

QT Power Chain® II Carbon Drive Installation

Center Distance & Drive Alignment

1. Center Distance Allowances for Installation and Tensioning

Since fixed center drives are not recommended, center distance allowances for a TB Wood's QT Power Chain II Carbon belt drive are necessary to assure that the belt can be installed without damage and then tensioned correctly. The standard installation allowance is the minimum decrease in center distance required to install a belt when flanged sprockets are removed from their shafts for belt installation. This is shown in the first column of Table 6a. This table also lists the minimum increase in center distance required to assure that a belt can be properly tensioned over its normal lifetime. If a belt is to be installed over flanged sprockets without removing them, the additional center distance allowance for installation shown in the second table below must be added to the first table data.

Table 6a. Center distance allowance for installation and tensioning

Length Belt in (mm)	Installation Allowance (Flanged Sprockets Removed For Installation) in (mm)	Tension Allowance (All Drives) in (mm)
Up to (125) 5	(0.5) 0.02	(0.5) 0.02
Over (125) to (250) 5 10	(0.8) 0.03	(0.8) 0.03
Over (250) to (500) 10 20	(1.0) 0.04	(0.8) 0.03
Over (500) to (1000) 20 40	(1.8) 0.07	(0.8) 0.03
Over (1000) to (1780) 40 70	(2.8) 0.10	(0.8) 0.04
Over (1780) to (2540) 70 100	(3.3) 0.13	(1.0) 0.04
Over (2540) to (3300) 100 130	(4.1) 0.16	(1.3) 0.05
Over (3300) to (4600) 130 180	(4.8) 0.19	(1.3) 0.05
Over (4600) to (6900) 180 270	(5.6) 0.22	(1.3) 0.05

Table 6b. Installation adder* for flanged sprockets

Pitch	One Sprocket Flanged in (mm)	Both Sprockets Flanged in (mm)
8mm	(21.8) 0.86	(33.3) 1.31
14mm	(31.2) 1.23	(50.0) 1.97

*For drives that require installation of the belt over one sprocket at a time, use the value for "Both Sprockets Flanged"

2. Drive Alignment

Provision should be made for center distance adjustment, according to the two tables on this page, or to change the idler position so the belt can be slipped easily onto the drive. When installing a belt, never force it over the flange. This will cause internal damage to the belt tensile member.

Synchronous belts typically are made with high modulus tensile members which provide length stability over the belt life. Consequently, misalignment does not allow equal load distribution across the entire belt top width. In a misaligned drive, the load is being carried by only a small portion of the belt top width, resulting in uneven belt wear and premature tensile failure.

There are two types of misalignment: parallel and angular (See

Fig.1). Parallel misalignment is where the driveR and driveN shafts are parallel, but the two sprockets lie in different planes. When the two shafts are not parallel, the drive is angularly misaligned.

A fleeting angle is the angle at which the belt enters and exits the sprocket, and equals the sum of the parallel and angular misalignments.

Any degree of sprocket misalignment will result in some reduction of belt life, which is not accounted for in the normal drive design procedure. Misalignment of all synchronous belt drives should not exceed 1/4° or 1/16" per foot of linear distance. Misalignment should be checked with a good straight edge or by using a laser alignment tool. The straight edge tool should be applied from driveR to driveN, and then from driveN to driveR so that the total effect of parallel and angular misalignment is made visible.

Drive misalignment can also cause belt tracking problems. However, light flange contact by the belt is normal and won't affect performance.

