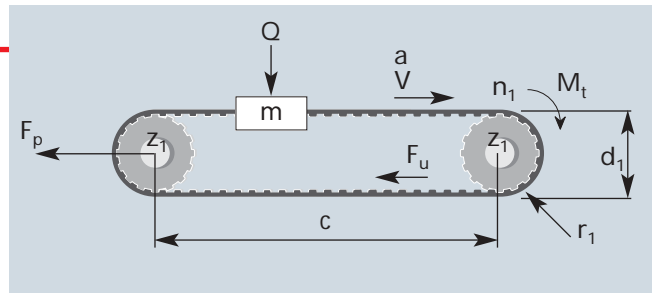
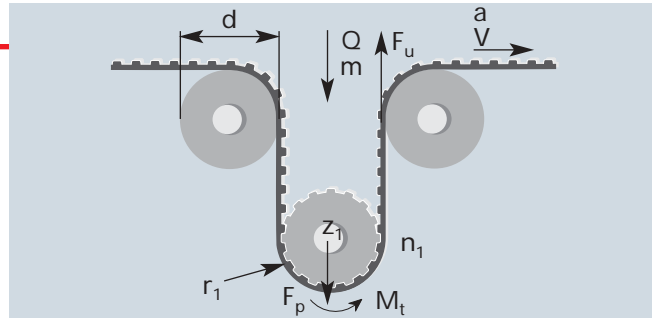


# TECHNICAL CALCULATION

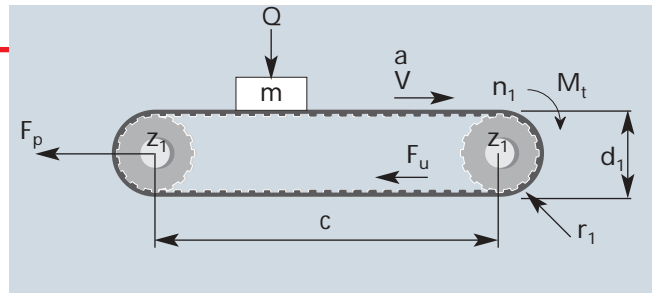
## LINEAR MOTION BELT



## OMEGA LINEAR MOTION BELT



## CONVEYOR BELT



The following pages contain data, formulae and tables that are required to design a new belt drive. For critical and difficult drives, it is recommended that you contact your supplier's Technical Staff for advice.

| Symbol                    | Unit             | Definition                                   | Symbol               | Unit             | Definition                                      |
|---------------------------|------------------|--|----------------------|------------------|---|
| <b>a</b>                  | m/s <sup>2</sup> | acceleration                                 | <b>c</b>             | mm               | centre distance                                 |
| <b>b</b>                  | mm               | belt width                                   | <b>g</b>             | m/s <sup>2</sup> | gravity (9,81)                                  |
| <b>C<sub>s</sub></b>      | -                | safety factor                                | <b>μ</b>             | -                | friction coefficient                            |
| <b>Δl/l<sub>00</sub></b>  | ‰                | elongation                                   | <b>m</b>             | Kg               | conveyed mass                                   |
| <b>d</b>                  | mm               | idler pitch diameters                        | <b>M<sub>t</sub></b> | Nm               | drive torque                                    |
| <b>d<sub>1</sub></b>      | mm               | sprocket pitch diameter                      | <b>n<sub>1</sub></b> | 1/min            | revs/min (RPM) of drive sprocket 1              |
| <b>F<sub>p</sub></b>      | N                | pretension                                   | <b>P</b>             | KW               | drive power                                     |
| <b>F<sub>u</sub></b>      | N                | peripheral force                             | <b>Q</b>             | N                | force exerted by mass (m)                       |
| <b>F<sub>p spec</sub></b> | N/cm             | transmittable force per tooth per unit width | <b>V</b>             | m/s              | belt speed                                      |
| <b>MTL</b>                | N                | max traction load                            | <b>Z<sub>i</sub></b> |                  | number of teeth of sprocket                     |
| <b>BS</b>                 | N                | breaking strength                            | <b>Z<sub>m</sub></b> |                  | number of teeth in mesh on driver sprocket (12) |

Max traction load is maximum acceptable traction on cords.  
 Breaking strength is necessary load to break belt cords.  
 Elongation is belt elongation under load.

