## INTRODUCTION

Three types of transmission system are offered in this catalogue,

Timing belt - an endless toothed belt system available in 2.5mm and 5mm pitch; intended for applications requiring a level of power transmission.

Cable chain - a jointed belt system available in 0.0982" (2.5mm), 0.1475" (3.75mm) and 0.15708"(4mm) pitch; intended for low power instrument drives, but not suitable for reverse bending applications.

Link chain - a stainless steel roller chain available in 0.1475" (3.75mm) pitch; intended for use in harsh environments that preclude the use of belts.

## ENGINEERING DATA

### 1. Belt and Chain Length

Knowing the centre distance the belt or chain length can be calculated from the following:

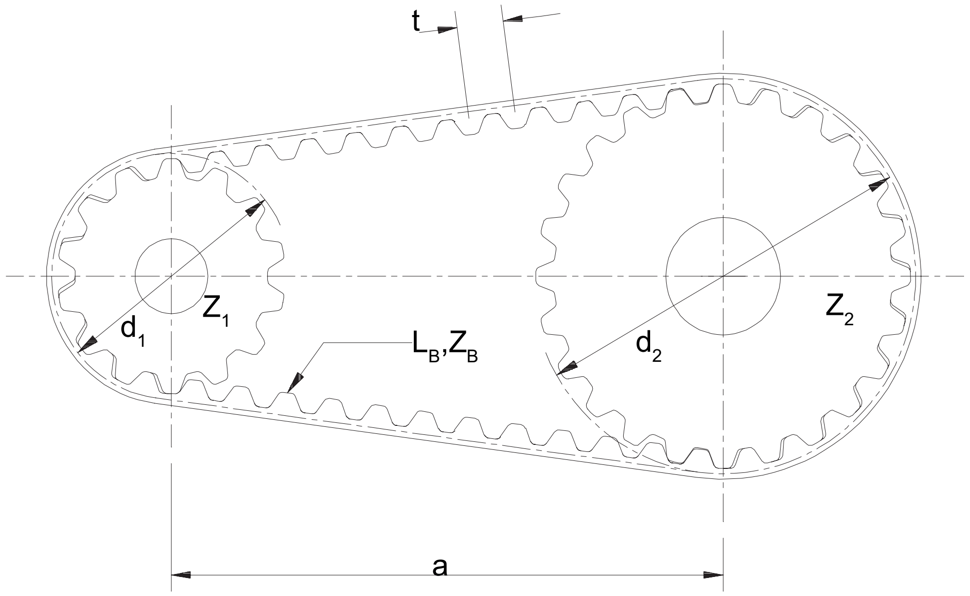
For ratios = 1:1 $L_B = Z_1 * t + 2a$ [mm]

For ratios ≠ 1:1 (approximate formula)

$$L_B \approx \frac{t}{2}(Z_2 + Z_1) + 2a + \frac{1}{4a}\left[\frac{(Z_2 - Z_1)t}{\pi}\right]^2 \quad \text{[mm]}$$

$a$ = Centre distance

| | | | | | |
|---|---|---|---|---|---|
| $L_B$ | = | Belt length | $t$ | = | Belt pitch |
| $d_1$ | = | Pitch diameter small pulley | $d_2$ | = | Pitch circle diameter large pulley |
| $Z_1$ | = | No of teeth, small pulley | $Z_2$ | = | No of teeth, large pulley |
| $Z_B$ | = | No of teeth in belt | $Z_e$ | = | No of teeth in mesh |



## 2. Centre Distance Calculation

Knowing the belt or chain length the centre distance can be calculated from the following;

For ratios = 1:1

$$a = \frac{(Z_B - Z_1)t}{2} \quad \text{[mm]}$$

For ratios ≠ 1:1 (approximate formula)

$$a \approx \frac{L_B - \frac{\pi}{2}(d_2 + d_1)}{4} + \sqrt{\left(\frac{L_B - \frac{\pi}{2}(d_2 + d_1)}{4}\right)^2 - \frac{(d_2 - d_1)^2}{8}} \quad \text{[mm]}$$

$$d_1 = \frac{Z_1 * t}{\pi} \text{ [mm]} \qquad d_2 = \frac{Z_2 * t}{\pi} \text{ [mm]}$$

## 3. Design Guidelines

### (i) Timing belts

Timing belt efficiency ranges from 95 to 98%, better than flat or vee belts which rely on friction to transmit power.