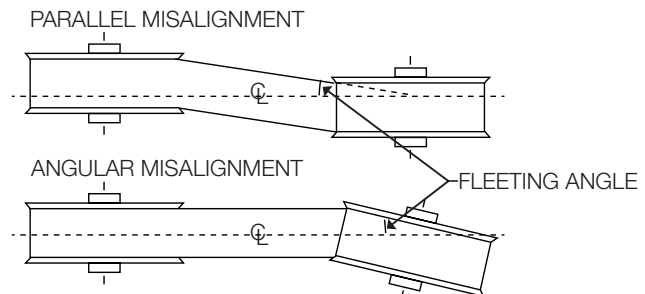


Figure 1

For those drives in which the center distance is greater than eight times the small sprocket diameter, belt tracking can be a problem. In these cases, the parallel position of the two sprockets may need to be adjusted until only one flange guides the belt in the system and the belt tracks fully on all sprockets. Regardless of the drive center distance, the optimum drive performance will occur with the belt lightly contacting one flange in the system. The worst case is for the belt to contact flanges on opposite sides of the system. This traps the belt between opposite flanges and can force the belt into undesirable parallel misalignment.

Improper installation of the bushing can result in the bushing/sprocket assembly being "cocked" on the shaft. This leads to angular misalignment and sprocket wobble. Be sure to follow the instructions provided with the bushings.

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Belt Installation & Tension

3. Belt Installation

During the belt installation process, it is very important the belt be fully seated in the sprocket grooves before applying final tension. Serpentine drives with multiple sprockets and drives with large sprockets are particularly vulnerable to belt tensioning problems resulting from the belt teeth being only partially engaged in the sprockets during installation. In order to prevent these problems, the belt installation tension should be evenly distributed to all belt spans by rotating the system by hand. After confirming that belt teeth are fully engaged in the sprocket grooves, belt tension should be rechecked and verified. Failure to do this may result in an undertensioned condition with the potential for belt ratcheting.

4. Belt Installation Tension

Standard Belt Tensioning Procedure

When installing a TB Wood's belt:

- Be sure it is tensioned adequately to prevent tooth jumping (ratcheting) under the most severe load conditions which the drive will encounter during operation.
- Avoid extremely high tension which can reduce belt life and possibly damage bearings, shafts and other drive components.

The proper way to check belt tension is to use a tension tester. The spring scale type tester is used by measuring how much force is required to deflect the belt at the center of its span by a specified distance (force deflection method), as shown in the sketch below.

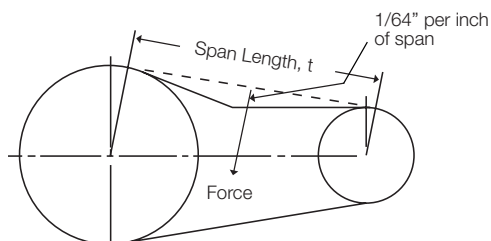


Figure 2

When you wish to use a numerical method for calculating recommended belt installation tension values, the following procedure may be used.

STEP 1: Calculate the required base static installation tension.

Use Formula 16 to calculate the required base static installation tension.

Formula 16

$$T_{st} = \frac{20HP}{S} + mS$$

Where:

T_{st} = base static installation tension, pounds

HP = Horsepower

$S = \frac{PD \times RPM}{3820}$

m = Value from Table 7

PD = Sprocket Pitch Diameter, inches

RPM = Revolutions per minute of same sprocket

Table 7

Pitch	Belt Width	m	Y	Minimum T _{st} (lb)
8mm	12mm	0.33	65	28
	21mm	0.57	113	49
	36mm	0.97	194	84
	62mm	1.68	335	145
14mm	20mm	0.92	230	119
	37mm	1.69	426	220
	68mm	3.11	782	405
	90mm	4.12	1035	536
	125mm	5.72	1438	744

Because of the high performance capabilities of QT Power Chain II Carbon belts, it is possible to design drives that have significantly greater load than are necessary to carry the actual design load. Consequently, Formula 16 can provide T_{st} values less than are necessary for the belt to operate properly, resulting in poor belt performance and reduced service life. If a more appropriately sized drive cannot be designed, minimum recommended T_{st} values are provided in Table 7 to assure that the belts function properly when lightly loaded.

Always use the greater T_{st} value; i.e., from T_{st} Formula 16 or Table 7.