### USEFUL FORMULAE AND CONVERSION FACTORS

$$V = \frac{d_1 \cdot n_1}{19100} \quad n_1 = \frac{V \cdot 19100}{d_1} \quad d_1 = \frac{V \cdot 19100}{n_1} \quad Q = m \cdot g$$

$$P = \frac{M_t \cdot n_1}{9550} \quad M_t = \frac{9550 \cdot P}{n_1} \quad M_t = \frac{F_u \cdot d_1}{2000}$$

### CHOICE OF BELT PITCH AND SPROCKETS

For optimum belt pitch see tables on page 12.

For optimum choice of sprocket size, it is desirable to have as near to 12 teeth in mesh as possible.

### CALCULATION OF THE PERIPHERAL FORCE ON THE TIMING BELT

|                    |   |   |
|--------------------|---|---|
| known mass         | → For horizontal & conveying drives                         | $F_u = (m \cdot a) + (m \cdot g \cdot \mu)$       |
|                    | (Note: values of $\mu$ can be found in table 1 on page 13). |   |
|                    | → For vertical drives                                       | $F_u = (m \cdot a) + (m \cdot g)$                 |
| known drive torque |   | $F_u = 2000 M_t / d_1$                            |
| known drive power  |   | $F_u = 19.1 \cdot 10^6 \cdot P / (d_1 \cdot n_1)$ |

### DETERMINATION OF THE BELT WIDTH

The belt width  $b$  should be calculated using the following formula

$$b = (F_u \cdot C_s \cdot 10) / (F_{p \text{ spec}} \cdot Z_m)$$

$C_s$  = safety factor from page 13 table 2

$F_u$  = from above calculation

$Z_m$  = number of teeth in mesh on driver sprocket

$Z_m = Z_1 \cdot \text{arc of contact} / 360$

= (if calculated  $Z_m \geq 12$  for an open-end application

use  $Z_m = 12$ )

= (if calculated  $Z_m \geq 6$  for a joined application

use  $Z_m = 6$ )

$F_{p \text{ spec}}$  = transmittable force per tooth per unit width (see table on belt data pages)

### PRE-TENSIONING

The suggested installation tension:  $F_p = 2 \cdot F_u$  for linear and omega linear movement applications  
 $F_p = F_u$  for conveyor applications

### CORD CHECK

The maximum allowable tensile load of the belt pitch/width combination selected (see tables on belt data pages):

$$\text{max traction load of chosen belt} > \frac{F_p}{2} + (F_u \cdot C_s)$$

### SPROCKET AND IDLER DIAMETER CHECK

Ensure that all selected pulley and idler diameters are equal to or greater than the minimum values specified in corresponding belt data page.

### ELONGATION

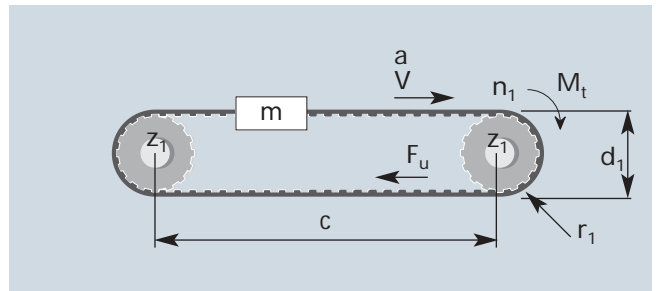
When the belt is operating there will be an elongation proportional to max traction load:

$$\Delta l_{00} = (F_u \cdot 4) / \text{max traction load}$$

# LINEAR MOTION CALCULATION EXAMPLE (open-end belt)

## MACHINE DATA

$C = 2.000 \text{ mm}$   
 $d_1 = 76 \text{ mm}$   
 $n_1 = 300 \text{ RPM}$   
 $P = 1,8 \text{ KW}$   
 low fluctuating load



## CHOICE OF BELT PITCH AND SPROCKETS

According to the belt pitch selection table n.1 on page 12 considering the values of  $P$  and  $n_1$ , we select RPP8 belt. Then we consider the pulley diameter nearest to the requested value and the corresponding  $n$ . of teeth (see technical information on page 55).

Therefore  $Z_1 = 30$  teeth (with a pitch diameter of 76,4 mm).

