



## TIPS ON SELECTING AND APPLYING DRIVE BELTS

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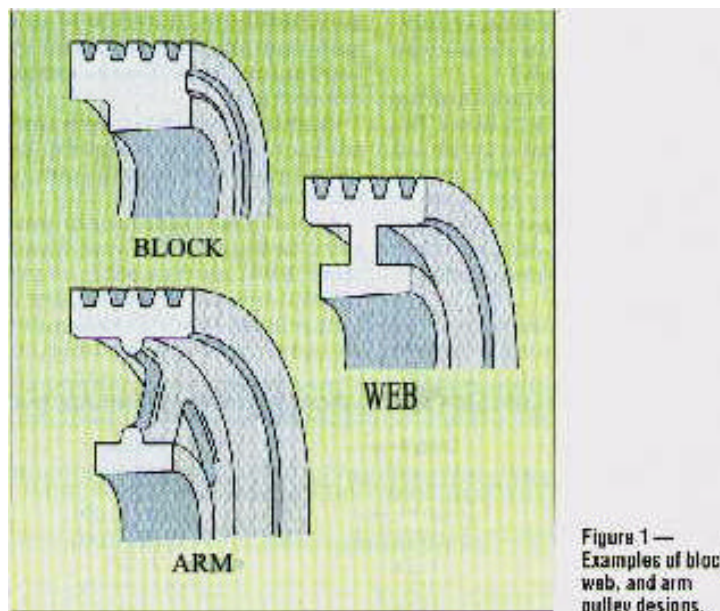
*Want to simplify and improve your belt-drive applications? Having the answers to commonly asked questions will make it easier to select the best drive for the application and get the best drive performance.*

Though belt-drive applications may seem routine, some areas are often misunderstood, as attested to by the many questions received by belt manufacturers. To put you on the right track, here are the answers to the belt-drive questions most commonly asked.

### **Q. What is the maximum speed that a drive belt can safely handle?**

A. For most drives, pulley rim speed is the limiting factor, rather than the belt. This limiting speed depends on the pulley material and design, Table 1 and Figure 1.

Stock pulleys made of iron are statically balanced for rim speeds up to 6,500 fpm. A pulley running at more than 6,500 fpm may cause vibration, noise, poor bearing life, and high fatigue stresses. Therefore, pulleys that exceed 6,500 fpm should be dynamically balanced as described in Mechanical Power Transmission Association (MPTA) bulletin No. SPB-86. In some cases, depending on pulley size or application requirements, dynamic balancing may be required for pulleys operating at less than 6,500 fpm. For speeds outside of the normal ranges, consult the manufacturer.





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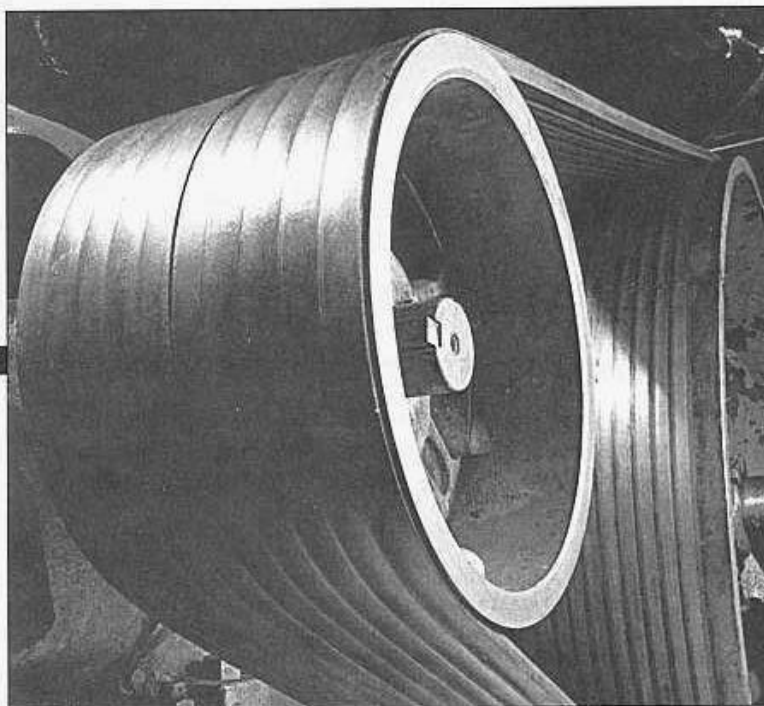
**Q. What causes belt-drive vibration and how can it be corrected?**

A. Drive belts experience both vertical and lateral vibrations when their natural frequencies coincide with resonant frequency of connected equipment.

