Pulley Speed Calculation: Formula and Worked Examples

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Article address: https://drgmotor.com/en/blog/electric-motors/pulley-speed-calculation-formula

Technical assumptions

- The formula n1·D1 = n2·D2 gives the theoretical, no-slip value; with a V-belt the real speed is slightly lower.
- Diameters are pulley pitch (effective) diameters, not outside diameters. For timing belts use tooth counts.
- Motor speed is the rated speed on the nameplate (1450 and 2900 rpm in the examples); 1500/3000 rpm are synchronous values.
- Torque is estimated with T ≈ 9550·P/n, losses ignored. All values are examples.
- Belt profile, number of belts and pulleys are selected from the belt/pulley maker’s data; the motor is selected from its nameplate.

Safety notice

- This content is for technical information only. Wiring, measurement and commissioning must be carried out by qualified electrical personnel, following lock-out and verification of de-energised state, and in line with the motor and device manufacturer's documentation.

Suitable DRG motors and store

- DRG-112M-4 – 4 kW 1500 rpm: https://drgmotor.com/en/buy-electric-motors-online/4-kw-1500-rpm-three-phase-motor-aluminium-drg-112m-4
- DRG-132S-4 – 5.5 kW 1500 rpm: https://drgmotor.com/en/buy-electric-motors-online/5-5-kw-1500-rpm-three-phase-motor-aluminium-drg-132s-4
- DRG-132M1-6 – 4 kW 1000 rpm: https://drgmotor.com/en/buy-electric-motors-online/4-kw-1000-rpm-three-phase-motor-aluminium-drg-132m1-6
- DRG-132M-4 – 7.5 kW 1500 rpm: https://drgmotor.com/en/buy-electric-motors-online/7-5-kw-1500-rpm-three-phase-motor-aluminium-drg-132m-4
- https://drgmotor.com/en/buy-electric-motors-online

