6
	Vibration screens	1.3	1.5	1.7
Fans, blowers	Exhausters, radial blowers	1.4	1.6	1.8
	Pit ventilators, axial blowers	1.6	1.8	2.0
Compressors	Helical compressors	1.4	1.5	1.6
	Piston compressors	1.6	1.8	2.0
Pumps	Centrifugal pumps and gear pumps	1.2	1.4	1.6
	Reciprocating pumps	1.7	1.9	2.1
Generators	Generators and exciters	1.4	1.6	1.8
Elevators	Elevators and hoists	1.4	1.6	1.8
Packaging machines		1.4	1.5	1.6
Rubber industry	Rubber processing machines	1.5	1.7	1.9
Mills	Hammer mills	1.5	1.7	1.9
	Ball, roller and gravel mills	1.7	1.9	2.1

**Acceleration Factor  $c_3$**

The acceleration factor  $c_3$  is to be applied when the step-up transmission ratio is  $> 1.24$ .

Table 19

Transmission ratio $\frac{1}{i}$	Acceleration factor $c_3$
1 – 1.24	–
1.25–1.74	0.1
1.75–2.49	0.2
2.50–3.49	0.3
$\geq 3.50$	0.4

**Fatigue Factor  $c_4$**

The fatigue factor  $c_4$  takes account of the daily operating period and any particular operating conditions.

Table 20

Type and period of operation	Fatigue factor $c_4$
Daily operating period 10–16 hours	+ 0.2
Daily operating period more than 16 hours	+ 0.4
Additional belt deflection e.g. by using tensioning pulleys	+ 0.2
Intermittent operation	– 0.2

**Length Factor  $c_5$** 

The length factor  $c_5$  takes account of the belt flexing frequency as a function of the timing belt pitch length  $L_w$ .

Length Factor  $c_5$ 

Table 21

HTD/STD Heavy-Duty Timing Belts 8M/S8M

Pitch Length $L_w$	mm	< 640	640 to 959	960 to 1279	1280 to 1799	> 1799
$c_5$		0.8	0.9	1.0	1.1	1.2

HTD Heavy-Duty Timing Belts 14M

Pitch Length $L_w$	mm	> 1400	1400 to 1777	1778 to 2099	2100 to 2589	2590 to 3499	> 3499
$c_5$		0.8	0.9	0.95	1.0	1.05	1.1

**Width factor  $c_6$** 

The width factors are listed on pages 36 to 38 together with the power ratings  $P_N$  for for the different toothed profiles.

**Belt Tension Load Factor  $k_1$** 

The belt tension load factor  $k_1$  takes account of different operating conditions.

Table 22a

Light-duty drives, constant loading	0.75
Medium-duty drives	1.0
Frequent load drives	1.25
High shock loading	1.4

**Belt Tension Service Factor  $k_2$** 

The belt tension service factor  $k_2$  takes account of the service factor calculated for the selected belt width.

Table 22b

Calculated service factor $c_{0\text{err}}$	Belt tension service factor $k_2$
$\leq 1.49$	1.0
1.50–1.74	1.2
1.75–2.00	1.4
> 2.00	1.6

**Selection of the Timing Belt Pitch**

Fig. 2 below enables operators to select the most suitable timing belt pitch for the power to be transmitted by the timing belt drive, duly corrected to take account of both the total service factor  $c_0$  and the speed of the small toothed pulley.

For borderline cases – where the pitch is between two pitch alternatives it is recommended that operators calculate the drive for both pitches. An optimum utilisation of power is obtained if the largest possible pulley diameters are selected.

**CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts**

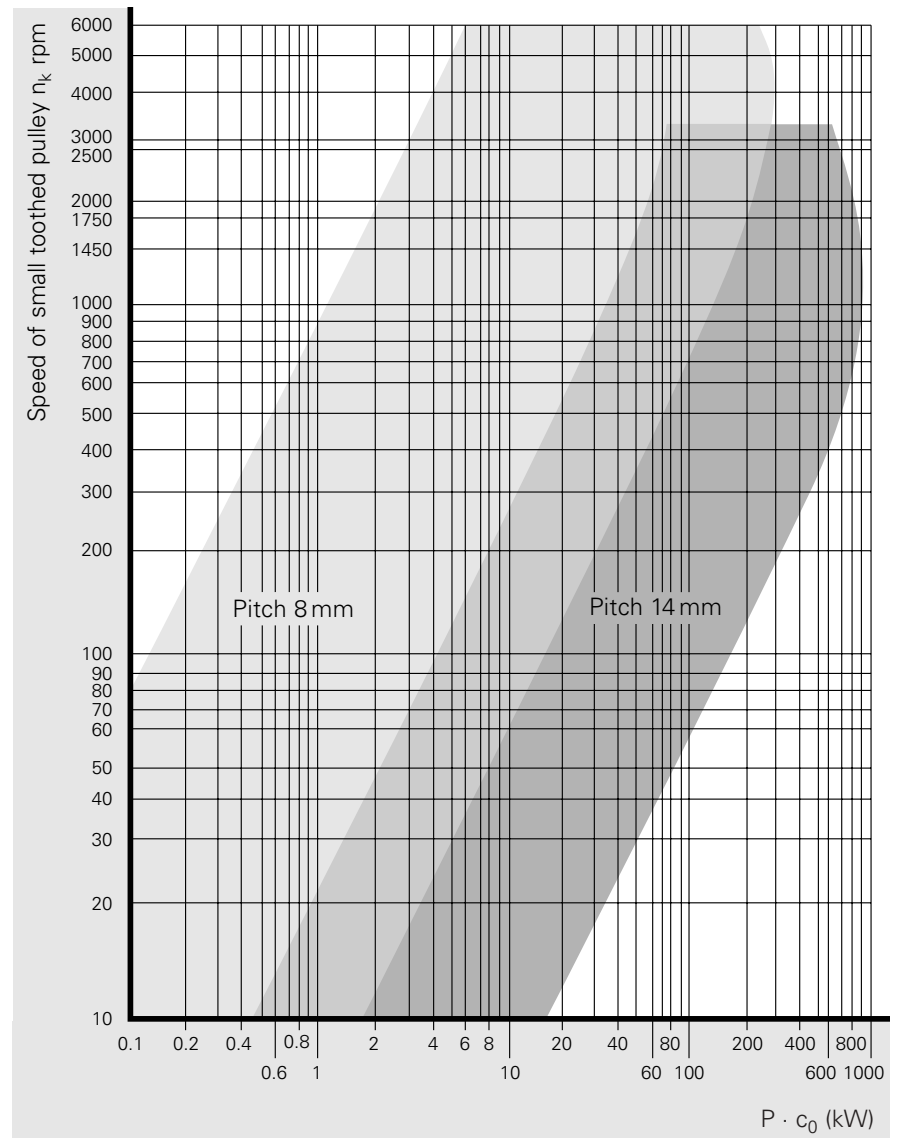


Fig. 2

**Permissible effective pull  $F_{u\ zul}$** 

The permissible effective pull  $F_{u\ zul}$  is shown in Table 23.

Permissible effective pull in N

Table 23

Belt width mm	Tooth profile		
	HTD 8M	HTD 14M	STD S 8M
20	1800		1800
30	2900		2900
40		5600	
50	4000		4000
55		8500	
85	7000	16000	7000
115		22000	
170		32500	

**Checking the initial tension**

The initial tension is obtained by measuring the natural frequency of the part of the belt that is set vibrating. The formula below can be used to calculate the static belt tension  $F_{stat}$ .

$$F_{stat} = 4 \cdot m \cdot L_f^2 \cdot f^2 \quad \text{N}$$

$m$  — Timing belt weight in kg/m, see Table 24

$L_f$  — Free span length in m

$f$  — Natural frequency in Hz

Specific belt weights  $m_s$

Table 24

Timing belt profile	HTD 8M	HTD 14M	STD S 8M
$m_s$ kg/m per mm belt width	$4.82 \cdot 10^{-3}$	$8.68 \cdot 10^{-3}$	$4.70 \cdot 10^{-3}$

In practice, the initial tension is checked by making a simple comparison between the predefined desired frequency and the actual as-measured frequency.

The desired frequency is calculated from the predefined initial tension:

$$f = \sqrt{\frac{F_{stat}}{4 \cdot m \cdot L_f^2}} \quad \text{Hz}$$

If the actual as-measured frequency is higher than the calculated desired frequency, the initial tension of the timing belt must be reduced. In the reverse case, its initial tension must be increased.

ContiTech computer calculations (see example on page 39) show the desired frequency of the free span.

**Power ratings**

The power ratings  $P_N$  for CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts with HTD and STD profiles are shown in Tables 25, 27 and 29 on pages 35 to 38.

The transmittable power depends on the rotational speed and on the diameter or the number of teeth of the small pulley.

The power ratings apply in each case to the smallest possible standard width. The belt power for other widths can be calculated by multiplying this value by the width factor  $c_6$  (Tables 26, 28 and 30 on pages 36 to 38).

Account is taken of the influence of the flexing frequency by multiplying by the length factor  $c_5$  (Table 21 page 33).

CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts

with HTD toothed profile 8M; 20 mm belt width Power rating  $P_N$  in kW

Table 25

Speed of small toothed pulley $n_k$ rpm	No. of teeth of the small toothed pulley $z_k$																
	22	24	26	28	30	32	34	36	38	40	44	48	52	56	64	72	80
	Pitch diameter of toothed pulley $d_w$ (mm)																
	56.02	61.12	66.21	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	203.72
20	0.18	0.21	0.24	0.27	0.31	0.34	0.37	0.40	0.43	0.46	0.52	0.57	0.61	0.64	0.68	0.67	0.62
50	0.42	0.48	0.55	0.62	0.70	0.77	0.84	0.91	0.98	1.05	1.17	1.29	1.38	1.46	1.54	1.52	1.40
100	0.77	0.90	1.02	1.15	1.29	1.42	1.55	1.68	1.81	1.93	2.17	2.38	2.55	2.69	2.84	2.80	2.58
200	1.41	1.64	1.87	2.11	2.35	2.60	2.84	3.08	3.31	3.54	3.96	4.34	4.66	4.91	5.17	5.10	4.69
300	2.01	2.33	2.66	2.99	3.34	3.68	4.02	4.35	4.68	5.00	5.60	6.13	6.57	6.92	7.27	7.16	6.57
400	2.56	2.97	3.39	3.82	4.25	4.69	5.12	5.55	5.96	6.37	7.12	7.78	8.34	8.77	9.21	9.04	8.29
500	3.09	3.58	4.09	4.60	5.12	5.65	6.16	6.67	7.17	7.65	8.55	9.34	10.00	10.51	11.01	10.79	9.87
600	3.60	4.17	4.75	5.35	5.95	6.56	7.15	7.74	8.32	8.87	9.90	10.81	11.56	12.13	12.69	12.41	11.33
<b>700</b>	<b>4.09</b>	<b>4.73</b>	<b>5.39</b>	<b>6.07</b>	<b>6.75</b>	<b>7.43</b>	<b>8.10</b>	<b>8.76</b>	<b>9.41</b>	<b>10.03</b>	<b>11.19</b>	<b>12.20</b>	<b>13.03</b>	<b>13.67</b>	<b>14.26</b>	<b>13.92</b>	<b>12.68</b>
800	4.56	5.27	6.01	6.76	7.51	8.26	9.01	9.74	10.45	11.14	12.41	13.52	14.43	15.11	15.74	15.33	13.93
<b>950</b>	<b>5.23</b>	<b>6.05</b>	<b>6.89</b>	<b>7.74</b>	<b>8.60</b>	<b>9.46</b>	<b>10.30</b>	<b>11.13</b>	<b>11.94</b>	<b>12.71</b>	<b>14.14</b>	<b>15.38</b>	<b>16.39</b>	<b>17.14</b>	<b>17.79</b>	<b>17.27</b>	<b>15.64</b>
1000	5.45	6.30	7.17	8.06	8.95	9.84	10.72	11.58	12.41	13.21	14.69	15.97	17.01	17.78	18.43	17.87	16.16
1200	6.29	7.27	8.27	9.28	10.30	11.31	12.30	13.27	14.22	15.12	16.78	18.20	19.34	20.16	20.80	20.06	18.05
<b>1450</b>	<b>7.28</b>	<b>8.40</b>	<b>9.54</b>	<b>10.70</b>	<b>11.85</b>	<b>13.00</b>	<b>14.13</b>	<b>15.22</b>	<b>16.28</b>	<b>17.29</b>	<b>19.13</b>	<b>20.69</b>	<b>21.92</b>	<b>22.79</b>	<b>23.36</b>	<b>22.37</b>	<b>19.98</b>
1600	7.84	9.04	10.26	11.50	12.73	13.95	15.15	16.31	17.43	18.49	20.42	22.05	23.31	24.19	24.69	23.54	20.92
1800	8.56	9.85	11.18	12.51	13.83	15.14	16.42	17.66	18.85	19.98	22.01	23.70	24.99	25.86	26.24	24.86	21.93
2000	9.24	10.63	12.04	13.46	14.87	16.26	17.61	18.92	20.17	21.35	23.46	25.19	26.49	27.32	27.55	25.91	22.69
2200	9.89	11.36	12.86	14.36	15.84	17.30	18.72	20.08	21.38	22.60	24.77	26.52	27.81	28.59	28.63	26.72	23.20
2500	10.80	12.39	14.00	15.60	17.19	18.74	20.24	21.67	23.02	24.28	26.50	28.24	29.46	30.14	29.83		
<b>2850</b>	<b>11.79</b>	<b>13.50</b>	<b>15.22</b>	<b>16.93</b>	<b>18.60</b>	<b>20.23</b>	<b>21.80</b>	<b>23.28</b>	<b>24.67</b>	<b>25.96</b>	<b>28.17</b>	<b>29.84</b>	<b>30.94</b>	<b>31.43</b>			
3000	12.19	13.94	15.70	17.45	19.16	20.81	22.40	23.90	25.30	26.58	28.78	30.40	31.43				
3500	13.42	15.30	17.17	19.02	20.81	22.53	24.15	25.66	27.05	28.31	30.36	31.75					
4000	14.50	16.48	18.43	20.34	22.17	23.90	25.51	26.99	28.32	29.49							
4500	15.45	17.49	19.50	21.42	23.25	24.96	26.52	27.92	29.13								
5000	16.27	18.36	20.37	22.29	24.08	25.72	27.18										
6000	17.57	19.65	21.61	23.41													

Width factor  $c_6$

Table 26

Belt width mm	<b>20</b>	<b>30</b>	40	<b>50</b>	65	<b>85</b>	
Width factor $c_6$	1.00	1.58	2.16	2.73	3.60	4.76	

Standard widths are printed in bold type.

## CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts

with HTD toothed profile 14M; 40 mm belt width Power rating  $P_N$  in kW

Table 27

Speed of small toothed pulley $n_k$ rpm	No. of teeth of the small toothed pulley $z_k$																
	28	29	30	32	34	36	38	40	42	44	46	48	52	56	64	72	80
	Pitch diameter of toothed pulley $d_w$ (mm)																
	124,78	129,23	133,69	142,60	151,52	160,43	169,34	178,25	178,17	196,08	204,99	213,90	231,73	249,55	285,21	320,86	356,51
20	1.46	1.53	1.60	1.74	1.89	2.03	2.18	2.33	2.48	2.63	2.79	2.94	3.26	3.58	4.23	4.90	5.59
40	2.73	2.87	3.00	3.27	3.54	3.82	4.10	4.38	4.67	4.96	5.25	5.55	6.15	6.76	8.00	9.27	10.56
60	3.93	4.12	4.31	4.70	5.10	5.50	5.91	6.32	6.74	7.16	7.58	8.01	8.87	9.75	11.55	13.38	15.25
100	6.18	6.48	6.79	7.41	8.03	8.67	9.31	9.97	10.62	11.29	11.96	12.64	14.00	15.39	18.22	21.09	24.02
200	11.27	11.83	12.39	13.53	14.68	15.85	17.03	18.22	19.42	20.63	21.85	23.07	25.55	28.04	33.09	38.19	43.32
300	15.86	16.65	17.44	19.04	20.66	22.29	23.94	25.60	27.27	28.94	30.63	32.33	35.73	39.15	46.01	52.85	59.65
400	20.08	21.08	22.07	24.09	26.12	28.16	30.22	32.29	34.37	36.45	38.54	40.63	44.81	48.98	57.28	65.45	73.44
500	23.99	25.17	26.36	28.74	31.14	33.55	35.97	38.40	40.82	43.25	45.68	48.09	52.91	57.69	67.07	76.16	84.88
600	27.63	28.98	30.33	33.05	35.77	38.51	41.24	43.97	46.69	49.41	52.11	54.80	60.12	65.35	75.49	85.12	94.13
<b>700</b>	<b>31.02</b>	<b>32.52</b>	<b>34.03</b>	<b>37.04</b>	<b>40.05</b>	<b>43.06</b>	<b>46.06</b>	<b>49.05</b>	<b>52.02</b>	<b>54.97</b>	<b>57.90</b>	<b>60.79</b>	<b>66.49</b>	<b>72.03</b>	<b>82.61</b>	<b>92.39</b>	<b>101.28</b>
800	34.19	35.82	37.46	40.73	44.00	47.25	50.47	53.67	56.84	59.97	63.06	66.11	72.05	77.77	88.47	98.05	106.39
<b>950</b>	<b>38.54</b>	<b>40.36</b>	<b>42.16</b>	<b>45.76</b>	<b>49.33</b>	<b>52.86</b>	<b>56.35</b>	<b>59.78</b>	<b>63.16</b>	<b>66.47</b>	<b>69.71</b>	<b>72.87</b>	<b>78.96</b>	<b>84.70</b>	<b>95.01</b>	<b>103.62</b>	<b>110.36</b>
1000	39.90	41.76	43.62	47.31	50.96	54.57	58.12	61.61	65.03	68.37	71.64	74.82	80.89	86.57	96.61	104.72	110.73
1200	44.84	46.87	48.89	52.88	56.78	60.60	64.31	67.92	71.41	74.77	78.01	81.10	86.84	91.96	100.16	105.41	107.51
<b>1450</b>	<b>50.04</b>	<b>52.21</b>	<b>54.34</b>	<b>58.52</b>	<b>62.55</b>	<b>66.43</b>	<b>70.14</b>	<b>73.66</b>	<b>76.99</b>	<b>80.12</b>	<b>83.04</b>	<b>85.73</b>	<b>90.42</b>	<b>94.13</b>	<b>98.41</b>	<b>98.21</b>	
1600	52.67	54.87	57.04	61.25	65.26	69.07	72.66	76.02	79.12	81.97	84.55	86.85	90.58	93.08	94.18		
1800	55.63	57.84	60.01	64.15	68.03	71.63	74.94	77.93	80.59	82.92	84.89	86.49	88.56	89.03			
2000	57.99	60.17	62.27	66.24	69.86	73.13	76.01	78.49	80.55	82.17	83.35	84.06	84.03				
2200	59.79	61.88	63.87	67.55	70.80	73.60	75.91	77.73	79.02	79.78	79.97	79.60					

Width factor  $c_6$ 

Table 28

Belt width	mm	<b>40</b>	<b>55</b>	<b>85</b>	<b>115</b>	<b>170</b>		
Width factor $c_6$		1.00	1.44	2.31	3.18	4.78		

Standard widths are printed in bold type.

