

# CONTI® SYNCHRODRIVE

## Polyurethane Synchronous Drive Belts



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# CONTI® SYNCHRODRIVE Synchronous Drive Belts

Properties / Construction / Designation / Product range / Tolerances





# CONTI® SYNCHRODRIVE Synchronous Drive Belts

## CONTI® SYNCHRODRIVE Belts for synchronous transmission of rotary and linear motion

CONTI® SYNCHRODRIVE belts are power transmission products made from a highly durable polyurethane elastomer incorporating a steel-cord tension member. They are manufactured precisely to length using a newly developed production technique.

CONTI® SYNCHRODRIVE belts can be used in the open-ended or endless form. In all cases, they ensure that rotary motion is transmitted uniformly and with angular precision. CONTI® SYNCHRODRIVE belts permit low-cost drive designs, even where difficult operating conditions have to be taken into account. Their properties provide a highly reliable, maintenance-free solution to even the most demanding drive problems.

CONTI® SYNCHRODRIVE belts are available in 10 tooth profiles and several standard widths, covering a host of different applications involving various loads and service conditions. They are ideal for drives with a large center distance, for synchronous conveyor systems and transport devices with sliding rails as well as for positioning and reversing drives in linear and control engineering. Modern production techniques and rigorous in-process quality controls guarantee products with maximum reliability and a consistently high standard of quality.

### Properties

#### Precise synchronism due to positive engagement

The belt teeth mesh with those of the pulley in the same manner as the teeth on a gear. This positive drive principle provides synchronous operation and eliminates speed variation.

#### A variety of possible applications at low design cost

CONTI® SYNCHRODRIVE belts can be used as synchronous drive or transport belts in either the open-ended or endless version. For special applications, CONTI® SYNCHRODRIVE belts can have heavy-duty profiles welded to them for indexing and conveying applications. As open-ended drive components, CONTI® SYNCHRODRIVE belts are ideal for linear and control drives that have to transmit rotary motion with repeat accuracy and multiple positioning control.

#### Low loads on shafts and bearings

The tooth grip principle requires only low initial belt tensioning. Thus the load on shafts and bearings is kept to a minimum.

#### Compact drive design

High dynamic stability and flexibility allows the use of small pulley diameters, low center distances, and belt-back idlers. This enables a lightweight, low-cost drive setup with less space requirement.

#### No maintenance

CONTI® SYNCHRODRIVE belts are maintenance-free; no lubrication or retensioning is required. Constant belt tension is guaranteed by the use of a high-strength steel-cord tension member.

#### High efficiency

The superb flexural properties of the synchronous drive belt as well as the exact dimensional mating of the belt and pulley tooth contours permit drives with an efficiency of 98%.

CONTI® SYNCHRODRIVE belts are resistant to

- wear
- oil and grease
- petrol and benzene
- hydrolysis
- UV and ozone
- temperatures ranging from – 30 °C to 80 °C (for operational temperatures outside –10 °C to 50 °C please seek advice from your Mulco sales partner)
- can be bonded to thermoplastics

## Belt versions

CONTI® SYNCHRODRIVE belts are supplied in the following versions:

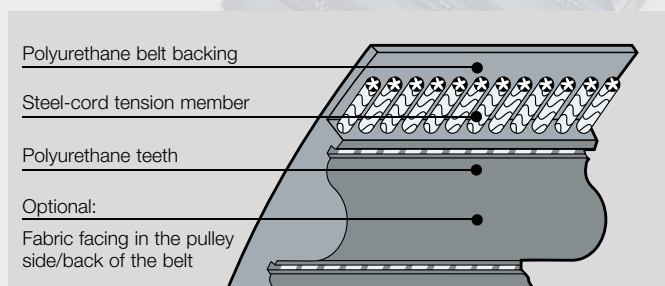
- |   |  |
|---|--|
| <p><b>HF</b>    <span style="color: orange;">▶</span> high flexibility version<br/>all profiles except for 3 mm pitch<br/>e.g. for drives with small pulley diameters.</p> <p><b>HP</b>    <span style="color: orange;">▶</span> high power reinforced version<br/>HTD and STD profiles, e.g. for heavy-duty control systems.</p> <p><b>HS</b>    <span style="color: orange;">▶</span> high stiffness of tension member<br/>HTD and STD profiles, e.g. for high-precision linear drives.</p> | <p><b>XHP</b>    <span style="color: orange;">▶</span> extremely high power tensile-strength<br/>HTD 14M profile, e.g. for lifting systems.</p> <p><b>PAZ</b>    <span style="color: orange;">▶</span> with polyamide fabric facing on the teeth side<br/>e.g. for sliding-rail transport systems.<br/>Antistatic <b>aPAZ</b> version on request.</p> <p><b>PAR</b>    <span style="color: orange;">▶</span> with polyamide fabric facing on the back of the belt e.g. for skid-queuing conveyors.<br/>Antistatic <b>aPAR</b> version on request.</p> <p><b>V</b>        <span style="color: orange;">▶</span> endless belt in HF version and lengths from 1000 mm, all profiles except for 3 mm pitch<br/>e.g. for rotary drives with large center distances.</p> |
|---|--|

Other special versions, e. g. aramid tension member, can be supplied on request.

## Construction

Our synchronous drive belts are made up of:

- ▶ polyurethane teeth and back, color: black
- ▶ steel-cord tension member, with balanced right/left-handed cord twist



### Polyurethane teeth and back

Belt teeth and back are made from a tough polyurethane elastomer with excellent adhesion to the tension member. The high wear resistance of the polyurethane ensures trouble-free drive performance and a long service life. These features are enhanced even more by the balanced layout of the tension cords.

### Steel-cord tension member

Synchronous drive belts for positive drive systems must have a high resistance to elongation and a high tensile strength. Extra-strong steel tension cords, laid parallel to the belt edges, guarantee the belt's high loading capacity and accurate running properties.

# CONTI® SYNCHRODRIVE Synchronous Drive Belts

## Designation

CONTI® SYNCHRODRIVE synchronous drive belts are specified in accordance with defined standards for the different belt types showing the pitch length, tooth pitch and belt width, plus a code for the belt version, see page 5.

- Pitch length in m  
The pitch length of the belt is the overall circumference, or length measured at the neutral pitch line. The pitch length is located in the middle of the tension member.
- Tooth pitch in mm  
The tooth pitch is the linear distance between two adjacent teeth at the pitch line.
- Belt width in mm  
The belt width and width designation are identical.

### Examples:

CONTI® SYNCHRODRIVE HTD drive belts  
M 30-8M-50 HP

|    |                                |
|----|--------------------------------|
| M  | open-ended type                |
| 30 | pitch length 30 m              |
| 8M | tooth pitch 8 mm , HTD profile |
| 50 | belt width 50 mm               |
| HP | reinforced version             |

CONTI® SYNCHRODRIVE STD drive belts  
V 2400-S 5M-30 HF

|      |                               |
|------|-------------------------------|
| V    | endless type                  |
| 2400 | belt length 2400 mm           |
| S 5M | tooth pitch 5 mm, STD profile |
| 30   | belt width 30 mm              |
| HF   | flexible version              |

The number of teeth is a function of pitch length and pitch:

$$z = \frac{L_w}{t}$$

## Product range

### Profiles

CONTI® SYNCHRODRIVE synchronous drive belts are manufactured in 10 profile sizes. Dimensions of HTD and STD synchronous drive belts correspond to the specifications laid down in ISO/F DIS 13050 (draft version). Table 1 on page 7 gives a summary of the profile dimensions as well as other technical information for the belts we supply. Special pulleys must be used for linear drives with high precision requirements. More information about pulleys is given in section 2 on “Pulleys” which starts on page 10.

### Lengths

CONTI® SYNCHRODRIVE synchronous drive belts are available in either the open-ended or endless version.

### Widths

CONTI® SYNCHRODRIVE synchronous drive belts are supplied in several standard widths. Dimensions are given in Table 2 on page 7. Other widths are available on request.

### Versions

CONTI® SYNCHRODRIVE synchronous drive belts made from polyurethane with steel cords aligned parallel to the belt edges are precision-made components for applications in drive and transportation engineering. Several versions are available to meet various operating requirements. More details are given on page 4 under “Properties”.

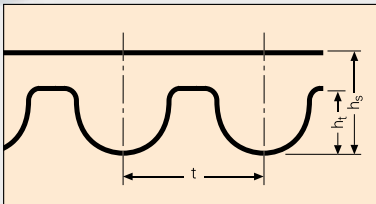
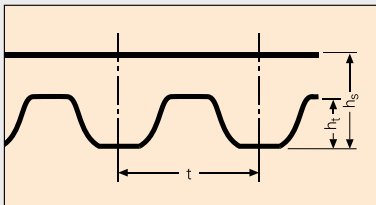


Fig. 1

Tooth profile  
HTD 3M, HTD 5M,  
HTD 8M, HTD 14M



Tooth profile  
STD S 5M, STD S 8M,  
STD S 3M on request

| Table 1 Specifications                 |                |          |      |      |       |      |      |      |
|--|----------------|----------|------|------|-------|------|------|------|
| Tooth profile                          |                | HTD      |      |      |       | STD  |      |      |
|  |                | 3M       | 5M   | 8M   | 14 M  | S 3M | S 5M | S 8M |
| Tooth pitch t                          | mm             | 3,00     | 5,00 | 8,00 | 14,00 | 3,00 | 5,00 | 8,00 |
| Belt thickness $h_s$                   | mm             | 2,40     | 3,60 | 5,60 | 10,00 | 2,30 | 3,40 | 5,20 |
| Tooth height $h_t$                     | mm             | 1,30     | 2,10 | 3,40 | 6,10  | 1,14 | 1,90 | 3,00 |
| Weight $m_{spez}$ per mm of belt width |                |          |      |      |       |      |      |      |
| Type HF                                | $10^{-3}$ kg/m |          | 3,36 | 5,40 | 10,37 |      | 3,21 | 5,24 |
| Type HP                                | $10^{-3}$ kg/m | 3,15     | 4,06 | 6,32 | 11,27 | 3,08 | 3,91 | 6,22 |
| Type HS                                | $10^{-3}$ kg/m |          |      | 7,22 | 11,40 |      | 4,64 | 7,12 |
| Type XHP                               | $10^{-3}$ kg/m |          |      |      | 14,00 |      |      |      |
| Standard lengths                       |                |          |      |      |       |      |      |      |
| Type M $L_w$                           | m              | 30 or 60 |      |      |       |      |      |      |

| Table 2 Belt width – b in mm |     |    |     |       |      |      |      |
|------------------------------|-----|----|-----|-------|------|------|------|
| Tooth profile                | HTD |    |     |       | STD  |      |      |
|                              | 3M  | 5M | 8M  | 14M   | S 3M | S 5M | S 8M |
|                              | 5   | 5  |     |       | 5    | 5    |      |
|                              | 10  | 10 | 10  |       | 10   | 10   | 10   |
|                              | 15  | 15 | 15  |       | 15   | 15   | 15   |
|                              |     |    | 20  |       |      |      | 20   |
|                              | 25  | 25 |     | 25    | 25   | 25   |      |
|                              |     |    | 30  |       |      |      | 30   |
|                              |     |    |     | 40    |      |      |      |
|                              | 50  | 50 | 50  | 50/55 | 50   | 50   | 50   |
|                              |     |    | 85  | 85    |      |      | 85   |
|                              |     |    | 100 | 100   |      |      | 100  |
|                              |     |    |     | 115   |      |      |      |
|                              |     |    |     | 120   |      |      |      |
|                              |     |    |     | 150   |      |      |      |

Other intermediate widths on request.

