# FLEXIBLE BELTS AND SHEAVES

Flexible belt drives are used in industrial power transmission applications, especially when the speeds of the driver and driven shafts must be different or when shafts must be widely separated. The trend toward higher speed prime movers and the need to achieve a slower, useful driven speed are additional factors favoring the use of belts. Belts have numerous advantages over other means of power transmission; these advantages include overall economy, cleanliness, no need for lubrication, lower maintenance costs, easy installation, dampening of shock loads, and the abilities to be used for clutching and variable speed power transmission between widely spaced shafts.

**Power Transmitted By Belts.—**With belt drives, the force that produces work acts on the rim of a pulley or sheave and causes it to rotate. Since a belt on a drive must be tight enough to prevent slip, there is a belt pull on both sides of a driven wheel. When a drive is stationary or operating with no power transmitted, the pulls on both sides of the driven wheel are equal. When the drive is transmitting power, however, the pulls are not the same. There is a tight side tension $T_T$ and a slack side tension, $T_S$. The difference between these two pulls ($T_T - T_S$) is called *effective pull* or *net pull*. This effective pull is applied at the rim of the pulley and is the force that produces work.

Net pull equals horsepower (HP) × 33,000 ÷ belt speed (fpm). Belt speed in fpm can be set by changing the pulley, sprocket, or sheave diameter. The shaft speeds remain the same. Belt speed is directly related to pulley diameter. Double the diameter and the total belt pull is cut in half, reducing the load on the shafts and bearings.

A belt experiences three types of tension as it rotates around a pulley: working tension (tight side – slack side), bending tension, and centrifugal tension.

The *tension ratio* ($R$) equals tight side divided by slack side tension (measured in pounds). The larger $R$ is, the closer a V-belt is to slipping—the belt is too loose. (Synchronous belts do not slip, because they depend on the tooth grip principle.)

In addition to working tension (tight side – slack side), two other tensions are developed in a belt when it is operating on a drive. *Bending tension* $T_B$ occurs when the belt bends around the pulley. One part of the belt is in tension and the other is in compression, so compressive stresses also occur. The amount of tension depends on the belt's construction and the pulley diameter. *Centrifugal tension* ($T_C$) occurs as the belt rotates around the drive and is calculated by $T_C = MV^2$, where $T_C$ is centrifugal tension in pounds, $M$ is a constant dependent on the belt's weight, and $V$ is the belt velocity in feet per minute. Neither the bending nor centrifugal tensions are imposed on the pulley, shaft, or bearing—only on the belt.

Combining these three types of tension results in *peak tension* which is important in determining the degree of performance or belt life: $T_{\text{peak}} = T_T + T_B + T_C$.

**Measuring the Effective Length.—**The effective length of a V-belt is determined by placing the belt on a measuring device having two equal diameter sheaves with standard groove dimensions. The shaft of one of the sheaves is fixed. A specified measuring tension is applied to the housing for the shaft of the other sheave, moving it along a graduated scale. The belt is rotated around the sheaves at least two revolutions of the belt to seat it properly in the sheave grooves and to divide the total tension equally between the two strands of the belt.

The effective length of the belt is obtained by adding the effective (outside) circumference of one of the measuring sheaves to twice the center distance. Synchronous belts are measured in a similar manner.

The following sections cover common belts used in industrial applications for power transmission and specified in Rubber Manufacturers Association (RMA), Mechanical Power Transmission Association (MPTA), and The Rubber Association of Canada (RAC) standards. The information presented does not apply to automotive or agricultural drives, for which other standards exist. The belts covered in this section are Narrow, Classical, Double, and Light-Duty V-Belts, V-Ribbed Belts, Variable-Speed Belts, 60 deg V-Belts, and Synchronous (Timing) Belts.

**Narrow V-Belts ANSI/RMA IP-22.—**Narrow V-belts serve the same applications as multiple, classical V-belts, but allow for a lighter, more compact drive. Three basic cross sections—3V and 3VX, 5V and 5VX, and 8V—are provided, as shown in Fig. 1. The 3VX and 5VX are molded, notched V-belts that have greater power capacity than conventional belts. Narrow V-belts are specified by cross section and effective length and have top widths ranging from $\frac{3}{8}$ to 1 in.

Narrow V-belts usually provide substantial weight and space savings over classical belts. Some narrow belts can transmit up to three times the horsepower of conventional belts in the same drive space, or the same horsepower in one-third to one-half the space. These belts are designed to operate in multiples and are also available in the joined configuration.

*Belt Cross Sections:* Nominal dimensions of the three cross sections are given in Fig. 1.

*Belt Size Designation:* Narrow V-belt sizes are identified by a standard belt number. The first figure of this number followed by the letter V denotes the belt cross section. An X following the V indicates a notched cross section. The remaining figures show the effective belt length in tenths of an inch. For example, the number 5VX1400 designates a notched V-belt with a 5V cross section and an effective length of 140.0 in. Standard effective lengths of narrow V-belts are shown in Table 1.

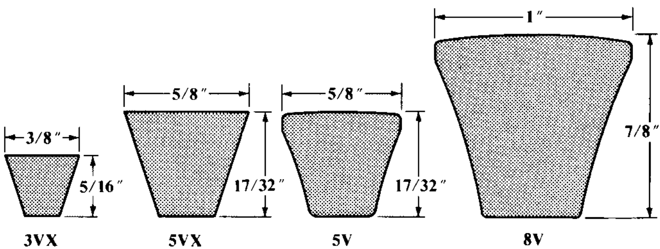



Fig. 1. Nominal Narrow V-Belt Dimensions

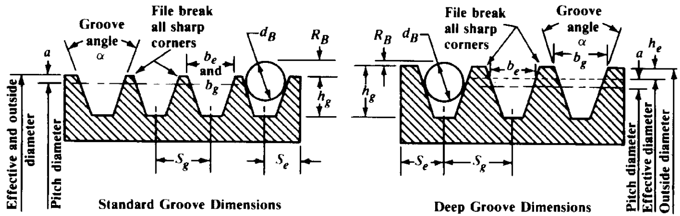
## Table 1. Narrow V-Belt Standard Effective Lengths *ANSI/RMA IP-22 (1983)*

| Standard Length Designation[a] | Standard Effective Outside Length, Cross Section | | | Permissible Deviation from Standard Length | Matching Limits for One Set | Standard Length Designation[a] | Standard Effective Outside Length, Cross Section | | | Permissible Deviation from Standard Length | Matching Limits for One Set |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3V | 5V | 8V | | | | 3V | 5V | 8V | | |
| 250 | 25.0 | … | … | ±0.3 | 0.15 | 1060 | 106.0 | 106.0 | 106.0 | ±0.6 | 0.30 |
| 265 | 26.5 | … | … | ±0.3 | 0.15 | 1120 | 112.0 | 112.0 | 112.0 | ±0.6 | 0.30 |
| 280 | 28.0 | … | … | ±0.3 | 0.15 | 1180 | 118.0 | 118.0 | 118.0 | ±0.6 | 0.30 |
| 300 | 30.0 | … | … | ±0.3 | 0.15 | 1250 | 125.0 | 125.0 | 125.0 | ±0.6 | 0.30 |
| 315 | 31.5 | … | … | ±0.3 | 0.15 | 1320 | 132.0 | 132.0 | 132.0 | ±0.6 | 0.30 |
| 335 | 33.5 | … | … | ±0.3 | 0.15 | 1400 | 140.0 | 140.0 | 140.0 | ±0.6 | 0.30 |
| 355 | 35.5 | … | … | ±0.3 | 0.15 | 1500 | … | 150.0 | 150.0 | ±0.8 | 0.30 |
| 375 | 37.5 | … | … | ±0.3 | 0.15 | 1600 | … | 160.0 | 160.0 | ±0.8 | 0.45 |
| 400 | 40.0 | … | … | ±0.3 | 0.15 | 1700 | … | 170.0 | 170.0 | ±0.8 | 0.45 |
| 425 | 42.5 | … | … | ±0.3 | 0.15 | 1800 | … | 180.0 | 180.0 | ±0.8 | 0.45 |
| 450 | 45.0 | … | … | ±0.3 | 0.15 | 1900 | … | 190.0 | 190.0 | ±0.8 | 0.45 |
| 475 | 47.5 | … | … | ±0.3 | 0.15 | 2000 | … | 200.0 | 200.0 | ±0.8 | 0.45 |
| 500 | 50.0 | 50.0 | … | ±0.3 | 0.15 | 2120 | … | 212.0 | 212.0 | ±0.8 | 0.45 |
| 530 | 53.0 | 53.0 | … | ±0.4 | 0.15 | 2240 | … | 224.0 | 224.0 | ±0.8 | 0.45 |
| 560 | 56.0 | 56.0 | … | ±0.4 | 0.15 | 2360 | … | 236.0 | 236.0 | ±0.8 | 0.45 |
| 600 | 60.0 | 60.0 | … | ±0.4 | 0.15 | 2500 | … | 250.0 | 250.0 | ±0.8 | 0.45 |
| 630 | 63.0 | 63.0 | … | ±0.4 | 0.15 | 2650 | … | 265.0 | 265.0 | ±0.8 | 0.60 |
| 670 | 67.0 | 67.0 | … | ±0.4 | 0.30 | 2800 | … | 280.0 | 280.0 | ±0.8 | 0.60 |
| 710 | 71.0 | 71.0 | … | ±0.4 | 0.30 | 3000 | … | 300.0 | 300.0 | ±0.8 | 0.60 |
| 750 | 75.0 | 75.0 | … | ±0.4 | 0.30 | 3150 | … | 315.0 | 315.0 | ±1.0 | 0.60 |
| 800 | 80.0 | 80.0 | … | ±0.4 | 0.30 | 3350 | … | 335.0 | 335.0 | ±1.0 | 0.60 |
| 850 | 85.0 | 85.0 | … | ±0.5 | 0.30 | 3550 | … | 355.0 | 355.0 | ±1.0 | 0.60 |
| 900 | 90.0 | 90.0 | … | ±0.5 | 0.30 | 3750 | … | … | 375.0 | ±1.0 | 0.60 |
| 950 | 95.0 | 95.0 | … | ±0.5 | 0.30 | 4000 | … | … | 400.0 | ±1.0 | 0.75 |
| 1000 | 100.0 | 100.0 | 100.0 | ±0.5 | 0.30 | 4250 | … | … | 425.0 | ±1.2 | 0.75 |

[a] To specify belt size, use the Standard Length Designation prefixed by the cross section, for example, 5 V850.