CONTI SYNCHROFORCE® CXA III Heavy-Duty Timing Belts

with STD toothed profile 8M; 20 mm belt width Power rating  $P_N$  in kW

Table 29

Speed of small toothed pulley $n_k$ rpm	No. of teeth of the small toothed pulley $z_k$																
	22	24	26	28	30	32	34	36	38	40	44	48	52	56	64	72	80
	Pitch diameter of toothed pulley $d_w$ (mm)																
	56.02	61.12	66.21	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	203.72
20	0.20	0.23	0.26	0.33	0.33	0.36	0.40	0.43	0.47	0.50	0.56	0.61	0.66	0.69	0.73	0.72	0.67
50	0.45	0.52	0.60	0.68	0.75	0.83	0.91	0.99	1.06	1.13	1.27	1.39	1.50	1.58	1.67	1.65	1.52
100	0.84	0.97	1.11	1.25	1.39	1.54	1.68	1.82	1.96	2.10	2.35	2.57	2.77	2.92	3.08	3.04	2.80
200	0.53	1.78	2.03	2.29	2.55	2.81	3.08	3.33	3.59	3.83	4.29	4.70	5.05	5.32	5.60	5.52	5.08
300	2.17	2.52	2.88	3.24	3.61	3.98	4.35	4.72	5.07	5.42	6.06	6.64	7.12	7.49	7.88	7.75	7.12
400	2.78	3.22	3.67	4.14	4.61	5.08	5.55	6.01	6.46	6.90	7.71	8.43	9.04	9.50	9.98	9.80	8.98
500	3.35	3.88	4.43	4.99	5.55	6.12	6.68	7.23	7.77	8.29	9.26	10.12	10.83	11.38	11.93	11.69	10.69
600	3.90	4.52	5.15	5.80	6.45	7.10	7.75	8.39	9.01	9.61	10.73	11.71	12.52	13.14	13.75	13.44	12.28
<b>700</b>	<b>4.43</b>	<b>5.12</b>	<b>5.84</b>	<b>6.57</b>	<b>7.31</b>	<b>8.05</b>	<b>8.78</b>	<b>9.49</b>	<b>10.19</b>	<b>10.87</b>	<b>12.12</b>	<b>13.22</b>	<b>14.12</b>	<b>14.81</b>	<b>15.45</b>	<b>15.08</b>	<b>13.74</b>
800	4.94	5.71	6.51	7.32	8.14	8.95	9.76	10.55	11.32	12.07	13.45	14.65	15.63	16.37	17.05	16.61	15.09
<b>950</b>	<b>5.67</b>	<b>6.55</b>	<b>7.46</b>	<b>8.39</b>	<b>9.32</b>	<b>10.25</b>	<b>11.16</b>	<b>12.06</b>	<b>12.93</b>	<b>13.77</b>	<b>15.32</b>	<b>16.66</b>	<b>17.76</b>	<b>18.57</b>	<b>19.27</b>	<b>18.70</b>	<b>16.94</b>
1000	5.90	6.83	7.77	8.73	9.70	10.66	11.61	12.54	13.45	14.31	15.92	17.30	18.43	19.26	19.97	19.35	17.51
1200	6.82	7.87	8.95	10.05	11.15	12.25	13.33	14.38	15.40	16.38	18.17	19.71	20.95	21.84	22.54	21.73	19.55
<b>1450</b>	<b>7.89</b>	<b>9.10</b>	<b>10.34</b>	<b>11.59</b>	<b>12.84</b>	<b>14.08</b>	<b>15.30</b>	<b>16.49</b>	<b>17.64</b>	<b>18.73</b>	<b>20.73</b>	<b>22.41</b>	<b>23.75</b>	<b>24.69</b>	<b>25.30</b>	<b>24.23</b>	<b>21.64</b>
1600	8.49	9.79	11.12	12.45	13.79	15.11	16.41	17.67	18.88	20.03	22.12	23.88	25.25	26.20	26.74	25.50	22.66
1800	9.27	10.68	12.11	13.55	14.99	16.40	17.79	19.13	20.42	21.64	23.85	25.68	27.08	28.01	28.43	26.93	23.76
2000	10.01	11.51	13.04	14.58	16.11	17.61	19.08	20.50	21.85	23.13	25.41	27.29	28.70	29.60	29.84	28.07	24.58
2200	10.71	12.31	13.93	15.55	17.16	18.74	20.28	21.76	23.16	24.49	26.83	28.73	30.12	30.97	31.01	28.95	25.13
2450	11.70	13.43	15.17	16.90	18.62	20.30	21.92	23.47	24.94	26.31	28.71	30.59	31.92	32.65	32.32		
<b>2850</b>	<b>12.77</b>	<b>14.62</b>	<b>16.49</b>	<b>18.34</b>	<b>20.15</b>	<b>21.92</b>	<b>23.61</b>	<b>25.22</b>	<b>26.73</b>	<b>28.12</b>	<b>30.52</b>	<b>32.33</b>	<b>33.52</b>	<b>34.05</b>			
3000	13.20	15.10	17.01	18.90	20.75	22.55	24.27	25.89	27.41	28.80	31.17	32.94	34.05				
3500	14.53	16.57	18.61	20.60	22.54	24.40	26.16	27.80	29.31	30.66	32.89	34.40					
4000	15.71	17.85	19.97	22.03	24.01	25.89	27.64	29.24	30.68	31.94							
4500	16.73	18.95	21.12	23.21	25.19	27.04	28.73	30.24	31.56								
5000	17.63	19.88	22.07	24.15	26.09	27.86	29.45										
6000	19.03	21.29	23.41	25.36													

Width factor  $c_6$

Table 30


Belt width	mm	<b>20</b>	<b>30</b>	40	<b>50</b>	65	<b>85</b>
Width factor $c_6$		1.00	1.58	2.16	2.73	3.60	4.76

Standard widths are printed in bold type.

## ContiTech Drive Design Service

Anyone planning to operate a complex drive system or series applications is recommended to seek advice from the application engineers of ContiTech Antriebssysteme GmbH. Computer-aided drive calculations are completed in close consultation with the customer in a competent and reliable way.

The example shows the printout for the calculation of a two-pulley drive with the data from the calculation example cited on page 27.

ContiTech Antriebssysteme GmbH The ContiTech Group of Continental AG		<b>CONTITECH</b> 	
Timing Belt Drive Design		5. February 2002 15:12:44	
Customer:	Test Ltd.	Address:	ContiTech
Reference:	packing machine	Phone:	+49 (0) 511-938-71
Remarks:	example	Fax:	+49 (0) 511-938-5237
Remarks:		Responsible:	application engineering
CONTI SYNCHROFORCE CXA III STD			
Belt Profile		PROF =	S8M
Tooth Pitch		T =	8 mm
Number of Teeth of Small Pulley		ZK =	29.00
Pitch Diameter of Small Pulley		DWK =	73.85 mm
Number of Teeth of Large Pulley		ZG =	40.00
Pitch Diameter of Large Pulley		DWG =	101.86 mm
Speed of Small Pulley		NK =	1450.00 1/min
Speed of Large Pulley		NG =	1051.25 1/min
Transmission Ratio		I =	1.38
Given Belt Pitch Length		LW =	1200.00 mm
Number of Teeth of Belt		Z =	150.00
Calculated Centre Distance		AER =	461.79 mm
Angle of Belt Wrap around the Small Pulley		BETA =	176.52 Grad
Number of Teeth in Mesh on Small Pulley		ZE =	14.22
Belt Speed		V =	5.61 m/s
Belt Flex Frequency		FB =	9.35 Hz
Service Factor		C0 =	2.00
Teeth in Mesh Factor		C1 =	1.00
Length Factor		C5 =	1.00
Power to be Transmitted		P =	6.000 kW
Calculated Belt Width		BER =	19.70 mm
Chosen Belt Width		B =	20.00 mm
Power Rating for Belt Width		PR =	12.21 kW
Calculated Service Factor		COER =	2.04
Effective Pull		FU =	1070.15 N
Static Belt Tension		FSTAT =	856.12 N
Total Axle Load		FV =	1711.46 N
Belt Tension Load Factor		k1 =	1.00
Belt Tension Service Factor		k2 =	1.60
Natural Frequency of Belt Span		EIF =	103 Hz
<b>Result:</b>			
<hr/>			
CONTI SYNCHROFORCE CXA III STD Timing Belt	1200	-	S8M - 20
Pulley	P 29	-	S8M - 20
Pulley	P 40	-	S8M - 20
<hr/>			
For questions relating liability we refer to our conditions of business.			

