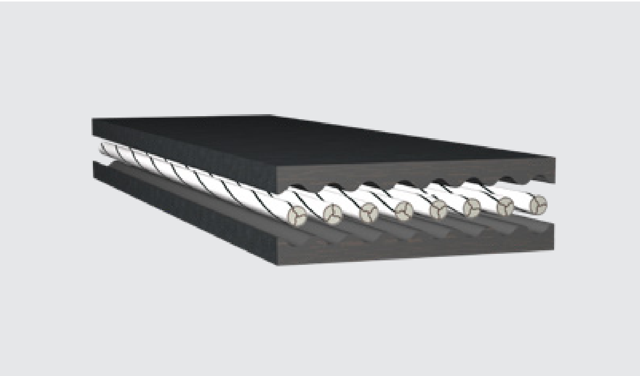
SPECIAL DRIVES
PRODUCT DESCRIPTION
optibelt OPTIMAX HF2
ENDLESS HIGH-PERFORMANCE FLAT BELTS

Structure
The new generation of the optibelt OPTIMAX HF2 high-performance flat belt is manufactured using an optimised production process. Precisely wound polyester tensile cords are used, enclosed on both sides by a high-quality polychloroprene rubber compound. During final finishing, the flat belt is additionally ground on one side to ensure optimum running characteristics. In this new design, additional fabric layers have deliberately been omitted in the standard range, as this design already achieves the performance of the predecessor.



Characteristics
The optibelt OPTIMAX HF2 features the following characteristics:
- full replacement for the predecessor optibelt OPTIMAX HF150 without modifications*
- very good flexibility
- minimum pulley diameter (d_{min} 15 mm)
- high belt speeds
- high efficiency
- very smooth running
- antistatic properties (based on ISO 9563)
- good resistance to ozone and a wide range of chemicals
- temperature range from −30 °C to +90 °C
- manufactured without intentionally added PFAS

*Due to the new specific weight of the optibelt OPTIMAX HF2 high-performance flat belt, the same pre-tensioning force results only in a different pre-tensioning frequency.

The further-developed optibelt OPTIMAX HF2 high-performance flat belt offers a significant improvement in overall quality and transverse stiffness through its increased material thickness of 1.6 mm, without compromising its ability to operate on even the smallest pulley diameters. It is designed as a successor to the optibelt OPTIMAX HF150 and can be used in an existing drive without major modifications. Particular attention was paid to matching performance and elongation values, enabling direct replacement.

Our high-quality materials stand for reliability and durability. These properties are further underlined by the wide operating temperature range and good resistance to oil, grease, solvents and moisture.
Thanks to the ground inner surface, the optibelt OPTIMAX HF2 high-performance flat belt delivers remarkably smooth running, with low vibrations and noise emissions. This also enables belt speeds of more than 50 m/s.
Its electrical conductivity is another notable feature. The antistatic properties can be certified on request, based on ISO 9563.
Furthermore, the optibelt OPTIMAX HF2 high-performance flat belt features extended Optibelt marking, including symbols identifying belt properties and enabling improved traceability.

Applications
The optibelt OPTIMAX HF2 high-performance flat belts are primarily used for power transmission in applications involving low to medium torques or high speeds. Typical applications include machine tools, wood processing machinery, textile machinery, printing machinery and similar equipment. The optibelt OPTIMAX HF2 high-performance flat belt is also suitable for light transport applications and for use in garden and agricultural machinery. The embedded polyester tensile cord dampens shocks and vibrations and can contribute to a longer service life for the entire drive system.