All dimensions in inches.

**Table 2. Narrow V-Belt Standard Sheave and Groove Dimensions** *ANSI/RMA IP-22 (1983)*




Face Width of Standard and Deep Groove Sheaves $= s_g (N_g - 1) + 2S_e$, where $N_g$ = number of grooves

| Cross Section | Standard Groove Outside Diameter | Standard Groove Dimensions | | | | | | | | Design Factors | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Groove Angle, α, ±0.25 deg | $b_g$ ±0.005 | $b_e$ (Ref) | $h_g$ (Min) | $R_B$ (Min) | $d_B$ ±0.0005 | $S_g$[a] ±0.015 | $S_e$ | Min Recommended OD | $2a$ |
| 3V | Up through 3.49 | 36 | | | | 0.181 | | | | | |
| | Over 6.00 up to and including 12.00 | 40 | 0.350 | 0.350 | 0.340 | 0.186 | 0.3438 | 0.406 | 0.344 (+ 0.099, −0.031) | 2.65 | 0.050 |
| | Over 9.99 up to and including 16.00 | 40 | 0.600 | 0.600 | 0.590 | 0.332 | 0.5938 | 0.688 | 0.500 +0.125, −0.047) | 7.10 | 0.100 |
| | Over 16.00 | 42 | | | | 0.336 | | | | | |
| 8V | Up through 15.99 | 38 | | | | 0.575 | | | | | |
| | Over 15.99 up to and including 22.40 | 40 | 1.000 | 1.000 | 0.990 | 0.580 | 1.0000 | 1.125 | 0.750 (+0.250, −0.062) | 12.50 | 0.200 |
| | Over 22.40 | 42 | | | | 0.585 | | | | | |

[a] Summation of the deviations from $S_g$ for all grooves in any one sheave should not exceed ±0.031 in. The variations in pitch diameter between the grooves in any one sheave must be within the following limits: Up through 19.9 in. outside diameter and up through 6 grooves—0.010 in. (add 0.0005 in. for each additional groove). 20.0 in. and over on outside diameter and up through 10 grooves—0.015 in. (add 0.0005 in. for each additional groove). This variation can be obtained by measuring the distance across two measuring balls or rods placed in the grooves diametrically opposite each other. Comparing this "diameter over balls or rods" measurement between grooves will give the variation in pitch diameter.

**Table 2.** *(Continued)* **Narrow V-Belt Standard Sheave and Groove Dimensions ANSI/RMA IP-22 (1983)**

| Cross Section | Deep Groove Outside Diameter | Deep Groove Dimensions[a] | | | | | | | | Design Factors | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Groove Angle, α, ±0.25 deg | $b_g$ ±0.005 | $b_e$ (Ref) | $h_g$ (Min) | $R_B$ (Min) | $d_B$ ±0.0005 | $S_g$[a] ±0.015 | $S_e$ | Min Recommended OD | $2a$ | $2h_e$ |
| 3V | Up through 3.71 | 36 | 0.421 | 0.350 | 0.449 | 0.070 | 0.3438 | 0.500 | 0.375 (+0.094, −0.031) | 2.87 | 0.050 | 0.218 |
| | Over 3.71 up to and including 6.22 | 38 | 0.425 | | | 0.073 | | | | | | |
| | Over 6.22 up to and including 12.22 | 40 | 0.429 | | | 0.076 | | | | | | |
| | Over 12.22 | 42 | 0.434 | | | 0.078 | | | | | | |
| 5V | Up through 10.31 | 38 | 0.710 | 0.600 | 0.750 | 0.168 | 0.5938 | 0.812 | 0.562 (+0.125, − 0.047) | 7.42 | 0.100 | 0.320 |
| | Over 10.31 up to and including 16.32 | 40 | 0.716 | | | 0.172 | | | | | | |
| | Over 16.32 | 42 | 0.723 | | | 0.175 | | | | | | |
| 8V | Up through 16.51 | 38 | 1.180 | 1.000 | 1.252 | 0.312 | 1.0000 | 1.312 | 0.844 (+0.250, −0.062) | 13.02 | 0.200 | 0.524 |
| | Over 16.51 up to and including 22.92 | 40 | 1.191 | | | 0.316 | | | | | | |
| | Over 22.92 | 42 | 1.201 | | | 0.321 | | | | | | |

[a] Deep groove sheaves are intended for drives with belt offset such as quarter-turn or vertical shaft drives. They may also be necessary where oscillations in the center distance may occur. Joined belts will not operate in deep groove sheaves.

| Other Sheave Tolerances | | |
|---|---|---|
| Outside Diameter | Radial Runout[a] | Axial Runout[a] |
| Up through 8.0 in. outside diameter ±0.020 in. | Up through 10.0 in. outside diameter 0.010 in. | Up through 5.0 in. outside diameter 0.005 in. |
| For each additional inch of outside diameter add ±0.0025 in. | For each additional inch of outside diameter add 0.0005 in. | For each additional inch of outside diameter add 0.001 in. |

[a] Total indicator reading.
All dimensions in inches.

*Sheave Dimensions:* Groove angles and dimensions for sheaves and face widths of sheaves for multiple belt drives are given in Table 2, along with various tolerance values. Standard sheave outside diameters are given in Table 3.

**Table 3. Standard Sheave Outside Diameters** *ANSI/RMA IP-22, 1983*

| 3V | | | 5V | | | 8V | | |
|---|---|---|---|---|---|---|---|---|
| Nom | Min | Max | Nom | Min | Max | Nom | Min | Max |
| 2.65 | 2.638 | 2.680 | 7.10 | 7.087 | 7.200 | 12.50 | 12.402 | 12.600 |
| 2.80 | 2.795 | 2.840 | 7.50 | 7.480 | 7.600 | 13.20 | 13.189 | 13.400 |
| 3.00 | 2.953 | 3.000 | 8.00 | 7.874 | 8.000 | 14.00 | 13.976 | 14.200 |
| 3.15 | 3.150 | 3.200 | 8.50 | 8.346 | 8.480 | 15.00 | 14.764 | 15.000 |
| 3.35 | 3.346 | 3.400 | 9.00 | 8.819 | 8.960 | 16.00 | 15.748 | 16.000 |
| 3.55 | 3.543 | 3.600 | 9.25 | 9.291 | 9.440 | 17.00 | 16.732 | 17.000 |
| 3.65 | 3.642 | 3.700 | 9.75 | 9.567 | 9.720 | 18.00 | 17.717 | 18.000 |
| 4.00 | 3.937 | 4.000 | 10.00 | 9.843 | 10.000 | 19.00 | 18.701 | 19.000 |
| 4.12 | 4.055 | 4.120 | 10.30 | 10.157 | 10.320 | 20.00 | 19.685 | 20.000 |
| 4.50 | 4.409 | 4.480 | 10.60 | 10.433 | 10.600 | 21.20 | 20.866 | 21.200 |
| 4.75 | 4.646 | 4.720 | 10.90 | 10.709 | 10.880 | 22.40 | 22.047 | 22.400 |
| 5.00 | 4.921 | 5.000 | 11.20 | 11.024 | 11.200 | 23.60 | 23.622 | 24.000 |
| 5.30 | 5.197 | 5.280 | 11.80 | 11.811 | 12.000 | 24.80 | 24.803 | 25.200 |
| 5.60 | 5.512 | 5.600 | 12.50 | 12.402 | 12.600 | 30.00 | 29.528 | 30.000 |
| 6.00 | 5.906 | 6.000 | 13.20 | 13.189 | 13.400 | 31.50 | 31.496 | 32.000 |
| 6.30 | 6.299 | 6.400 | 14.00 | 13.976 | 14.200 | 35.50 | 35.433 | 36.000 |
| 6.50 | 6.496 | 6.600 | 15.00 | 14.764 | 15.000 | 40.00 | 39.370 | 40.000 |
| 6.90 | 6.890 | 7.000 | 16.00 | 15.748 | 16.000 | 44.50 | 44.094 | 44.800 |
| 8.00 | 7.874 | 8.000 | 18.70 | 18.701 | 19.000 | 50.00 | 49.213 | 50.000 |
| 10.00 | 9.843 | 10.000 | 20.00 | 19.685 | 20.000 | 52.00 | 51.969 | 52.800 |
| 10.60 | 10.433 | 10.600 | 21.20 | 20.866 | 21.200 | 63.00 | 62.992 | 64.000 |
| 12.50 | 12.402 | 12.600 | 23.60 | 23.622 | 24.000 | 71.00 | 70.866 | 72.000 |
| 14.00 | 13.976 | 14.200 | 25.00 | 24.803 | 25.200 | 79.00 | 78.740 | 80.000 |
| 16.00 | 15.748 | 16.000 | 28.00 | 27.953 | 28.400 | 99.00 | 98.425 | 100.000 |
| 19.00 | 18.701 | 19.000 | 31.50 | 31.496 | 32.000 | … | … | … |
| 20.00 | 19.685 | 20.000 | 37.50 | 37.402 | 38.000 | … | … | … |
| 25.00 | 24.803 | 25.200 | 40.00 | 39.370 | 40.000 | … | … | … |
| 31.50 | 31.496 | 32.000 | 44.50 | 44.094 | 44.800 | … | … | … |
| 33.50 | 33.465 | 34.000 | 50.00 | 49.213 | 50.000 | … | … | … |
| … | … | … | 63.00 | 62.992 | 64.000 | … | … | … |
| … | … | … | 71.00 | 70.866 | 72.000 | … | … | … |

