- *The table below will allow you to determine a shaft diameter based on the type of material to be used and the torque to be transmitted.*

| | Material | Shaft diameter (mm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ø6 | Ø10 | Ø12 | Ø15 | Ø17 | Ø20 | Ø25 | Ø30 | Ø40 | Ø50 | Ø75 | Ø100 |
| Torque (Nm) | Soft steel XC18 XC65 35000 kN/mm² | 1,50 | 6,60 | 11,50 | 23 | 34 | 55 | 105 | 180 | 440 | 840 | 2800 | 6600 |
| Torque (Nm) | 60 C40 Z10CNF18.09 45000 kN/mm² | 1,90 | 8,50 | 15 | 28 | 43 | 70 | 135 | 230 | 550 | 1000 | 3600 | 8500 |
| Torque (Nm) | 42CD4 20NCD2 60000 kN/mm² | 2,50 | 12,00 | 20 | 39 | 56 | 95 | 180 | 310 | 750 | 1500 | 4800 | 12000 |

*This table is offered as a guide only and does not take specific applications into account*

## Useful formulae

$$kW = 0,746 \times CV$$

$$Nm = \frac{9550 \times kW}{rpm}$$

## Choosing a gear

- *When choosing a gear as part of a system there are many factors to be taken into account. The torque and the speed are the most obvious but there is also the material, the operating environment, the required life expectancy and the lubrication system. HPC can suggest the use of two simple methods to make the choice but neither takes into account all of the various parameters and as such HPC cannot be held responsible for any problems that may arise. However they do offer a good place to start.*

***The first method*** *uses the different values you will find in this catalogue and consists of applying coefficients to a given torque in two ways.*
- *Firstly, the next 2 pages allow you to calculate the module required based on the torque to be transmitted.*
- *The following 2 pages allow you to calculate the torque that can be transmitted by gears you have already chosen*

***The second method*** *takes two factors into account: wear and resistance.*
*Depending on the results you get, you should use the lowest value.*
***Don't forget. our technical team is always there to help you.***

# How to calculate the module you need ?

- *The majority of the pages in this catalogue contain references to torque and the table below provides a brief summary. The values for standard gears should only be used as a reference in your own calculations. These numbers are based on two well lubricated 50 tooth gears turning at 1000 rpm (input speed) for 12 hours per day, it will need to modifying to meet your requirements. To calculate the module required, you need to apply weighting coefficients A, B, C and D (see next page) to the torque to be transmitted.*

$$\frac{\text{Torque to be transmitted}}{A \times B \times C \times D} < \text{Indicative torque}$$

- ***Example***:
  *We need to transmit 20Nm at 500 rpm for 6H per day with a 20 tooth input gear and 100 tooth output gear:*

$$\frac{20}{0,25 \times 1,27 \times 1,15 \times 1,1} < 49,80$$

- ***Many different solutions are possible, such as the following***:
  *Straight gears module 1.75 hardened (G1.75 hardened). module 2 (YG2 untreated)*
  *Helical gears module 1.5 hardened (SH1.5 hardened)*