Belt tension can affect the amplitude of this vibration. Therefore, to correct the problem, first check for proper tension. A common method to control vertical vibration uses a restraining device (metal rod or idler pulley) placed perpendicular to the belt span and close to or lightly touching the belt. This device should be positioned roughly 1/3 of the span distance from the larger pulley.

If this does not work, consider changing other drive parameters to reduce the amplitude of vibration or alter its frequency. Such parameters include span length, belt type, misalignment, inertia of driving or driven machinery, pulley diameter and weight (inertia), speed, and the number of belts. In some cases (where original unit was oversized), it may be possible to downsize the drive by reducing the number of belts or belt width, and increasing the static tension to alter the belt's natural frequency so it doesn't coincide with the excitation frequency of the machinery. When it can be done safely, it is preferable to reduce the static tension to keep the operating belt tension below the belt's natural frequency range.

To reduce lateral vibration, increase flexural rigidity in the lateral direction. This can be accomplished by using joined belts, Figure 2, which consist of two or more belts held together with a high-strength band that prevents the belts from bending sideways and keeps them running straight into the pulley grooves even under severe pulsating or shock loads. A wider synchronous belt can increase lateral rigidity, but should be tensioned carefully. Undertensioning may cause a synchronous belt to jump teeth (ratchet).



**Figure 2 -- Joined V-belts increase lateral rigidity, thereby reducing vibration.**



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**Q. What causes a squealing belt?**

A. A V-belt squealing is usually caused by belt slip, often due to undertensioning. When a new belt replaces one belt in a multibelt drive, the new belt may be tensioned properly, but all of the old ones are undertensioned. To avoid this problem, replace all belts in a multibelt drive at the same time, and with belts of the same construction from the same manufacturer. Belts from different manufacturers, although identified as being similar, may not be of the same size or construction.

Replace worn sheaves, which can lead to noise and belt rollover, as well as worn or damaged belts.

Sudden, high startup torques or peak loads also cause belt slip. Usually, this condition lasts only a few seconds. But, it can lead to heat build-up, Figure 3, which reduces belt life. If belt slip and heat build-up is suspected, turn off the drive and place a gloved hand on the belt to feel if the belt is too hot.

Grit, oil, or grease cause belts to slip. Therefore, keep the drive components clean. And don't use belt dressing. This only masks the real problem of inadequate tension. (Also, see the following question on cutting fluids.)

Large pitch, wide synchronous drives may generate noise at high speeds. This can be caused by too-high or too-low belt tension, or misalignment, which prevents the belt teeth from smoothly entering or leaving the sprocket grooves. Because of this, alignment requirements are tighter for synchronous belts than standard V-belts.

A reminder: when inspecting a problem drive, review all components. Noise can be caused by nonbelt sources, such as bearings, guard vibration, and loose mounts.

**Q. Do cutting fluids or oil affect belts?**

A. Occasional splattering by oil or grease usually does not adversely affect standard belts. But, a large amount of oil or grease on a V-ribbed or V-belt will cause it to slip. In such a case, either shield the belt from oil or grease, or use a synchronous belt. These belts are less affected and may be able to operate under such conditions.

Extensive exposure to petroleum products also causes rubber to swell and the adhesion between belt components to breakdown.

All stock belts manufactured by members of the Rubber Manufacturers Association (RMA) are reasonably oil and chemical-resistant. When evaluating a belt's resistance to chemicals, consider the type of chemical, concentration, exposure time, type of belt, temperature, and humidity. Some belts that contain polyurethane compounds show better resistance to many chemicals.