All dimensions in inches. The nominal diameters were selected from R40 and R80 preferred numbers (see page 19).

*Cross Section Selection:* The chart (Fig. 2, on page 2379) is a guide to the V-belt cross section to use for any combination of design horsepower and speed of the faster shaft. When the intersection of the design horsepower and speed of the faster shaft falls near a line between two areas on the chart, it is advisable to investigate the possibilities in both areas. Special circumstances (such as space limitations) may lead to a choice of belt cross section different from that indicated in the chart.

*Horsepower Ratings:* The horsepower ratings of narrow V-belts can be calculated using the following formula:

$$\text{HP} = d_p r[K_1 - K_2/d_p - K_3(d_p r)^2 - K_4 \log(d_p r)] + K_{SR} r$$

where $d_p$ = the pitch diameter of the small sheave, in.; $r$ = rpm of the faster shaft divided by 1000; $K_{SR}$, speed ratio correction factor, and $K_1$, $K_2$, $K_3$, and $K_4$, cross section parameters, are listed in the accompanying tables. This formula gives the basic horsepower rating, corrected for the speed ratio. To obtain the horsepower per belt for an arc of contact other than 180° and for belts shorter or longer than average length, multiply the horsepower obtained from this formula by the length correction factor (Table 4) and the arc of contact correction factor (Table 5).

### Table 4. Length Correction Factors

| Standard Length Designation | Cross Section 3V | Cross Section 5V | Cross Section 8V | Standard Length Designation | Cross Section 3V | Cross Section 5V | Cross Section 8V |
|---|---|---|---|---|---|---|---|
| 250 | 0.83 | | | 1180 | 1.12 | 0.99 | 0.89 |
| 265 | 0.84 | | | 1250 | 1.13 | 1.00 | 0.90 |
| 280 | 0.85 | | | 1320 | 1.14 | 1.01 | 0.91 |
| 300 | 0.86 | | | 1400 | 1.15 | 1.02 | 0.92 |
| 315 | 0.87 | | | 1500 | | 1.03 | 0.93 |
| 335 | 0.88 | | | 1600 | | 1.04 | 0.94 |
| 355 | 0.89 | | | 1700 | | 1.05 | 0.94 |
| 375 | 0.90 | | | 1800 | | 1.06 | 0.95 |
| 400 | 0.92 | | | 1900 | | 1.07 | 0.96 |
| 425 | 0.93 | | | 2000 | | 1.08 | 0.97 |
| 450 | 0.94 | | | 2120 | | 1.09 | 0.98 |
| 475 | 0.95 | | | 2240 | | 1.09 | 0.98 |
| 500 | 0.96 | 0.85 | | 2360 | | 1.10 | 0.99 |
| 530 | 0.97 | 0.86 | | 2500 | | 1.11 | 1.00 |
| 560 | 0.98 | 0.87 | | 2650 | | 1.12 | 1.01 |
| 600 | 0.99 | 0.88 | | 2800 | | 1.13 | 1.02 |
| 630 | 1.00 | 0.89 | | 3000 | | 1.14 | 1.03 |
| 670 | 1.01 | 0.90 | | 3150 | | 1.15 | 1.03 |
| 710 | 1.02 | 0.91 | | 3350 | | 1.16 | 1.04 |
| 750 | 1.03 | 0.92 | | 3550 | | 1.17 | 1.05 |
| 800 | 1.04 | 0.93 | | 3750 | | | 1.06 |
| 850 | 1.06 | 0.94 | | 4000 | | | 1.07 |
| 900 | 1.07 | 0.95 | | 4250 | | | 1.08 |
| 950 | 1.08 | 0.96 | | 4500 | | | 1.09 |
| 1000 | 1.09 | 0.96 | 0.87 | 4750 | | | 1.09 |
| 1060 | 1.10 | 0.97 | 0.88 | 5000 | | | 1.10 |
| 1120 | 1.11 | 0.98 | 0.88 | … | | | … |

### Table 5. Arc of Contact Correction Factors

| $\frac{D_e - d_e}{C}$ | Arc of Contact, θ, on Small Sheave (deg) | Correction Factor | $\frac{D_e - d_e}{C}$ | Arc of Contact, θ, on Small Sheave (deg) | Correction Factor |
|---|---|---|---|---|---|
| 0.00 | 180 | 1.00 | 0.80 | 133 | 0.87 |
| 0.10 | 174 | 0.99 | 0.90 | 127 | 0.85 |
| 0.20 | 169 | 0.97 | 1.00 | 120 | 0.82 |
| 0.30 | 163 | 0.96 | 1.10 | 113 | 0.80 |
| 0.40 | 157 | 0.94 | 1.20 | 106 | 0.77 |
| 0.50 | 151 | 0.93 | 1.30 | 99 | 0.73 |
| 0.60 | 145 | 0.91 | 1.40 | 91 | 0.70 |
| 0.70 | 139 | 0.89 | 1.50 | 83 | 0.65 |

### Speed Ratio Correction Factors

| Speed Ratio[a] Range | $K_{SR}$ Cross Section 3VX | $K_{SR}$ Cross Section 5VX | Speed Ratio[a] Range | $K_{SR}$ Cross Section 5V | $K_{SR}$ Cross Section 8V |
|---|---|---|---|---|---|
| 1.00–1.01 | 0.0000 | 0.0000 | 1.00–1.01 | 0.0000 | 0.0000 |
| 1.02–1.03 | 0.0157 | 0.0801 | 1.02–1.05 | 0.0963 | 0.4690 |
| 1.04–1.06 | 0.0315 | 0.1600 | 1.06–1.11 | 0.2623 | 1.2780 |
| 1.07–1.09 | 0.0471 | 0.2398 | 1.12–1.18 | 0.4572 | 2.2276 |
| 1.10–1.13 | 0.0629 | 0.3201 | 1.19–1.26 | 0.6223 | 3.0321 |
| 1.14–1.18 | 0.0786 | 0.4001 | 1.27–1.38 | 0.7542 | 3.6747 |
| 1.19–1.25 | 0.0944 | 0.4804 | 1.39–1.57 | 0.8833 | 4.3038 |
| 1.26–1.35 | 0.1101 | 0.5603 | 1.58–1.94 | 0.9941 | 4.8438 |
| 1.36–1.57 | 0.1259 | 0.6405 | 1.95–3.38 | 1.0830 | 5.2767 |
| Over 1.57 | 0.1416 | 0.7202 | Over 3.38 | 1.1471 | 5.5892 |

[a] $D_p/d_p$, where $D_p$ ($d_p$) is the pitch diameter of the large (small) sheave.

**Cross Section Correction Factors**

| Cross Section | $K_1$ | $K_2$ | $K_3$ | $K_4$ |
|---|---|---|---|---|
| 3VX | 1.1691 | 1.5295 | $1.5229 \times 10^{-4}$ | 0.15960 |
| 5VX | 3.3038 | 7.7810 | $3.6432 \times 10^{-4}$ | 0.43343 |
| 5V | 3.3140 | 10.123 | $5.8758 \times 10^{-4}$ | 0.46527 |
| 8V | 8.6628 | 49.323 | $1.5804 \times 10^{-3}$ | 1.1669 |

*Number of Belts:* The number of belts required for an application is obtained by dividing the design horsepower by the corrected horsepower rating for one belt.

*Minimum Sheave Size:* The recommended minimum sheave size depends on the rpm of the faster shaft. Minimum sheave diameters for each belt cross-section are listed in Table 3.