| **Indicative torque**<br>Output torque indication (Nm) for two gears with 50 teeth at 1000rpm (input speed) | **Module** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0,25** | **0,3** | **0,4** | **0,5** | **0,6** | **0,7** | **0,75** | **0,8** | **0,9** | **1** |
| **Spur gear** | | | | | | | | | | |
| **G/PG/SSG/HG** (20NCD2, S/steel) | 0,05 | 0,07 | 0,147 | 0,391 | 0,63 | 0,6 | 0,99 | 1 | 1,91 | 2,6 |
| **G/PG** (20NCD2 hardened) | 0,23 | 0,32 | 0,698 | 1,85 | 2,91 | 3,2 | 4,57 | 5 | 8,82 | 12 |
| **YG/XG** (35NCD6, 20NCD2) | - | - | - | - | - | - | - | 4 | - | 10,6 |
| **YG/XG** (35NCD6 hardened) | - | - | - | - | - | - | - | 5,8 | - | 15,5 |
| **YG/XG** (20NCD2 hardened) | - | - | - | - | - | - | - | 11 | - | 29,3 |
| **GB** (brass) | - | - | - | 0,195 | - | - | - | 0,54 | - | 1,25 |
| **ZG/ZPG** (Delrin) | - | - | 0,04 | 0,1 | - | - | - | 0,3 | - | 0,7 |
| **Helical gear** | | | | | | | | | | |
| **SH/PSH** (20NCD2) | - | - | 0,28 | 0,53 | - | 1,73 | - | 2,25 | - | 4,23 |
| **SH/PSH** (20NCD2 hardened) | - | - | 1,12 | 2,09 | - | 6,83 | - | 8,92 | - | 16,74 |
| **ZSH/ZPSH** (delrin) | - | - | - | 0,13 | - | 0,4 | - | 0,5 | - | 1 |
| **H/PH** (20NCD2) | - | - | 0,056 | 0,127 | - | 0,272 | - | 0,395 | - | 0,747 |
| **H/PH** (20NCD2 hardened) | - | - | 0,375 | 0,705 | - | 1,791 | - | 2,596 | - | 4,908 |
| **ZH/ZPH** (Delrin) | - | - | - | 0,03 | - | - | - | 0,1 | - | 0,18 |
| **Roue et vis sans fin** | | | | | | | | | | |
| **M/PM et W/SW** (Bronze/steel) | - | - | 0,57 | 1,01 | - | - | - | 2,82 | - | 5,87 |
| **M/PM et WH/SWH** (Bronze/treated steel) | - | - | 1 | 1,86 | - | - | - | 5,26 | - | 10,06 |
| **ZM/ZPM et ZW/ZSW** (Delrin) | - | - | 0,14 | 0,25 | - | - | - | 0,7 | - | 1,32 |
| **ZM/ZPM et W/SW** (Delrin/steel) | - | - | 0,36 | 0,65 | - | - | - | 1,84 | - | 3,42 |

*Dimensions in mm*

| A | Variation in number of teeth of driving wheel |
|---|---|
| Number of teeth | Coef. A |
| 100 | 2,00 |
| 75 | 1,50 |
| 50 | 1,00 |
| 40 | 0,75 |
| 30 | 0,50 |
| 20 | 0,25 |

| C | Speed variation |
|---|---|
| Speed (rpm) | Coef. C |
| 2000 | 0,85 |
| 1000 | 1,00 |
| 500 | 1,15 |
| 100 | 1,54 |
| 10 | 2,38 |

| B | Variation in number of teeth of driven wheel |
|---|---|
| Number of teeth | Coef. B |
| 100 | 1,27 |
| 50 | 1,00 |
| 30 | 0,80 |
| 20 | 0,63 |

| D | Variation in working time |
|---|---|
| Hours of work per day (H) | Coef. C |
| 24 | 0,90 |
| 12 | 1,00 |
| 6 | 1,10 |
| 3 | 1,22 |
| 1 | 1,44 |
| 1/2 | 1,58 |