# CONTI® SYNCHRODRIVE Synchronous Drive Belts

## Tolerances

CONTI® SYNCHRODRIVE synchronous drive belts are precision-made products. Manufacturing involves reliable process techniques and maximum accuracy throughout all stages. Deviations in length, width and thickness are subject to extremely tight tolerances.

| Table 3 Belt length tolerances |                    |
|--------------------------------|--------------------|
| Pitch length $L_w$ mm          | Length tolerance % |
| $L_w$                          | $\pm 0,1$          |

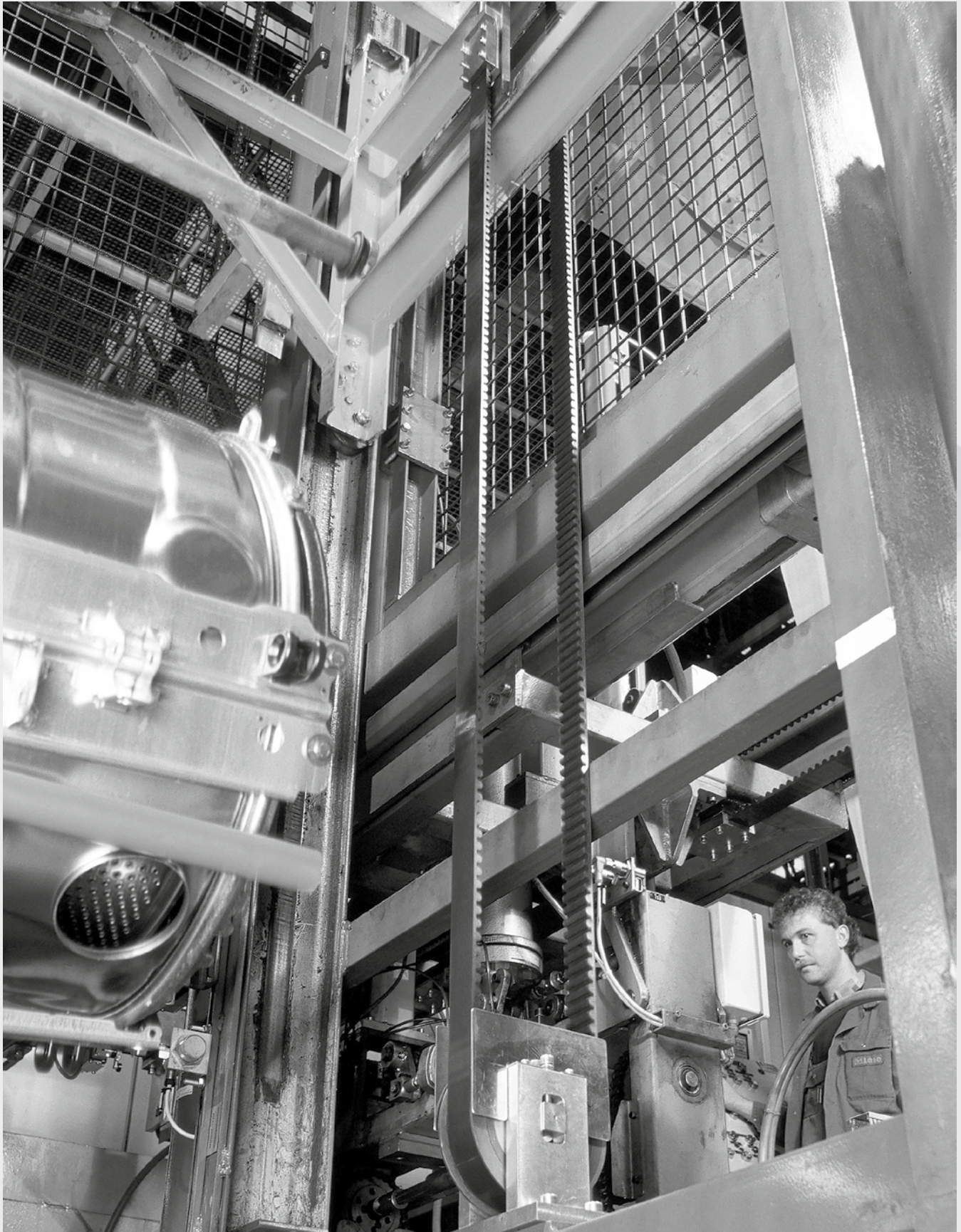
| Table 4 Belt width tolerances |             |           |           |           |           |           |           |           |
|-------------------------------|-------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Tooth profile                 |             | HTD       |           |           |           | STD       |           |           |
|                               |             | 3M        | 5M        | 8M        | 14 M      | S 3M      | S 5M      | S 8M      |
| Belt width b                  | up to 25 mm | $\pm 0,5$ | $\pm 0,5$ | $\pm 0,6$ | $\pm 0,6$ | $\pm 0,5$ | $\pm 0,5$ | $\pm 0,6$ |
|                               | > 25-50 mm  | $\pm 0,6$ | $\pm 0,6$ | $\pm 0,7$ | $\pm 1,0$ | $\pm 0,6$ | $\pm 0,6$ | $\pm 0,7$ |
|                               | > 50 mm     |           |           | $\pm 0,8$ | $\pm 1,2$ |           |           | $\pm 0,8$ |

| Table 5 Belt thickness tolerances (Type M) |    |            |            |           |           |            |            |           |
|--|----|------------|------------|-----------|-----------|------------|------------|-----------|
| Tooth profile                              |    | HTD        |            |           |           | STD        |            |           |
|  |    | 3M         | 5M         | 8M        | 14 M      | S 3M       | S 5M       | S 8M      |
| Belt thickness $h_s$                       | mm | 2,4        | 3,6        | 5,6       | 10        | 2,3        | 3,4        | 5,2       |
| Thickness tolerance                        | mm | $\pm 0,25$ | $\pm 0,25$ | $\pm 0,4$ | $\pm 0,6$ | $\pm 0,25$ | $\pm 0,25$ | $\pm 0,4$ |



# Pulleys

Designation / Minimum number of teeth / Diameters / Tolerances / Clamping length



# Pulleys

## Pulleys

Precise belt/pulley conformance is vital to ensure accurate power transmission as well as smooth operation and a long service life for synchronous belt drives. ContiTech engineers have modified pulley tooth-gap profiles so that they conform ideally to the respective belt profiles. Use of these optimized pulleys is recommended especially for CONTI® SYNCHRODRIVE HTD belts.

Pulleys with optimized profiles are obtainable from your Mulco sales partner. Linear drives with demanding positioning requirements need pulleys with minimized gap clearance. If you are planning a special drive design, please consult our application engineers for advice.

### Designation

Pulleys for CONTI® SYNCHRODRIVE belt drives are identified in accordance with the standards defined for the various belt types by their number of teeth, tooth pitch and pulley width, as well as a code denoting the type of pulley.

- ▶ **P**  
General designation for toothed pulleys.
- ▶ **Number of teeth**  
The pulley's number of teeth is calculated from the pitch circumference and the pitch:

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

- ▶ **Tooth pitch in mm**  
The tooth pitch of the pulley is the distance between two reference points on adjacent teeth at the circumference of the pitch diameter. The pitch diameter is larger than the outside diameter of the pulley by double the thickness at which the pitch line of belt rides above the pulley.

- ▶ **Pulley width in mm**  
The width designation defines the exact width of the corresponding synchronous drive belt, and not that of the pulley.
- ▶ **Flanged pulley data**  
F stands for pulleys that are flanged on both sides. Flanged pulleys prevent the belt from riding off. At least one pulley with two flanges must be used and generally, for economy, the smaller pulley of a drive is the flanged pulley. It is also possible to provide each pulley with one flange on alternate sides.

| Examples:                     |  |
|-------------------------------|--|
| HTD Pulley – P 36 – 8M – 40   |  |
| P                             | Designation for toothed pulley                             |
| 36                            | 36 teeth   |
| 8M                            | 8 mm tooth pitch, HTD profile                              |
| 40                            | Pulley designation for a 40 mm wide synchronous drive belt |
| STD Pulley – P 48 – S 5M – 30 |  |
| P                             | Designation for toothed pulley                             |
| 48                            | 48 teeth   |
| S 5M                          | 5mm tooth pitch, STD profile                               |
| 30                            | Pulley designation for a 30 mm wide synchronous drive belt |



## Minimum number of teeth

Drives fitted with CONTI® SYNCHRODRIVE synchronous drive belts should have pulleys that meet the specified minimum number of teeth. Table 6 shows the minimum number of teeth  $z_{\min}$  and the minimum pitch diameter  $d_{w \min}$  for pulleys as well as the minimum diameter  $d_{\min}$  for inside and outside idlers that are to be considered when designing a drive. Inside idlers should be toothed pulleys.

| Table 6 Minimum number of teeth / - $z_{\min}$ |     |         |    |       |       |        |        |       |       |        |
|--|-----|---------|----|-------|-------|--------|--------|-------|-------|--------|
| Tooth profile                                  |     |         |    | HTD   |       |        |        | STD   |       |        |
|  |     |         |    | 3M    | 5M    | 8M     | 14M    | S 3M  | S 5M  | S 8M   |
| Minimum number of teeth $z_{\min}$             |     |         |    |       |       |        |        |       |       |        |
| Type   | HF  |         |    |       | 12    | 16     | 18     |       | 12    | 16     |
|  | HP  |         |    | 20    | 16    | 20     | 26     | 20    | 16    | 20     |
|  | HS  |         |    |       |       | 28     | 30     |       | 24    | 28     |
|  | XHP |         |    |       |       |        | 34     |       |       |        |
| Minimum pitch Ø $d_{w \min}$                   |     |         |    |       |       |        |        |       |       |        |
| Type   | HF  |         | mm |       | 19,10 | 40,74  | 80,21  |       | 19,10 | 40,74  |
|  | HP  |         | mm | 19,10 | 25,46 | 50,93  | 115,86 | 19,10 | 25,46 | 50,93  |
|  | HS  |         | mm |       |       | 71,30  | 133,69 |       | 38,20 | 71,30  |
|  | XHP |         | mm |       |       |        | 151,52 |       |       |        |
| Minimum Ø of idler $d_{\min}$                  |     |         |    |       |       |        |        |       |       |        |
| Type   | HF  | inside  | mm |       | 19,10 | 40,74  | 80,21  |       | 19,10 | 40,74  |
|  |     | outside | mm |       | 30,00 | 60,00  | 120,00 |       | 30,00 | 60,00  |
|  | HP  | inside  | mm | 19,10 | 25,46 | 50,93  | 115,86 | 19,10 | 25,46 | 50,93  |
|  |     | outside | mm | 30,00 | 50,00 | 100,00 | 160,00 | 30,00 | 50,00 | 100,00 |
|  | HS  | inside  | mm |       |       | 71,30  | 133,69 |       | 44,56 | 71,30  |
|  |     | outside | mm |       |       | 120,00 | 180,00 |       | 80,00 | 120,00 |
|  | XHP | inside  | mm |       |       |        | 151,52 |       |       |        |
|  |     | outside | mm |       |       |        | 200,00 |       |       |        |

Minimum diameter Belt version V with omega pulley configuration: please call for technical support.

# Pulleys

## Diameters

Number of teeth, pitch and outside diameter of pulleys for drives fitted with CONTI® SYNCHRODRIVE belts are contained in Tables 7 to 13 (pages 12 to 15).

| Table 7 Pulleys for CONTI® SYNCHRODRIVE HTD synchronous drive belts<br>3 mm tooth pitch, 3M profile (measurement in mm) |                                  |                                    |                      |                                  |                                    |                      |                                  |                                    |                      |                                  |                                    |
|---|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|
| Number of teeth<br>z  | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of Teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of Teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> |
| 20  | 19,10                            | 18,34                              | 35                   | 33,42                            | 32,66                              | 50                   | 47,75                            | 46,99                              | 65                   | 62,07                            | 61,31                              |
| 21  | 20,05                            | 19,29                              | 36                   | 34,38                            | 33,62                              | 51                   | 48,70                            | 47,94                              | 66                   | 63,03                            | 62,27                              |
| 22  | 21,01                            | 20,25                              | 37                   | 35,33                            | 34,57                              | 52                   | 49,66                            | 48,90                              | 67                   | 63,98                            | 63,22                              |
| 23  | 21,96                            | 21,20                              | 38                   | 36,29                            | 35,53                              | 53                   | 50,61                            | 49,85                              | 68                   | 64,94                            | 64,18                              |
| 24  | 22,92                            | 22,16                              | 39                   | 37,24                            | 36,48                              | 54                   | 51,57                            | 50,81                              | 69                   | 65,89                            | 65,13                              |
| 25  | 23,87                            | 23,11                              | 40                   | 38,20                            | 37,44                              | 55                   | 52,52                            | 51,75                              | 70                   | 66,85                            | 66,09                              |
| 26  | 24,83                            | 24,07                              | 41                   | 39,15                            | 38,39                              | 56                   | 53,48                            | 52,72                              | 71                   | 67,80                            | 67,04                              |
| 27  | 25,78                            | 25,02                              | 42                   | 40,11                            | 39,35                              | 57                   | 54,43                            | 53,67                              | 72                   | 68,75                            | 67,99                              |
| 28  | 26,74                            | 25,98                              | 43                   | 41,06                            | 40,30                              | 58                   | 55,39                            | 54,63                              |                      |                                  |                                    |
| 29  | 27,69                            | 26,93                              | 44                   | 42,02                            | 41,26                              | 59                   | 56,34                            | 55,58                              |                      |                                  |                                    |
| 30  | 28,65                            | 27,89                              | 45                   | 42,97                            | 42,21                              | 60                   | 57,30                            | 56,54                              |                      |                                  |                                    |
| 31  | 29,60                            | 28,84                              | 46                   | 43,93                            | 43,17                              | 61                   | 58,25                            | 57,49                              |                      |                                  |                                    |
| 32  | 30,56                            | 29,80                              | 47                   | 44,88                            | 44,12                              | 62                   | 59,21                            | 58,45                              |                      |                                  |                                    |
| 33  | 31,51                            | 30,75                              | 48                   | 45,84                            | 45,08                              | 63                   | 60,16                            | 59,40                              |                      |                                  |                                    |
| 34  | 32,47                            | 31,71                              | 49                   | 46,79                            | 46,03                              | 64                   | 61,12                            | 60,36                              |                      |                                  |                                    |