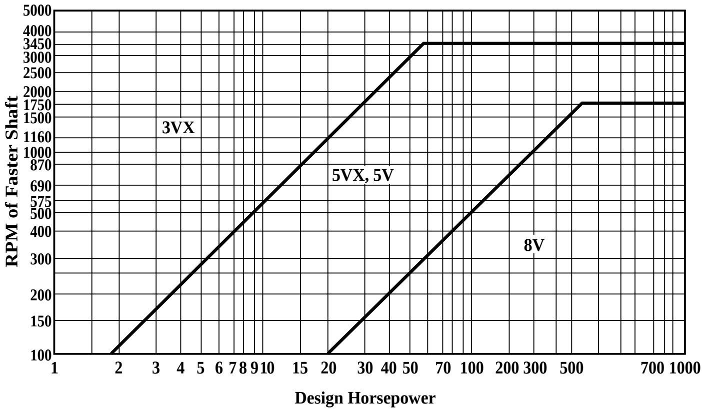



Fig. 2. Selection of Narrow V-Belt Cross Section

Arc of contact on the small sheave may be determined by the formulas.

*Exact formula:*

$$\text{Arc of Contact (deg)} = 2\cos^{-1}\left(\frac{D_e - d_e}{2C}\right)$$

*Approximate formula:*

$$\text{Arc of Contact (deg)} = 180 - \frac{(D_e - d_e)60}{C}$$

where: $D_e$ = Effective diameter of large sheave, inch

$d_e$ = Effective diameter of small sheave, inch

$C$ = Center distance, inch

**Classical V-Belts ANSI/RMA IP-20.—**Classical V-belts are most commonly used in heavy-duty applications and include these standard cross sections: A, AX, B, BX, C, CX, D, and DX (Fig. 3, page 2383). Top widths range from ½ to 1¼ in. and are specified by cross section and nominal length. Classical belts can be teamed in multiples of two or more. These multiple drives can transmit up to several hundred horsepower continuously and absorb reasonable shock loads.

*Belt Cross Sections:* Nominal dimensions of the four cross sections are given in Fig. 3.

*Belt Size Designation:* Classical V-belt sizes are identified by a standard belt number consisting of a letter-numeral combination. The letter identifies the cross section; the numeral identifies the length as shown in Table 6. For example, A60 indicates an A cross section and a standard length designation of 60. An X following the section letter designation indicates a molded notch cross section, for example, AX60.

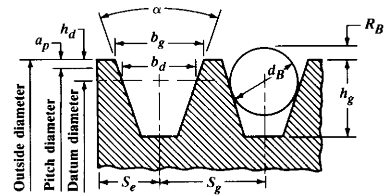
**Table 6. Classical V-Belt Standard Datum Length** *ANSI/RMA IP-20, 1988*

| Standard Length Designation[a] | Standard Datum lengths | | | | Permissible Deviations from Std. Datum Length | Matching Limits for One Set |
|---|---|---|---|---|---|---|
| | Cross Section | | | | | |
| | A, AX | B, BX | C, CX | D | | |
| 26 | 27.3 | … | … | … | +0.6, −0.6 | 0.15 |
| 31 | 32.3 | … | … | … | +0.6, −0.6 | 0.15 |
| 35 | 36.3 | 36.8 | … | … | +0.6, −0.6 | 0.15 |
| 38 | 39.3 | 39.8 | … | … | +0.7, −0.7 | 0.15 |
| 42 | 43.3 | 43.8 | … | … | +0.7, −0.7 | 0.15 |
| 46 | 47.3 | 47.8 | … | … | +0.7, −0.7 | 0.15 |
| 51 | 52.3 | 52.8 | 53.9 | … | +0.7, −0.7 | 0.15 |
| 55 | 56.3 | 56.8 | … | … | +0.7, −0.7 | 0.15 |
| 60 | 61.3 | 61.8 | 62.9 | … | +0.7, −0.7 | 0.15 |
| 68 | 69.3 | 69.8 | 70.9 | … | +0.7, −0.7 | 0.30 |
| 75 | 75.3 | 76.8 | 77.9 | … | +0.7, −0.7 | 0.30 |
| 80 | 81.3 | … | … | … | +0.7, −0.7 | 0.30 |
| 81 | … | 82.8 | 83.9 | … | +0.7, −0.7 | 0.30 |
| 85 | 86.3 | 86.8 | 87.9 | … | +0.7, −0.7 | 0.30 |
| 90 | 91.3 | 91.8 | 92.9 | … | +0.8, −0.8 | 0.30 |
| 96 | 97.3 | … | 98.9 | … | +0.8, −0.8 | 0.30 |
| 97 | … | 98.8 | … | … | +0.8, −0.8 | 0.30 |
| 105 | 106.3 | 106.8 | 107.9 | … | +0.8, −0.8 | 0.30 |
| 112 | 113.3 | 113.8 | 114.9 | … | +0.8, −0.8 | 0.30 |
| 120 | 121.3 | 121.8 | 122.9 | 123.3 | +0.8, −0.8 | 0.30 |
| 128 | 129.3 | 129.8 | 130.9 | 131.3 | +0.8, −0.8 | 0.30 |
| 144 | … | 145.8 | 146.9 | 147.3 | +0.8, −0.8 | 0.30 |
| 158 | … | 159.8 | 160.9 | 161.3 | +1.0, −1.0 | 0.45 |
| 173 | … | 174.8 | 175.9 | 176.3 | +1.0, −1.0 | 0.45 |
| 180 | … | 181.8 | 182.9 | 183.3 | +1.0, −1.0 | 0.45 |
| 195 | … | 196.8 | 197.9 | 198.3 | +1.1, −1.1 | 0.45 |
| 210 | … | 211.8 | 212.9 | 213.3 | +1.1, −1.1 | 0.45 |
| 240 | … | 240.3 | 240.9 | 240.8 | +1.3, −1.3 | 0.45 |
| 270 | … | 270.3 | 270.9 | 270.8 | +1.6, −1.6 | 0.60 |
| 300 | … | 300.3 | 300.0 | 300.8 | +1.6, −1.6 | 0.60 |
| 330 | … | … | 330.9 | 330.8 | +2.0, −2.0 | 0.60 |
| 360 | … | … | 380.9 | 360.8 | +2.0, −2.0 | 0.60 |
| 540 | … | … | … | 540.8 | +3.3, −3.3 | 0.90 |
| 390 | … | … | 390.9 | 390.8 | +2.0, −2.0 | 0.75 |
| 420 | … | … | 420.9 | 420.8 | +3.3, −3.3 | 0.75 |
| 480 | … | … | … | 480.8 | +3.3, −3.3 | 0.75 |
| 600 | … | … | … | 600.8 | +3.3, −3.3 | 0.90 |
| 660 | … | … | … | 660.8 | +3.3, −3.3 | 0.90 |

[a] To specify belt size use the Standard Length Designation prefixed by the letter indicating the cross section, e.g., B90.

All dimensions in inches.

## Table 7. Classical V-Belt Sheave and Groove Dimensions *ANSI/RMA IP-20, 1988*




Face Width of Standard and Deep Groove Sheaves = $S_g(N_g - 1) + 2S_e$, where $N_g$ = number of grooves

| Cross Section | Datum[a] Diameter Range | α Groove Angle ±0.33° | $b_d$ Ref | $b_g$ | $h_g$ Min | $2h_d$ | $R_B$ Min | $d_B$ ±0.0005 | $S_g$[b] ±0.025 | $S_e$ | Min Recom. Datum Diameter | $2a_p$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Standard Groove Dimensions | | | | | | | | | Design Factors | |
| A, AX | Through 5.4 | 34 | 0.418 | 0.494 ± 0.005 | 0.460 | 0.250 | 0.148 | 0.4375 (7/16) | 0.625 | 0.375 + 0.090 − 0.062 | A 3.0 | 0 |
| | Over 5.4 | 38 | | 0.504 | | | 0.149 | | | | AX 2.2 | |
| B, BX | Through 7.0 | 34 | 0.530 | 0.637 ± 0.006 | 0.550 | 0.350 | 0.189 | 0.5625 (9/16) | 0.750 | 0.500 + 0.120 − 0.065 | B 5.4 | 0 |
| | Over 7.0 | 38 | | 0.650 | | | 0.190 | | | | BX 4.0 | |
| Combination A, AX Belt | Through 7.4[c] | 34 | 0.508[d] | 0.612 ±0.006 | 0.612 | 0.634[e] | 0.230 | 0.5625 (9/16) | 0.750 | 0.500 +0.120 −0.065 | A 3.6[c] | 0.37 |
| | Over 7.4 | 38 | | 0.625 | | 0.602[e] | 0.226 | | | | AX 2.8 | |
| Combination B, BX Belt | Through 7.4[c] | 34 | | 0.612 ±0.006 | | 0.333[e] | 0.230 | | | | B 5.7[c] | −0.01 |
| | Over 7.4 | 38 | | 0.625 | | 0.334[e] | 0.226 | | | | BX 4.3 | |
| C, CX | Through 7.99 | 34 | 0.757 | 0.879 ±0.007 | 0.750 | 0.400 | 0.274 | 0.7812 (25/32) | 1.000 | 0.688 +0.160 −0.070 | C 9.0 CX 6.8 | 0 |
| | Over 7.99 to and incl. 12.0 | 36 | | 0.887 | | | 0.276 | | | | | |
| | Over 12.0 | 38 | | 0.895 | | | 0.277 | | | | | |
| D | Through 12.99 | 34 | 1.076 | 1.259 ± 0.008 | 1.020 | 0.600 | 0.410 | 1.1250 (1 1/8) | 1.438 | 0.875 + 0.220 − 0.080 | 13.0 | 0 |
| | Over 12.99 to and incl. 17.0 | 36 | | 1.271 | | | 0.410 | | | | | |
| | Over 17.0 | 38 | | 1.283 | | | 0.411 | | | | | |