Table 77

Type	Height [mm]	Height tolerance [mm]	Width tolerance [mm]	Minimum pulley diameter [mm]	Weight per metre per 1 mm of belt width [g]
HF2	1.6	± 0.15	± 0.5	15	2.2

SPECIAL DRIVES
STANDARD RANGE
optibelt OPTIMAX HF2

Table 78

Standard range optibelt OPTIMAX HF2							
610	880	1130	1370	1630	1900	2220	2660
625	890	1140	1390	1640	1920	2240	2700
630	900	1145	1400	1650	1930	2250	2780
640	910	1150	1410	1660	1940	2260	2850
660	915	1160	1420	1670	1950	2270	2860
670	920	1170	1430	1680	1960	2280	2950
680	930	1180	1440	1700	1970	2290	3000
690	935	1190	1450	1710	1980	2300	3050
700	940	1200	1460	1720	2000	2320	3150
710	960	1210	1470	1730	2020	2340	3200
720	970	1220	1480	1740	2040	2350	3250
730	980	1230	1490	1750	2050	2370	3300
740	990	1240	1500	1760	2060	2380	3480
750	1000	1250	1510	1770	2070	2400	
760	1010	1260	1520	1780	2080	2440	
780	1020	1270	1530	1800	2090	2450	
790	1030	1280	1540	1810	2110	2460	
800	1040	1290	1550	1820	2120	2480	
805	1050	1300	1560	1830	2130	2500	
810	1070	1310	1570	1840	2140	2520	
820	1080	1320	1580	1850	2150	2540	
830	1090	1330	1590	1860	2170	2550	
840	1100	1340	1600	1870	2190	2570	
850	1110	1350	1610	1880	2200	2600	
860	1120	1360	1620	1890	2210	2650	

Widths
The standard range is available in any width from 10 to 440 mm or, in some cases, 560 mm.