| Table 8 Pulleys for CONTI® SYNCHRODRIVE HTD synchronous drive belts<br>5 mm tooth pitch, 5M profile (measurement in mm) |                                  |                                    |                      |                                  |                                    |                      |                                  |                                    |                      |                                  |                                    |
|---|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|
| Number of teeth<br>z  | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> |
| 12  | 19,10                            | 17,96                              | 28                   | 44,56                            | 43,42                              | 44                   | 70,03                            | 68,89                              | 60                   | 95,49                            | 94,35                              |
| 13  | 20,69                            | 19,55                              | 29                   | 46,15                            | 45,01                              | 45                   | 71,62                            | 70,48                              | 61                   | 97,08                            | 95,94                              |
| 14  | 22,28                            | 21,14                              | 30                   | 47,75                            | 46,61                              | 46                   | 73,21                            | 72,07                              | 62                   | 98,68                            | 97,54                              |
| 15  | 23,87                            | 22,73                              | 31                   | 49,34                            | 48,20                              | 47                   | 74,80                            | 73,66                              | 63                   | 100,27                           | 99,13                              |
| 16  | 25,46                            | 24,32                              | 32                   | 50,93                            | 49,79                              | 48                   | 76,39                            | 75,25                              | 64                   | 101,86                           | 100,72                             |
| 17  | 27,06                            | 25,92                              | 33                   | 52,52                            | 51,38                              | 49                   | 77,99                            | 76,85                              | 65                   | 103,45                           | 102,31                             |
| 18  | 28,65                            | 27,51                              | 34                   | 54,11                            | 52,97                              | 50                   | 79,58                            | 78,44                              | 66                   | 105,04                           | 103,90                             |
| 19  | 30,24                            | 29,10                              | 35                   | 55,70                            | 54,56                              | 51                   | 81,17                            | 80,03                              | 67                   | 106,63                           | 105,49                             |
| 20  | 31,83                            | 30,69                              | 36                   | 57,30                            | 56,16                              | 52                   | 82,76                            | 81,62                              | 68                   | 108,23                           | 107,09                             |
| 21  | 33,42                            | 32,28                              | 37                   | 58,89                            | 57,75                              | 53                   | 84,35                            | 83,21                              | 69                   | 109,82                           | 108,68                             |
| 22  | 35,01                            | 33,87                              | 38                   | 60,48                            | 59,34                              | 54                   | 85,94                            | 84,80                              | 70                   | 111,41                           | 110,27                             |
| 23  | 36,61                            | 35,47                              | 39                   | 62,07                            | 60,93                              | 55                   | 87,54                            | 86,40                              | 71                   | 113,00                           | 111,86                             |
| 24  | 38,20                            | 37,06                              | 40                   | 63,66                            | 62,52                              | 56                   | 89,13                            | 87,99                              | 72                   | 114,59                           | 113,45                             |
| 25  | 39,79                            | 38,65                              | 41                   | 65,25                            | 64,11                              | 57                   | 90,72                            | 89,58                              |                      |                                  |                                    |
| 26  | 41,38                            | 40,24                              | 42                   | 66,85                            | 65,71                              | 58                   | 92,31                            | 91,17                              |                      |                                  |                                    |
| 27  | 42,97                            | 41,83                              | 43                   | 68,44                            | 67,30                              | 59                   | 93,90                            | 92,76                              |                      |                                  |                                    |



**Table 9** Pulleys for CONTI® SYNCHRODRIVE HTD synchronous drive belts  
8 mm tooth pitch, 8M profile (measurement in mm)

| Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> |
|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|
| 16                   | 40,74                            | 39,37                              | 31                   | 78,94                            | 77,57                              | 46                   | 117,14                           | 115,77                             | 61                   | 155,34                           | 153,97                             |
| 17                   | 43,29                            | 41,92                              | 32                   | 81,49                            | 80,12                              | 47                   | 119,68                           | 118,31                             | 62                   | 157,88                           | 156,51                             |
| 18                   | 45,84                            | 44,47                              | 33                   | 84,03                            | 82,66                              | 48                   | 122,23                           | 120,86                             | 63                   | 160,43                           | 159,06                             |
| 19                   | 48,38                            | 47,01                              | 34                   | 86,58                            | 85,21                              | 49                   | 124,78                           | 123,41                             | 64                   | 162,97                           | 161,60                             |
| 20                   | 50,93                            | 49,56                              | 35                   | 89,13                            | 87,76                              | 50                   | 127,32                           | 125,95                             | 65                   | 165,52                           | 164,15                             |
| 21                   | 53,48                            | 52,11                              | 36                   | 91,67                            | 90,30                              | 51                   | 129,87                           | 128,50                             | 66                   | 168,07                           | 166,70                             |
| 22                   | 56,02                            | 54,65                              | 37                   | 94,22                            | 92,85                              | 52                   | 132,42                           | 131,05                             | 67                   | 170,61                           | 169,24                             |
| 23                   | 58,57                            | 57,20                              | 38                   | 96,77                            | 95,40                              | 53                   | 134,96                           | 133,59                             | 68                   | 173,16                           | 171,79                             |
| 24                   | 61,12                            | 59,75                              | 39                   | 99,31                            | 97,94                              | 54                   | 137,51                           | 136,14                             | 69                   | 175,71                           | 174,34                             |
| 25                   | 63,66                            | 62,29                              | 40                   | 101,86                           | 100,49                             | 55                   | 140,06                           | 138,69                             | 70                   | 178,25                           | 176,88                             |
| 26                   | 66,21                            | 64,84                              | 41                   | 104,41                           | 103,04                             | 56                   | 142,60                           | 141,23                             | 71                   | 180,80                           | 179,43                             |
| 27                   | 68,75                            | 67,38                              | 42                   | 106,95                           | 105,58                             | 57                   | 145,15                           | 143,78                             | 72                   | 183,35                           | 181,98                             |
| 28                   | 71,30                            | 69,93                              | 43                   | 109,50                           | 108,13                             | 58                   | 147,70                           | 146,33                             |                      |                                  |                                    |
| 29                   | 73,85                            | 72,48                              | 44                   | 112,05                           | 110,68                             | 59                   | 150,24                           | 148,87                             |                      |                                  |                                    |
| 30                   | 76,39                            | 75,02                              | 45                   | 114,59                           | 113,22                             | 60                   | 152,79                           | 151,42                             |                      |                                  |                                    |

**Table 10** Pulleys for CONTI® SYNCHRODRIVE HTD synchronous drive belts  
14 mm tooth pitch, 14M profile (measurement in mm)

| Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> |
|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|
| 18                   | 80,21                            | 77,41                              | 33                   | 147,06                           | 144,26                             | 48                   | 213,90                           | 211,10                             | 63                   | 280,75                           | 277,95                             |
| 19                   | 84,67                            | 81,87                              | 34                   | 151,52                           | 148,71                             | 49                   | 218,36                           | 215,56                             | 64                   | 285,20                           | 282,40                             |
| 20                   | 89,13                            | 86,33                              | 35                   | 155,97                           | 153,17                             | 50                   | 222,82                           | 220,02                             | 65                   | 289,66                           | 286,86                             |
| 21                   | 93,58                            | 90,78                              | 36                   | 160,43                           | 157,63                             | 51                   | 227,27                           | 224,47                             | 66                   | 294,12                           | 291,32                             |
| 22                   | 98,04                            | 95,24                              | 37                   | 164,88                           | 162,08                             | 52                   | 231,73                           | 228,93                             | 67                   | 298,57                           | 295,77                             |
| 23                   | 102,50                           | 99,70                              | 38                   | 169,34                           | 166,54                             | 53                   | 236,18                           | 233,38                             | 68                   | 303,03                           | 300,23                             |
| 24                   | 106,95                           | 104,15                             | 39                   | 173,80                           | 171,00                             | 54                   | 240,64                           | 237,84                             | 69                   | 307,48                           | 304,68                             |
| 25                   | 111,41                           | 108,61                             | 40                   | 178,25                           | 175,45                             | 55                   | 245,10                           | 242,30                             | 70                   | 311,94                           | 309,14                             |
| 26                   | 115,86                           | 113,06                             | 41                   | 182,71                           | 179,91                             | 56                   | 249,55                           | 246,75                             | 71                   | 316,40                           | 313,60                             |
| 27                   | 120,32                           | 117,52                             | 42                   | 187,16                           | 184,36                             | 57                   | 254,01                           | 251,21                             | 72                   | 320,85                           | 318,05                             |
| 28                   | 124,78                           | 121,98                             | 43                   | 191,62                           | 188,82                             | 58                   | 258,47                           | 255,67                             |                      |                                  |                                    |
| 29                   | 129,23                           | 126,43                             | 44                   | 196,08                           | 193,28                             | 59                   | 262,92                           | 260,12                             |                      |                                  |                                    |
| 30                   | 133,69                           | 130,89                             | 45                   | 200,53                           | 197,73                             | 60                   | 267,38                           | 264,58                             |                      |                                  |                                    |
| 31                   | 138,15                           | 135,35                             | 46                   | 204,99                           | 202,19                             | 61                   | 271,83                           | 269,03                             |                      |                                  |                                    |
| 32                   | 142,50                           | 139,80                             | 47                   | 209,45                           | 206,65                             | 62                   | 276,29                           | 273,49                             |                      |                                  |                                    |

# Pulleys

## Diameter

| Table 11 Pulleys for CONTI® SYNCHRODRIVE STD synchronous drive belts<br>3 mm tooth pitch, S 3M profile (measurement in mm) |                                  |                                    |                      |                                  |                                    |                      |                                  |                                    |                      |                                  |                                    |
|--|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|
| Number of teeth<br>z   | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> |
| 20   | 19,10                            | 18,34                              | 35                   | 33,42                            | 32,66                              | 50                   | 47,75                            | 46,99                              | 65                   | 62,07                            | 61,31                              |
| 21   | 20,05                            | 19,29                              | 36                   | 34,38                            | 33,62                              | 51                   | 48,70                            | 47,94                              | 66                   | 63,03                            | 62,27                              |
| 22   | 21,01                            | 20,25                              | 37                   | 35,33                            | 34,57                              | 52                   | 49,66                            | 48,90                              | 67                   | 63,98                            | 63,22                              |
| 23   | 21,96                            | 21,20                              | 38                   | 36,29                            | 35,53                              | 53                   | 50,61                            | 49,85                              | 68                   | 64,94                            | 64,18                              |
| 24   | 22,92                            | 22,16                              | 39                   | 37,24                            | 36,48                              | 54                   | 51,57                            | 50,81                              | 69                   | 65,89                            | 65,13                              |
| 25   | 23,87                            | 23,11                              | 40                   | 38,20                            | 37,44                              | 55                   | 52,52                            | 51,75                              | 70                   | 66,85                            | 66,09                              |
| 26   | 24,83                            | 24,07                              | 41                   | 39,15                            | 38,39                              | 56                   | 53,48                            | 52,72                              | 71                   | 67,80                            | 67,04                              |
| 27   | 25,78                            | 25,02                              | 42                   | 40,11                            | 39,35                              | 57                   | 54,43                            | 53,67                              | 72                   | 68,75                            | 67,99                              |
| 28   | 26,74                            | 25,98                              | 43                   | 41,06                            | 40,30                              | 58                   | 55,39                            | 54,63                              |                      |                                  |                                    |
| 29   | 27,69                            | 26,93                              | 44                   | 42,02                            | 41,26                              | 59                   | 56,34                            | 55,58                              |                      |                                  |                                    |
| 30   | 28,65                            | 27,89                              | 45                   | 42,97                            | 42,21                              | 60                   | 57,30                            | 56,54                              |                      |                                  |                                    |
| 31   | 29,60                            | 28,84                              | 46                   | 43,93                            | 43,17                              | 61                   | 58,25                            | 57,49                              |                      |                                  |                                    |
| 32   | 30,56                            | 29,80                              | 47                   | 44,88                            | 44,12                              | 62                   | 59,21                            | 58,45                              |                      |                                  |                                    |
| 33   | 31,51                            | 30,75                              | 48                   | 45,84                            | 45,08                              | 63                   | 60,16                            | 59,40                              |                      |                                  |                                    |
| 34   | 32,47                            | 31,71                              | 49                   | 46,79                            | 46,03                              | 64                   | 61,12                            | 60,36                              |                      |                                  |                                    |

| Table 12 Pulleys for CONTI® SYNCHRODRIVE STD synchronous drive belts<br>5 mm tooth pitch, S 5M profile (measurement in mm) |                                  |                                    |                      |                                  |                                    |                      |                                  |                                    |                      |                                  |                                    |
|--|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|----------------------|----------------------------------|------------------------------------|
| Number of teeth<br>z   | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> | Number of teeth<br>z | Pitch diameter<br>d <sub>w</sub> | Outside diameter<br>d <sub>a</sub> |
| 12   | 19,10                            | 18,14                              | 28                   | 44,56                            | 43,60                              | 44                   | 70,03                            | 69,07                              | 60                   | 95,49                            | 94,53                              |
| 13   | 20,69                            | 19,73                              | 29                   | 46,15                            | 45,19                              | 45                   | 71,62                            | 70,66                              | 61                   | 97,08                            | 96,12                              |
| 14   | 22,28                            | 21,32                              | 30                   | 47,75                            | 46,79                              | 46                   | 73,21                            | 72,25                              | 62                   | 98,68                            | 97,72                              |
| 15   | 23,87                            | 22,91                              | 31                   | 49,34                            | 48,38                              | 47                   | 74,80                            | 73,84                              | 63                   | 100,27                           | 99,31                              |
| 16   | 25,46                            | 24,50                              | 32                   | 50,93                            | 49,97                              | 48                   | 76,39                            | 75,43                              | 64                   | 101,86                           | 100,90                             |
| 17   | 27,06                            | 26,10                              | 33                   | 52,52                            | 51,56                              | 49                   | 77,99                            | 77,03                              | 65                   | 103,45                           | 102,49                             |
| 18   | 28,65                            | 27,69                              | 34                   | 54,11                            | 53,15                              | 50                   | 79,58                            | 78,62                              | 66                   | 105,04                           | 104,08                             |
| 19   | 30,24                            | 29,28                              | 35                   | 55,70                            | 54,74                              | 51                   | 81,17                            | 80,21                              | 67                   | 106,63                           | 105,67                             |
| 20   | 31,83                            | 30,87                              | 36                   | 57,30                            | 56,34                              | 52                   | 82,76                            | 81,80                              | 68                   | 108,23                           | 107,27                             |
| 21   | 33,42                            | 32,46                              | 37                   | 58,89                            | 57,93                              | 53                   | 84,35                            | 83,39                              | 69                   | 109,82                           | 108,86                             |
| 22   | 35,01                            | 34,05                              | 38                   | 60,48                            | 59,52                              | 54                   | 85,94                            | 84,98                              | 70                   | 111,41                           | 110,45                             |
| 23   | 36,61                            | 35,65                              | 39                   | 62,07                            | 61,11                              | 55                   | 87,54                            | 86,58                              | 71                   | 113,00                           | 112,04                             |
| 24   | 38,20                            | 37,24                              | 40                   | 63,66                            | 62,70                              | 56                   | 89,13                            | 88,17                              | 72                   | 114,59                           | 113,63                             |
| 25   | 39,79                            | 38,83                              | 41                   | 65,25                            | 64,29                              | 57                   | 90,72                            | 89,76                              |                      |                                  |                                    |
| 26   | 41,38                            | 40,42                              | 42                   | 66,85                            | 65,89                              | 58                   | 92,31                            | 91,35                              |                      |                                  |                                    |
| 27   | 42,97                            | 42,01                              | 43                   | 68,44                            | 67,48                              | 59                   | 93,90                            | 92,94                              |                      |                                  |                                    |