**Note:** *for worms and wheels, only use B, C and D.*

| **Indicative torque**<br>Output torque indication (N) for two gears with 50 teeth at 1000 rpm (input speed) | Module | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1,25 | 1,5 | 1,75 | 2 | 2,5 | 3 | 4 | 5 | 6 | 8 |
| **Spur gear** | | | | | | | | | | |
| **G/PG/SSG/HG** (20NCD2, stainless steel) | 3,8 | 8,88 | 16 | 25 | 48 | 88 | 200 | 294 | 441 | 918 |
| **G/PG** (20NCD2 hardened) | 18 | 41,5 | 75 | 119 | 228 | 421 | 953 | 1570 | 2350 | 5360 |
| **YG/XG** (35NCD6, 20NCD2) | 17 | 32 | 48 | 70 | 122 | 223 | 420 | - | - | - |
| **YG/XG** (35NCD6 hardened) | 24 | 46 | 69 | 103 | 178 | 325 | 665 | - | - | - |
| **YG/XG** (20NCD2 hardened) | 47 | 88 | 132 | 195 | 337 | 615 | 1256 | - | - | - |
| **GB** (Brass) | - | - | - | - | - | - | - | - | - | - |
| **ZG/ZPG** (Delrin) | 1 | 2,4 | - | 6 | 11 | 18 | 55 | 90 | 140 | 179 |
| **Helical gear** | | | | | | | | | | |
| **SH/PSH** (20NCD2) | 6,61 | 12,71 | - | 33,89 | 66,17 | 114,2 | 338 | - | - | - |
| **SH/PSH** (20NCD2 hardened) | 43,45 | 50,29 | - | 134 | 261,7 | 451,9 | 1340 | - | - | - |
| **ZSH/ZPSH** (delrin) | 1,5 | 3 | - | 8 | 12 | 20 | - | - | - | - |
| **H/PH** (20NCD2) | 1,386 | 2,32 | - | 5,2 | 9,71 | 16,17 | 36,07 | - | - | - |
| **H/PH** (20NCD2 hardened) | 9,108 | 15,28 | - | 34,18 | 63,84 | 106,3 | 237,1 | - | - | - |
| **ZH/ZPH** (Delrin) | 0,4 | 0,7 | - | 1,5 | 3 | 5 | - | - | - | - |
| **Worm and wheel** | | | | | | | | | | |
| **M/PM and W/SW** (Bronze/steel) | 11,41 | 16,8 | - | 45 | 81 | 139 | 309 | - | - | - |
| **M/PM and WH/SWH** (Bronze/treated steel) | 20,25 | 30 | - | 79 | 124 | 200 | 417 | - | - | - |
| **ZM/ZPM and ZW/ZSW** (Delrin) | 2,75 | 3,97 | - | 11 | 16 | 27 | 61 | - | - | - |
| **ZM/ZPM and W/SW** (Delrin/steel) | 7,02 | 10,05 | - | 28,3 | 40 | 69 | 154 | - | - | - |

*Dimensions in mm*

# How to calculate the torque that can be transmitted by the gears you have already chosen ?

*The majority of the pages in this catalogue contain a value for torque. The values for standard gears should only be used as a reference in your own calculations.*

***They are based on:***

(1) *A driving gear with 50 teeth. turning at a speed of 1000 rpm*
(2) *A driven gear with 50 teeth.*
(3) *Gear used 12H per day.*
(4) *Good lubrication.*

## A

**Variation in the number of teeth of the driving gear:**
**Fixed parameters:**
**Speed of driving gear: 1000 rpm**
**50 tooth driving gear**

| Teeth/driving gear | Real torque (Nm) |
|---|---|
| 100 | Reference torque x 2,00 |
| 75 | Reference torque x 1,50 |
| 50 | Reference torque x 1,00 |
| 40 | Reference torque x 0,75 |
| 30 | Reference torque x 0,50 |
| 20 | Reference torque x 0,25 |

*Dimensions in mm*

## B

**Variation in the number of teeth of the driven gear:**
**Fixed parameters:**
**Speed of driving gear: 1000 rpm**
**50 tooth driving gear**

| Teeth/driven gear | Real torque (Nm) |
|---|---|
| 100 | Reference torque x 1,27 |
| 50 | Reference torquee x 1,00 |
| 30 | Reference torque x 0,80 |
| 20 | Reference torque x 0,63 |

**NOTE:** *For worm and wheel systems, only B, C and D are used.*

# How to calculate the torque that can be transmitted by the gears you have already chosen ?

## C — Speed variation:

**Fixed parameters :**
**50 tooth driving gear**
**50 tooth driven gear**

| Speed rpm | Real torque (Nm) |
|---|---|
| 2000 | Reference torque x 0,85 |
| 1000 | Reference torque x 1,00 |
| 500 | Reference torque x 1,15 |
| 100 | Reference torque x 1,54 |
| 10 | Reference torque x 2,38 |

## D — Variation in working time:

**Fixed parameters:**
**Speed of driving gear: 1000 rpm**
**50 tooth driving gear**
**50 tooth driven gear**

| Hours of work per day (H) | Real torque (Nm) |
|---|---|
| 24 | Reference torque x 0,90 |
| 12 | Reference torque x 1,00 |
| 6 | Reference torque x 1,10 |
| 3 | Reference torque x 1,22 |
| 1 | Reference torque x 1,44 |
| 1/2 | Reference torque x 1,58 |

## Calculation and examples

- *Exemple: helical gears*
  *H 0,8-30 and H0,8-100*
  *Reference torque Co = 0,395 Nm*