NOTE: When applying static belt tension values directly, multiply the required base static installation tension (T_{st}) calculated in Formula 16 by the following factors:

Minimum Static Tension = Base Static Tension X 1.0
Maximum Static Tension = Base Static Tension X 1.2

Formula 17

$$t = \sqrt{C^2 - \left(\frac{D-d}{2}\right)^2}$$

Where:

t = belt span length, inches

C = center distance, inches

D = pitch diameter of larger sprocket, inches

d = pitch diameter of smaller sprocket, inches

STEP 2: Calculate the minimum and maximum recommended deflection forces.

- Calculate the span length of your drive (Formula 17).
- Belt minimum recommended force:

Formula 18

$$\text{deflection force, min} = \frac{T_{st} + \left(\frac{t}{L}\right)Y}{16}, \text{ lb}_f$$

- Belt maximum recommended force:

Formula 19

$$\text{deflection force, min} = \frac{1.2 T_{st} + \left(\frac{t}{L}\right)Y}{16}, \text{ lb}_f$$

Shaft Load

Where: T_{st} = Base Static tension, lbf
 t = span length, inches
 L = belt pitch length, inches
 Y = constant from Table 7

STEP 3: Applying the tension.

Force deflection tension method

- A.** At the center of the span (t) apply a force perpendicular to the span large enough to deflect the belt on the drive 1/64 inch per inch of span length from its normal position. One sprocket should be free to rotate. Be sure the force is applied evenly across the entire belt width. If the belt is a wide synchronous belt, place a piece of steel or angle iron across the belt width and deflect the entire width of the belt evenly.
- B.** Compare this deflection force with the range of forces calculated in Step 2
 1. If it is less than the minimum recommended deflection force, the belt should be tightened.
 2. If it is greater than the maximum recommended deflection force, the belt should be loosened.

5. Shaft Load

When the machine designer requests shaft load calculations from the drive designer, the following procedure can be applied:

A. Calculate Belt Span Tensions

Belt pull is the vector sum of T_T and T_S , the tightside and slackside tensions. T_T and T_S may be calculated using the following formulas:

Formula 20

$$T_T = \frac{144,067 \text{ HP}}{(PD)(RPM)}$$

Formula 21

$$T_S = \frac{18,008 \text{ HP}}{(PD)(RPM)}$$

Where: HP = Horsepower
 PD = Sprocket Pitch Diameter (in)
 RPM = Sprocket Speed (rev/min)

B. Solution For Both Magnitude and Direction

The vector sum of T_T and T_S can be found so that the direction of belt pull, as well as magnitude, is known. This is necessary if belt pull is to be vectorially added to sprocket weight, shaft weight, etc., to find true bearing loads. In this case, the easiest method of finding the belt pull vector is by graphical addition of T_T and T_S . If only the magnitude of belt pull is needed, numerical methods for vector additions are faster to use.

If both direction and magnitude of belt pull are required, the vector sum of T_T and T_S can be found by graphical vector addition as shown in Fig. 3. T_T and T_S vectors are drawn to a convenient scale and parallel to the tightside and slackside, respectively.

Fig. 3 shows vector addition for belt pull on the motor shaft. The same procedures can be used for finding belt pull on the driveN shaft. This method may be used for drives using three or more sprockets or idlers.

For two-sprocket drives, belt pull on the driveR and driveN shafts is equal but opposite in direction. For drives using idlers, both magnitude and direction may be different.

C. Solution For Magnitude Only

If only the magnitude of belt pull is needed, follow the steps below. Use this method for drives with two sprockets. Use the graphical method shown if the drive uses idlers.

1. Add T_T and T_S
2. Using the value of $\frac{D-d}{C}$ for the drive, find the vector sum correction factor using

Fig. 4, where:

D = large diameter
 d = small diameter
 C = center distance

Or, use the arc of contact on the small sprocket if known.