## Table 7. *(Continued)* Classical V-Belt Sheave and Groove Dimensions *ANSI/RMA IP-20, 1988*

| Deep Groove Dimensions[f] | | | | | | | | | | | | | Design Factors | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cross Section | Datum[a] Dia. Range | α Groove Angle ± 0.33° | $b_g$ Ref | $b_g$ | | $h_g$ Min | $2h_d$ Ref | $R_B$ Min | $d_B$ ± 0.0005 | $S_g$[b] ± 0.025 | $S_e$ | | Min Rec. Datum Diameter | $2a_p$ |
| B, BX | Through 7.0 | 34 | 0.530 | 0.747 | ± 0.006 | 0.730 | 0.710 | 0.007 | 0.5625 | 0.875 | 0.562 | + 0.120 | B 5.4 | 0.36 |
| | Over 7.0 | 38 | | 0.774 | | | | 0.008 | (9/16) | | | − 0.065 | BX 4.0 | |
| C, CX | Through 7.99 | 34 | 0.757 | 1.066 | ± 0.007 | 1.055 | 1.010 | − 0.035 | 0.7812 (25/32) | 1.250 | 0.812 | + 0.160 − 0.070 | C 9.0 CX 6.8 | 0.61 |
| | Over 7.99 to and incl. 12.0 | 36 | | 1.085 | | | | − 0.032 | | | | | | |
| | Over 12.0 | 38 | | 1.105 | | | | −0.031 | | | | | | |
| D | Through 12.99 | 34 | 1.076 | 1.513 | ±0.008 | 1.435 | 1.430 | −0.010 | 1.1250 (1 1/8) | 1.750 | 1.062 | +0.220 −0.080 | 13.0 | 0.83 |
| | Over 12.99 to and incl. 17.0 | 36 | | 1.514 | | | | −0.009 | | | | | | |
| | Over 17.0 | 38 | | 1.569 | | | | −0.008 | | | | | | |

[a] The A/AX, B/BX combination groove should be used when deep grooves are required for A or AX belts.

[b] Summation of the deviations from $S_g$ for all grooves in any one sheave should not exceed ±0.050 in. The variation in datum diameter between the grooves in any one sheave must be within the following limits: Through 19.9 in. outside diameter and through 6 grooves: 0.010 in. (add 0.0005 in. for each additional groove). 20.0 in. and over on outside diameter and through 10 grooves: 0.015 in. (add 0.0005 in. for each additional groove). This variation can be obtained by measuring the distance across two measuring balls or rods placed diametrically opposite each other in a groove. Comparing this "diameter over balls or rods" measurement between grooves will give the variation in datum diameter.

[c] Diameters shown for combination grooves are outside diameters. A specific datum diameter does not exist for either A or B belts in combination grooves.

[d] The $b_d$ value shown for combination grooves is the "constant width" point, but does not represent a datum width for either A or B belts ($2h_d = 0.340$ ref).

[e] $2h_d$ values for combination grooves are calculated based on $b_d$ for A and B grooves.

[f] Deep groove sheaves are intended for drives with belt offset such as quarter-turn or vertical shaft drives. Joined belts will not operate in deep groove sheaves. Also, A and AX joined belts will not operate in A/AX and B/BX combination grooves.

| Other Sheave Tolerances | | |
|---|---|---|
| Outside Diameter | Radial Runout[a] | Axial Runout[a] |
| Through 8.0 in. outside diameter ±0.020 in. For each additional inch of outside diameter add ±0.005 in. | Through 10.0 in. outside diameter 0.010 in. For each additional inch of outside diameter add 0.0005 in. | Through 5.0 in. outside diameter 0.005 in. For each additional inch of outside diameter add 0.001 in. |

[a] Total indicator readings.

<u>A, AX & B, BX Combin.</u> All dimensions in inches.

*Sheave Dimensions:* Groove angles and dimensions for sheaves and the face widths of sheaves for multiple belt drives are given in Table 7, along with various tolerance values.

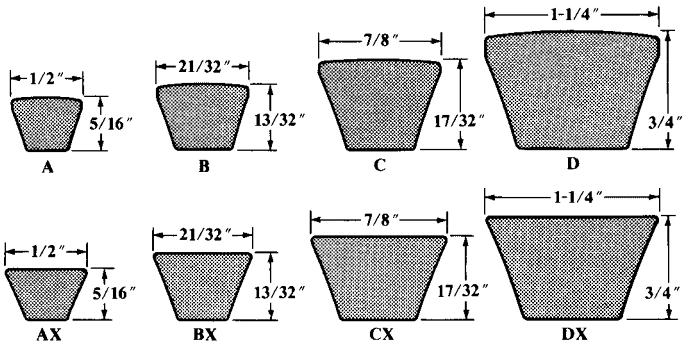



Fig. 3. Classical V-Belt Cross Sections

*Cross Section Selection:* Use the chart (Fig. 4) as a guide to the Classical V-belt cross section for any combination of design horsepower and speed of the faster shaft. When the intersection of the design horsepower and speed of the faster shaft falls near a line between two areas on the chart, the possibilities in both areas should be investigated. Special circumstances (such as space limitations) may lead to a choice of belt cross section different from that indicated in the chart.

*Horsepower Ratings:* The horsepower rating formulas for classical V-belts are:

$$\textbf{A:}\mathrm{HP} = d_p r\left[1.004 - \frac{1.652}{d_p} - 1.547\times10^{-4}(d_p r)^2 - 0.2126\log(d_p r)\right] + 1.652r\left(1 - \frac{1}{K_{SR}}\right)$$

$$\textbf{AX:}\mathrm{HP} = d_p r\left[1.462 - \frac{2.239}{d_p} - 2.198\times10^{-4}(d_p r)^2 - 0.4238\log(d_p r)\right] + 2.239r\left(1 - \frac{1}{K_{SR}}\right)$$

$$\textbf{B:}\mathrm{HP} = d_p r\left[1.769 - \frac{4.372}{d_p} - 3.081\times10^{-4}(d_p r)^2 - 0.3658\log(d_p r)\right] + 4.372r\left(1 - \frac{1}{K_{SR}}\right)$$

$$\mathbf{BX:}\text{HP} = d_p r\left[2.051 - \frac{3.532}{d_p} - 3.097\times10^{-4}(d_p r)^2 - 0.5735\log(d_p r)\right] + 3.532r\left(1 - \frac{1}{K_{SR}}\right)$$

$$\mathbf{C:}\text{HP} = d_p r\left[3.325 - \frac{12.07}{d_p} - 5.828\times10^{-4}(d_p r)^2 - 0.6886\log(d_p r)\right] + 12.07r\left(1 - \frac{1}{K_{SR}}\right)$$

$$\mathbf{CX:}\text{HP} = d_p r\left[3.272 - \frac{6.655}{d_p} - 5.298\times10^{-4}(d_p r)^2 - 0.8637\log(d_p r)\right] + 6.655r\left(1 - \frac{1}{K_{SR}}\right)$$

$$\mathbf{D:}\text{HP} = d_p r\left[7.160 - \frac{43.21}{d_p} - 1.384\times10^{-3}(d_p r)^2 - 1.454\log(d_p r)\right] + 43.21r\left(1 - \frac{1}{K_{SR}}\right)$$

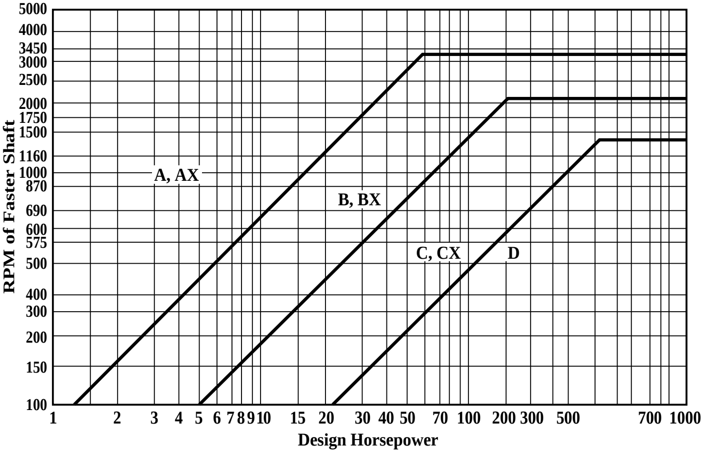



Fig. 4. Selection of Classic V-Belt Cross Sections

In these equations, $d_p$ = pitch diameter of small sheave, in.; $r$ = rpm of the faster shaft divided by 1000; $K_{SR}$ = speed ratio factor given in the accompanying table. These formulas give the basic horsepower rating, corrected for the speed ratio. To obtain the horsepower per belt for an arc of contact other than 180 degrees and for belts shorter or longer than average length, multiply the horsepower obtained from these formulas by the length correction factor (Table 8) and the arc of contact correction factor (Table 9).