## CALCULATION OF THE EFFECTIVE TENSION

Since the drive power is known,  $F_u$  can be calculated

$$F_u = \frac{19,1 \cdot 10^6 \cdot P}{d_1 \cdot n_1} = \frac{19,1 \cdot 10^6 \cdot 1,8}{76,4 \cdot 300} = 1500 \text{ N}$$

## DETERMINATION OF THE BELT WIDTH

$$b = \frac{F_u \cdot C_s \cdot 10}{F_{p \text{ spec}} \cdot Z_m}$$

$$b = \frac{1500 \cdot 1,4 \cdot 10}{62 \cdot 12} = 28,2 \text{ mm}$$

$F_u$  = from before (1500 N)

$C_s$  = from page 13 table 4, for low fluctuating load  $C_s = 1,4$

$Z_m$  = given that driver pulley has 30 teeth and angle of belt wrap is 180 degrees  $n$ . of teeth in mesh = 12

$n_1$  = 300 RPM (given)

$F_{p \text{ spec}} = 62 \text{ N / cm}$  (refer page 54 at 300 RPM)

Since the next closest width is 30 mm: 30 RPP8 is chosen.

## PRE-TENSIONING

$$F_p = 2 \cdot F_u \quad F_p = 3000 \text{ N}$$

## CORD CHECK

From page 54, RPP8 pitch 30 mm wide: max traction load 4510 N

$$\text{max traction load} > \frac{F_p}{2} + (F_u \cdot C_s) \quad \frac{F_p}{2} + (F_u \cdot C_s) = 1500 + 1500 \cdot 1,4$$

4510 N > 3600 N selected belt is acceptable.

## SPROCKET AND IDLER DIAMETER CHECK

Ensure that all selected pulley and idler diameters are greater than or equal the minimum values specified on page 55.

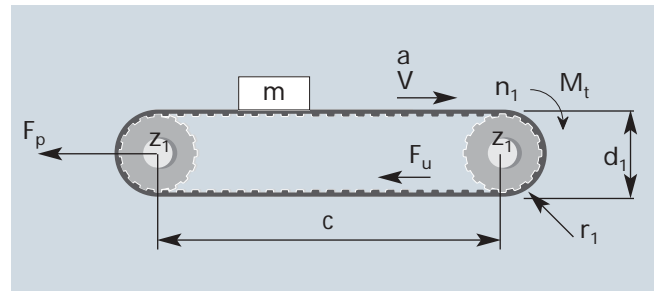
## ELONGATION

$$\Delta l_{/00} = \frac{F_u \cdot 4}{\text{max traction load}} = \frac{1500 \cdot 4}{4510} = 1,33 \text{ mm/m}$$

In the dynamic situations you will have an elongation of 1,33 mm per meter of operating belt.

## MACHINE DATA

$C = 5.000 \text{ mm}$   
 $d_1 = 100 \text{ mm}$   
 $V = 0,5 \text{ m/s}$   
 $a = 0,5 \text{ m/s}^2$   
 Guide in nylon  
 $Q = 7000 \text{ N}$   
 low fluctuating load



## CALCULATION OF THE EFFECTIVE TENSION

Since the mass is known,  $F_u$  can be calculated  $F_u = (m \cdot a) + (m \cdot g \cdot \mu)$  value of  $\mu$  according to table 3 on page 13 = 0,35

$F_u = (714 \cdot 0,5) + (714 \cdot 9,81 \cdot 0,35) = 2808 \text{ N}$   
 $m = Q/g = 7000 / 9,81 = 714 \text{ kg}$

## CHOICE OF BELT PITCH AND SPROCKETS

According to the belt selection table n. 2 on page 12, considering the values of  $F_u$  (for joined belts enter double of calculated  $F_u$  in table 2), we select AT 10. Then we consider the pulley diameter nearest to the requested value and the corresponding n. of teeth (see technical information page 41). Therefore  $Z_1 = 32$  teeth (with a pitch diameter of 101,86 mm).

## DETERMINATION OF THE BELT WIDTH

$$b = \frac{F_u \cdot C_s \cdot 10}{F_{p \text{ spec}} \cdot Z_m}$$

$$b = \frac{2808 \cdot 1,4 \cdot 10}{69 \cdot 6} = 94,95 \text{ mm}$$

$F_u =$  from before (2808 N)  
 $C_s =$  from page 13 table 4, for low fluctuating load  $C_s = 1,4$   
 $Z_m =$  given that driver pulley has 32 teeth and angle of belt wrap is 180 degrees, n. of teeth in mesh = 16. But, max  $Z_m$  for joined belt is 6. Hence,  $Z_m = 6$   
 $n_1 = (V_p \cdot 60.000) / (\pi \cdot d_1)$   
 $= (0,5 \cdot 60.000) / (\pi \cdot 101,86)$  as  $d_1 = 101,86$  from before  
 $= 99 \text{ RPM}$   
 $F_{p \text{ spec}} = 69 \text{ N / cm}$  (refer page 40, at 100 RPM)

Since the next closest width is 100 mm: 100 AT10 is chosen.