3. Multiply the sum of T_T plus T_S by the vector sum correction factor to find the vector sum of T_T plus T_S .

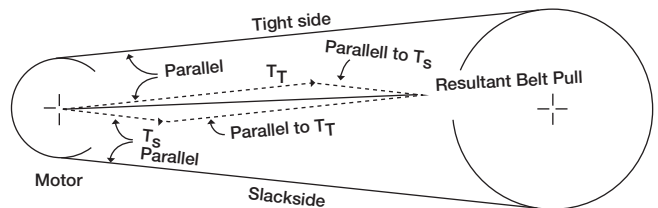


Figure 3

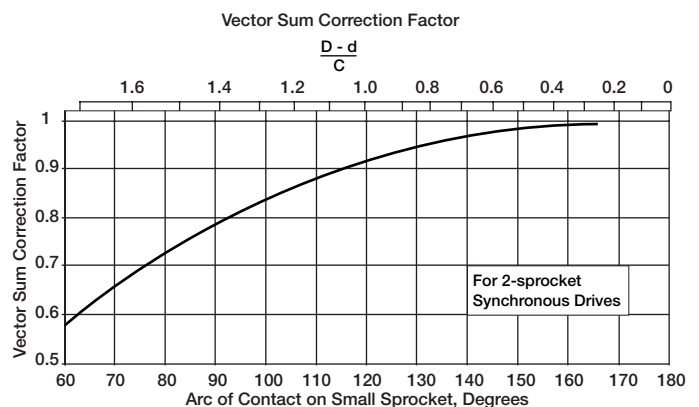


Figure 4

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Bearing/Load Calculations

6. Bearing/Load Calculations

If true side load on the shaft, including sprocket weight, is desired, the sprocket weight can be added to the belt pull using the same graphical method shown in Fig. 3. The sprocket weight vector is vertical toward the ground. Weights for standard sprockets are shown in the sprocket specification tables.

In order to find actual bearing loads, it is necessary to know weights of machine components and the value of all other forces contributing to the load. However, it is sometimes desirable to know the bearing load contributed by the synchronous drive alone. Bearing loads resulting from a synchronous belt drive can be calculated knowing bearing placement with respect to the sprocket center and the shaft load as previously calculated. For rough estimates, machine designers sometimes use belt pull alone, ignoring sprocket weight. If accuracy is desired, or if the sprocket is unusually heavy, actual shaft load values including sprocket weight should be used.

Overhung Sprocket

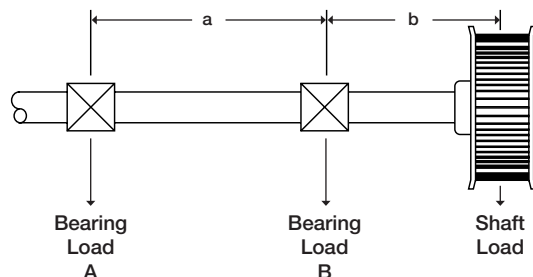


Figure 5

Formula 22

$$\text{Load at B, (lb)} = \frac{\text{ShaftLoad} \times (a + b)}{a}$$

Formula 23

$$\text{Load at A, (lb)} = \text{ShaftLoad} \times \frac{b}{a}$$

Where: a and b = spacing, (in), per Fig. 5

Sprocket Between Bearings

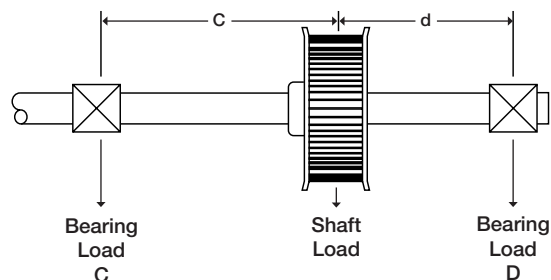


Figure 6

Formula 24

$$\text{Load at C (lb)} = \frac{\text{ShaftLoad} \times c}{(c + d)}$$

Formula 25

$$\text{Load at D (lb)} = \frac{\text{ShaftLoad} \times d}{(c + d)}$$

Where: c and d = spacing (in), per Fig. 6