The 2.5mm and 5mm pitch timing belts are manufactured in wear resistant polyurethane with high grade steel wire tension members, therefore any elongation due to load and pre-tension will follow Hookes' law. The manufacturing process for these timing belts produces the "classical" trapeziodal tooth form to close tolerances. This ensures an even distribution of load during use and the transmission of high torques. These belts are suitable for indexing, positioning and conveying drives.

It is possible to design drives with fixed centres but generally the drive centres should be adjustable or have idler pulleys. This is particularly important in multi-shaft or high power drives. The idler pulleys should be fitted to the slack side of the drive and must not be spring loaded.

Timing belt drives do not require as much tension as other belt drives which depend on friction to transmit the load. The belt should be installed with a snug fit, neither taut nor loose. As a general guide the correct level of tension can be determined by measuring the force necessary to deflect the belt an amount equal to $1/64^{th}$ of the span centres "a".

Values for the measuring force recorded on a spring balance applied mid-span should be within 20% of the values shown below.

2.5mm - 0.07kg     5mm - 0.30kg

The belts must be rigidly mounted. Variations in centre distance can lead to premature wear. The belt and pulley system must be assembled loose to prevent over stretching. The belts are guided on the pulleys by flanges. One pulley should be flanged on both sides, or two alternate flanges provided, one on each pulley. For drives with vertical shafts both pulleys should be flanged on both sides.

For a belt to transmit full power, a minimum of 6 teeth must be in mesh on each pulley.
The number of teeth in mesh can be determined from the following formula:

$$Ze = \frac{Z_1}{180} * \text{arc cos} \frac{(Z_2 - Z_1) * t}{2 \pi a}$$

Number of teeth in mesh calculation is always based on the smallest pulley.

To minimise belt fatigue, pulleys with a minimum of 20 teeth are recommended. As a general guide larger pulleys reduce the amount of belt flexing and therefore improve belt life.

### (ii) Cable Chain

Design adjustable centres to take up belt slack. Belts should be a snug fit over the sprockets, not loose or so tight that the belt needs excessive force to drive. An adjustable idler can be used to remove belt slack. Use a small sprocket on the same side of the belt as the drive sprocket. Do not use a flat roller.

Always use as large a sprocket as possible to eliminate potential cable fatigue as the crimp splice travels around small sprockets. The more pins in contact with the sprocket the stronger and smoother the drive.

Do not force a chain over installed sprockets or fixed sprockets as the chains are not elastic. Remove the sprockets, assemble the chain to the sprockets, then slide the sprockets on to the shafts. The life of precision moulded cable chain can be increased by spraying with a light mist of silicone oil.

### (iii) Link Chain

The link chain is manufactured in 300 series stainless steel. Although the material is essentially nonmagnetic, the manufacturing process of the chain induces a small amount of magnetism.
Lubrication of the chain is required, the quantity depends on load, velocity and sprocket size. As these factors increase so should the level of lubrication.
Proper chain tension may be obtained by adjusting the sprocket centres or by use of an adjustable idler. As a general guide the total mid span movement (double amplitude) in the slack span should be 4-6% of the span length. For high speed, impulsive or reversing loads the total movement should be reduced to 2-3%. The chain tension device should allow enough adjustment to permit removal of two pitches of chain.
Drive ratios should not exceed 9:1 and the recommended maximum is 7:1. The chain should be a full number of pitches. The same formulae as for belts apply. In addition centre distance should not exceed 80 pitches.
Chain drives suffer from polygonal speed variations, as the rigid chain forms a polygon when wrapped around a sprocket. As the roller chain link approaches, it is not a tangent to the sprocket pitch circle, links may make contact below the tangency line then rise to the top of the sprocket. This movement (through a distance called chordal rise) accounts for repeated drive speed fluctuation.
Although negligible, in some cases such as when the drive machinery is vibration sensitive, or high inertial loads exist and/or sprockets of less than 20 teeth are used, it should be considered.