**Table 13** Pulleys for CONTI® SYNCHRODRIVE STD synchronous drive belts  
8 mm tooth pitch, S 8M profile (measurement in mm)

| Number of teeth<br>z | Pitch diameter $d_w$ | Outside diameter $d_a$ | Number of teeth<br>z | Pitch diameter $d_w$ | Outside diameter $d_a$ | Number of teeth<br>z | Pitch diameter $d_w$ | Outside diameter $d_a$ | Number of teeth<br>z | Pitch diameter $d_w$ | Outside diameter $d_a$ |
|----------------------|----------------------|------------------------|----------------------|----------------------|------------------------|----------------------|----------------------|------------------------|----------------------|----------------------|------------------------|
| 16                   | 40,74                | 39,37                  | 31                   | 78,94                | 77,57                  | 46                   | 117,14               | 115,77                 | 61                   | 155,34               | 153,97                 |
| 17                   | 43,29                | 41,92                  | 32                   | 81,49                | 80,12                  | 47                   | 119,68               | 118,31                 | 62                   | 157,88               | 156,51                 |
| 18                   | 45,84                | 44,47                  | 33                   | 84,03                | 82,66                  | 48                   | 122,23               | 120,86                 | 63                   | 160,43               | 159,06                 |
| 19                   | 48,38                | 47,01                  | 34                   | 86,58                | 85,21                  | 49                   | 124,78               | 123,41                 | 64                   | 162,97               | 161,60                 |
| 20                   | 50,93                | 49,56                  | 35                   | 89,13                | 87,76                  | 50                   | 127,32               | 125,95                 | 65                   | 165,52               | 164,15                 |
| 21                   | 53,48                | 52,11                  | 36                   | 91,67                | 90,30                  | 51                   | 129,87               | 128,50                 | 66                   | 168,07               | 166,70                 |
| 22                   | 56,02                | 54,65                  | 37                   | 94,22                | 92,85                  | 52                   | 132,42               | 131,05                 | 67                   | 170,61               | 169,24                 |
| 23                   | 58,57                | 57,20                  | 38                   | 96,77                | 95,40                  | 53                   | 134,96               | 133,59                 | 68                   | 173,16               | 171,79                 |
| 24                   | 61,12                | 59,75                  | 39                   | 99,31                | 97,94                  | 54                   | 137,51               | 136,14                 | 69                   | 175,71               | 174,34                 |
| 25                   | 63,66                | 62,29                  | 40                   | 101,86               | 100,49                 | 55                   | 140,06               | 138,69                 | 70                   | 178,25               | 176,88                 |
| 26                   | 66,21                | 64,84                  | 41                   | 104,41               | 103,04                 | 56                   | 142,60               | 141,23                 | 71                   | 180,80               | 179,43                 |
| 27                   | 68,75                | 67,38                  | 42                   | 106,95               | 105,58                 | 57                   | 145,15               | 143,78                 | 72                   | 183,35               | 181,98                 |
| 28                   | 71,30                | 69,93                  | 43                   | 109,50               | 108,13                 | 58                   | 147,70               | 146,33                 |                      |                      |                        |
| 29                   | 73,85                | 72,48                  | 44                   | 112,05               | 110,68                 | 59                   | 150,24               | 148,87                 |                      |                      |                        |
| 30                   | 76,39                | 75,02                  | 45                   | 114,59               | 113,22                 | 60                   | 152,79               | 151,42                 |                      |                      |                        |

## Tolerances

**Table 14** Outside diameter tolerances

| Outside diameter $d_a$ mm | Tolerance mm |
|---------------------------|--------------|
| $\leq 25$                 | + 0,05<br>0  |
| > 25 - 50                 | + 0,08<br>0  |
| > 50 - 100                | + 0,10<br>0  |
| > 100 - 175               | + 0,13<br>0  |
| > 175 - 300               | + 0,15<br>0  |
| > 300 - 500               | + 0,18<br>0  |
| > 500                     | + 0,20<br>0  |

**Table 15** Axial runout tolerances

| Outside diameter $d_a$ mm | Tolerance mm                             |
|---------------------------|--|
| $\leq 100$                | 0,1                                      |
| > 100 - 250               | 0,001<br>per mm outside diameter         |
| > 250                     | 0,25 + 0,0005<br>per mm outside diameter |

**Table 16** Radial runout tolerances

| Outside diameter $d_a$ mm | Tolerance mm                             |
|---------------------------|--|
| $\leq 200$                | 0,13                                     |
| > 200                     | 0,13 + 0,0005<br>per mm outside diameter |

### Parallelism

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

### Draft

The maximum allowable draft is 1  $\mu\text{m}$  per millimetre of face width, but it must not exceed the permissible diameter tolerance.

# Pulleys

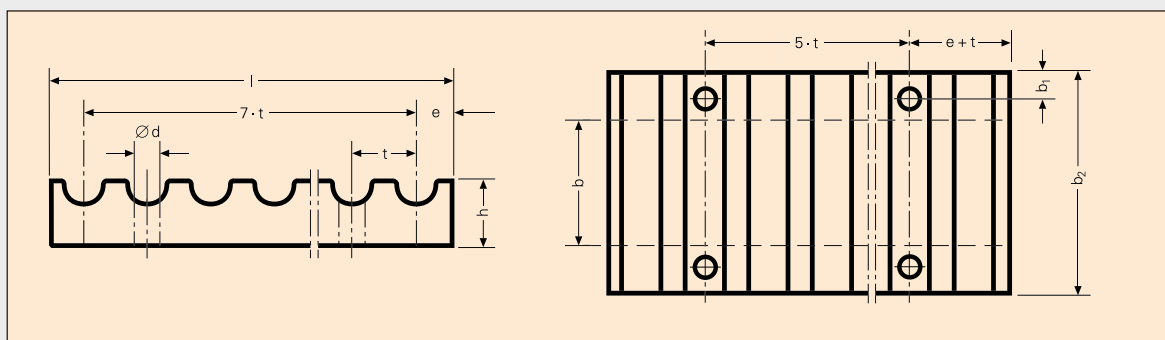
## Clamp plates

CONTI® SYNCHRODRIVE synchronous drive belts that are used as opened power transmission components must be clamped with a positive fit at their ends. Clamp plates must have the corresponding tooth profile. The clamping screws should be positioned on both sides of the belt, and tightened in a uniform fashion.

Fig. 2 shows the type of clamp plate used. Dimensions for the standard type are given in Table 17.

Clamp plates for CONTI® SYNCHRODRIVE belt drives are available from your Mulco sales partner.

Fig. 2



Clamp plate layout principle

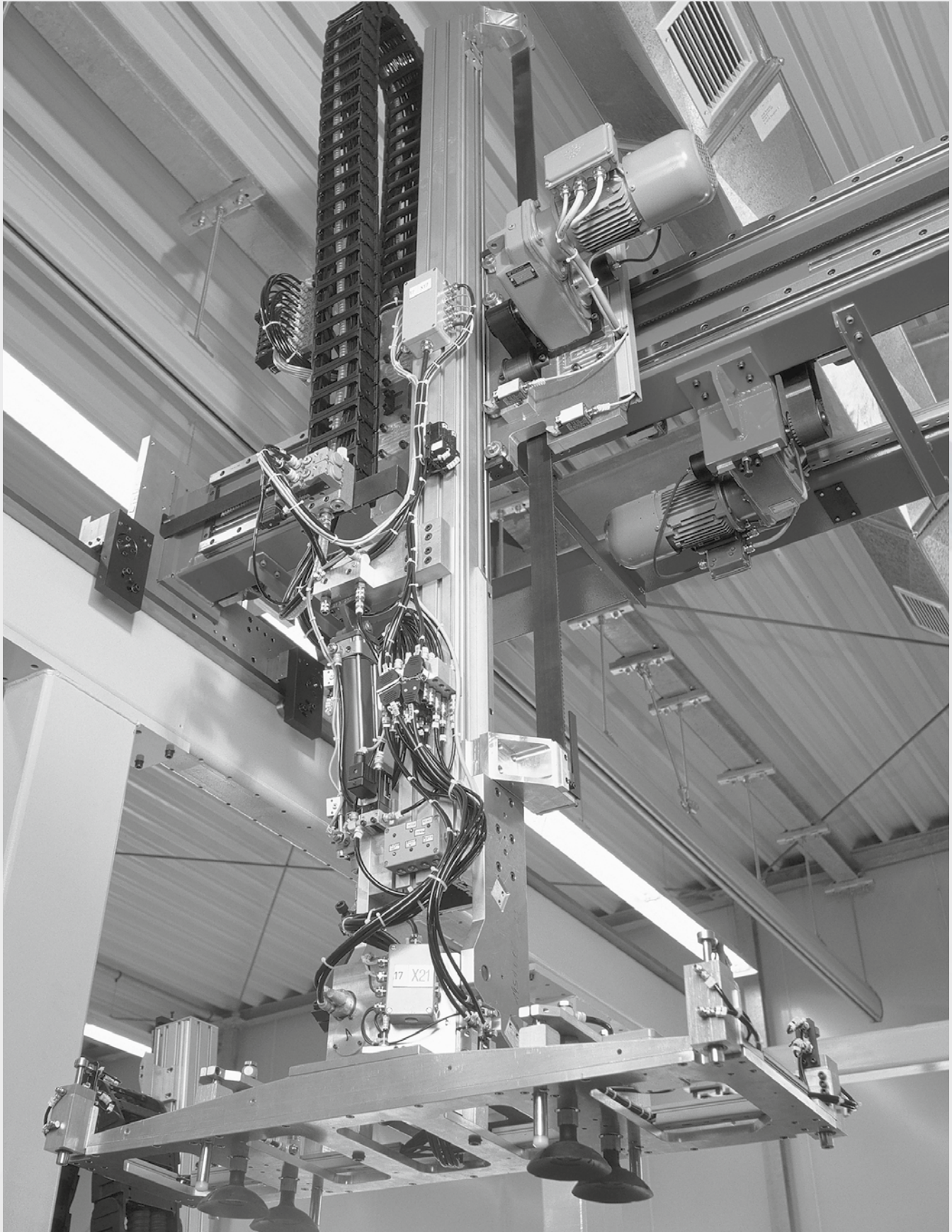
| Table 17 Clamp plate dimensions (in mm)                 |        |     |      |       |       |      |      |       |
|---|--------|-----|------|-------|-------|------|------|-------|
| Tooth profile   |        | HTD |      |       |       | STD  |      |       |
|   |        | 3M  | 5M   | 8M    | 14M   | S 3M | S 5M | S 8M  |
| t   |        |     | 5,0  | 8,0   | 14,0  |      | 5,0  | 8,0   |
| l   |        |     | 41,4 | 66,0  | 116,0 |      | 41,4 | 66,0  |
| e   |        |     | 3,2  | 5,0   | 9,0   |      | 3,2  | 5,0   |
| h   |        |     | 8,0  | 15,0  | 22,0  |      | 8,0  | 15,0  |
| d   |        |     | 5,5  | 9,0   | 11,0  |      | 5,5  | 9,0   |
| b <sub>1</sub>  |        |     | 6,0  | 8,0   | 10,0  |      | 6,0  | 8,0   |
| b <sub>2</sub> for synchronous drive belt width<br>b mm | 10,00  |     | 28,0 |       |       |      |      | 28,0  |
|   | 15,00  |     | 34,0 | 40,0  |       |      | 34,0 | 40,0  |
|   | 20,00  |     |      | 45,0  |       |      |      | 45,0  |
|   | 25,00  |     | 44,0 |       |       |      | 44,0 |       |
|   | 30,00  |     |      | 55,0  |       |      |      | 55,0  |
|   | 40,00  |     |      |       | 71,0  |      |      |       |
|   | 50,00  |     |      | 75,0  |       |      |      | 75,0  |
|   | 55,00  |     |      |       | 86,0  |      |      |       |
|   | 85,00  |     |      | 110,0 | 116,0 |      |      | 110,0 |
|   | 100,00 |     |      |       | 131,0 |      |      |       |
|   | 115,00 |     |      |       | 146,0 |      |      |       |
|   | 120,00 |     |      |       | 151,0 |      |      |       |
| 150,00  |        |     |      | 181,0 |       |      |      |       |

Clamp plates for STD S 3M and HTD 3M are available on request.