Sleeve widths: 440 mm, in some cases 560 mm

Tolerances
Length tolerance:
- > 610 mm nominal length ± 0.5 %

Width tolerance:
- Cut belts ± 0.5 mm

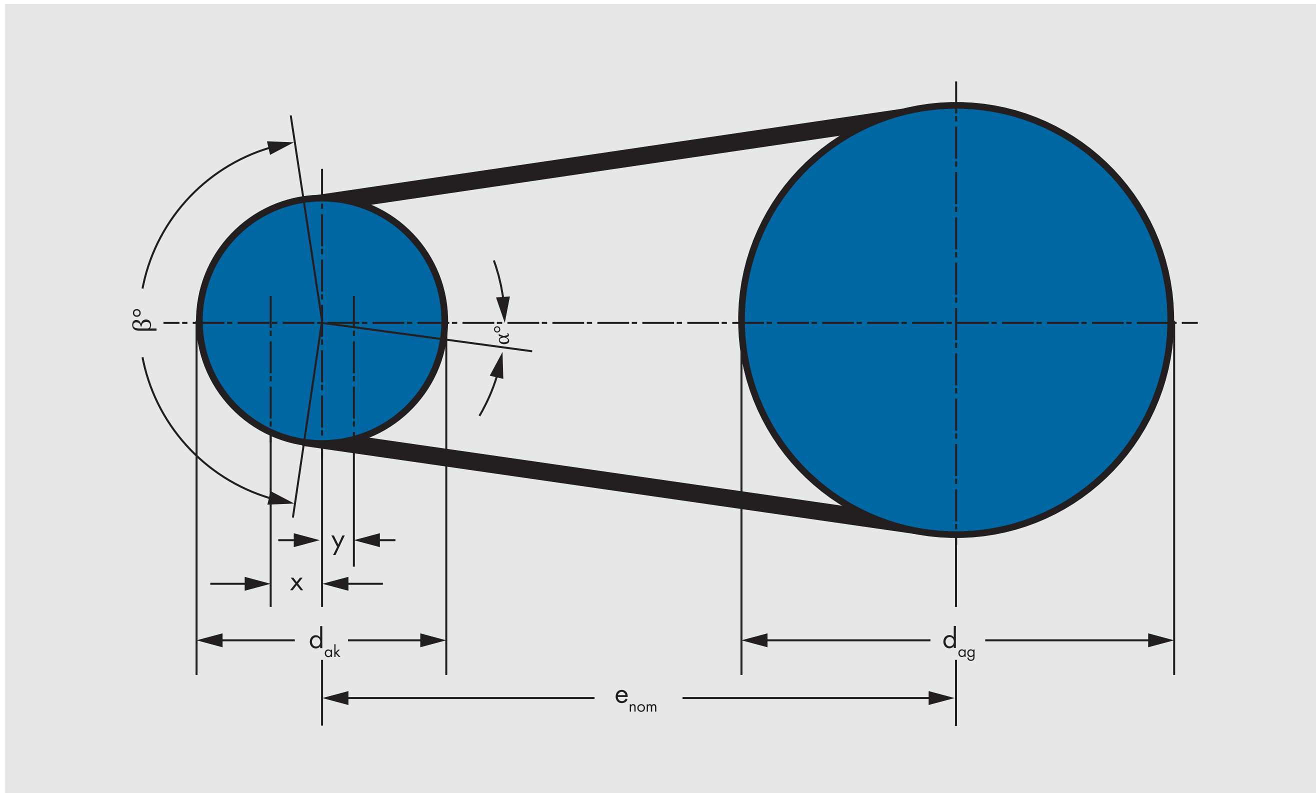
Sleeve-width tolerance:
- ± 10 mm

Delivery options
Special widths, lengths and heights as well as special materials, available on request.

SPECIAL DRIVES
CALCULATION
optibelt OPTIMAX HF2
ABBREVIATIONS USED IN FORMULAE

A	= Length addition value	[mm]
B	= Width of the flat belt	[mm]
c_0	= Base drive service factor	
c_1	= Arc of contact correction factor	
c_2	= Total drive service factor	
c_4	= Additional factor	
d_{a1}	= Outside diameter of driver pulley	[mm]
d_{a2}	= Outside diameter of driven pulley	[mm]
d_{ag}	= Outside diameter of large pulley	[mm]
d_{ak}	= Outside diameter of small pulley	[mm]
e	= Drive centre distance	[mm]
e_{nom}	= Drive centre distance, calculated with a standard belt length	[mm]
i	= Speed ratio	
L_{iSt}	= Standard inside length of the flat belt	[mm]
L_{ith}	= Calculated inside length of the flat belt	[mm]
L_{ad}	= Measured length after tensioning	[mm]
L	= Span length	[mm]
n_g	= Speed of large pulley	[min^{-1}]
n_k	= Speed of small pulley	[min^{-1}]
n_1	= Speed of driver pulley	[min^{-1}]
n_2	= Speed of driven pulley	[min^{-1}]
P	= Power to be transmitted by the belt drive	[kW*]
P_B	= Design power	[kW*]
P_N	= Power rating per 10 mm flat belt width	[kW*]
R	= Elongation factor	
S_a	= Minimum shaft loading	[N]
v	= Belt speed	[m/s]
x	= Minimum allowance above drive centre distance e_{nom} for tensioning and retensioning of the flat belt	[mm]
y	= Minimum allowance below drive centre distance e_{nom} for installation of the flat belt	[mm]
α	= Angle of belt run = $90° - \frac{\beta}{2}$	[°]
β	= Arc of contact on small pulley	[°]

* 1 kW = 1 kNm/s



SPECIAL DRIVES
CALCULATION
optibelt OPTIMAX HF2
BASE DRIVE SERVICE FACTOR c_0 – ARC OF CONTACT CORRECTION FACTOR c_1 – ADDITIONAL FACTOR c_4

Base drive service factor c_0

The base drive service factor c_0 takes into account the type of drive and driven machine. It applies exclusively to two-pulley drives and for a daily operating time of less than ten hours. No special conditions have been taken into account. Please observe the additional factor c_4.
Since it is practically impossible to condense every possible combination of drive unit, driven machine, and operating conditions into a standard-compliant short version, the drive service factors are **guide values**. In special cases, e.g. increased starting torque (direct starting with fans), drives with a high switching frequency, extraordinary impact load, considerable mass acceleration and deceleration, the drive service factor must be increased.
In cases of doubt. we recommend that you contact our consulting engineers.