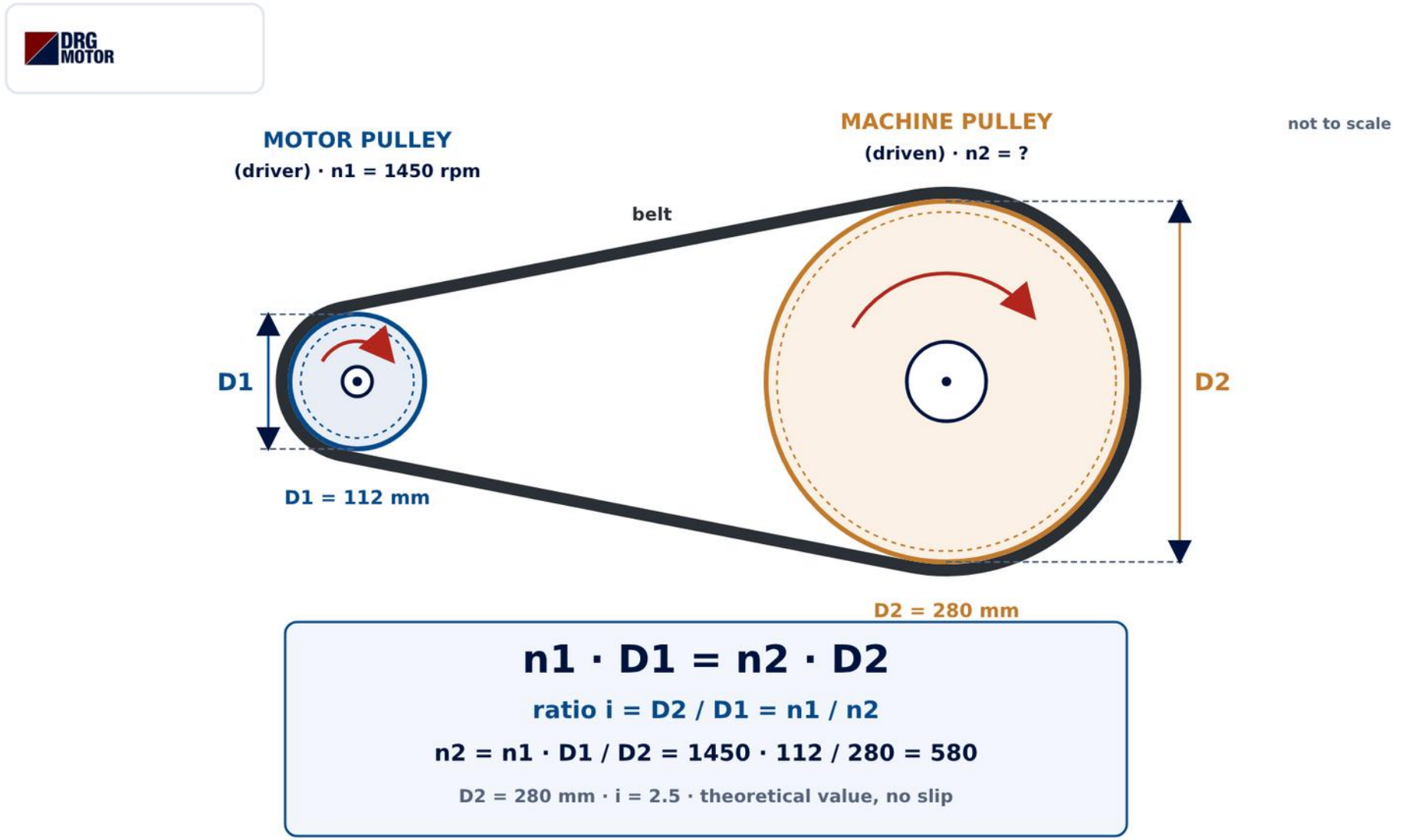

MOTOR PULLEY
(driver) · n1 = 1450 rpm
MACHINE PULLEY
(driven) · n2 = ?
not to scale
belt
D1
D2
D1 = 112 mm
D2 = 280 mm
n1 · D1 = n2 · D2
ratio i = D2 / D1 = n1 / n2
n2 = n1 · D1 / D2 = 1450 · 112 / 280 = 580
D2 = 280 mm · i = 2.5 · theoretical value, no slip
Pulley speed formula: n1 · D1 = n2 · D2
The large pulley turns slower, the small one faster · with an open belt both turn the same way