# Calculation of synchronous belt drives

Glossery of symbols and terms, Drive calculation data,  
Examples of design procedure steps: Lifting drive, Linear drive

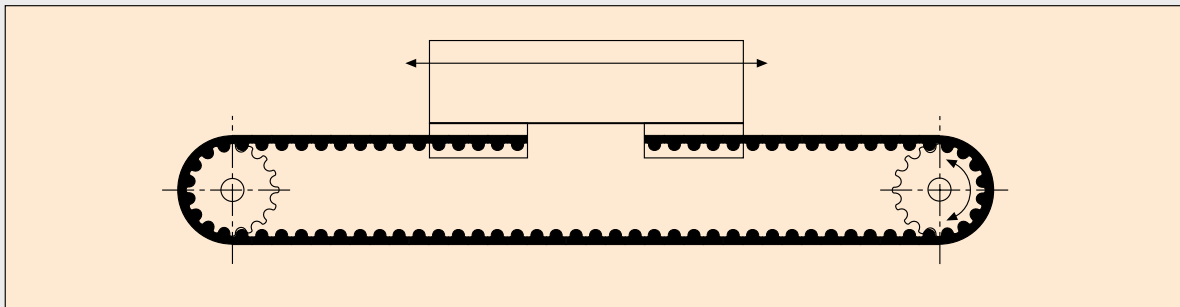


# Calculation of synchronous belt drives

## Calculation of synchronous belt drives

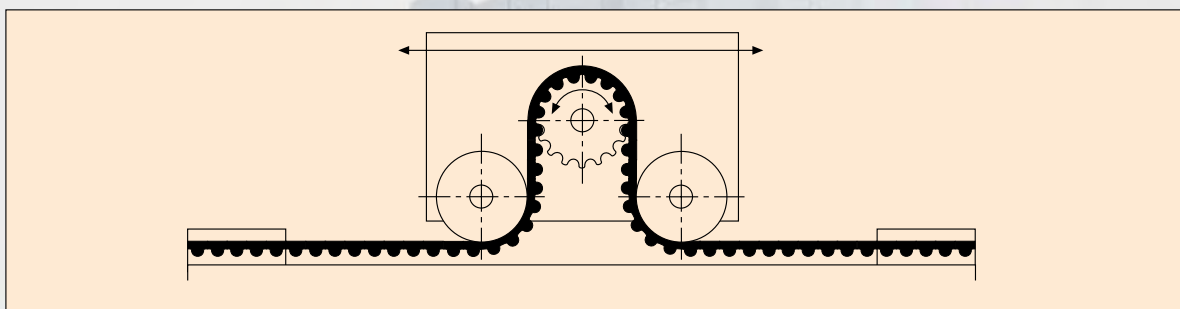
Calculations are based on drives fitted with CONTI® SYNCHRODRIVE synchronous drive belts. Drive design data are given in the following diagrams and tables. As so many factors influence belt performance, it is suggested that designers of complicated drives consult your Mulco sales Partner.

Fig. 3



Synchronous belt linear drive with 2 pulleys and no deflection

Fig. 4



Synchronous belt linear drive with 1 pulley and deflection idlers



# Calculation of synchronous belt drives

## Glossary of symbols, units and terms

| Symbol        | Unit          | Definition   | Symbol         | Unit        | Definition   |
|---------------|---------------|--|----------------|-------------|--|
| $a$           | mm            | centre distance  | $m_{ges}$      | kg          | total weight   |
| $\Delta a$    | mm            | take up allowance  | $m_R$          | kg          | weight of belt   |
| $a_b$         | $m/s^2$       | acceleration   | $m_S$          | kg          | weight of carriage                                       |
| $a_v$         | $m/s^2$       | braking deceleration   | $m_{Sch}$      | kg          | weight of pulley   |
| $b$           | mm            | belt width   | $m_{Sch\ red}$ | kg          | reduced weight of pulley                                 |
| $b_{err}$     | mm            | calculated belt width  | $m_{spez}$     | kg/m        | specific gravity of belt per m of length and mm of width |
| $c_{spez}$    | N/mm          | specific spring constant per mm of belt length and mm of width | $m_U$          | kg          | weight of deflection idler                               |
| $c_0$         |               | overall service factor   | $m_{U\ red}$   | kg          | reduced weight of deflection idler                       |
| $c_1$         |               | teeth in mesh factor   | $M$            | N/m         | torque   |
| $c_{1\ max}$  |               | maximum value for teeth in mesh factor                         | $n$            | $min^{-1}$  | pulley speed   |
| $c_2$         |               | load factor  | $n_1$          | $min^{-1}$  | speed of driver pulley                                   |
| $c_3$         |               | acceleration factor  | $n_2$          | $min^{-1}$  | speed of driven pulley                                   |
| $d$           | mm            | pulley/idler diameter  | $P$            | kW          | power  |
| $d_a$         | mm            | outside diameter of pulley                                     | $s_b$          | m           | acceleration distance                                    |
| $d_F$         | mm            | design-specific finished bore                                  | $s_c$          | m           | travel at $v_{const}$                                    |
| $d_{min}$     | mm            | minimum diameter of idler                                      | $s_{ges}$      | m           | total travel   |
| $d_w$         | mm            | pitch diameter of pulley                                       | $s_v$          | m           | braking distance   |
| $d_{w1}$      | mm            | pitch diameter of driver pulley                                | $t$            | mm          | pitch  |
| $d_{w2}$      | mm            | pitch diameter of driven pulley                                | $t_c$          | s           | travel time at $v_{const}$                               |
| $f$           | Hz            | natural frequency  | $U_w$          | mm          | pitch circumference of pulley                            |
| $F_R$         | N             | friction force   | $v$            | m/s         | belt speed   |
| $F_T$         | N             | static belt tension  | $z$            |             | number of teeth on the pulley                            |
| $F_{T\ max}$  | N             | maximum belt tension dynamic                                   | $z_e$          |             | number of meshing teeth                                  |
| $F_u$         | N             | effective pull   | $z_g$          |             | number of teeth on the large pulley                      |
| $F_{u\ max}$  | N             | maximum effective pull   | $z_k$          |             | number of teeth on the small pulley                      |
| $F_{u\ spez}$ | N             | specific load on tooth flank                                   | $z_{min}$      |             | minimum number of teeth                                  |
| $F_v$         | N             | belt installation tension                                      | $z_1$          |             | number of teeth on the driver pulley                     |
| $F_{zul}$     | N             | allowable load on tension member                               | $z_2$          |             | number of teeth on the driven pulley                     |
| $g$           | $9,81\ m/s^2$ | gravitational acceleration                                     | $\beta$        | ° (degrees) | arc of contact around the small pulley                   |
| $i$           |               | transmission ratio   | $\mu$          |             | coefficient of friction                                  |
| $L_f$         | m             | free span length for vibration excitation                      |                |             |  |
| $L_w$         | mm            | pitch length of belt   |                |             |  |
| $L_{w\ max}$  | mm            | maximum pitch length of belt                                   |                |             |  |

# Calculation of synchronous belt drives

## Drive calculation data

The following pages contain all the data, formulae and tables needed when designing a new drive fitted with a CONTI® SYNCHRODRIVE synchronous drive belt. Tables for values which can easily be calculated using the formulae provided have been omitted.

The torques and effective pulls to be transmitted do not require any safety factors providing the maximum values are observed and the load is uniform. Corresponding factors must be applied in the event of fluctuating and alternating loads as well as with accelerating or braking processes.

### Overall service factor $c_0$

The overall service factor  $c_0$  takes into consideration the loads occurring under special operating conditions, and is the sum of load factor  $c_2$  and acceleration factor  $c_3$ .

$$c_0 = c_2 + c_3$$

### Teeth in mesh factor $c_1$

The teeth in mesh factor  $c_1$  considers the number of teeth  $z_k$  of the small pulley meshing with the teeth of the synchronous drive belt.

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

Calculation of the arc of contact  $\beta$  is explained on page 21. The value for teeth in mesh factor  $c_1$  corresponds to the number of teeth in mesh  $z_e$ .

The following maximum values apply:

$$c_{1 \max} = 12 \text{ for CONTI® SYNCHRODRIVE synchronous drive belts, type M}$$

$$c_{2 \max} = 6 \text{ for CONTI® SYNCHRODRIVE synchronous drive belts, type V}$$

The minimum numbers of teeth  $z_{\min}$  for pulleys that are to be taken into consideration when designing a drive are contained in Table 6 on page 11.

### Load factor $c_2$

Load factor  $c_2$  is used to compensate for operating conditions. The factors given below are indicative values only.

| Table 18 Load factor $c_2$ |                   |
|----------------------------|-------------------|
| Operation conditions       | Load factor $c_2$ |
| Steady load                | 1,0               |
| Fluctuating load low       | 1,4               |
| Fluctuating load average   | 1,7               |
| Fluctuating load high      | 2,0               |

### Acceleration factor $c_3$

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

| Table 19 Acceleration factor $c_3$ |                           |
|------------------------------------|---------------------------|
| Transmission ratio $\frac{1}{i}$   | Acceleration factor $c_3$ |
| 1,00 - 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                       |

### Transmission ratio $i$

Transmission ratio  $i$  is obtained from the ratio of pulley speeds  $n_1$  and  $n_2$  or the number of teeth  $z_2$  and  $z_1$  or the pitch diameters of pulleys  $d_{w2}$  and  $d_{w1}$ .

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



### Number of teeth $z$ and pitch diameter $d_w$ of the pulleys

The number of teeth  $z$  and the pitch diameter  $d_w$  of the pulleys are determined by means of pitch  $t$  of the chosen tooth profile.

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

Numbers of teeth, pitch and outside diameters of pulleys are contained in Tables 7 to 13 on pages 12 to 15.

### Arc of contact $\beta$

For two-pulley drives, the arc of contact  $\beta$  around the small pulley is calculated as follows:

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

For multiple-pulley drives, the arc of contact  $\beta$  has to be calculated in accordance with the given geometry.

### Belt speed $v$

Belt speed  $v$  is derived from speed  $n$  in r.p.m., number of teeth  $z$  and pitch  $t$  in mm or pitch diameter  $d_w$ .

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

### Center distance $a$

Center distance is calculated as follows for circular path drives with two pulleys and where transmission ratio  $i = 1$ :

$$a = \frac{L_w - z \cdot t}{2} \text{ mm}$$

Where  $i$  does not equal 1, center distance  $a$  is approximated as below:

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

### Pitch length $L_w$

For a two-pulley drive, pitch length  $L_w$  of the synchronous drive belt is approximated as below:

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

and calculated precisely as follows:

$$L_w = 2 \cdot a \cdot \sin \frac{\beta}{2} + \frac{t}{2} \cdot \left[ z_g + z_k + \left( 1 - \frac{\beta}{180} \right) \cdot (z_g - z_k) \right] \text{ mm}$$

For linear and multiple-pulley drives, pitch length  $L_w$  is determined in accordance with the given geometry.

### Effective pull $F_u$ , torque $M$ , power $P$

The following equations are used to calculate effective pull  $F_u$ , torque  $M$  and power  $P$ :

$$\begin{aligned} F_u &= \frac{P \cdot 10^3}{v} = \frac{M \cdot 2 \cdot 10^3}{d_w} \text{ N} \\ &= \frac{P \cdot 9,55 \cdot 10^3}{n} = \frac{F_u \cdot d_w}{2 \cdot 10^3} \text{ Nm} \\ P &= \frac{M \cdot n}{9,55 \cdot 10^3} = \frac{F_u \cdot v}{10^3} \text{ kW} \end{aligned}$$

# Calculation of synchronous belt drives

## Drive calculation data

### Belt width b

Belt width  $b$  is calculated from the effective pull  $F_U$  to be transmitted, the specific load on tooth flank  $F_{U\text{ spez}}$  as well as the service factor  $c_0$  and the teeth in mesh factor  $c_1$ .

$$b_{\text{err}} = \frac{F_U \cdot c_0 \cdot 10}{F_{U\text{ spez}} \cdot c_1} \quad \text{mm}$$

Values for the specific load on tooth flank  $F_{U\text{ spez}}$  can be taken from Figs. 6 to 7 on pages 24 and 26.

Once the belt standard width  $b$  has been determined, it is necessary to check the tension member load.

Permissible tension member loads  $F_{Zul}$  for synchronous drive belts with standard widths are contained in Tables 20 and 22 on pages 25 and 27. The following rule applies:

$$F_{Zul} \geq F_{T\text{ max}} \cdot c_0 \quad \text{N}$$

The next section explains how to determine the dynamic belt tension  $F_{T\text{ max}}$ .

### Belt installation tension $F_T$

Tensioning of the belt is a decisive factor affecting the reliability, performance and life of a synchronous belt drive.

#### Calculation

For linear drives, installation tension is calculated as the belt tension. The following rule applies to the static belt tension  $F_T$ :

$$F_T \geq F_{U\text{ max}} \quad \text{N}$$

Maximum belt tension  $F_{T\text{ max}}$  occurring in the dynamic state is derived from

$$F_{T\text{ max}} = F_T + F_{U\text{ max}} \quad \text{N}$$

With circular path drives, installation tension is usually given as shaft load  $F_v$ . The following equation applies:

$$F_v = F_U \cdot \sin \frac{\beta}{2} \quad \text{N}$$

### Adjusting installation tension $F_T$ via the takeup allowance

On linear drives, installation tension is adjusted via belt elongation. The takeup allowance  $a$  in mm is derived from the belt tension  $F_T$ , the belt dimensions  $L_w$  and  $b$  as well as the spring constants  $c_{\text{spez}}$ .

