Storage & Handling, Center Distnace & Belt Length, and Operational Temperature

1. Belt Storage and Handling

Storage Recommendations
In order to retain their serviceability and dimensions, proper storage procedures must be followed for synchronous belts. Quite often premature belt failures can be traced to improper belt storage procedures that damaged the belt before it was installed on the drive. By following a few guidelines, these types of belt failures can be avoided.

Recommended
Belts should be stored in a cool and dry environment with no direct sunlight. Ideally, belts should be stored at less than 85°F and with lower than 70% relative humidity. Belts should be stored in original packaging.

Not Recommended
Belts should not be stored near windows, which may expose the belts to direct sunlight or moisture.

Belts should not be stored near heaters, radiators, or in the direct airflow of heating devices.

Belts should not be stored near any devices that generate ozone such as transformers and electric motors.

Belts should not be stored where they are exposed to solvents or chemicals in the atmosphere.

Do not store belts on the floor unless they are in a protective container. Floor locations are exposed to traffic that may damage the belts.

Do not crimp belts during handling or while being stored. To avoid this, belts must not be bent to diameters smaller than what is recommended (minimum recommended sprocket diameter for inside bends and 1.3 times the minimum recommended sprocket diameter for back side bends). Do not use ties or tape to pull belt spans tightly together near the end of the belt.

Do not hang on a small diameter pin that suspends all of the belt weight and bends the belt to a diameter smaller than the minimum recommended sprocket diameter. Improper storage will damage the tensile cord and the belt will fail prematurely. Handle belts carefully when removing from storage.

Storage Effects
Belts may be stored up to six years if properly stored at temperatures less than 85°F and relative humidity less than 70%.

For every 15°F increase in storage temperature above 85°F, the time the belt can be stored without reduced performance decreases by one-half. Belts should never be stored at temperatures above 115°F.

At relative humidity levels above 70%, fungus or mildew may form on stored belts. This has minimal affect on belt performance, but should be avoided if possible. When equipment is stored for prolonged periods of time (over six months), the belt tension should be relaxed so that the belt does not take a set, and the storage environment should meet the 85°F and 70% or less relative humidity condition. If this is not possible, belts should be removed and stored separately in a proper environment.

2. Center Distance and Belt Length

The approximate relationship between a center distance and belt pitch length is given by the following formula:

Formula 26

$$L_p = 2C + 1.57(D + d) + \frac{(D - d)^2}{4C}$$

Where: Lp = belt pitch length, inches
D = diameter of large sprocket, inches
d = diameter of small sprocket, inches
C = center distance, inches

A more precise formula is given below:

Formula 27

$$L_p = 2C \cos \varphi + \frac{\pi (D + d)}{2} + \frac{\pi\varphi (D - d)}{180}$$

Where: Lp = belt pitch length, inches
C = center distance, inches
D = pitch diameter of large sprocket, inches
d = pitch diameter of small sprocket, inches

$$\varphi = \sin^{-1} \frac{(D - d)}{2C} \text{ degrees}$$

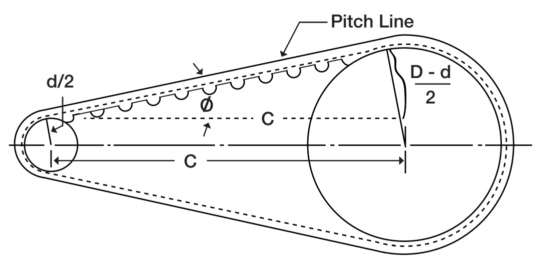


Figure 7

The approximate center distance can be found by this formula:

Formula 28

$$C = \frac{K + \sqrt{K^2 - 32 (D - d)^2}}{16}$$

Where: K = 4 Lp – 6.28 (D+d)

The exact center distance can be calculated using an iterative process between the center distance (Formula 28) and belt length (Formula 27) equations. The exact center distance has been found when the two equations converge. The pitch length increment of a synchronous belt is equal to a multiple of the belt pitch.

3. Operational Temperature

Belt performance is generally unaffected in ambient temperature environments between -65° and 185°F (-54° and 85°C). Temperature extremes beyond these limits should be reviewed by a TB Wood's Power Transmission Product Application Engineer.