**Table 1 - Maximum allowable speeds (fpm) for special pulley designs**



Material	Web/Arm	Block
Gray iron	6,500	7,500
Ductile iron	8,000 - 10,000	10,000 - 13,000
Steel	9,000 - 18,000	11,000 - 22,000
Sintered Steel	8,000	10,000
Aluminum	-	12,000 - 18,000

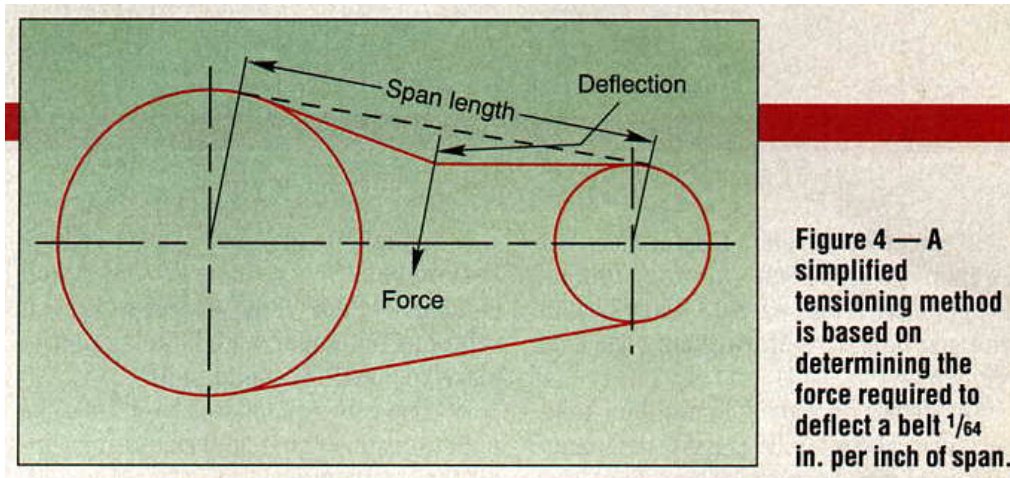
**Q. What is the proper procedure for tensioning a drive?**

A. First, consider another question: Why is proper tension necessary? V-belts use friction between the belt sidewalls and sides of the sheave to transmit power. By contrast, synchronous belts use the engagement of teeth to transmit power.

Over-tensioning either a V-belt or synchronous belt causes excessive bearing load, reduced belt life, and excessive pulley wear. Under-tensioning a V-belt causes belt slippage, whereas under-tensioning a synchronous belt can lead to severe tooth wear and even ratcheting (jumping teeth).

To tension a V-belt, apply the lowest amount of tension that prevents the belt from slipping under full load. For a synchronous belt, you must properly seat the belt in the sprocket. To ensure proper tension, either type of belt should be “run-in.” This process consists of running the drive under full load, then stopping, checking the tension, and retensioning it to recommended load values. Running a belt under full load allows it to seat into the pulley grooves. During initial running, the level of tension will decay (decrease) due to belt seating and initial elongation. The run-in time required to ensure that most tension decay has occurred ranges from 15 min. to 48 hr, depending on the severity of the application. A more severe application takes less run-in time.

Manufactures publish tables [By 1998 Gates had deleted these tables from catalogs due to their approximate only data.] for simplified tensioning methods based on geometry, speed, and belt type for heavy-duty drives. Older methods use a fish scale with a ruler to apply load to the belt and measure its deflection. Many gages enable accurate tensioning, such as direct reading gages that measure static belt tension by measuring force at a specified deflection of the belt span, Figure 4. Other gages determine static belt tension by measuring the harmonic frequency of the belt when strummed.



**Q. How is static conductivity of a belt determined and why is it important?**

A. RMA bulletin IP3-3 explains how to test for static conductivity by passing an electric current of specified voltage through a section of belt while measuring the belt's resistance to conduct the current. A resistance of 6 MΩ or less prevents measurable static voltage buildup, thus preventing a potentially hazardous static discharge.

V-belts are generally manufactured in accordance with this bulletin, but, to be certain, obtain the proper static conductivity from the manufacturer.

The RMA bulletin applies to new, clean belts. However, older belts can collect debris or become worn and damaged, which may give a belt infinite resistance. This condition enables a static charge to build up. Thus, in a hazardous environment, additional protection is recommended, such as grounding the entire system to ensure against accidental static spark discharges. Also, a static conductive brush or similar device will bleed off static buildup on the belt.