Figure 1

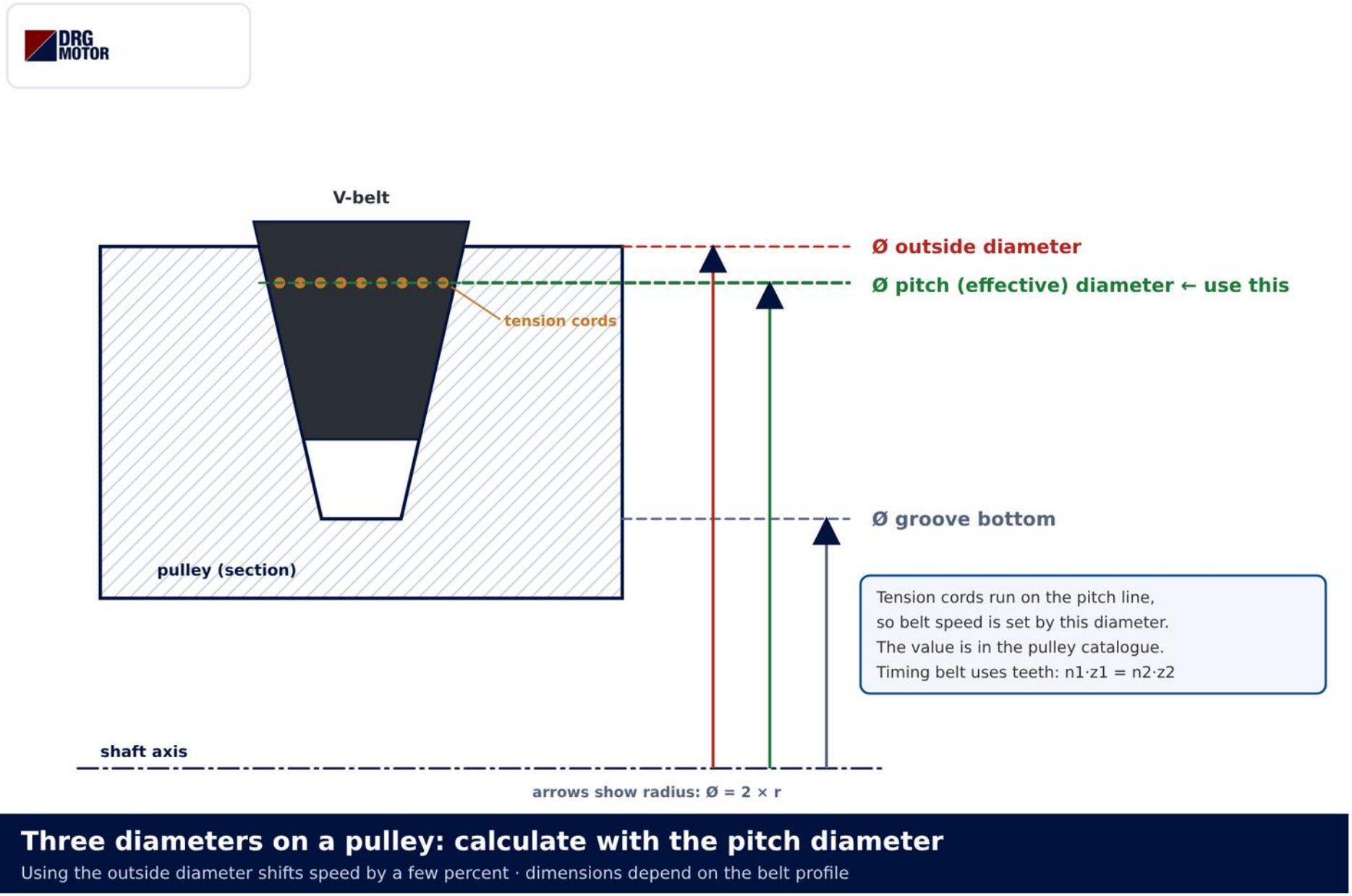

V-belt
Ø outside diameter
Ø pitch (effective) diameter ← use this
tension cords
Ø groove bottom
pulley (section)
Tension cords run on the pitch line,
so belt speed is set by this diameter.
The value is in the pulley catalogue.
Timing belt uses teeth: n1·z1 = n2·z2
shaft axis
arrows show radius: Ø = 2 × r
Three diameters on a pulley: calculate with the pitch diameter
Using the outside diameter shifts speed by a few percent · dimensions depend on the belt profile

