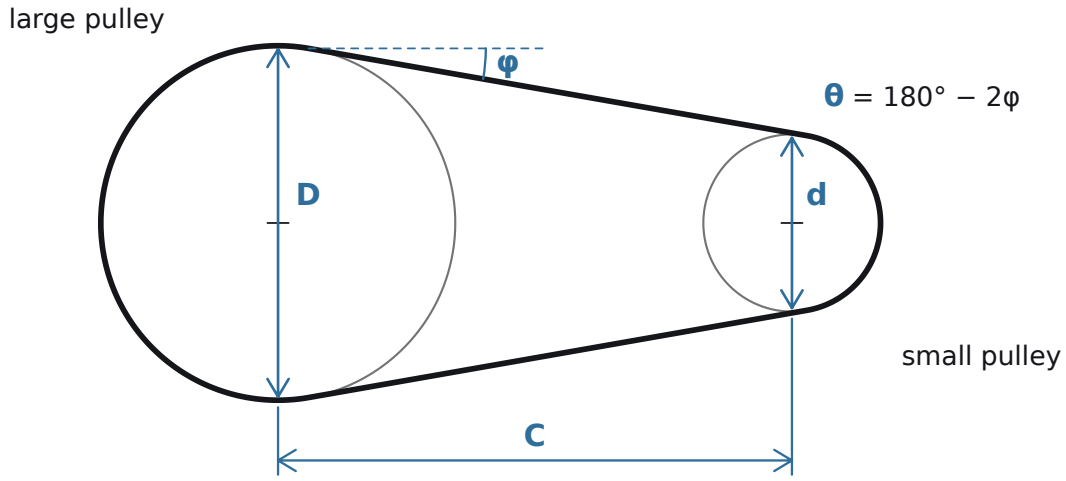
PRINTABLE REFERENCE CHART

Belt length: formulas, center distance and wrap angle

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1. Belt length formulas



Quantity	Formula
Span angle φ	sin φ = (D − d) / (2·C)
Exact length, open belt	L = 2·C·cos φ + π·(D + d)/2 + φ·(D − d)
Approximate length, open belt	L ≈ 2·C + π·(D + d)/2 + (D − d)² / (4·C)
Center distance for a length L	C = (b + √(b² − 8·(D − d)²)) / 8, with b = 2·L − π·(D + d)
Wrap angle	small pulley 180° − 2φ; large pulley 180° + 2φ
Speed ratio (no slip)	$i = n_1 / n_2 = D / d$
Belt speed	v (m/s) = π · d (mm) · n (rpm) / 60,000

φ is in radians in the exact formula. The approximate formula replaces cos φ and φ with their series expansions; the difference stays within a few hundredths of a millimetre as long as the pulleys are of similar size and the center distance is large compared with their difference (0.004 mm in the example below). With a high ratio and a short center distance it grows: for D = 400, d = 80 and C = 300 mm, 1,441.5 mm exact versus 1,439.3 mm approximate. D and d are the diameters the belt's neutral line runs on (see section 5).

3. Worked examples

Case	Calculation	Result
Open, D = 200, d = 100, C = 500 mm	φ = asin(100/1,000) = 0.1002 rad	**L = 1,476.24 mm (approximate: 1,476.24)**
Wrap angle	180° − 2 × 5.74°	**168.5° (small); 191.5° (large)**
Speeds, motor at 1,450 rpm on d	n_2 = 1,450 × 100/200; v = π × 0.1 × 1,450/60	**725 rpm; 7.59 m/s**
Stock belt of 1,500 mm	b = 3,000 − π × 300 = 2,057.5	**C = 511.94 mm**
Crossed, same pulleys, C = 500 mm	φ = asin(300/1,000) = 0.3047 rad	**L = 1,516.59 mm; wrap 214.9°**
GT2 timing belt (2 mm pitch), 20 and 40 teeth, C ≈ 100 mm	Pitch Ø 12.73 and 25.46; L = 260.4 mm = 130.2 teeth	**130-tooth belt: C = 99.80 mm**

For the 1,500 mm belt, the inverse formula from section 1 gives 511.94 mm and the exact formula 511.94 mm too (0.002 mm apart).

5. Timing, V- and flat belts: which diameter to use

The formulas apply to every belt type, provided you use the diameter the belt's neutral line runs on, the line that does not stretch in bending:

Belt	Diameter to use	Resulting length
Timing (synchronous)	Pitch diameter z·p/π (z teeth, pitch p)	Pitch length = pitch × number of belt teeth
V-belt	Datum (pitch) diameter of the groove, given by the pulley manufacturer	Datum (pitch) length; the inside length is shorter, by an amount that depends on the section
Flat	Pulley diameter + belt thickness	Mid-thickness length

Common timing belt pitches: 2 mm (GT2), 3, 5, 8 and 14 mm (HTD 3M to 14M profiles), 5.08 mm (XL, 1/5 inch) and 9.525 mm (L, 3/8 inch). For a V-belt, do the same with the catalogue's datum lengths, checking which length (inside or datum) it lists.

6. Belt length in Excel

With D in A2, d in B2, the center distance C in C2 and a stock belt length in D2 (example values: 200, 100, 500, 1,500):

Result	Excel or LibreOffice	Value
Exact length	`=2*C2*COS(ASIN((A2-B2)/(2*C2)))+PI()*(A2+B2)/2+ASIN((A2-B2)/(2*C2))*(A2-B2)`	1,476.243
Approximate length	`=2*C2+PI()*(A2+B2)/2+(A2-B2)^2/(4*C2)`	1,476.239
Small pulley wrap (°)	`=180-2*DEGREES(ASIN((A2-B2)/(2*C2)))`	168.52
Center distance for length D2	`=(2*D2-PI()*(A2+B2)+SQRT((2*D2-PI()*(A2+B2))^2-8*(A2-B2)^2))/8`	511.94

These formulas were checked in LibreOffice Calc on the example (values identical to the table in section 3).

Reference values taken from the article https://www.baouch.fr/en/blog/longueur-courroie-poulies-calcul/, which explains the assumptions, formulas and edge cases. For critical use, check the current standard or the manufacturer's documentation. Free to print and share with credit to the source.