## Table 8. Length Correction Factors

| Std. Length Designation | Cross Section | | | |
|---|---|---|---|---|
| | A, AX | B, BX | C, CX | D |
| 26 | 0.78 | … | … | … |
| 31 | 0.82 | … | … | … |
| 35 | 0.85 | 0.80 | … | … |
| 38 | 0.87 | 0.82 | … | … |
| 42 | 0.89 | 0.84 | … | … |
| 46 | 0.91 | 0.86 | … | … |
| 51 | 0.93 | 0.88 | 0.80 | … |
| 55 | 0.95 | 0.89 | … | … |
| 60 | 0.97 | 0.91 | 0.83 | … |
| 68 | 1.00 | 0.94 | 0.85 | … |
| 75 | 1.02 | 0.96 | 0.87 | … |
| 80 | 1.04 | … | … | … |
| 81 | … | 0.98 | 0.89 | … |
| 85 | 1.05 | 0.99 | 0.90 | … |
| 90 | 1.07 | 1.00 | 0.91 | … |
| 96 | 1.08 | … | 0.92 | … |
| 97 | … | 1.02 | … | … |
| 105 | 1.10 | 1.03 | 0.94 | … |
| 112 | 1.12 | 1.05 | 0.95 | … |
| 120 | 1.13 | 1.06 | 0.96 | 0.88 |
| 128 | 1.15 | 1.08 | 0.98 | 0.89 |
| 144 | … | 1.10 | 1.00 | 0.91 |
| 158 | … | 1.12 | 1.02 | 0.93 |
| 173 | … | 1.14 | 1.04 | 0.94 |
| 180 | … | 1.15 | 1.05 | 0.95 |
| 195 | … | 1.17 | 1.08 | 0.96 |
| 210 | … | 1.18 | 1.07 | 0.98 |
| 240 | … | 1.22 | 1.10 | 1.00 |
| 270 | … | 1.24 | 1.13 | 1.02 |
| 300 | … | 1.27 | 1.15 | 1.04 |
| 330 | … | … | 1.17 | 1.06 |
| 360 | … | … | 1.18 | 1.07 |
| 390 | … | … | 1.20 | 1.09 |
| 420 | … | … | 1.21 | 1.10 |
| 480 | … | … | … | 1.13 |
| 540 | … | … | … | 1.15 |
| 600 | … | … | … | 1.17 |
| 660 | … | … | … | 1.18 |

## Table 9. Arc of Contact Correction Factors

| $\frac{D_d - d_d}{C}$ | Arc of Contact, θ, Small Sheave (deg) | Correction Factor | | $\frac{D_d - d_d}{C}$ | Arc of Contact, θ Small Sheave (deg) | Correction Factor | |
|---|---|---|---|---|---|---|---|
| | | V-V | V-Flat[a] | | | V-V | V-Flat[a] |
| 0.00 | 180 | 1.00 | 0.75 | 0.80 | 133 | 0.87 | 0.85 |
| 0.10 | 174 | 0.99 | 0.76 | 0.90 | 127 | 0.85 | 0.85 |
| 0.20 | 169 | 0.97 | 0.78 | 1.00 | 120 | 0.82 | 0.82 |
| 0.30 | 163 | 0.96 | 0.79 | 1.10 | 113 | 0.80 | 0.80 |
| 0.40 | 157 | 0.94 | 0.80 | 1.20 | 106 | 0.77 | 0.77 |
| 0.50 | 151 | 0.93 | 0.81 | 1.30 | 99 | 0.73 | 0.73 |
| 0.60 | 145 | 0.91 | 0.83 | 1.40 | 91 | 0.70 | 0.70 |
| 0.70 | 139 | 0.89 | 0.84 | 1.50 | 83 | 0.65 | 0.65 |

[a] A V-flat drive is one using a small sheave and a large diameter flat pulley.

## Speed Ratio Correction Factors

| Speed Ratio[a] Range | $K_{SR}$ | Speed Ratio[a] Range | $K_{SR}$ |
|---|---|---|---|
| 1.00–1.01 | 1.0000 | 1.15–1.20 | 1.0586 |
| 1.02–1.04 | 1.0112 | 1.21–1.27 | 1.0711 |
| 1.05–1.07 | 1.0226 | 1.28–1.39 | 1.0840 |
| 1.08–1.10 | 1.0344 | 1.40–1.64 | 1.0972 |
| 1.11–1.14 | 1.0463 | Over 1.64 | 1.1106 |

[a] $D_p/d_p$, where $D_p$ ($d_p$) is the pitch diameter of the large (small) sheave.

Arc of contact on the small sheave may be determined by the formulas.

*Exact formula:* $\text{Arc of Contact (deg)} = 2\cos^{-1}\left(\frac{D_d - d_d}{2C}\right)$

*Approximate formula:* $\text{Arc of Contact (deg)} = 180 - \left(\frac{(D_d - d_d)60}{C}\right)$

where $D_d$ = Datum diameter of large sheave or flat pulley, inch; $d_d$ = Datum diameter of small sheave, inch; and, $C$ = Center distance, inch.

*Number of Belts:* The number of belts required for an application is obtained by dividing the design horsepower by the corrected horsepower rating for one belt.

*Minimum Sheave Size:* The recommended minimum sheave size depends on the rpm of the faster shaft. Minimum groove diameters for each belt cross section are listed in Table 11.

**Double V-Belts ANSI/RMA IP-21.—**Double V-belts or hexagonal belts are used when power input or takeoff is required on both sides of the belt. Designed for use on “serpentine” drives, which consist of sheaves rotating in opposite directions, the belts are available in AA, BB, CC, and DD cross sections and operate in standard classical sheaves. They are specified by cross section and nominal length.

*Belt Cross Sections:* Nominal dimensions of the four cross sections are given in Fig. 5.

*Belt Size Designation:* Double V-belt sizes are identified by a standard belt number, consisting of a letter-numeral combination. The letters identify the cross section; the numbers identify length as shown in Column 1 of Table 10. For example, AA51 indicates an AA cross section and a standard length designation of 51.

**Table 10. Double V-Belt Standard Effective Lengths** *ANSI/RMA IP-21, 1984*

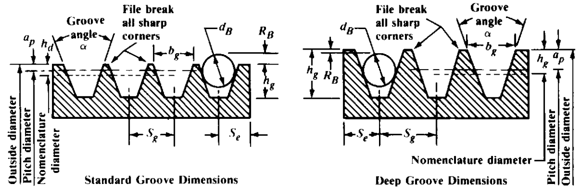
| Standard Length Designation[a] | Standard Effetive Length | | | | Permissible Deviation from Standard Effective Length | Matching Limits for One Set |
|---|---|---|---|---|---|---|
| | Cross Section | | | | | |
| | AA | BB | CC | DD | | |
| 51 | 53.1 | 53.9 | … | … | ±0.7 | 0.15 |
| 55 | … | 57.9 | … | … | ±0.7 | 0.15 |
| 60 | 62.1 | 62.9 | … | … | ±0.7 | 0.15 |
| 68 | 70.1 | 70.9 | … | … | ±0.7 | 0.30 |
| 75 | 77.1 | 77.9 | … | … | ±0.7 | 0.30 |
| 80 | 82.1 | … | … | … | ±0.7 | 0.30 |
| 81 | … | 83.9 | 85.2 | … | ±0.7 | 0.30 |
| 85 | 87.1 | 87.9 | 89.2 | … | ±0.7 | 0.30 |
| 90 | 92.1 | 92.9 | 94.2 | … | ±0.8 | 0.30 |
| 96 | 98.1 | … | 100.2 | … | ±0.8 | 0.30 |
| 97 | … | 99.9 | … | … | ±0.8 | 0.30 |
| 105 | 107.1 | 107.9 | 109.2 | … | ±0.8 | 0.30 |
| 112 | 114.1 | 114.9 | 116.2 | … | ±0.8 | 0.30 |
| 120 | 122.1 | 122.9 | 124.2 | 125.2 | ±0.8 | 0.30 |
| 128 | 130.1 | 130.9 | 132.2 | 133.2 | ±0.8 | 0.30 |
| 144 | … | 146.9 | 148.2 | 149.2 | ±0.8 | 0.30 |
| 158 | … | 160.9 | 162.2 | 163.2 | ±1.0 | 0.45 |
| 173 | … | 175.9 | 177.2 | 178.2 | ±1.0 | 0.45 |
| 180 | … | 182.9 | 184.2 | 185.2 | ±1.0 | 0.45 |
| 195 | … | 197.9 | 199.2 | 200.2 | ±1.1 | 0.45 |
| 210 | … | 212.9 | 214.2 | 215.2 | ±1.1 | 0.45 |
| 240 | … | 241.4 | 242.2 | 242.7 | ±1.3 | 0.45 |
| 270 | … | 271.4 | 272.2 | 272.7 | ±1.6 | 0.60 |
| 300 | … | 301.4 | 302.2 | 302.7 | ±1.6 | 0.60 |
| 330 | … | … | 332.2 | 332.7 | ±2.0 | 0.60 |
| 360 | … | … | 362.2 | 362.7 | ±2.0 | 0.60 |

[a] To specify belt size use the Standard Length Designation prefixed by the letters indicating cross section; for example, BB90.

All dimensions in inches.

*Sheave Dimensions:* Groove angles and dimensions for sheaves and face widths of sheaves for multiple belt drives are given in Table 11, along with various tolerance values.