For linear drives as shown in Fig. 3 on page 18

$$\Delta a = \frac{F_T \cdot L_w}{2 \cdot c_{\text{spez}} \cdot b} \quad \text{mm}$$

For linear drives as shown in Fig. 4 on page 18

$$\Delta a = \frac{F_T \cdot L_w}{c_{\text{spez}} \cdot b} \quad \text{mm}$$

The values for the spring constants  $c_{\text{spez}}$  can be taken from Tables 21 and 23 on pages 25 and 27.

### Adjusting installation tension via the frequency measurement method

Installation tension on linear drives can also be adjusted by measuring the natural frequency of a vibrating belt span. It must be remembered, however, that measurable vibrations are only obtainable from a free span length  $L_f$  up to a certain length.

See also our calculation examples.

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

### Selecting the tooth profile

A suitable tooth profile is selected from Fig. 5 by locating the point at which the effective pull to be transmitted intersects with the possible belt width. The belt with the greatest power transmitting capacity should be selected. In borderline cases, it is recommended that the smaller profile is taken as a basis for drive design calculation.

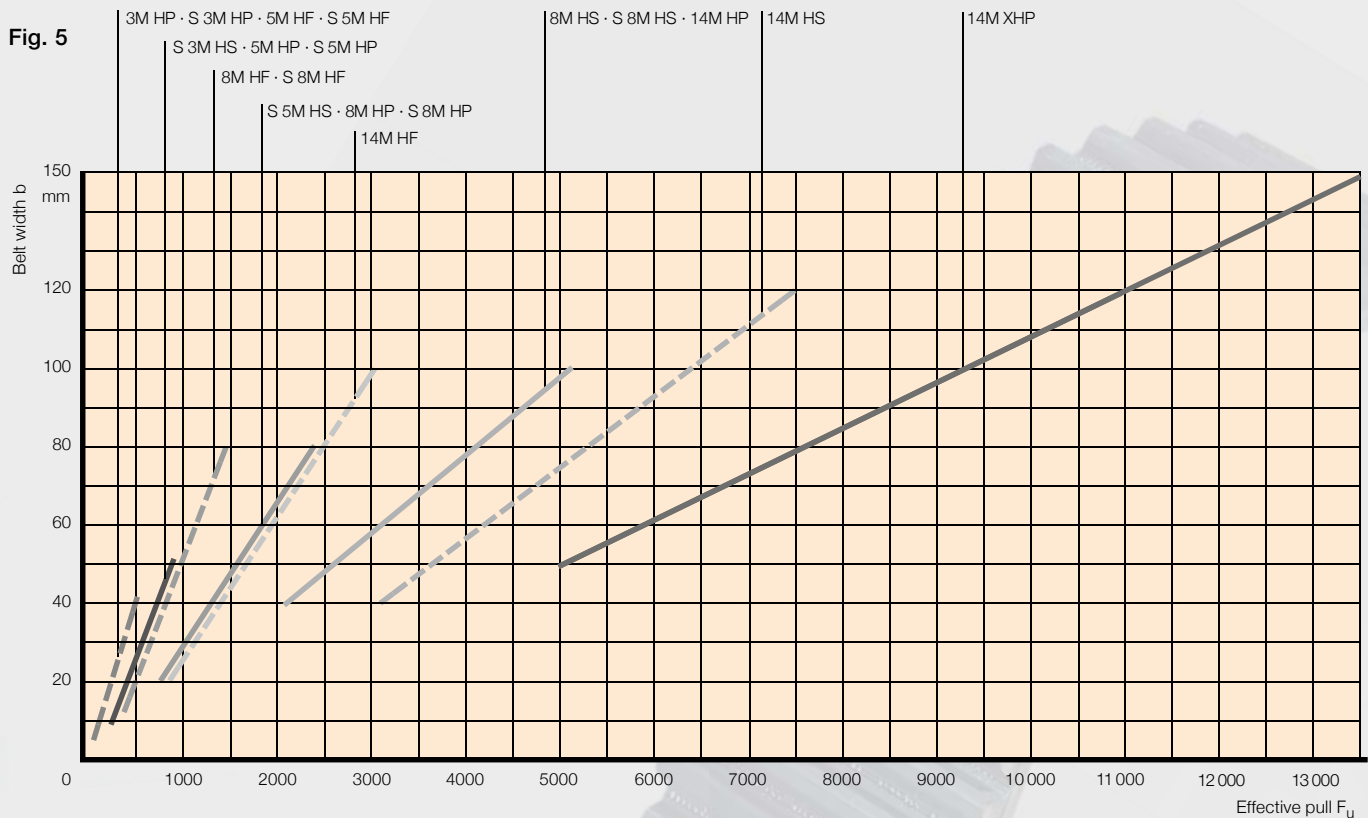


Diagram for selecting CONTI® SYNCHRODRIVE synchronous drive belts

### Specific load on tooth flank $F_{u\text{ spez}}$ , tension member load $F_{zul}$ , specific spring constant $c_{spez}$

The values required for the specific load on tooth flank, tension member load and specific spring constant in order to arrive at a precise drive design can be taken from the diagrams and tables on the following pages.

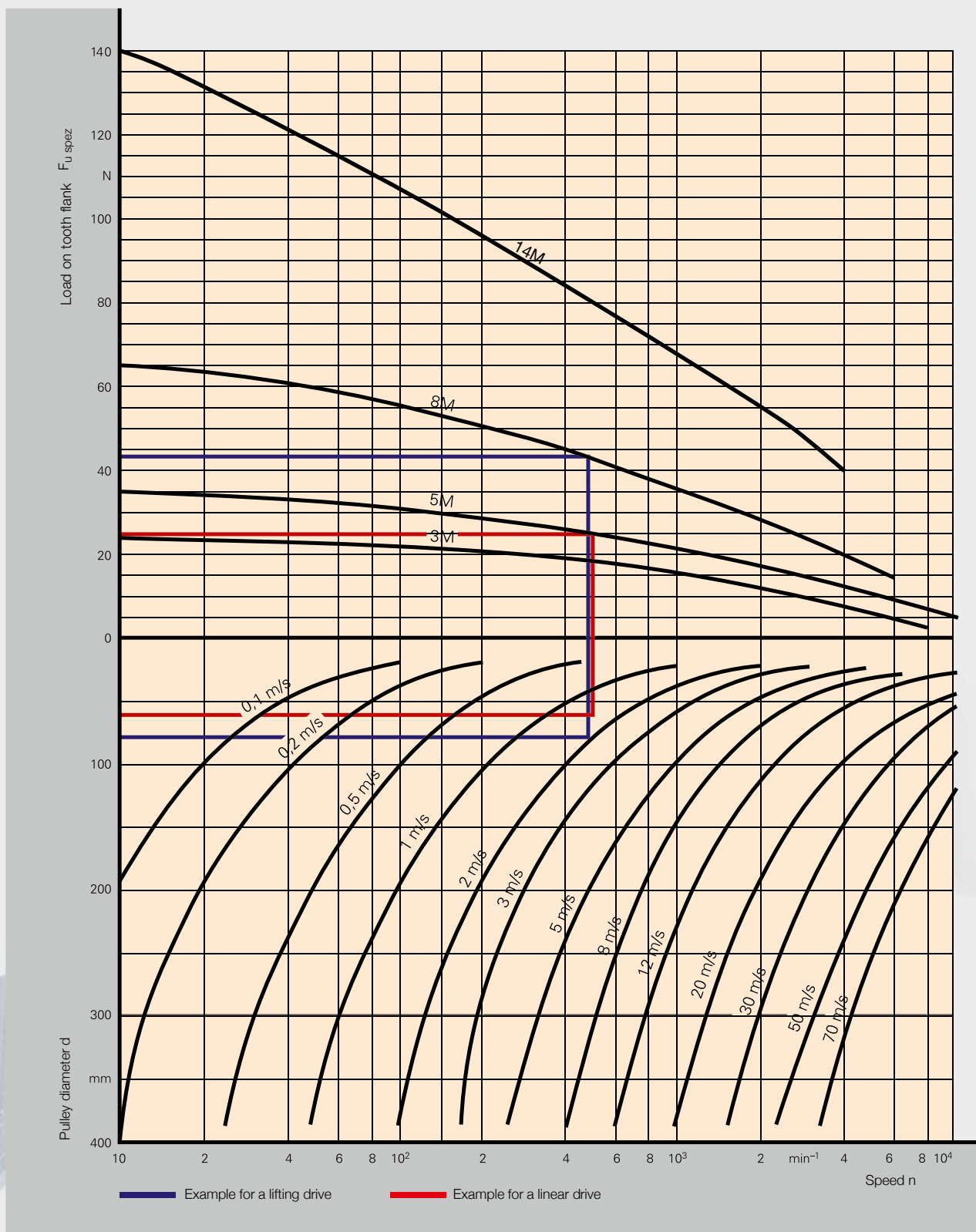
The specific load on tooth flank  $F_{u\text{ spez}}$  can be taken from Figs. 6 and 7 after calculating speed  $n$  in r.p.m. from the

given belt speed  $v$  in m/s and the pulley diameter  $d_w$  in mm for the corresponding profile.

Tension member load  $F_{zul}$  in N is given in Tables 20 and 22. Tables 21 and 23 show the specific spring constant  $c_{spez}$  in N/mm for calculating takeup allowance  $\Delta a$ .

# Calculation of synchronous belt drives

Fig. 6



Specific load on tooth flank  $F_{u\ spez}$  in N per 10 mm belt width and per meshing tooth for CONTI® SYNCHRODRIVE HTD synchronous drive belts 3M, 5M, 8M, 14M



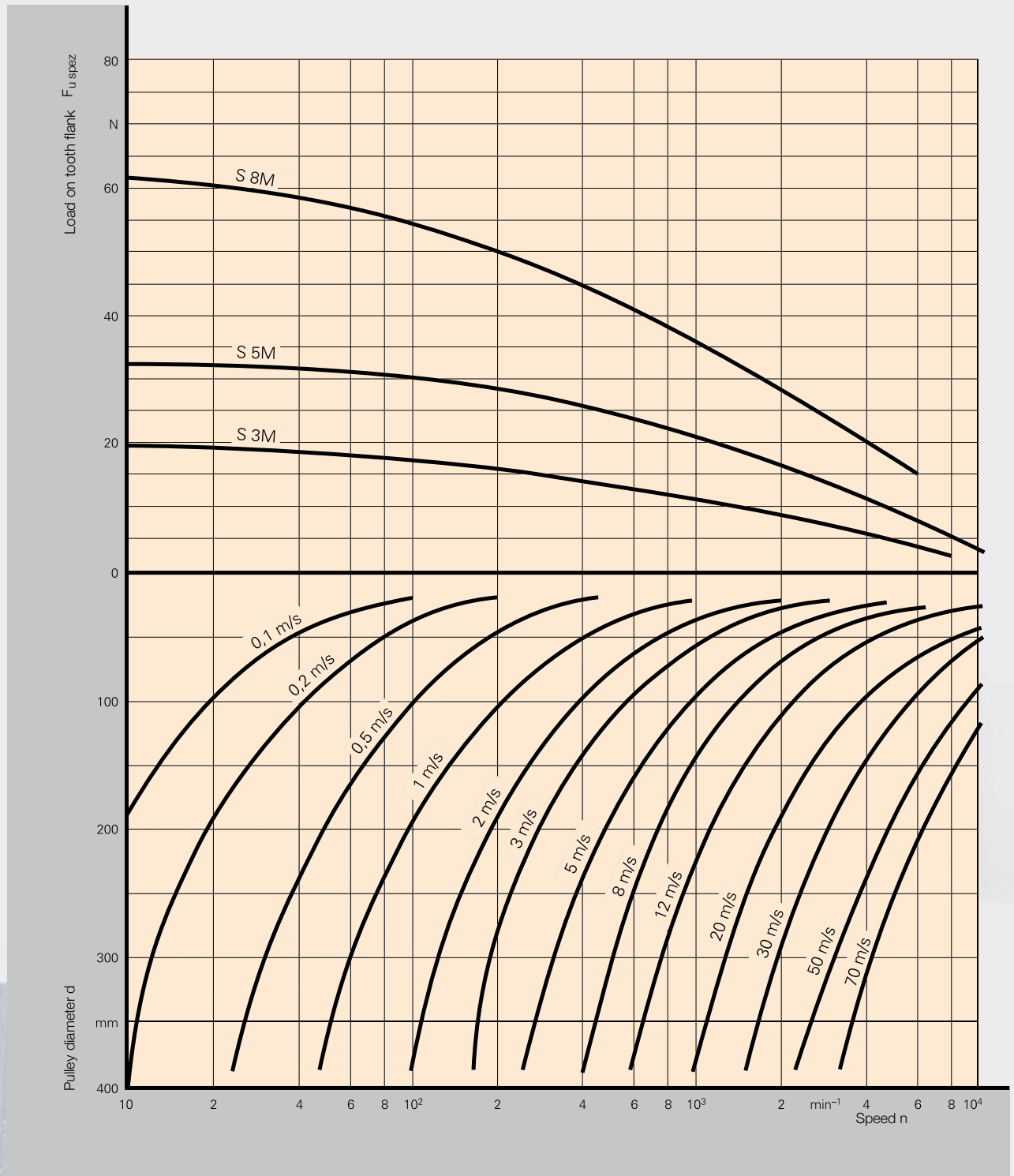
| Tab. 20 Allowable tension member load* $F_{zul}$ in N at 0.4% elongation |     |          |          |      |      |          |       |       |      |           |       |       |       |      |
|--|-----|----------|----------|------|------|----------|-------|-------|------|-----------|-------|-------|-------|------|
| CONTI® SYNCHRODRIVE HTD synchronous drive belts – 3M, 5M, 8M, 14M        |     |          |          |      |      |          |       |       |      |           |       |       |       |      |
| Tooth profile<br>Type/Version  |     | 3M<br>HP | 5M<br>HF | HP   | V-HF | 8M<br>HF | HP    | HS    | V-HF | 14M<br>HF | HP    | HS    | XHP   | V-HF |
| Belt width b mm  | 5   | 150      | 150      |      |      |          |       |       |      |           |       |       |       |      |
|  | 10  | 300      | 300      | 650  |      | 650      |       |       |      |           |       |       |       |      |
|  | 15  | 450      | 450      | 975  |      | 975      | 1800  | 3150  |      |           |       |       |       |      |
|  | 20  | 600      | 600      | 1300 | 300  | 1300     | 2400  | 4200  |      | 2400      |       |       |       |      |
|  | 25  | 750      | 750      | 1625 | 375  | 1625     | 3000  | 5250  | 750  | 3000      | 5250  |       |       |      |
|  | 30  | 900      | 900      | 1950 | 450  | 1950     | 3600  | 6300  | 900  | 3600      | 6300  | 7500  |       | 1800 |
|  | 40  | 1200     | 1200     | 2600 | 600  | 2600     | 4800  | 8400  | 1200 | 4800      | 8400  | 10000 | 19000 | 2400 |
|  | 50  | 1500     | 1500     | 3250 | 750  | 3250     | 6000  | 10500 | 1500 | 6000      | 10500 | 12500 | 23800 | 3000 |
|  | 55  |          |          |      |      | 3575     | 6600  | 11550 | 1650 | 6600      | 11550 | 13750 | 26100 | 3300 |
|  | 85  |          |          |      |      | 5525     | 10200 | 17850 | 2550 | 10200     | 17850 | 21250 | 40400 | 5100 |
|  | 100 |          |          |      |      | 6500     | 12000 | 21000 | 3000 | 12000     | 21000 | 25000 | 47600 | 6000 |
|  | 115 |          |          |      |      |          |       |       |      |           | 24150 | 28750 | 54700 |      |
|  | 120 |          |          |      |      |          |       |       |      |           | 25200 | 30000 | 57100 |      |
|  | 150 |          |          |      |      |          |       |       |      |           |       |       | 71400 |      |