Table 79

Examples for work machines	Examples for drive machines				
	Small motors	Single-phase and three-phase AC motors with normal starting torque (up to 1.8 times the nominal torque)	Single-phase AC motor with star-delta connection	Single-phase and three-phase AC motors with high starting torque (more than 1.8 times the nominal torque)	Single-phase and three-phase AC motors with high starting torque (more than 1.8 times the nominal torque) and direct starting
Light duty drives Centrifugal pumps, fans, etc.	1.0	1.2	1.3	1.5	1.6
Medium duty drives Textile machines, paper mills, presses, tool machines, wood processing machines, machines in the paper industry, rotating presses, printing machines, lifting tools, oil burners, etc.	1.2	1.4	1.5	1.7	1.8
Heavy duty drives Weaving looms, combing machines in the textile industry, calenders, crushers, cranes, ball mills, piston compressors, agricultural machines, band saws and circular saws. etc.	1.4	1.6	1.7	1.9	2.0

Arc of contact correction factor c_1

The arc of contact correction factor c_1 corrects the power rating P_N, when the arc of contact of the belt is smaller than 180°, since the P_N value of the arc of contact β = 180° was determined on the small pulley d_{ak}.

Additional factor c_4

If special conditions need to be taken into account on a drive, the additional factor c_4 is to be added to the base drive service factor c_0.

Table 80

$\frac{d_{ag} - d_{ak}}{e_{nom}}$	$\beta \approx$	c_1
0	180°	1.00
0.15	170°	0.94
0.35	160°	0.89
0.50	150°	0.84
0.70	140°	0.78
0.85	130°	0.72
1.00	120°	0.66
1.15	< 120°	0.60

Table 81

Operating conditions	c_4
Daily operating time ≥ 10 hours	0.20
Strong exposure to dust	0.30
Multi-pulley drive	0.40
Reversing operation	1.00
Fixed drive centre distance	1.00

SPECIAL DRIVES
CALCULATION
optibelt OPTIMAX HF2
FORMULAS AND CALCULATION EXAMPLE

Driving machine
Three phase AC motor with direct starting
P = 5 kW
n_1 = 3000 min^{-1}

Operating conditions
Starting: under load
Centre distance: selectable between 550 and 600 mm
Pulley diameter: freely selectable
Operating conditions: normal
Daily operating time: > 10 hours

Driven machine
Textile machine
P = 5 kW
n_2 = 5376 min^{-1}

Formulas	Calculation example
Total drive service factor $c_2 = c_0 + c_4$ c_0 from table 79, page 138 c_4 from table 81, page 138	$c_2 = 1.8 + 0.2 = \mathbf{2.0}$
Design power $P_B = P \cdot c_2$	$P_B = 5\ kW \cdot 2.0 = \mathbf{10\ kW}$
Speed ratio $i = \frac{n_1}{n_2} = \frac{d_{a2}}{d_{a1}}$	$i = \frac{3000\ min^{-1}}{5376\ min^{-1}} = \mathbf{0.56}$
Outside diameter of flat belt pulleys d_{a1} = selected from DIN 111 $d_{a2} = d_{a1} \cdot i$ $d_{a1} = \frac{d_{a2}}{i}$	d_{a1} = **224 mm** selected d_{a2} = 224 mm · 0.56 = 125.4 mm d_{a2} = **125 mm** selected from DIN 111
Drive centre distance (preliminary) e selectable between 550 and 600 mm	e = **580 mm** preliminary
Inside length of the flat belt $L_{ith} \approx 2e + 1.57\,(d_{ag} + d_{ak}) + \frac{(d_{ag} - d_{ak})^2}{4e}$	$L_{ith} \approx 2 \cdot 580 + 1.57 \cdot 349 + \frac{99^2}{4 \cdot 580} \approx 1712$ mm Next standard inside length selected from table 78, page 136 L_{iSt} = **1710 mm**