Efficiency, Flanged Sprockets, Fixed Center, Teeth in Mesh, Belt Drive Noise

Efficiency

When properly designed and applied, Synchronous belt drive efficiency will be as high as 98%. This high efficiency is primarily due to the positive, no slip characteristic of synchronous belts. Since the belt has a thin profile, it flexes easily, thus resulting in low hysteresis losses as evidenced by low heat buildup in the belt.

Synchronous belt drive efficiency can be simply defined as shown in the following equation:

Formula 29

$$\text{Efficiency, percent} = \frac{\text{dN RPM} \times \text{dN Torque}}{\text{dR RPM} \times \text{dR Torque}} \times 100$$

When examining the loss of energy, it is necessary to consider belt losses in terms of shaft torque and shaft speed. Torque losses result from bending stress and friction. Chain drives running unlubricated may generate significant heat build up due to increased friction in the roller joints. Even properly lubricated chains running at higher speeds tend to throw off the oil due to centrifugal forces, making it difficult to maintain proper lubrication at the load bearing surfaces. Consequently, chain drives are typically only 92-98% efficient.

Flanged Sprockets

Due to the tracking characteristics, even on the best aligned drives, all synchronous belts have a tendency to move axially and will ride off the edge of the sprockets. In order to keep the belt on the sprocket, side flanges are needed.

On all synchronous drives the following conditions should be considered when selecting flanged sprockets.

1. **Two Sprocket Drives:** One sprocket must have flanges on both sides or both sprockets must have one flange but on opposite sides.

2. **Long Center Drives:** When the center distance is greater than or equal to eight times the small sprocket diameter, both sprockets should be flanged.

3. **Vertical Shaft Drives:** One sprocket should be flanged on both sides, all other sprockets in the drive system should have one flange on the bottom side.

4. **Multiple Sprocket Drives:** Every other sprocket should be flanged on both sides, or there should be one flange on each sprocket on alternating sides around the entire system.

Most smaller stock sprockets are flanged on both sides (80 tooth and smaller).

Fixed Centers (No Adjustment)

True fixed center applications are those where no provision for adjustment of driveR or driveN shaft exist. Fixed centers are not recommended for any synchronous belt drive other than motion transfer (low or no torque) drives. Fixed center drives imply need for exact tolerances. Although length tolerances for synchronous belts are considerably less than those for other belts, no belt can be manufactured without some tolerance. Sprocket manufacturing tolerances also contribute to the fixed center drive problem.

Fixed center applications prevent proper belt installation and tensioning procedures, reduced belt performance can result. The use of an idler can solve the problems associated with fixed center drives. See the page in this section concerning the use of idlers.

Teeth In Mesh

For a synchronous drive to transmit the full capacity of the belt, it is necessary to have a minimum of 6 teeth in mesh on the driveR and all driveN wheels in the drive. The two-wheel drives selected from our pre-engineered selection area of our catalog meet this requirement. For drives having less than 6 teeth in mesh, the horsepower of the drive should be multiplied by the proper correction factor.

Teeth In Mesh	Correction Factor
6	1.00
5	0.80
4	0.60
3	0.40
2	0.20

Belt Drive Noise and Use of Idlers

Belt Drive Noise

When noise is an issue, there are several design and maintenance tips that should be followed to minimize belt drive noise.

1. Belt Drive Tension and Alignment

Properly tensioning and aligning a belt drive will allow the belt drive to perform at its quietest level. Improper tension in synchronous belt drives can affect how the belt fits in the sprocket grooves. Proper tension minimizes tooth to groove interference, and thereby reduces belt noise.

Misaligned synchronous belt drives tend to be much noisier than properly aligned drives due to the amount of interference that is created between the belt teeth and the sprocket grooves. Misaligned synchronous belt drives also may cause belt tracking that forces the edge of the belt to ride hard against a sprocket flange. Misalignment causing belt contact with a flange will generate noise that is easily detected.

2. Noise Barriers and Absorbers

Noise barriers are used to block and reflect noise. Noise barriers do not absorb or deaden the noise; they block the noise and generally reflect most of the noise back towards its point of origin. Good noise barriers are dense, and should not vibrate. A sheet metal belt guard is a noise barrier. The more complete the enclosure is, the more effective it is as a noise barrier. Noise barrier belt guards can be as sophisticated as a completely enclosed case, or as simple as sheet metal covering the front of the guard to prevent direct sound transmission.