## Table 11. Double V-Belt Sheave and Groove Dimensions *ANSI/RMP IP-21, 1984*




Face Width of Standard and Deep Groove Sheaves = $S_g(N_g - 1) + 2S_e$, where $N_g$ = number of grooves

| Standard Groove Dimensions | | | | | | | | | | | | Drive Design Factors | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cross Section | Outside Diameter Range | Groove Angle, α ±0.33° | $b_g$ | | $h_g$ (Min.) | $2h_d$ | $R_B$ (Min.) | $d_B$ ±0.0005 | $S_g$[a] ±0.025 | $S_e$ | | Min. Recomm. Outside Diam. | $2a_p$[b] |
| AA | Up through 5.65 | 34 | 0.494 | ±0.005 | 0.460 | 0.250 | 0.148 | 0.4375 | 0.625 | 0.375 | +0.090 | 3.25 | 0.0 |
| | Over 5.65 | 38 | 0.504 | | | | 0.149 | (7/16) | | | −0.062 | | |
| BB | Up through 7.35 | 34 | 0.637 | ±0.006 | 0.550 | 0.350 | 0.189 | 0.5625 | 0.750 | 0.500 | +0.120 | 5.75 | 0.0 |
| | Over 7.35 | 38 | 0.650 | | | | 0.190 | (9/16) | | | −0.065 | | |
| AA-BB | Up through 7.35 | 34 | 0.612 | ±0.006 | 0.612 | A = 0.750 | 0.230 | 0.5625 | 0.750 | 0.500 | +0.120 | A = 3.620 | A = 0.370 |
| | Over 7.35 | 38 | 0.625 | | | B = 0.350 | 0.226 | (9/16) | | | −0.065 | B = 5.680 | B = −0.070 |
| CC | Up through 8.39 | 34 | 0.879 | ±0.007 | 0.750 | 0.400 | 0.274 | 0.7812 | 1.000 | 0.688 | +0.160 | 9.4 | 0.0 |
| | Over 8.39 up to and including 12.40 | 36 | 0.887 | | | | 0.276 | (25/32) | | | −0.070 | | |
| | Over 12.40 | 38 | 0.895 | | | | 0.277 | | | | | | |
| DD | Up through 13.59 | 34 | 1.259 | ±0.008 | 1.020 | 0.600 | 0.410 | 1.1250 | 1.438 | 0.875 | +0.220 | 13.6 | 0.0 |
| | Over 13.59 up to and including 17.60 | 36 | 1.271 | | | | 0.410 | (1 1/8) | | | −0.080 | | |
| | Over 17.60 | 38 | 1.283 | | | | 0.411 | | | | | | |

**Table 11.** *(Continued)* **Double V-Belt Sheave and Groove Dimensions** *ANSI/RMP IP-21, 1984*

| Deep Groove Dimensions[c] | | | | | | | | | | | | Drive Design Factors | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cross Section | Outside Diameter Range | Groove Angle, α ±0.33° | $b_g$ | | $h_g$ (Min.) | $2h_d$ | $R_B$ (Min.) | $d_B$ ±0.0005 | $S_g$[a] ±0.025 | $S_e$ | | Minimum Recommended Outside Diameter | $2a_p$ |
| AA | Up through 5.96 | 34 | 0.589 | ±0.005 | 0.615 | 0.560 | −0.009 | 0.4375 (7⁄16) | 0.750 | 0.438 | +0.090 | 3.56 | 0.310 |
| | Over 5.96 | 38 | 0.611 | | | | −0.008 | | | | −0.062 | | |
| BB | Up through 7.71 | 34 | 0.747 | ±0.006 | 0.730 | 0.710 | +0.007 | 0.5625 (9⁄16) | 0.875 | 0.562 | +0.120 | 6.11 | 0.360 |
| | Over 7.71 | 38 | 0.774 | | | | +0.008 | | | | −0.065 | | |
| CC | Up through 9.00 | 34 | 1.066 | ±0.007 | 1.055 | 1.010 | −0.035 | 0.7812 (25⁄32) | 1.250 | 0.812 | +0.160 | 10.01 | 0.610 |
| | Over 9.00 up to and including 13.01 | 36 | 1.085 | | | | −0.032 | | | | −0.070 | | |
| | Over 13.01 | 38 | 1.105 | | | | −0.031 | | | | | | |
| DD | Up through 14.42 | 34 | 1.513 | ±0.008 | 1.435 | 1.430 | −0.010 | 1.1250 (1⅛) | 1.750 | 1.062 | +0.220 | 14.43 | 0.830 |
| | Over 14.42 up to and including 18.43 | 36 | 1.541 | | | | −0.009 | | | | −0.080 | | |
| | Over 18.43 | 38 | 1.569 | | | | −0.008 | | | | | | |

[a] Summation of the deviations from $S_g$ for all grooves in any one sheave shall not exceed ±0.050 in. The variation in pitch diameter between the grooves in any one sheave must be within the following limits: Up through 19.9 in. outside diameter and up through 6 grooves: 0.010 in. (add 0.005 in. for each additional groove). 20.0 in. and over on outside diameter and up through 10 grooves: 0.015 in. (add 0.0005 in. for each additional groove). This variation can be obtained easily by measuring the distance across two measuring balls or rods placed diametrically opposite each other in a groove. Comparing this "diameter over balls or rods" measurement between grooves will give the variation in pitch diameter.

[b] The $a_p$ values shown for the A/B combination sheaves are the geometrically derived values. These values may be different from those shown in manufacturer's catalogs.

[c] Deep groove sheaves are intended for drives with belt offset such as quarter-turn or vertical shaft drives.

| Other Sheave Tolerances | | |
|---|---|---|
| Outside Diameter | Radial Runout[a] | Axial Runout[a] |
| Up through 4.0 in. outside diameter ±0.020 in.<br>For each additional inch of outside diameter add ±0.005 in. | Up through 10.0 in. outside diameter ±0.010 in.<br>For each additional inch of outside diameter add 0.0005 in. | Up through 5.0 in. outside diameter 0.005 in.<br>For each additional inch of outside diameter add 0.001 in. |

[a] Total indicator reading.
All dimensions in inches.

*Cross Section Selection:* Use the chart (Fig. 5) as a guide to the double V-belt cross section for any combination of design horsepower and speed of the faster shaft. When the intersection of the design horsepower and speed of the faster shaft falls near a line between two areas on the chart, it is best to investigate the possibilities in both areas. Special circumstances (such as space limitations) may lead to a choice of belt cross section different from that indicated in the chart.

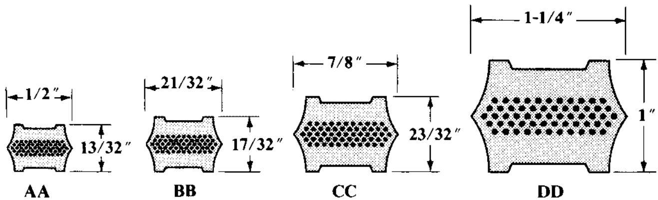



Fig. 5. Double-V Belt Cross Section

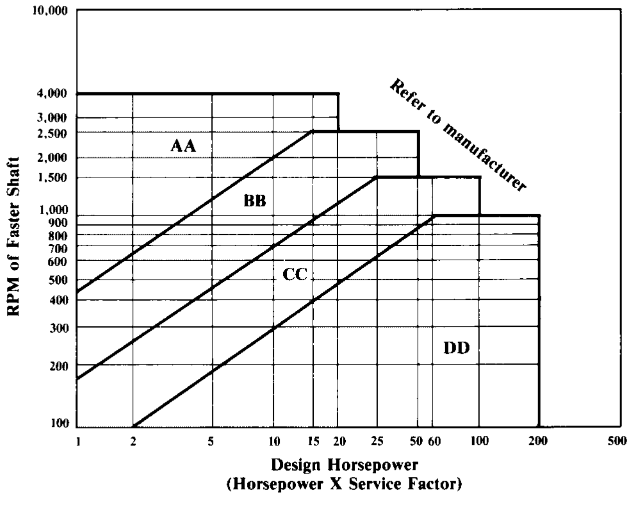



Fig. 6. Selection of Double V-Belt Cross Section

*Effective Diameter Determination:* Fig. 6 shows the relationship of effective diameter, outside diameter, and nomenclature diameter. Nomenclature diameter is used when ordering sheaves for double V-belt drives. The effective diameter is determined as follows:

$$\text{Effective diameter} = \text{Nomenclature diameter} + 2h_d - 2a_p$$

The values of $2h_d$ and $2a_p$ are given in Table 11.

*Double V-belt Length Determination:* The effective belt length of a specific drive may be determined by making a scaled layout of the drive. Draw the sheaves in terms of their effective diameters and in the position when a new belt is applied and first brought to driving tension. Next, measure the tangents and calculate the effective arc length ($AL_e$) of each sheave (see Table 12 for a glossary of terms):

$$AL_e = \frac{d_e\theta}{115}$$

The effective length of the belt will then be the sum of the tangents and the connecting arc lengths. Manufacturers may be consulted for mathematical calculation of effective belt length for specific drive applications.