**Q. What is the normal shelf life of a drive belt?**

A. When belts are properly stored, according to RMA bulletin IP3-4, no significant change in performance should be detected for up to 8 years. Proper storage, as described in this bulletin, means the belt should be protected from moisture, temperature extremes, direct sunlight, and high ozone levels. The belt should be stored in its original package, avoiding sharp bends or crimping that could damage the belt. Also, belts should not be bent or hung on anything with a diameter less than the smallest recommended pulley diameter for that cross section.

Machines using belt drives sometimes stand idle for prolonged periods (6 mo. or longer). The tension on such belts should be relaxed during idle periods and the equipment should be stored in an environment that is consistent with belt-storage guidelines. If this is not possible, such as with equipment stored outdoors in a cold environment, the belts should be removed and stored separately.

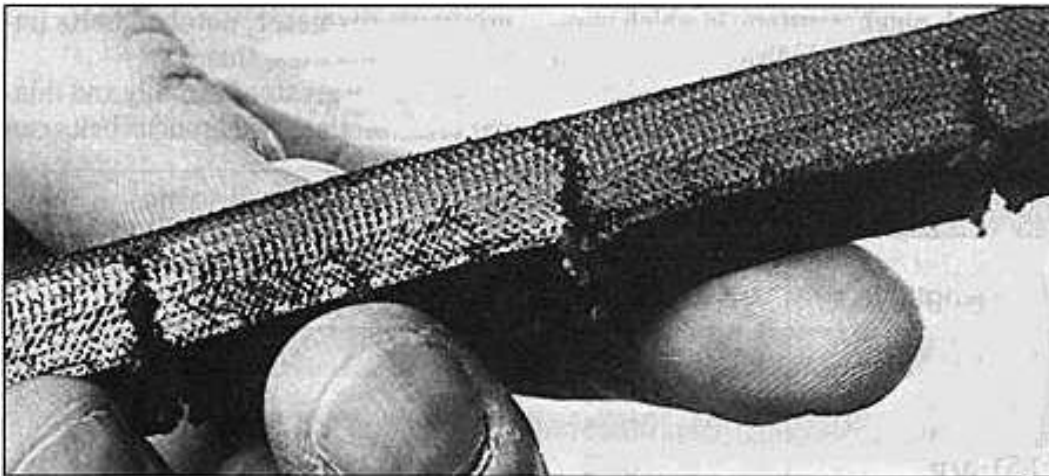


**Q. What is the acceptable temperature range for most belt drives?**

A. There is no well defined temperature limit that ensures satisfactory performance. However, a properly applied belt generally yields acceptable service within an ambient temperature range of -30 to 140 F as specified in RMA bulletin IP 3-1.

When a rubber belt operates with excessively high internal temperatures, the adhesion between belt components breaks down, causing premature failure. Internal belt temperature is affected by ambient temperature, time of exposure, and ventilation, as well as drive design. Tests indicate that for every 36 F increase in ambient temperature, V-belt service life is cut in half. And, for every 2 F increase in ambient temperature, there is a 1 F increase in the belt's internal running temperature. Thus, each 18 F increase in internal belt temperature cuts the belt life in half.

For drives operating in ambient temperatures above 140 F, consult the manufacturer for recommendations. Specially compounded belts can be used in high or low ambient temperatures. But, if the manufacturer uses a compound to raise the upper temperature limit, the lower limit rises as well, and vice versa. Belts that contain polyurethane compounds perform satisfactorily in ambient temperatures between -65 and 185 F.



**Figure 3 — Heat caused by belt slippage, and indicated by glazed sidewalls, can lead to premature failure.**

**Q. What are the primary causes of heat buildup in belt drives?**

A. Both internal and external heat is generated when a belt drive operates. Internal heat (within the belt) is caused by belt flexing as it moves around the pulleys. External heat is created by slippage between for example, a V-belt and sheave.

Parameters that affect belt operating temperature include pulley diameter, load, belt flexing, belt type, maintenance, ambient temperature, and air cooling. To counteract adverse effects on belt temperature, apply these guidelines:

- Use the largest pulley diameter possible. This reduces internal heat buildup due to small-radius bending. Plus, it reduces belt tension and bearing loads, increases air flow, and increases belt contact area, all of which minimize belt slip and heat buildup.