SPECIAL DRIVES
CALCULATION
optibelt OPTIMAX HF2
FORMULAS AND CALCULATION EXAMPLE

Formulas	Calculation example
Drive centre distance Calculated from L_{iSt} and L_{ith} (If $L_{iSt} > L_{ith}$) $e_{nom} \approx e + \frac{L_{iSt} - L_{ith}}{2}$ (If $L_{iSt} < L_{ith}$) $e_{nom} \approx e - \frac{L_{ith} - L_{iSt}}{2}$	$e_{nom} \approx 580 \text{ mm} - \frac{1712 \text{ mm} - 1710 \text{ mm}}{2} = \mathbf{579 \text{ mm}}$
Minimum allowance x/y for the drive centre distance e_{nom} x = 1.0% of L_{iSt} y = 0.5% of L_{iSt}	x = **17.0 mm** y = **8.5 mm**
Speed of the flat belt $v = \frac{d_{ak} \cdot n_k}{19100}$ ($v_{max} \approx 50$ m/s)	$v = \frac{125 \text{ mm} \cdot 5376 \text{ min}^{-1}}{19100} = \mathbf{35.18 \text{ m/s}}$
Arc of contact correction factor and arc of contact $\frac{d_{ag} - d_{ak}}{e_{nom}}$ β approximated and c_1 from table 80, page 138	$\frac{224 \text{ mm} - 125 \text{ mm}}{579 \text{ mm}}$ c_1 = **0.94** β ≈ **170°**
Power rating per 10 mm flat belt width P_N from table 82, page 141	P_N = **3.18 kW** by linear interpolation
Width of the flat belt $B = \frac{P \cdot c_2 \cdot 10}{P_N \cdot c_1}$	$B = \frac{5 \text{ kW} \cdot 2 \cdot 10}{3.18 \text{ kW} \cdot 0.94} = 33.5 \text{ mm}$ Design: **1 optibelt OPTIMAX HF2 high-performance flat belt HF2 1710 x 35**
Determination of the belt tension with length addition value A = L · R (L and R see page 141) L_{ad} = L + A	A = 1710 mm · 0.007 = **11.97 mm** L_{ad} = 1710 mm + 10 mm = **1720 mm**

SPECIAL DRIVES
CALCULATION
optibelt OPTIMAX HF2
POWER RATING AND BELT TENSION

Table 82

Belt speed v [m/s]	Transferable power per 10 mm belt width [kW] HF2
2	0.18
3	0.22
4	0.37
5	0.46
6	0.56
7	0.65
8	0.75
9	0.82
10	0.89
11	0.93
12	1.11
13	1.21
14	1.31
15	1.41
16	1.51
17	1.57
18	1.63
19	1.69
20	1.75
21	1.82
22	1.89
23	1.99
24	2.09
25	2.19
26	2.28
27	2.39
28	2.50
29	2.60
30	2.70
31	2.81
32	2.91
33	3.01
34	3.11
35	3.18
36	3.25
37	3.33
38	3.40
39	3.48
40	3.55
41	3.58
42	3.60
43	3.63
44	3.65
45	3.66
46	3.70
47	3.73
48	3.75
49	3.78
50	3.80

Tension of flat belts
The correct level of belt tension is of enormous importance for trouble-free transmission of power and for achieving an acceptable belt service life.
Often tension which is either too high or too low results in early belt failure. Over tensioning often leads to bearing failure on the driver or the driven machine.
It has been shown that common tensioning instructions, such as using the "thumb pressure deflection method", are not suitable for obtaining optimum tension for operating at full efficiency.
Over- or undertensioning of the drive can be avoided if the tension is calculated, set or checked according to the following method.