Computer printout for timing belt drive design

Fig. 3

#### Useful formulas

The following list contains formulas that are in common use, but that are not listed in the "Design data" section.

##### Torque M

P in kW  
n in min<sup>-1</sup>

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

F<sub>u</sub> in N  
d<sub>w</sub> in mm

$$M = \frac{F_u \cdot d_w}{2 \cdot 10^3} \quad \text{Nm}$$

##### Speed n

v in m/s

$$n = \frac{60 \cdot 10^3 \cdot v}{\pi \cdot d_w} \quad \text{min}^{-1}$$

##### Forces

##### Acceleration force F<sub>b</sub>

m in kg  
a<sub>b</sub> in m/s<sup>2</sup>

$$F_b = m \cdot a_b \quad \text{N}$$

##### Brake force F<sub>v</sub>

m in kg  
a<sub>v</sub> in m/s<sup>2</sup>

$$F_v = m \cdot a_v \quad \text{N}$$

##### Centrifugal force F<sub>z</sub>

m in kg  
v in m/s  
d<sub>w</sub> in mm

$$F_z = \frac{2 \cdot 10^3 \cdot m \cdot v^2}{d_w} \quad \text{N}$$

##### Effective pull F<sub>u</sub>

P in kW  
v in m/s

$$F_u = \frac{10^3 \cdot P}{v} \quad \text{N}$$

M in Nm  
d<sub>w</sub> in mm

$$F_u = \frac{2 \cdot 10^3 \cdot M}{d_w} \quad \text{N}$$

##### Power P

F<sub>u</sub> in N  
v in m/s

$$P = \frac{F_u \cdot v}{10^3} \quad \text{kW}$$

M in Nm  
n in min<sup>-1</sup>

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

##### Circumferential speed v

d<sub>w</sub> in mm  
n in min<sup>-1</sup>

$$v = \frac{\pi \cdot d_w \cdot n}{60 \cdot 10^3} \quad \text{m/s}$$

##### Pitch diameter of toothed pulley d<sub>w</sub>

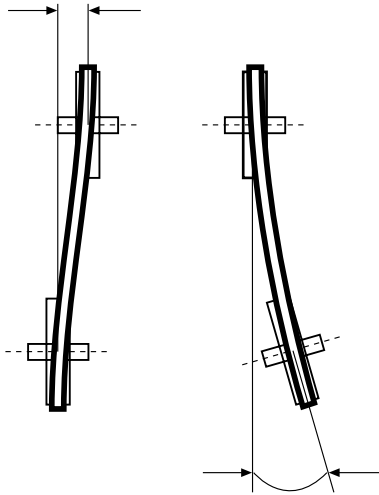
t in mm

$$d_w = \frac{t \cdot z}{\pi} \quad \text{mm}$$



## Installation instructions

Any out-of-parallel deviation = max. 0.5% of the centre distance



Any out-of-true angle = max. 0.25° per m of centre distance

The meticulous parallel alignment of the toothed pulleys is an essential precondition for straight belt running and a long service life of the drive. Excessive deviations in the pulley alignment result in an uneven distribution of tension in the belt cross-section and a belt drift towards a flange. This causes increased noise and premature belt wear.

Any out-of-parallel deviation of pulleys should not exceed 0.5% of the centre distance.

For larger centre distances, it must also be ensured that the belt does not run over the face of the toothed pulleys. Likewise, any out-of-true angle must not exceed a value equivalent to 0.25° per metre of centre distance.

It must be ensured that the centre distance cannot change while the drive is in operation and that the jumping of belt teeth over pulley teeth is not made possible by the resulting lower belt tension.

### Flanged Pulleys

Flanges are necessary to ensure the timing belt cannot slip off a pulley. In general the smaller pulley of the drive is provided with two flanges. It is sometimes useful to fit single flanges on alternate sides of consecutive pulleys. Flanges should be fitted on both sides of horizontal pulley arrangements.

### Tensioning Pulleys

Tensioning pulleys transmit no power within the drive system, but act to generate the required initial tension. Tensioning pulleys increase the flex frequency of the belt, and hence shorten its service life. So they should be avoided wherever possible.



Flanges attached on both sides

Depending on design requirements, the tensioning pulleys may be used on the inside or outside of the belt.