## Variables

- *30 tooth driving gear*
- *100 tooth driven gear*
- *Speed in rotation of driving gear: 500 rpm*
- *Hours of work per day: 6 h*
- ***So for 30 teeth*:**

**{[(0,395 x 0,50) x 1,27 ] x 1,15} x 1,1 = 0,317 Nm**
*Co A B C D*

# Spur gear calculations

## Pitch factor

| Module | «K» |
|---|---|
| 0,5 | 23,00 |
| 0,6 | 20,00 |
| 0,75 | 16,70 |
| 0,9 | 14,60 |
| 1 | 13,40 |
| 1,25 | 11,20 |
| 1,5 | 9,87 |
| 1,75 | 8,60 |
| 2 | 8,00 |
| 2,5 | 6,50 |
| 3 | 5,60 |
| 4 | 4,40 |
| 5 | 3,70 |

## Use factor

| Hours of work per day | Factor X | |
|---|---|---|
| | Wear | Resistance |
| 24 | 0,80 | 0,90 |
| 12 | 1,00 | 1,00 |
| 6 | 1,25 | 1,10 |
| 3 | 1,65 | 1,20 |
| 1 | 2,20 | 1,40 |
| 0,5 | 2,90 | 1,60 |

## Speed coefficient

| rpm | 3000 | 2000 | 1000 | 600 | 400 | 200 | 100 | 50 | 10 | 5 |
|---|---|---|---|---|---|---|---|---|---|---|
| 'X' | 0,20 | 0,23 | 0,24 | 0,30 | 0,32 | 0,36 | 0,42 | 0,47 | 0,57 | 0,60 |

## Size factor

| «Z» value | | Number of teeth of the driving gear | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 12 | 16 | 20 | 25 | 30 | 40 | 50 |
| Number of teeth of the driven gear | 12 | 1,00 | 1,12 | 1,18 | 1,22 | 1,23 | 1,24 | 1,25 |
| | 16 | 1,12 | 1,26 | 1,38 | 1,44 | 1,49 | 1,52 | 1,59 |
| | 20 | 1,18 | 1,38 | 1,52 | 1,62 | 1,66 | 1,75 | 1,89 |
| | 25 | 1,22 | 1,44 | 1,62 | 1,75 | 1,84 | 2,00 | 2,20 |
| | 30 | 1,23 | 1,49 | 1,66 | 1,84 | 1,98 | 2,20 | 2,35 |
| | 40 | 1,24 | 1,52 | 1,75 | 2,00 | 2,20 | 2,50 | 2,75 |
| | 50 | 1,25 | 1,60 | 1,89 | 2,20 | 2,35 | 2,75 | 3,00 |
| | Rack | 1,49 | 2,05 | 2,55 | 3,20 | 3,60 | 4,70 | 5,60 |

- ***Calculation of the forces that spur and helical gears can withstand***

- *The following formulae allow you to calculate the resistance to wear (1) and resistance to force (2), both of which must be taken into account when designing a system.*

| Resistance to wear | Resistance to force |
|---|---|
| (1) $F_U = \dfrac{X \times Z \times Sc \times L}{5{,}71 \times K}$ | (2) $F_E = \dfrac{X \times Sb \times Mod \times L}{242}$ |

**With :**

- $F_U$: Resistance to wear (N)
- $F_E$: Resistance to force (N)
- X = Use factor x Speed factor
- Sc: Surface tension (material data)
- Sb: Bending force (material data)
- K: Pitch factor
- L: Gearing width (in mm)
- Mod: Module

- *These formulae give the maximum forces the pitch diameter can withstand.*
  *To find the admissible torque, use both formulae (3) and (4) and use the lowest of the two values.*

**(3)** $C_A = F_U \times R$ ou **(4)** $C_A = F_E \times R$

R = Pitch radius = Pitch diameter/2 (in m)

$C_A$: Admissible torque (in Nm)

- *These factors, coefficients and formulae are only given as a guide to enable you to do your own calculations and the results will only be approximations.*
- *The only way to obtain accurate results is to carry out repeated tests under real conditions. HPC decline any responsibility for the results obtained from these formulae.*