Tension through span force
An optimum tension is achieved if a span force of 300 N per 10 mm belt width is applied for type HF2.
This belt tension approximately corresponds to an elongation of 0.7% of the belt length.
The span force can be checked easily on a belt width of up to 50 mm with the aid of optibelt TT using the frequency measuring method. If the frequency has been determined, the span force can be calculated as follows:
$T = 4 \cdot k \cdot L^2 \cdot f^2$
T = Span force [kN]
k = Mass per metre per mm of belt width [g/m]
L = Span length [m]
f = Frequency [Hz]

Checking the tension with a length addition value
The length (L) of the relevant flat belt is measured in an untensioned condition on the top surface of the belt.
Calculate the length addition value "A" by using the formula:
A = L · R (elongation value)
R = 0.007 for type HF2

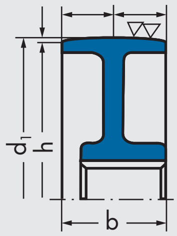
This length addition value A should then be added to the measured length.
The flat belts are now tensioned until the calculated length is reached (length + length addition value A). The belt is then correctly tensioned.
If the drive is to be retensioned, the belt must first be slackened off so that it can be measured in a tension-free state.

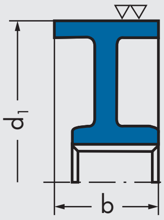
After that, follow the procedure described above.

A	= Length addition value	[mm]
L	= Length of flat belt	[mm]
L_{ad}	= Measured length after tensioning	[mm]
R	= Elongation factor	[mm]

SPECIAL DRIVES
optibelt OPTIMAX HF2
FLAT BELT PULLEYS
STANDARDS – SELECTION CRITERIA – TYPES

Crowned





Cylindrical

Flat belt pulleys are an essential part of the flat belt drive. They are predominantly manufactured from EN-GJL 200 cast iron in accordance with DIN EN 1561 and are available with a pilot bore, finished bore or Taper-Bushing system. Other materials, such as steel or aluminium can also be used depending on the drive conditions.
When selecting the flat belt pulleys, the following must be adhered to:

- Use standardised pulley diameters. If this is not possible for structural reasons, a standardised diameter should be selected for the largest pulley.
- Do not use less than the minimum pulley diameter in the interest of the belt lifetime and the efficiency of the drive.

Minimum pulley diameter
HF2 = 15 mm

- If flat belt pulleys are manufactured in-house, their design and machining must comply with DIN 111.
- Flat belt pulleys are generally balanced in one plane (statically) to balancing quality grade G 16 in accordance with DIN ISO 21940-11.
- Balancing in two planes (dynamically) to balancing quality grade G 6.3 is required if:
  1. v > 30 m/s or
  2. the ratio of diameter to pulley face width is d : b < 4 with v > 20 m/s.
- Flanged pulleys should be avoided if possible.

Pulley face widths
When selecting flat belt pulleys, a suitable width must be ensured. The following rule applies: Belt width plus 10%.

Pulley type
The flat belt pulley should be of cylindrical or crowned design. When using crowned pulleys, the crown height specified in DIN 111 must be observed (also see tables).

Table 83

<table>
<tr><th colspan="2">Diameter d_1 [mm]</th><th rowspan="2">Crown height
h
[mm]</th><th rowspan="2">Run-out toler-
ance
t
[mm]</th></tr>
<tr><th>Nominal size</th><th>Permissible deviation</th></tr>
<tr><td>40</td><td>± 0.5</td><td rowspan="3">0.3</td><td rowspan="7">0.2</td></tr>
<tr><td>50</td><td>± 0.6</td></tr>
<tr><td>63</td><td>± 0.8</td></tr>
<tr><td>71</td><td rowspan="2">± 1</td><td rowspan="2">0.3</td></tr>
<tr><td>80</td></tr>
<tr><td>90</td><td rowspan="2">± 1.2</td><td rowspan="2">0.3</td></tr>
<tr><td>100</td></tr>
<tr><td>112</td><td>± 1.2</td><td>0.3</td><td rowspan="4">0.3</td></tr>
<tr><td>125</td><td rowspan="2">± 1.6</td><td rowspan="2">0.4</td></tr>
<tr><td>140</td></tr>
<tr><td>160</td><td>± 2</td><td>0.5</td></tr>
<tr><td>180</td><td rowspan="2">± 2</td><td>0.5</td><td rowspan="4">0.4</td></tr>
<tr><td>200</td><td>0.6</td></tr>
<tr><td>224</td><td rowspan="2">± 2.5</td><td>0.6</td></tr>
<tr><td>250</td><td>0.8</td></tr>
<tr><td>280</td><td rowspan="3">± 3.2</td><td>0.8</td><td rowspan="3">0.5</td></tr>
<tr><td>315</td><td rowspan="2">1</td></tr>
<tr><td>355</td></tr>
</table>