#### Inside tensioning pulleys

Inside tensioning pulleys are to be preferred to outside tensioning pulleys as they do not cause any unfavourable alternate bending. The inside tensioning pulley is invariably toothed and is to be positioned on the slack side as close as possible to the large pulley, so as not to unnecessarily reduce the arc of contact on the small pulley. The number of teeth of an inside tensioning pulley should at least equal the smallest possible section-related number of teeth. Plain inside tensioning pulleys may be used when the outside diameter  $\approx 2.5$ – $3.0$  times larger than the smallest permissible number of teeth of the selected section.



Small pulley with flanges on both sides

#### Outside tensioning pulleys

Outside tensioning pulleys cause the drive belt to counter-flex with an increase in the number of meshing teeth. The diameter of plain outside tensioning pulleys should be at least 1.5 times the diameter of the smallest pulley. Outside tensioning pulleys should in principle be positioned close to the small pulley.



Single flanges on alternate sides of consecutive pulleys

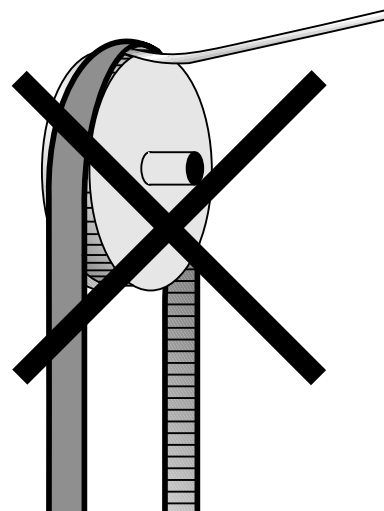
#### Deflection pulleys

The same guidelines apply as for the use of tensioning pulleys.

## Mounting

Timing belts must never be installed by using brute force or with the help of unsuitable tools such as tyre levers. When mounting the belt, the tensioning pulley is to be adjusted so that the belt can be placed on the pulleys without the use of force. For drives without tensioning pulleys, it must be possible to adjust the centre distance. General values on adjustment sizes are given in ISO 155.

The use of force can permanently impair the belt body in a way that is not necessarily visible. This can considerably reduce the useful service life.





**A**

Acceleration factor \_\_\_\_\_ 24, 27, 32  
 Axle load \_\_\_\_\_ 5, 26, 29

**B**

Belt speed \_\_\_\_\_ 4, 5, 6

Belt tension load factor \_\_\_\_ 33  
 Belt tension service factor \_ 33  
 Bending capacity \_\_\_\_\_ 5

**C**

Calculation documentation \_ 30–35  
 Calculation example \_\_\_\_\_ 27–29  
 Centre distance \_\_\_\_\_ 5, 25, 28  
 Circumferential speed \_\_\_\_ 5  
 Comparison  
 - of power transmitted \_\_\_\_ 5  
 - of service life \_\_\_\_\_ 5  
 - of sound pressure \_\_\_\_ 5  
 Construction \_\_\_\_\_ 4, 5

**D**

Design data \_\_\_\_\_ 24–26  
 Designation  
 - of timing belts \_\_\_\_\_ 6  
 - of toothed pulleys \_\_\_\_ 15  
 Drive data required \_\_\_\_\_ 24  
 Drives, fast running \_\_\_\_\_ 5

**E**

Effective pull, permissible \_ 35  
 Effective width \_\_\_\_\_ 25  
 Efficiency \_\_\_\_\_ 5

**F**

Fatigue factor \_\_\_\_\_ 24, 27, 32  
 Flanged pulleys \_\_\_\_\_ 14  
 Formulas, useful \_\_\_\_\_ 40  
 Free span length \_\_\_\_\_ 29, 35  
 Frequency measuring  
 method \_\_\_\_\_ 26, 29, 35

**H**

High Torque Drive HTD \_\_\_\_ 4, 6

**I**

Initial tension  
 checking the \_\_\_\_\_ 26, 29, 35  
 Installation Instructions \_\_\_\_ 41–43  
 Intermeshing width \_\_\_\_\_ 18, 19

**L**

Lateral runout tolerance \_\_\_\_ 20  
 Length factor \_\_\_\_\_ 25, 28, 33  
 Length measurement \_\_\_\_ 11  
 Lengths, available \_\_\_\_\_ 7–10  
 Load factor \_\_\_\_\_ 24, 27, 31

**M**

Maintenance \_\_\_\_\_ 5  
 Materials for  
 toothed pulleys \_\_\_\_\_ 14  
 Measuring forces \_\_\_\_\_ 11

**N**

Natural frequency \_\_\_\_\_ 34  
 Number of teeth  
 - of toothed pulleys \_\_\_\_ 24, 27  
 - meshing \_\_\_\_\_ 25, 30

**O**

Oil-resistant, moderately \_\_\_\_ 5  
 Operating conditions \_\_\_\_\_ 30, 32  
 Outside diameter \_\_\_\_\_ 15, 16 19  
 Outside diameter  
 tolerance \_\_\_\_\_ 20  
 Ozone-resistant,  
 moderately \_\_\_\_\_ 5

**P**

Parallelism \_\_\_\_\_ 20  
 Permissible effective pull \_\_\_\_ 35  
 Pitch diameter of  
 toothed pulleys \_\_\_\_\_ 15, 16–19,  
 24, 27  
 Pitch length of belts \_\_\_\_\_ 5, 7–10,  
 27  
 Positive engagement \_\_\_\_\_ 5  
 Power rating \_\_\_\_\_ 25, 36–38  
 Power transmitted,  
 comparison of \_\_\_\_\_ 5  
 Product range of  
 timing belts \_\_\_\_\_ 6, 10  
 Properties \_\_\_\_\_ 5  
 Pulley diameter \_\_\_\_\_ 15, 19