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- Follow proper installation procedures. V-belts require a run-in period and re-tensioning to ensure proper seating and prevent slippage, which can generate external heat.
- Install a belt guard that allows good ventilation. If additional measures are necessary, use forced ventilation or finned pulleys to dissipate heat and reduce heat buildup.
- Select a flexible belt type to reduce heat buildup. Synchronous, V-ribbed, and molded notched V-belts may provide good solutions to temperature buildup, particularly for small-diameter pulleys.
- If heat is a suspected problem, use pulleys made of steel and similar materials that conduct heat away from the belt. Avoid plastic materials, which do not conduct heat.

**Q. What determines if a set of belts match?**

A. Horsepower requirements in many applications call for a multibelt drive. RMA standards IP-20 and IP-22 specify permissible length variations, Table 2, for a set of classical or narrow industrial V-belts. For example, all belts up to 63 in. long in a set must not vary more than 0.15 in. from the longest to the shortest belt. If they exceed this limit, the load will not be evenly distributed and belts will wear out faster.

Industry leaders have improved their manufacturing processes in the past 10 to 12 years so that classical, narrow, and molded notched belts now have tighter than RMA tolerances. Thus, for example, any Gates V80 belt of a given length designation will run with any other V80 belt of the same cross-section and construction. Some belt types are still grouped by the old match-number system, in which numbers are printed on individual belts; each number represents a measured belt-length range. These numbers are grouped in sequential order for matching according to length.

**Table 2 - RMA standard for matching V-belt lengths**

Belt length, in.	RMA tolerance, in.	Tolerance as a ratio of maximum length
Up to 63	0.15	0.0024
63 - 150	0.30	0.0020
151 - 250	0.45	0.0018
251 - 375	0.60	0.0016
376 - 500	0.75	0.0015
501 - 660	0.90	0.0014

**Q. How can belt-drive efficiency be improved?**



A. V-belts operate with 95 to 98% efficiency when properly applied and maintained. But, torque and speed losses reduce belt efficiency.

Torque losses are caused by bending stresses and frictional losses at the belt-sheave interface.

Speed losses are caused by slip and creep around the sheave. Insufficient belt tension allows the belt to slip, which reduces drive efficiency as much as 10%. Conversely, excessive belt tension can reduce belt life as well as efficiency. Variations in belt tension around the driven sheave causes the belt to creep around the sheave, reducing the driven shaft speed.

The efficiency of molded notched belts (AX, BX, and CX types) is slightly better than classical belts (A, B, and C). When a notched belt runs around a sheave, the molded notches along the bottom of the belt reduce compressive stresses in the belt undercord. This enables easier bending around the sheave, which increases efficiency where sheave diameters are smaller than RMA minimum recommended values. Above the recommended minimum diameter, notched belts improve efficiency less than 1%.

Because of greater flexibility and thinner cross section, synchronous belts can operate with small sprocket diameters. These belts offer slightly higher efficiency, 97 to 99%, because there are no speed losses due to slip.

Proper maintenance helps more than anything else to improve V-belt drive efficiency. As stated earlier, replace all belts on multibelt drives at the same time with belts from one manufacturer, and apply tension according to the manufacturer's guidelines. Check and replace worn sheaves to avoid uneven loading or rollover. Also, correct excessive misalignment and provide adequate ventilation to avoid heat buildup.

### **Q. How much misalignment can a drive handle?**

A. Misalignment causes belt instability, tracking error, uneven belt wear, and potential tensile failure of the belt. The basic types of misalignment include parallel and angular. Parallel misalignment occurs when the driver and driven shafts are parallel, but the two pulleys lie in different planes. Angular misalignment occurs when the two shafts are not parallel. Angular and parallel misalignments need to be measured, quantified, added together, and the total compared to the manufacturer's recommendation.

Whereas V-belts operate at up to 6 deg of misalignment without rollover (lateral instability), misalignment should not exceed 1/2 deg (1/10in. per foot of span) for optimum belt life. Joined V-belts should have no more than 1/2 deg of misalignment for best performance and must be carefully aligned. Synchronous, V-ribbed, and joined urethane V-belts (Polyflex), should have no more than 1/3 deg (1/16 in. per foot of span) misalignment.