Figure 2

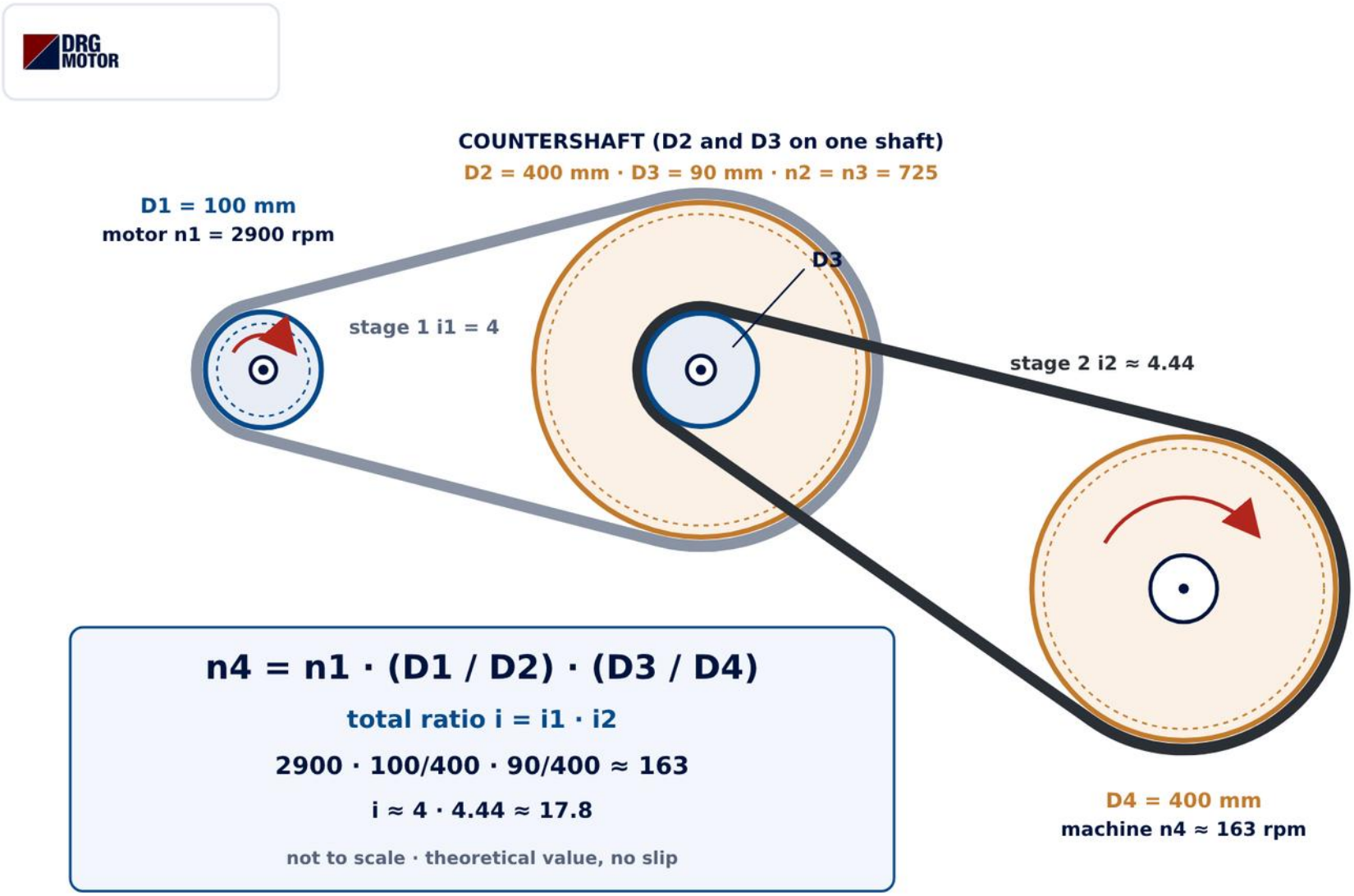
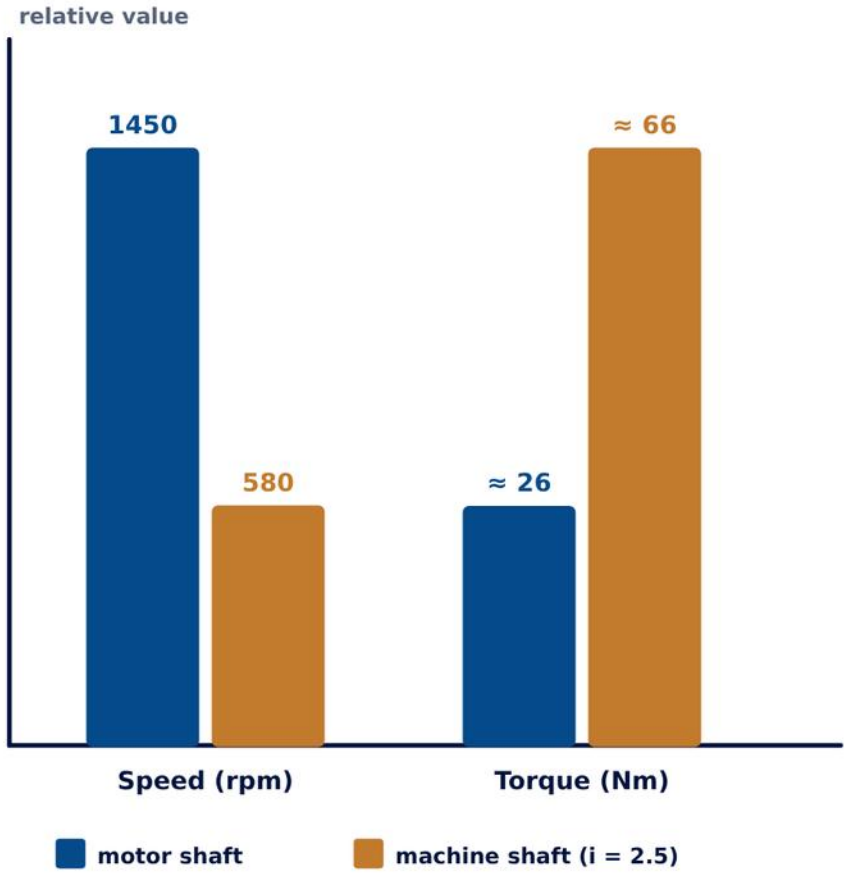

COUNTERSHAFT (D2 and D3 on one shaft)
D2 = 400 mm · D3 = 90 mm · n2 = n3 = 725
D1 = 100 mm
motor n1 = 2900 rpm
D3
stage 1 i1 = 4
stage 2 i2 ≈ 4.44
n4 = n1 · (D1 / D2) · (D3 / D4)
total ratio i = i1 · i2
2900 · 100/400 · 90/400 ≈ 163
i ≈ 4 · 4.44 ≈ 17.8
not to scale · theoretical value, no slip
D4 = 400 mm
machine n4 ≈ 163 rpm
Two-stage pulley drive: the ratios multiply
A countershaft is used when one stage would need too large a ratio · both pulleys on it share one speed

Figure 3



T ≈ 9550 · P / n

T: Nm · P: kW · n: rpm

4 kW: 9550·4/1450 ≈ 26 Nm

26 × 2.5 ≈ 66 Nm (losses ignored)

Slowing down

Pulleys do not add power: speed falls, torque rises. Belt, pulleys, shaft and key carry the higher torque; size belt count and profile for it.

Speeding up

On fans and centrifugal pumps power rises roughly with speed cubed: +10 % ≈ +33 %. Check motor current against the nameplate.

The pulley ratio also converts torque

Example: 4 kW, 1450 rpm motor, i = 2.5 · machine shaft 580 rpm, torque about 2.5 times

Figure 4