Use of Idlers

Synchronous Drives

Idlers are occasionally used in the design of synchronous belt drives for various reasons:

1. To provide take-up for fixed center drives.
2. To clear obstructions.
3. To subdue belt whip on long center drives.

NOTE: Do not use spring loaded or weighted idlers on synchronous drives.

Idlers should be avoided where possible because they either reduce the horsepower rating or shorten belt life. Idlers may be placed either outside or inside the drive. A common serious fault in designing drives is the use of idlers, which are too small. The use of such idlers introduces severe reverse bending stresses in the belt, resulting in drastically reduced belt life.

Table 8

Belt	Minimum Inside Idler	Minimum Inside Flat Idler	Minimum Backside Idler
8mm Pitch QTPC II Carbon	25 teeth	4.00" O.D.	3.00" O.D.
14mm Pitch QTPC II Carbon	28 teeth	7.00" O.D.	6.50" O.D.

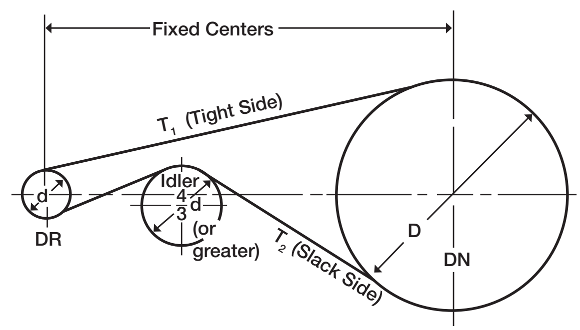
Positioning Idlers

Idlers should be located, if at all possible, on the slack side of the drive. Locating the idler on the tight side of the drive puts high stresses on the idler bearings and belt. This reduces the life of both parts. Idlers located on the tight side of the drive are the number one cause of idler related issues.

Outside Idlers

An outside idler increases the number of teeth in mesh, but the amount of take-up, in the case of take-up idlers, will be limited by the belt on the opposite side of the drive. Outside idlers are always flat because they contact the top of the belt. A flat idler pulley, outside, should be located as close as possible to the preceding sprockets. This is because belts move back and forth slightly on a flat pulley and locating it farther away from the next sprocket minimizes the possibility of the belt entering that sprocket in a misaligned condition. Outside flat idlers should be one third larger than the smallest loaded synchronous sprocket. It should be remembered that the smallest loaded synchronous sprocket should not be smaller than the minimum pitch diameter recommended.

Center distances must be fixed and rigid



Typical Outside Flat Idler Arrangement

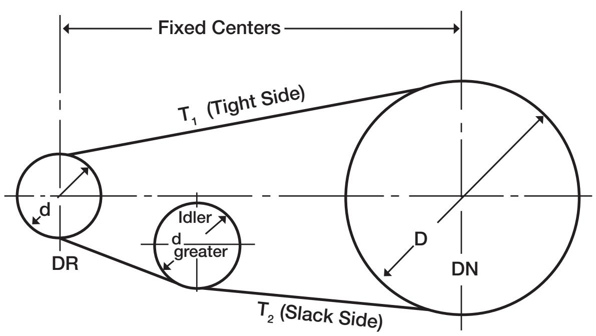
Figure 8

Use of Idlers

Inside Idlers

An inside idler decreases the number of teeth in mesh on the adjacent sprockets. Inside idlers are usually synchronous sprockets. An inside idler sprocket may be located at any point along the span, preferably so that it gives nearly equal arcs of contact on the two adjacent sprockets. Inside idlers should be at least as large in diameter as the smallest loaded synchronous sprocket. Flat idlers may be used on the inside of a synchronous belt drive if the diameter of the flat pulley meets the requirements given in Table 8, on page 79.

Center distances must be fixed and rigid



Typical Inside Idler Arrangement

Figure 9

Idler Mounting

Mounting brackets for idlers should be sturdily constructed and meticulously aligned. It is frequently found that drive problems described as "belt stretch," "belt instability," "short belt life," "belt roughness," "belt vibration," and many others are traceable to flimsy idler brackets, bearings, etc. the idler mounting must be designed to be capable of withstanding forces imposed by the operating belt tensions.