## PRE-TENSIONING

$$F_p = F_u \text{ so } F_p = 2808 \text{ N}$$

## CORD CHECK

From page 40, AT10 pitch 100 mm wide joined: max traction load 8312,5 N

$$\text{max traction load} > \frac{F_p}{2} + (F_u \cdot C_s) \quad \frac{F_p}{2} + (F_u \cdot C_s) = \frac{2808}{2} + (2808 \cdot 1,4)$$

8312,5 N > 5335 N selected belt is acceptable.

## SPROCKET AND IDLER DIAMETER CHECK

Checking technical data on page 41 for pulley and idlers, it can be seen that the drive has acceptable pulley diameters.

## ELONGATION

$$\Delta l / l_0 = \frac{F_u \cdot 4}{\text{max traction load}} = \frac{2808 \cdot 4}{8312,5} = 1,35 \text{ mm/m}$$

In the dynamic situations you will have an elongation of 1,35 mm per meter of operating belt.

# CALCULATION PARAMETERS

## BELT PITCH SELECTION

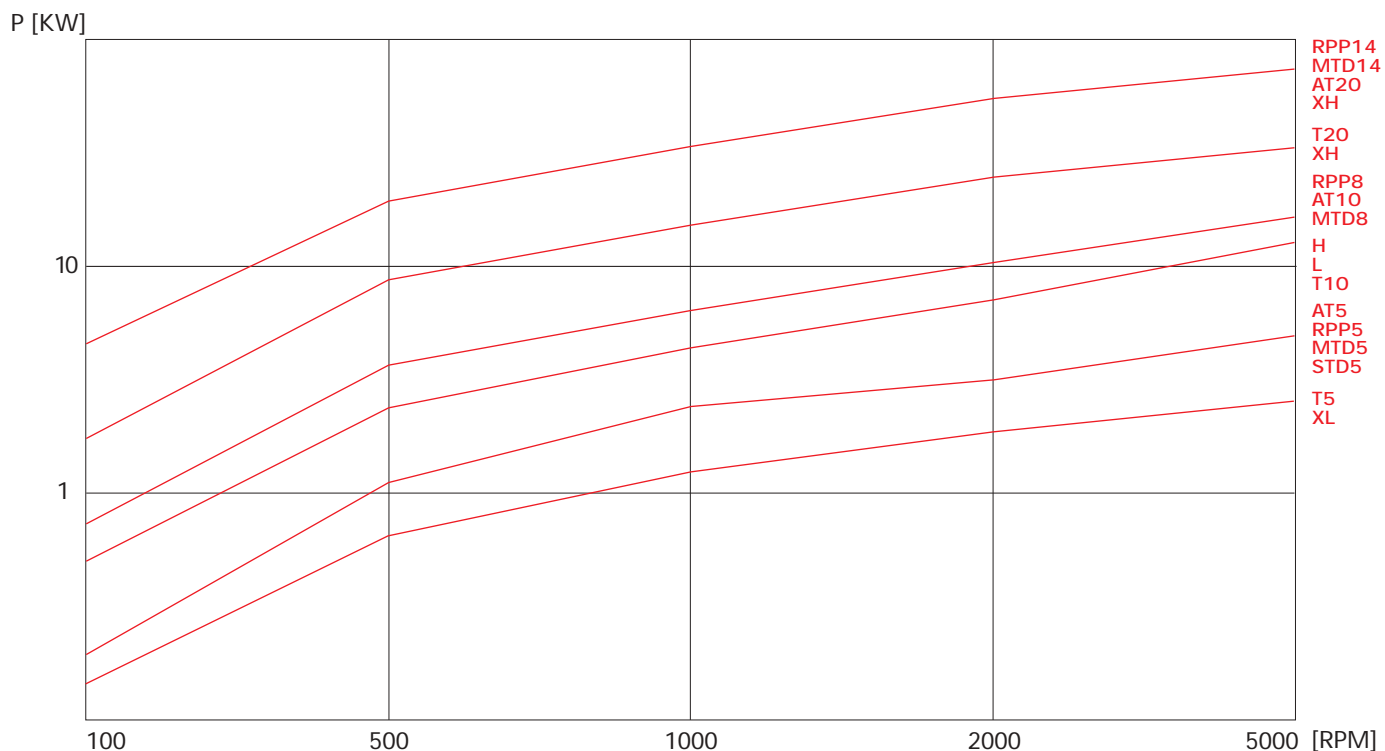


Table n.1

## BELT WIDTH SELECTION

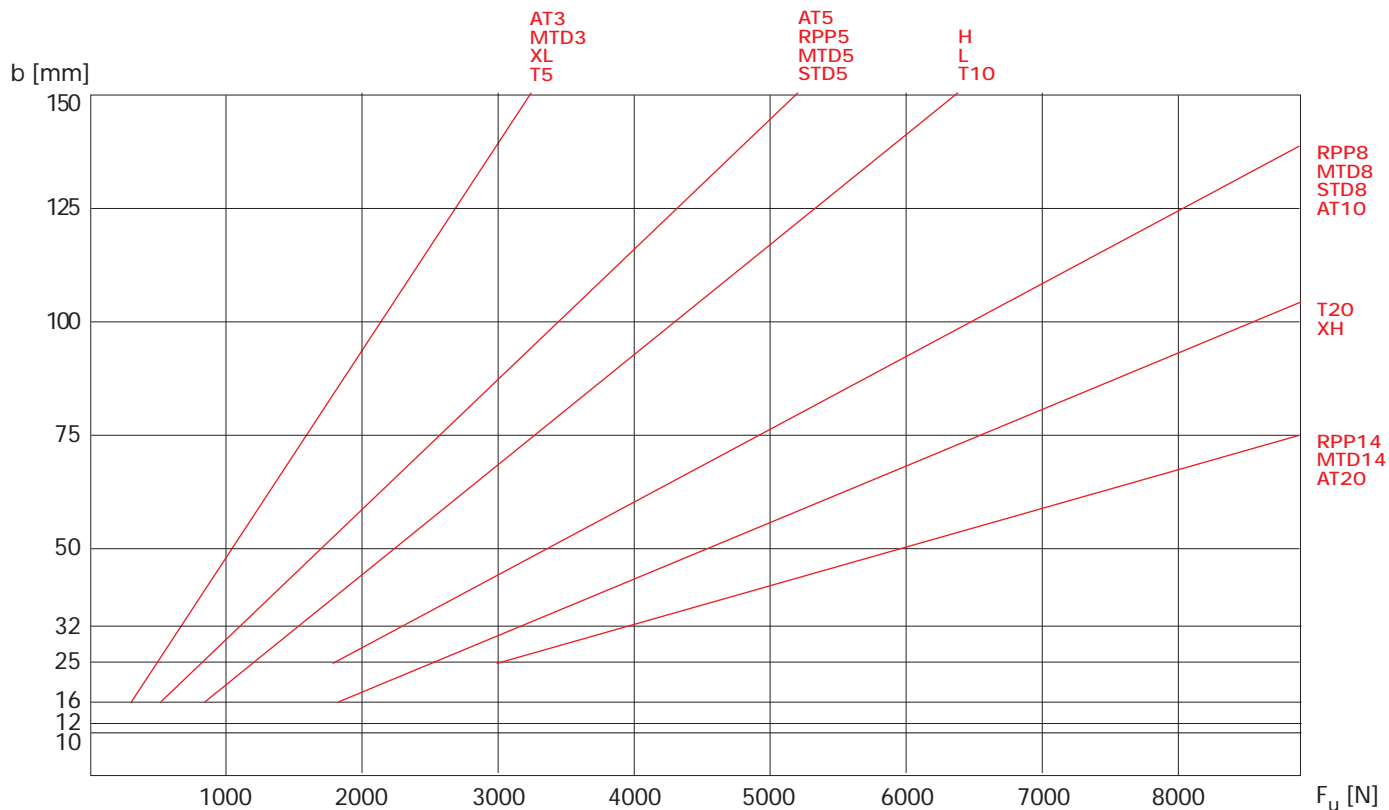


Table n.2