**Q**

Quiet running \_\_\_\_\_ 4, 5, 6

**R**

Radial runout tolerance \_\_\_\_ 20  
 Resistance \_\_\_\_\_ 5  
 Retensioning \_\_\_\_\_ 5  
 Running noise \_\_\_\_\_ 5

**S**

Selection diagram \_\_\_\_\_ 34  
 Service factor, total \_\_\_\_\_ 26, 30  
 Service life, comparison of \_ 5  
 Slipping off at side \_\_\_\_\_ 14  
 Smooth running \_\_\_\_\_ 6  
 Sound pressure,  
 comparison of \_\_\_\_\_ 5  
 Specific weight of belt \_\_\_\_ 29  
 Standard lengths \_\_\_\_\_ 7–10  
 Standard toothed pulleys \_ 5, 14, 18,  
 19  
 Standard widths  
 - of timing belts \_\_\_\_\_ 7–10  
 - of toothed pulleys \_\_\_\_ 18, 19

Static belt tension \_\_\_\_\_ 26, 29  
 Strength \_\_\_\_\_ 4  
 Super Torque Drive – STD \_ 4, 6  
 Symbols \_\_\_\_\_ 22, 23

**T**

Taper \_\_\_\_\_ 20  
 Teeth in mesh factor \_\_\_\_ 25, 28, 30  
 Temperature range- \_\_\_\_\_ 5  
 Terms \_\_\_\_\_ 22, 23  
 Thickness tolerance \_\_\_\_\_ 12  
 Timing belt  
 - characteristic values \_\_\_\_ 34  
 - construction \_\_\_\_\_ 4  
 - designation \_\_\_\_\_ 6  
 - effective width \_\_\_\_\_ 23  
 - free span frequency \_\_\_\_ 34  
 - initial tension \_\_\_\_\_ 26  
 - length \_\_\_\_\_ 25, 27  
 - pitch \_\_\_\_\_ 6, 24  
 - standard lengths \_\_\_\_\_ 7–10  
 - weight \_\_\_\_\_ 34  
 - width \_\_\_\_\_ 6, 7–10,  
 25, 28

**Tolerance**

- belt length \_\_\_\_\_ 11  
 - belt thickness \_\_\_\_\_ 12  
 - belt width \_\_\_\_\_ 12  
 - lateral runout \_\_\_\_\_ 20  
 - outside diameter \_\_\_\_\_ 20  
 - radial runout \_\_\_\_\_ 20  
 Tooth meshing \_\_\_\_\_ 4, 6  
 Tooth pitch \_\_\_\_\_ 6  
 Tooth profile \_\_\_\_\_ 4, 8

**Toothed pulleys**

- designation \_\_\_\_\_ 15  
 - diameter \_\_\_\_\_ 15  
 - materials \_\_\_\_\_ 14  
 - number of teeth \_\_\_\_\_ 15, 24  
 - pitch diameter \_\_\_\_\_ 24, 27  
 - standard range \_\_\_\_\_ 18, 19  
 - tolerances \_\_\_\_\_ 20  
 - widths \_\_\_\_\_ 18, 19  
 Torque, high \_\_\_\_\_ 4  
 Total axle load \_\_\_\_\_ 5, 26, 29  
 Total service factor \_\_\_\_\_ 24, 26,  
 27, 30  
 Transmission ratio \_\_\_\_\_ 5, 27, 32  
 Tropics suitability \_\_\_\_\_ 5

**U**

Units \_\_\_\_\_ 22, 23

**W**

Weathering influences \_\_\_\_ 5  
 Weight, timing belt \_\_\_\_\_ 34  
 Width  
 - of timing belts \_\_\_\_\_ 25, 28  
 - of toothed pulleys \_\_\_\_ 15, 18, 19  
 Width factor \_\_\_\_\_ 28, 33  
 Width tolerance \_\_\_\_\_ 12

ContiTech Antriebssysteme GmbH  
Postfach 445, D-30004 Hannover  
Philipsbornstraße 1, D-30165 Hannover  
Phone + 49 (0) 511 / 9 38-71  
Fax + 49 (0) 511 / 9 38-52 37  
E-Mail: [industrie.as@antriebssysteme.contitech.de](mailto:industrie.as@antriebssysteme.contitech.de)  
[www.contitech.de/antriebssysteme](http://www.contitech.de/antriebssysteme)

ContiTech Antriebssysteme GmbH  
Continentalstraße 1, D-29451 Dannenberg  
Phone +49 (0) 58 61 / 8 06-0  
Fax + 49 (0) 58 61 / 8 06-302  
E-Mail: [dannenberg@antriebssysteme.contitech.de](mailto:dannenberg@antriebssysteme.contitech.de)

The contents of this publication are the result of many years of research and experience gained in application technology. All information is given in good faith; it does not represent a guarantee with respect to characteristics and does not exempt the user from testing the suitability of products and from ascertaining that the industrial property rights of third parties are not violated. No liability whatsoever will be accepted for damage – regardless of its nature and its legal basis – arising from advice given in this pub-

lication. This does not apply in the event that we or our legal representatives or management are found guilty of having acted with intent or gross negligence. No liability is borne for damage due to ordinary negligence. This exclusion of liability applies also to the personal liability of our legal representatives and employees and other persons employed in performing our obligations.  
©2002 by ContiTech Holding GmbH, Hannover.  
All rights reserved.