Service Factor with Idlers

If the above recommendations are followed, it is possible to design satisfactory synchronous drives using idlers. However, idlers always impose an additional bending stress on the belt. This reduces the belt horsepower rating. This is reflected by an addition (0.2 for each idler) to the service factor when designing. If the horsepower ratings are not reduced to account for the use of an idler, belt life will be reduced. The rating of a drive or its life expectancy is drastically reduced when idlers below the minimum recommended diameter are used. The bending stress induced in the belt becomes greater as the idler diameter becomes smaller.

Troubleshooting

Problem Type	Probable Cause	Corrective Action
Tension Loss / belt stretch	Weak support structure	Reinforce support structure
	Excessive sprocket wear	Replace sprocket
	Fixed (nonadjustable) centers	Use idler to adjust tension
	Excessive debris	Clean drive, protect drive from debris
	Excessive load	Increase drive capacity
	Sprocket diameter too small	Redesign with larger sprockets
	Drive runs too hot	Check for heat transfer from local source
	Belt is softening or degrading	Protect drive from excessive temperatures and contanminants / chemicals
Belt tracking issue	Parallel or angular misalignment	Correct alignment
	Belt running partly off unflanged sprocket	Correct alignment
	Centers exceed 8X small sprocket diamter	Correct alignment to track belt or add flanged idler with low angular contact
	Excessive belt edge wear	Correct alignment / replace belt
Sprocket flange failure	Belt forces off flange	Correct alignment, reinforce support structure, replace flange or sprocket
Excessive belt edge wear	Parallel or angular misalignment	Correct alignment
	Damage due to improper belt handling	Follow proper belt handling procedure
	Belt rubbing drive guard or obstruction	Remove interference or use idler to adjust wrap
	Improper width belt	Use correct belt / sprocket combination
	Rough flange / debris at sprocket edge	Clean sprocket and flange
	Belt tension too low	Adjust belt tension per instructions
Premature tooth wear	Belt tension too high or too low	Adjust belt tension per instructions
	Belt running partly off unflanged sprocket	Correct alignment
	Parallel or angular misalignment	Correct alignment
	Worn or damaged sprocket	Replace sprocket
	Belt rubbing drive guard or obstruction	Remove interference or use idler to adjust wrap
	Excessive load	Increase drive capacity
	Excessive debris	Clean drive, protect drive from debris
Tooth shear	Belt tension too low	Adjust belt tension per instructions
	Excessive shock load	Redesign drive with higher capacity
	Less than 6 teeth in mesh on sprocket	Redesign drive, increase wrap with idler
	Worn or damaged sprocket	Replace sprocket
	Idler too small	Use properly sized idlers
Tensile break	Excessive load or shock	Redesign drive with higher capacity
	Sprocket diameter too small	Redesign with larger sprockets
	Idler too small	Use properly sized idlers
	Improper belt handling or storage	Replace belt, follow proper belt handling procedure
	Debris or foreign object in drive	Clean drive, protect drive from debris
	Excessive runout	Check shafts and sprocket installation, repair / replace components as needed
Belt cracking	Idler too small	Use properly sized idlers
	Temperature too low	Correct environment or preheat drive area prior to starting drive
	Exposure to chemical or radiation	Protect drive from chemical / exposure
	Parallel or angular misalignment	Correct alignment
	Belt tension too high or too low	Adjust belt tension per instructions
Vibration (make certain the vibration is not from another source)	Too high or too low tension	Adjust belt tension per instructions
	Sprockets not properly installed or tightened	Re-install sprockets using proper alignment and mounting procedures; MPB sprockets require interference fit or set screw locking
	Excessive runout	Check shafts and sprocket installation, repair / replace components as needed
Noise issues *	Parallel or angular misalignment	Correct alignment
	Belt speed too high	Redesign drive
	Belt tension too high or too low	Adjust belt tension per instructions
	Backside idler	Use inside idler
	Excessive load	Increase drive capacity
	Sprocket diameter too small	Redesign with larger sprockets
	Worn or damaged sprocket	Replace sprocket

*NOTE: Effective noise reduction for power transmission drives can be accomplished by incorporating a flexible noise absorbing material with the protective guard. The guard design must allow a cooling air passage on the top and bottom to prevent overheating the drive.