In the case of diameters < 400 mm, the crown height does not depend on the pulley face width (DIN 111).

Table 84

<table>
<tr><th colspan="2">Diameter
d_1 [mm]</th><th colspan="7" rowspan="2">Crown height h [mm]
(depending on the face width)</th><th rowspan="2">Run-out tolerance
t
[mm]</th></tr>
<tr><th>Nominal size</th><th>Perm. dev.</th></tr>
<tr><td>400</td><td rowspan="3">± 4</td><td rowspan="3">1</td><td rowspan="2">1.2</td><td rowspan="2">1.2</td><td rowspan="2">1.2</td><td rowspan="2">1.2</td><td rowspan="2">1.2</td><td rowspan="2">1.2</td><td>0.5</td></tr>
<tr><td>450</td><td>0.6</td></tr>
<tr><td>500</td><td>1.5</td><td>1.5</td><td>1.5</td><td>1.5</td><td>1.5</td><td>1.5</td><td>0.6</td></tr>
<tr><td>560</td><td rowspan="3">± 5</td><td rowspan="3">1</td><td rowspan="3">1.5</td><td>1.5</td><td>1.5</td><td>1.5</td><td>1.5</td><td>1.5</td><td rowspan="2">0.6</td></tr>
<tr><td>630</td><td rowspan="2">2</td><td rowspan="2">2</td><td rowspan="2">2</td><td rowspan="2">2</td><td rowspan="2">2</td></tr>
<tr><td>710</td><td>0.8</td></tr>
<tr><td>800</td><td rowspan="3">± 6.3</td><td rowspan="3">1</td><td rowspan="3">1.5</td><td rowspan="3">2</td><td rowspan="3">2.5</td><td rowspan="2">2.5</td><td rowspan="2">2.5</td><td rowspan="2">2.5</td><td rowspan="3">0.8</td></tr>
<tr><td>900</td></tr>
<tr><td>1000</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>1120</td><td rowspan="3">± 8</td><td rowspan="2">1.2</td><td rowspan="2">1.5</td><td rowspan="2">2</td><td rowspan="2">2.5</td><td rowspan="2">3</td><td>3</td><td>3.5</td><td rowspan="3">1</td></tr>
<tr><td>1250</td><td>3.5</td><td>4</td></tr>
<tr><td>1400</td><td>1.5</td><td>2</td><td>2.5</td><td>3</td><td>3.5</td><td>4</td><td>4</td></tr>
<tr><td>1600</td><td rowspan="3">± 10</td><td>1.5</td><td>2</td><td>2.5</td><td>3</td><td>3.5</td><td>4</td><td>5</td><td>1</td></tr>
<tr><td>1800</td><td rowspan="2">2</td><td rowspan="2">2.5</td><td rowspan="2">3</td><td rowspan="2">3.5</td><td rowspan="2">4</td><td rowspan="2">5</td><td>5</td><td rowspan="2">1.2</td></tr>
<tr><td>2000</td><td>6</td></tr>
<tr><td colspan="2">Pulley face width
b
[mm]</td><td>≤125</td><td>140
160</td><td>180
200</td><td>224
250</td><td>280
315</td><td>355</td><td>≤400</td><td></td></tr>
</table>