\* The breaking load equals about factor 4 in relation to the admissible load on the tension members.

| Tab. 21 Specific spring constant $c_{spez}$ in N/mm               |      |                  |                  |                 |                 |                 |                 |                 |                 |                 |                  |
|---|------|------------------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------|
| CONTI® SYNCHRODRIVE HTD synchronous drive belts – 3M, 5M, 8M, 14M |      |                  |                  |                 |                 |                 |                 |                 |                 |                 |                  |
| Tooth profile<br>Type/Version                                     |      | 3M<br>HP         | 5M<br>HF         | HP              | 8M<br>HF        | HP              | HS              | 14M<br>HF       | HP              | HS              | XHP              |
| $c_{spez}$  | N/mm | $7,5 \cdot 10^3$ | $7,5 \cdot 10^3$ | $20 \cdot 10^3$ | $20 \cdot 10^3$ | $35 \cdot 10^3$ | $53 \cdot 10^3$ | $35 \cdot 10^3$ | $53 \cdot 10^3$ | $63 \cdot 10^3$ | $120 \cdot 10^3$ |

# Calculation of synchronous belt drives

Fig. 7



Specific load on tooth flank  $F_{u\ spez}$  in N per 10 mm belt width and per meshing tooth for CONTI® SYNCHRODRIVE STD synchronous drive belts S 3M, S 5M, S 8M

| Tab. 22 Allowable tension member load* $F_{zul}$ in N at 0.4% elongation |     |      |      |      |      |      |      |       |       |      |
|--|-----|------|------|------|------|------|------|-------|-------|------|
| CONTI® SYNCHRODRIVE STD synchronous drive belts - S 3M, S 5M, S 8M       |     |      |      |      |      |      |      |       |       |      |
| Tooth profile  |     | S 3M | S 5M |      |      |      | S 8M |       |       |      |
| Type/Version   |     | HP   | HF   | HP   | HS   | V-HF | HF   | HP    | HS    | V-HF |
| Belt width b mm  | 5   | 150  | 150  |      |      |      |      |       |       |      |
|  | 10  | 300  | 300  | 650  | 1200 |      | 650  |       |       |      |
|  | 15  | 450  | 450  | 975  | 1800 |      | 975  | 1800  | 3150  |      |
|  | 20  | 600  | 600  | 1300 | 2400 | 300  | 1300 | 2400  | 4200  |      |
|  | 25  | 750  | 750  | 1625 | 3000 | 375  | 1625 | 3000  | 5250  | 750  |
|  | 30  | 900  | 900  | 1950 | 3600 | 450  | 1950 | 3600  | 6300  | 900  |
|  | 50  | 1500 | 1500 | 3250 | 6000 | 750  | 3250 | 6000  | 10500 | 1500 |
|  | 85  |      |      |      |      |      | 5525 | 10200 | 17850 | 2550 |
|  | 100 |      |      |      |      |      | 6500 | 12000 | 21000 | 3000 |
|  | 115 |      |      |      |      |      |      |       | 24150 |      |
|  | 120 |      |      |      |      |      |      |       | 25200 |      |

\* The breaking load equals about factor 4 in relation to the admissible load on the tension members.

| Tab. 23 Specific spring constant $c_{spez}$ in N/mm                |      |                  |                  |                 |                 |                 |                 |                 |
|--|------|------------------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| CONTI® SYNCHRODRIVE STD synchronous drive belts - S 3M, S 5M, S 8M |      |                  |                  |                 |                 |                 |                 |                 |
| Tooth profile  |      | S 3M             | S 5M             |                 |                 | S 8M            |                 |                 |
| Type/Version   |      | HP               | HF               | HP              | HS              | HF              | HP              | HS              |
| $c_{spez}$   | N/mm | $7,5 \cdot 10^3$ | $7,5 \cdot 10^3$ | $20 \cdot 10^3$ | $35 \cdot 10^3$ | $20 \cdot 10^3$ | $35 \cdot 10^3$ | $53 \cdot 10^3$ |

# Calculation of synchronous belt drives

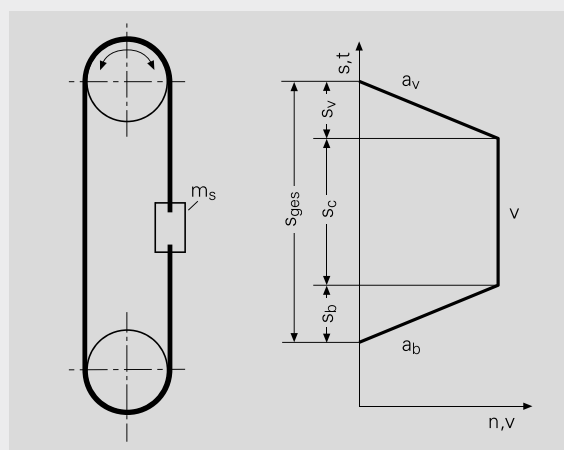
## Examples of design procedure steps: Lifting drive

Fig. 8

### Example

Determine the CONTI® SYNCHRODRIVE synchronous drive belt needed for a lifting drive with the following specification:

|                               |                           |
|-------------------------------|---------------------------|
| Pitch length of the belt      | $L_W = 6000 \text{ mm}$   |
| Pitch diameter of the pulleys | $d_W = 80 \text{ mm}$     |
| Mass of the carriage          | $m_s = 45 \text{ kg}$     |
| Friction force                | $F_R = 50 \text{ N}$      |
| Travel at $v_{\text{const}}$  | $s_c = 2,0 \text{ m}$     |
| Travel speed                  | $v = 2 \text{ m/s}$       |
| Acceleration                  | $a_b = 8,0 \text{ m/s}^2$ |
| Braking deceleration          | $a_v = 8,0 \text{ m/s}^2$ |



Lifting drive – principle and motion diagram

### Calculate linear monementum

Acceleration distance

$$s_b = \frac{v^2}{2 \cdot a_b} \quad s_b = \frac{2^2}{2 \cdot 8} = 0,25 \text{ m}$$

Braking distance

$$s_v = \frac{v^2}{2 \cdot a_v} \quad s_v = \frac{2^2}{2 \cdot 8} = 0,25 \text{ m}$$

Total travel

$$s_{\text{ges}} = s_b + s_c + s_v \quad s_{\text{ges}} = 0,25 + 2,0 + 0,25 = 2,5 \text{ m}$$

### Pulleys

Pitch diameter  $d_W$   
from Table 9 on  
page 13

Selected:  $d_W = 81.49 \text{ mm}$   
 $z = 32$

Design-specific  
finished bore

$d_F = 40 \text{ mm}$

Mass of the pulleys according to  
manufacturer's  
specification

$m_{\text{Sch}} = 1,53 \text{ kg}$

Pulley designation

HTD Pulley  
P 32 – 8M – 30

### Select tooth profile

$$F_U = m_s \cdot a_b + m_s \cdot g$$

$$F_U = 45 \cdot 8 + 45 \cdot 9,81 = 801,5 \text{ N}$$

Select profile  
Selected:

CONTI® SYNCHRODRIVE synchronous drive belt  
profile 8M  
width 30 mm  
type M HP



### Precisely determine the maximum effective pull to be transmitted

Mass of carriage  $m_s$

$$m_s = 45 \text{ kg}$$

Mass of belt  $m_R$

$$m_R = m_{\text{spez}} \cdot b \cdot L_w$$

Weight from Table 1 on page 7

$$m_R = 6,32 \cdot 10^{-3} \cdot 30 \cdot 6 = 1,14 \text{ kg}$$

Reduced mass of the pulleys

$$m_{\text{Sch red}} = \frac{m_{\text{Sch}}}{2} \cdot \left(1 + \frac{d_F^2}{d_a^2}\right)$$

$$m_{\text{Sch red}} = \frac{1,53}{2} \cdot \left(1 + \frac{40^2}{80,12^2}\right) = 0,96 \text{ kg}$$

Total mass

$$m_{\text{ges}} = m_s + m_R + m_{\text{Sch red}}$$

$$m_{\text{ges}} = 45 + 1,14 + 0,96 = 47,1 \text{ kg}$$

Maximum effective pull to be transmitted

$$F_{u \text{ max}} = m_{\text{ges}} \cdot a_b + m_s \cdot g + F_R$$

$$F_{u \text{ max}} = 47,1 \cdot 8 + 45 \cdot 9,81 + 50 = 868 \text{ N}$$

### Calculation factors

Tooth in mesh factor

$c_1$  from page 20

$$c_1 = 12$$

Load factor for average fluctuation load

$c_2$  from Table 18 on page 20

$$c_2 = 1,7$$

Acceleration factor  $c_3$

from Table 19 on page 20

$$c_3 = 0$$

Overall service factor

$$c_0 = c_2 + c_3$$

$$c_0 = 1,7 + 0 = 1,7$$

### Determine belt width in accordance with allowable flank load

$$b_{\text{err}} = \frac{F_{u \text{ max}} \cdot c_0 \cdot 10}{F_{u \text{ spez}} \cdot c_1}$$

$F_{u \text{ spez}}$  from Table 6 on page 24

$$b_{\text{err}} = \frac{868 \cdot 1,7 \cdot 10}{43 \cdot 12} = 29 \text{ mm}$$

Requirement

$$b > b_{\text{err}}$$

Next grater belt width  $b$

from Table 2 on page 7

$$\text{Selected: } b = 30 \text{ mm}$$

# Calculation of synchronous belt drives

## Belt installation tension

The following applies for linear drives:

$$F_T \geq F_{U \max}$$

Selected:

$$F_T = 900 \text{ N} > 868 \text{ N}$$

Max. belt tension dynamic

$$F_{T \max} = F_T + F_{U \max}$$

$$F_{T \max} = 900 + 868 = 1768 \text{ N}$$

Takeup allowance for linear drives

$$\Delta a = \frac{F_T \cdot L_W \cdot 10^3}{2 \cdot c_{\text{spez}} \cdot b}$$

$$\Delta a = \frac{900 \cdot 6000}{2 \cdot 35 \cdot 30} = 2,6 \text{ mm}$$

$c_{\text{spez}}$  from Table 21 on page 25

Alternatively it is possible to install the pretension via frequency measurement method. Therefore it is necessary to move the clamp end nearby (about 1 m) to the deflection point. This freely chosen span length can be used for calculation and measurements. See also page S. 22.

Free span length

Selected:  $L_f = 1 \text{ m}$

Weight m per m length

$$m = m_{\text{spez}} \cdot b$$

$m_{\text{spez}}$  from Table 1, Page 7

$$m = 6,32 \cdot 10^{-3} \cdot 30 = 0,19 \frac{\text{kg}}{\text{m}}$$

## Belt tension frequency

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

$$f = \sqrt{\frac{900}{4 \cdot 0,19 \cdot 1^2}} = 34 \text{ Hz}$$

The belt has the right pretension when the measured frequency is the same as the calculated frequency.

## Check allowable tension member load

$F_{\text{zul}}$  = from Table 20, Page 25

Requirement

$$F_{\text{zul}} \geq F_{T \max} \cdot c_0$$

$$F_{\text{zul}} = 3600 \text{ N}$$

$$3600 > 1768 \cdot 1,7$$

$$3600 > 3006$$

Requirement is fulfilled, i.e. the allowable tension member load is greater than the maximum belt tension taking the service factor into consideration.

Design choice:

CONTI® SYNCHRODRIVE HTD synchronous drive belt  
M 6 – 8M – 30 HP

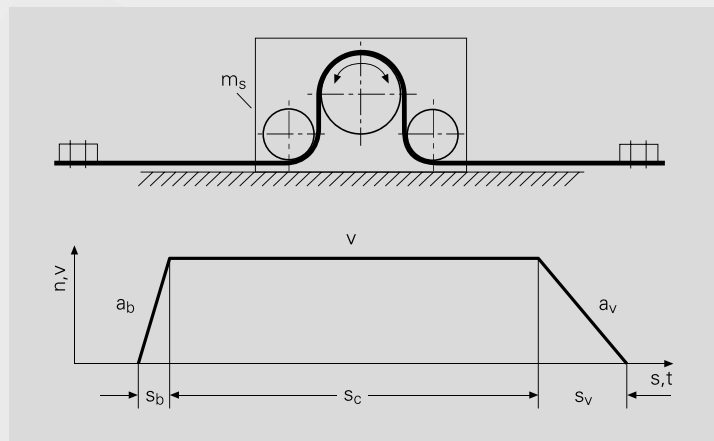
## Examples of design procedure steps: Linear drive

### Example

Determine the CONTI® SYNCHRODRIVE synchronous drive belt needed for a linear drive with the following specification:

|                              |                         |
|------------------------------|-------------------------|
| Pitch length of the belt     | $L_W = 8000 \text{ mm}$ |
| Pitch diameter of the pulley | $d_W = 80 \text{ mm}$   |
| Idler diameter               | $d < 60 \text{ mm}$     |
| Mass of carriage             | $m_s = 30 \text{ kg}$   |
| Coefficient of friction      | $\mu = 0,6$             |
| Travel time                  | $t_c = 3 \text{ s}$     |
| Travel at $v_{\text{const}}$ | $s_c = 5,0 \text{ m}$   |
| Acceleration distance        | $s_b = 0,5 \text{ m}$   |
| Braking distance             | $s_v = 1,5 \text{ m}$   |

Fig. 9



Linear drive – principle and motion diagram

### Calculate acceleration and braking deceleration

Travel speed

$$v = \frac{s_c}{t_c} = \frac{5}{3} = 1,67 \text{ m/s}$$

Acceleration

$$a_b = \frac{v^2}{2 \cdot s_b} = \frac{1,67^2}{2 \cdot 0,5} = 2,79 \text{ m/s}^2$$

Braking deceleration

$$a_v = \frac{v^2}{2 \cdot s_v} = \frac{1,67^2}{2 \cdot 1,5} = 0,93 \text{ m/s}^2$$

### Select tooth profile

Approximate calculation of  
effective pull to be transmitted

$$F_u = m_s \cdot a_b + m_s \cdot g \cdot \mu$$

$$F_u = 30 \cdot 2,79 + 30 \cdot 9,81 \cdot 0,6 = 260 \text{ N}$$

Select profile from

Fig. 5,  
page 23

Selected:

CONTI® SYNCHRODRIVE  
synchronous drive belt, profile 5M  
width 30 mm  
type M HP

# Calculation of synchronous belt drives

## Pulleys

Pitch diameter  $d_w$  from Table 8, Page 12Selected:  $d_w = 60,48 \text{ mm}$   
 $z = 38$ 

Design-specific finished bore

 $d_F = 30 \text{ mm}$ 

Mass of the pulleys according to manufacturer's specification

 $m_{Sch} = 0,47 \text{ kg}$ 

Pulley designation

HTD Pulley P 38 – 5M – 15

## Deflector idlers

Diameter

Selected:  $d_a = 55 \text{ mm}$ 

Finished bore

 $d_F = 30 \text{ mm}$ 

Mass of deflector idlers according to manufacturer's specification

 $m_U = 0,43 \text{ kg}$ 

## Precisely determine the maximum effective pull to be transmitted

Reduced mass of the idlers

$$m_{U \text{ red}} = \frac{m_U}{2} \cdot \left(1 + \frac{d_F^2}{d^2}\right)$$

$$F_{U \text{ max}} = (m_s + m_{Sch} + 2 \cdot m_U) \cdot a_b + 2 \cdot m_{U \text{ red}} \cdot a_b + (m_s + m_{Sch} + 2 \cdot m_U) \cdot g \cdot \mu$$

$$m_{U \text{ red}} = \frac{0,43}{2} \cdot \left(1 + \frac{30^2}{55^2}\right) = 0,28 \text{ kg}$$

$$F_{U \text{ max}} = (30 + 0,47 + 2 \cdot 0,43) \cdot 2,79 + 2 \cdot 0,28 \cdot 2,79 + (30 + 0,47 + 2 \cdot 0,43) \cdot 9,81 \cdot 0,6 = 273 \text{ N}$$

## Calculation factor

Tooth in mesh factor  $c_1$  page 20 $c_1 = 12$ Load factor for low-fluctuation load  $c_2$  from Table 18, Page 20 $c_2 = 1,4$ Acceleration factor  $c_3$  from Table 19, Page 20 $c_3 = 0$ Overall service factor  $c_0 = c_2 + c_3$  $c_0 = 1,4 + 0 = 1,4$



**Determine belt width in accordance with allowable flank load**

$$b_{err} = \frac{F_{u\ max} \cdot c_0 \cdot 10}{F_{u\ spez} \cdot c_1}$$

$F_{u\ spez}$  from Fig. 6, Page 24

Requirement  $b > b_{err}$

Next greater belt width  $b$  from Table 2, Page 7

$$b_{err} = \frac{273 \cdot 1,4 \cdot 10}{25 \cdot 12} = 13\ \text{mm}$$

Selected:  $b = 15\ \text{mm}$

**Belt installation tension**

The following applies for linear drives:

$$F_T \geq F_{u\ max}$$

Max. belt tension dynamic

$$F_{T\ max} = F_T + F_{u\ max}$$

Takeup allowance for linear drives

$$\Delta a = \frac{F_T \cdot L_w}{c_{spez} \cdot b}$$

$c_{spez}$  from Table 21, Page 25

Selected:

$$F_T = 300\ \text{N} > 273\ \text{N}$$

$$F_{T\ max} = 300\ \text{N} + 273 = 573\ \text{N}$$

$$\Delta a = \frac{300 \cdot 8000\ \text{mm}}{20 \cdot 10^3 \cdot 15} = 8,0\ \text{mm}$$

Alternatively it is possible to install the pretension via frequency measurement method. Therefore it is necessary to move the clamp end nearby (about 1 m) to the deflection point. This freely chosen span length can be used for calculation and measurements. See also page 22.

Free span length

Selected:  $L_f = 1\ \text{m}$

Weight  $m$  per  $m$  length

$$m = m_{spez} \cdot b$$

$m_{spez}$  from Table 1, Page 7

$$m = 4,06 \cdot 10^{-3} \cdot 15 = 0,0609\ \frac{\text{kg}}{\text{m}}$$

**Belt tension frequency**

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

$$f = \sqrt{\frac{300}{4 \cdot 0,0609 \cdot 1^2}} = 35\ \text{Hz}$$

The belt has the correct pretension when the measured frequency is the same as the calculated frequency.

**Check allowable tension member load**

$F_{zul}$  = from Table 20, Page 25

Requirement:  $F_{zul} \geq F_{T\ max} \cdot c_0$

$$F_{zul} = 975\ \text{N}$$

$$975 > 573 \cdot 1,4$$

$$975 > 802$$

Requirement is fulfilled, i. e. the allowable tension member load is greater than the maximum belt tension taking the service factor into consideration.

**Design choice**

CONTI® SYNCHRODRIVE HTD synchronous drive belt  
M8 – 5M – 15 HP

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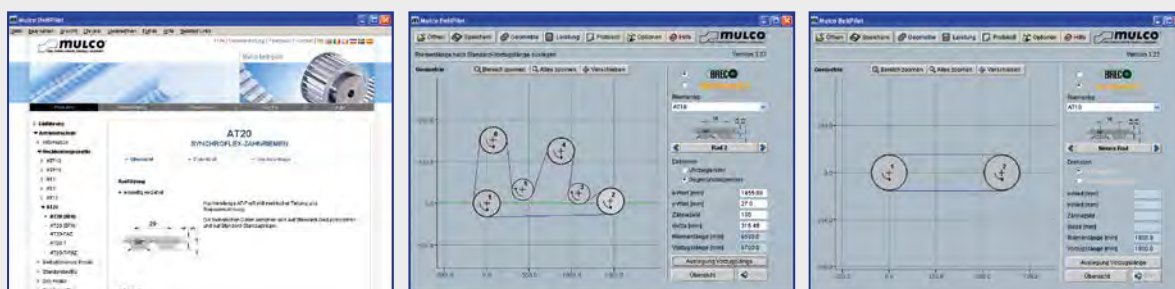
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# Mulco b@lt-pilot

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# Polyurethane timing belt welder

## Welds what belongs together

### The portable TSG 4 welder – ready for a quick change

Even top-quality products will eventually wear out. The same applies to polyurethane timing belts which, from time to time, need to be replaced. We designed the portable TSG welder to assist you in replacing drive units that take a lot of mounting effort and are difficult to access due to upstream machine components. The portable TSG welder is easy to operate and allows you to weld polyurethane timing belts onsite, immediately in or at the machine. The TSG 4 welding unit is available in two versions: for belt widths up to 50 mm and for belt widths up to 100 mm.

#### One welder, many benefits

- Suitable for all timing belt profiles
- Short machine downtimes
- Easy to operate
- Flexible through long power cords
- Welds and cools down in as little as about 30 minutes
- Air-cooled, no water supply required
- Powerful heater output

#### Standard package

- Welder with belt-specific, replaceable weld face
- Control unit for automatic welding and cooling down
- Control unit and welder connect by metal-reinforced cable
- Transport case with tools



#### Technical data TSG 4 - 50

Operating voltage: 230 V/50 Hz

Power consumption: 1.2 kW

Welder dimensions:

W 240 mm x H 220 mm x D 170 mm

Welder weight: approx. 7.5 kg\*

Control unit dimensions:

Type-III/TSG MR 10

W 350 mm x H 166 mm x D 355 mm

Control unit weight: approx. 9.0 kg

Carrying case weight: approx. 6.0 kg

#### Technical data TSG 4 - 100

Operating voltage: 230 V/50 Hz

Power consumption: 2 kW

Welder dimensions:

W 240 mm x H 220 mm x D 220 mm

Welder weight: approx. 9.5 kg\*

Control unit dimensions:

Type-III/TSG MR 10

B 350 mm x H 166 mm x D 355 mm

Control unit weight: approx. 9.0 kg

Carrying case weight: approx. 6.0 kg

\* including connecting leads



#### Special accessories

- Hydraulic punch
- Weld jigs for all standard belt profiles
- Punch box
- All units available separately

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## Sales partners Germany



Hilger u. Kern Antriebstechnik

Hilger u. Kern GmbH  
Antriebstechnik  
Käfertaler Straße 253  
68167 Mannheim  
Phone: +49 621 3705-0  
Fax: +49 621 3705-403  
e-mail: antriebstechnik@hilger-kern.de  
www.hilger-kern.com



Wilhelm Herm. Müller GmbH & Co. KG  
Heinrich-Nordhoff-Ring 14  
30826 Garbsen  
Phone: +49 5131 4522-0  
Fax: +49 5131 4522-110  
e-mail: info@whm.net  
www.whm.net



Roth GmbH & Co. KG  
Andernacher Straße 14  
90411 Nürnberg  
Phone: +49 911 99521-0  
Fax: +49 911 99521-70  
e-mail: info@roth-ing.de  
www.roth-ing.de



Anton Klocke Antriebstechnik GmbH  
Senner Straße 151  
33659 Bielefeld  
Phone: + 49 521 95005-01  
Fax: + 49 521 95005-11  
e-mail: info@klocke-antrieb.de  
www.klocke-antrieb.de



REIFF Technische Produkte GmbH  
Tübinger Straße 2-6  
72762 Reutlingen  
Phone: +49 7121 323-0  
Fax: +49 7121 323-318  
e-mail: zahnriemen@reiff-gruppe.de  
www.reiff-tp.de



Walter Rothermundt GmbH & Co. KG  
Am Tannenbaum 2  
41066 Mönchengladbach  
Phone: +49 2161 694620  
Fax: +49 2161 664469  
e-mail: info@rothermundt.de  
www.rothermundt.de

## Sales partner France



BINDER MAGNETIC  
1, Allée des Barbanniers  
92632 Gennevilliers Cedex  
France  
Phone: +33 1 461380-80  
Fax: +33 1 461380-99  
e-mail: info@binder-magnetic.fr  
www.binder-magnetic.fr

## Sales partner Sweden



Aratron AB  
Smidesvägen 4 – 8  
171 41 Solna  
Sweden  
Phone: +46 8 4041-600  
Fax: +46 8 984281  
e-mail: info@aratron.se  
www.aratron.se

## Sales partner Spain



Dinámica Distribuciones S.A.  
Ctra. N. II, km 592,6  
08740 S. Andreu de la Barca  
Spain  
Phone: +34 93 6533-500  
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## Sales partner Austria



Haberkorn GmbH  
Modecenterstraße 7  
1030 Wien  
Austria  
Phone: +43 1 74074-0  
Fax: +43 1 74074-99  
e-mail: antriebselemente@haberkorn.com  
www.haberkorn.com

## Sales partner Great Britain



Transmission Developments Co. (GB) Ltd  
Dawkins Road  
Poole, Dorset, BH15 4HF  
Great Britain  
Phone: +44 1202 675555  
Fax: +44 1202 677466  
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