**Table 12. Glossary of Terms for Double V-belt Calculations**

| | | |
|---|---|---|
| $AL_e$ | = | Length, arc, effective, in. |
| $2a_p$ | = | Diameter, differential, pitch to outside, in. |
| $d$ | = | Diameter, pitch, in. (same as effective diameter) |
| $d_e$ | = | Diameter, effective, in. |
| $2h_d$ | = | Diameter differential, nomenclature to outside, in. |
| $K_f$ | = | Factor, length – flex correction |
| $L_e$ | = | Length, effective, in. |
| $n$ | = | Sheaves, number on drive |
| $P_d$ | = | Power, design, horsepower (transmitted horsepower × service factor) |
| $R$ | = | Ratio, tight side to slack side tension |
| $R/(R-1)$ | = | Factor, tension ratio |
| $r$ | = | Angular velocity, faster shaft, rpm/1000 |
| $S$ | = | Speed, belt, fpm/1000 |
| $T_e$ | = | Tension, effective pull, lbf |
| $T_r$ | = | Tension, allowable tight side, lbf |
| $T_S$ | = | Tension, slack side, lbf |
| $T_T$ | = | Tension, tight side, lbf |
| $\theta$ | = | Angle, arc of belt contact, deg |

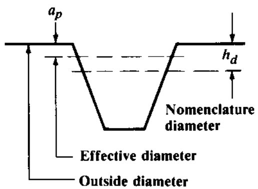



Fig. 7. Effective, Outside, and Nomenclature Sheave Diameters

*Number of Belts Determination:* The number of belts required may be determined on the basis of allowable tight side tension rating ($T_r$) at the most severe sheave. The allowable tight side tensions per belt are given in Tables 13 through 16, and must be multiplied by the length-flex correction factors ($K_f$) listed in Table 17. To select the allowable tight side tension from the tables for a given sheave, the belt speed and effective diameter of the sheave in question are required.

*Double V-Belt Drive Design Method:* The fourteen drive design steps are as follows:

1) Number the sheaves starting from the driver in the opposite direction to belt rotation; include the idlers.

2) Select the proper service factor for each loaded driven unit.

3) Multiply the horsepower requirement for each loaded driven sheave by the corresponding service factor. This is the design horsepower at each sheave.

4) Calculate driver design horsepower. This hp is equal to the sum of all the driven design horsepowers.

5) Calculate belt speed ($S$) in thousands of feet per minute: $S = rd/3.820$.

6) Calculate effective tension ($T_e$) for each loaded sheave: $T_e = 33P_d/S$.

7) Determine minimum $R/(R-1)$ for each loaded sheave from Table 18 using the arc of contact determined from the drive layout.

8) In most drives, slippage will occur first at the driver sheave. Assume this to be true and calculate $T_T$ and $T_S$ for the driver: $T_T = T_e\,[R/(R-1)]$ and $T_s = T_T - T_e$. Use $R/(R-1)$ from Step 7 and $T_e$ from Step 6 for the driver sheave.

9) Starting with the first driven sheave, determine $T_T$ and $T_S$ for each segment of the drive. The $T_T$ for the driver becomes $T_S$ for that sheave and is equal to $T_T - T_e$. Proceed around the drive in like manner.

10) Calculate actual $R/(R-1)$ for each sheave using: $R/(R-1) = T_T/T_e = T_T/(T_T - T_S)$. The $T_T$ and $T_S$ values are for those determined in Step 9. If these values are equal to or greater than those determined in Step 7, the assumption that slippage will first occur at the driver is correct and the next two steps are not necessary. If the value is less, the assumption was not correct, so proceed with Step 11.

11) Take the sheave where the actual value $R/(R-1)$ (Step 10) is less than the minimum, as determined in Step 7, and calculate a new $T_T$ and $T_S$ for this sheave using the minimum $R/(R-1)$ as determined in Step 7: $T_T = T_e\,[R/(R-1)]$ and $T_S = T_T - T_e$.

12) Start with this sheave and recalculate the tension in each segment of the drive as in Step 9.

13) The length-flex factor ($K_f$) is taken from Table 17. Before using this table, calculate the value of $L_e/n$. Be sure to use the appropriate belt cross-section column when selecting the correction factor.

14) Beginning with the driver sheave, determine the number of belts ($N_b$) needed to satisfy the conditions at each loaded sheave using: $N_b = T_T/T_rK_f$. Note: $T_T$ is tight side tension as determined in Step 9 or 11 and 12. $T_r$ is allowable tight side tension as shown in Tables 15-18. $K_f$ is the length-flex correction factor from Table 17. The sheave that requires the largest number of belts is the number of belts required for the drive. Any fraction of a belt should be treated as a whole belt.

**Table 13. Allowable Tight Side Tension for an AA Section**

| Belt Speed (fpm) | Sheave Effective Diameter (in.) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 | 5.5 | 6.0 | 6.5 |
| 200 | 30 | 46 | 57 | 66 | 73 | 79 | 83 | 88 |
| 400 | 23 | 38 | 49 | 58 | 65 | 71 | 76 | 80 |
| 600 | 18 | 33 | 44 | 53 | 60 | 66 | 71 | 75 |
| 800 | 14 | 30 | 41 | 50 | 57 | 63 | 67 | 72 |
| 1000 | 12 | 27 | 38 | 47 | 54 | 60 | 65 | 69 |
| 1200 | 9 | 24 | 36 | 45 | 52 | 57 | 62 | 66 |
| 1400 | 7 | 22 | 34 | 42 | 49 | 55 | 60 | 64 |
| 1600 | 5 | 20 | 32 | 40 | 47 | 53 | 58 | 62 |
| 1800 | 3 | 18 | 30 | 38 | 46 | 51 | 56 | 60 |
| 2000 | 1 | 16 | 28 | 37 | 44 | 50 | 54 | 58 |
| 2200 | … | 15 | 26 | 35 | 42 | 48 | 53 | 57 |
| 2400 | … | 13 | 24 | 33 | 40 | 46 | 51 | 55 |
| 2600 | … | 11 | 23 | 31 | 39 | 44 | 49 | 53 |
| 2800 | … | 9 | 21 | 30 | 37 | 43 | 47 | 51 |
| 3000 | … | 8 | 19 | 28 | 35 | 41 | 46 | 50 |
| 3200 | … | 6 | 17 | 26 | 33 | 39 | 44 | 48 |
| 3400 | … | 4 | 16 | 24 | 31 | 37 | 42 | 46 |
| 3600 | … | 2 | 14 | 23 | 30 | 35 | 40 | 44 |
| 3800 | … | 1 | 12 | 21 | 28 | 34 | 38 | 43 |
| 4000 | … | … | 10 | 19 | 26 | 32 | 37 | 41 |
| 4200 | … | … | 8 | 17 | 24 | 30 | 35 | 39 |
| 4400 | … | … | 6 | 15 | 22 | 28 | 33 | 37 |
| 4600 | … | … | 4 | 13 | 20 | 26 | 31 | 35 |
| 4800 | … | … | 2 | 11 | 18 | 24 | 29 | 33 |
| 5000 | … | … | … | 9 | 16 | 22 | 27 | 31 |
| 5200 | … | … | … | 7 | 14 | 20 | 24 | 28 |
| 5400 | … | … | … | 4 | 12 | 17 | 22 | 26 |
| 5600 | … | … | … | 2 | 9 | 15 | 20 | 24 |
| 5800 | … | … | … | … | 7 | 13 | 18 | 22 |

The allowable tight side tension must be evaluated for each sheave in the system (see Step 14). Values must be corrected by $K_f$ from Table 17.

## Table 14. Allowable Tight Side Tension for a BB Section

| Belt Speed (fpm) | Sheave Effective Diameter (in.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5.0 | 5.5 | 6.0 | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 | 9.0 |
| 200 | 81 | 93 | 103 | 111 | 119 | 125 | 130 | 135 | 140 |
| 400 | 69 | 81 | 91 | 99 | 107 | 113 | 118 | 123 | 128 |
| 600 | 61 | 74 | 84 | 92 | 99 | 106 | 111 | 116 | 121 |
| 800 | 56 | 68 | 78 | 87 | 94 | 101 | 106 | 111 | 115 |
| 1000 | 52 | 64 | 74 | 83 | 90 | 96 | 102 | 107 | 111 |
| 1200 | 48 | 60 | 71 | 79 | 86 | 93 | 98 | 103 | 107 |
| 1400 | 45 | 57 | 67 | 76 | 83 | 89 | 95 | 100 | 104 |
| 1600 | 42 | 54 | 64 | 73 | 80 | 86 | 92 | 97 | 101 |
| 1800 | 39 | 51 | 61 | 70 | 77 | 84 | 89 | 94 | 98 |
| 2000 | 36 | 49 | 59 | 67 | 74 | 81 | 86 | 91 | 96 |
| 2200 | 34 | 46 | 56 | 64 | 72 | 78 | 84 | 89 | 93 |
| 2400 | 31 | 43 | 53 | 62 | 69 | 75 | 81 | 86 | 90 |
| 2600 | 29 | 41 | 51 | 59 | 67 | 73 | 78 | 83 | 88 |
| 2800 | 26 | 38 | 48 | 57 | 64 | 70 | 76 | 81 | 85 |
| 3000 | 23 | 35 | 45 | 54 | 61 | 68 | 73 | 78 | 82 |
| 3200 | 21 | 33 | 43 | 51 | 59 | 65 | 70 | 75 | 80 |
| 3400 | 18 | 30 | 40 | 49 | 56 | 62 | 68 | 73 | 77 |
| 3600 | 15 | 27 | 37 | 46 | 53 | 59 | 65 | 70 | 74 |
| 3800 | 12 | 24 | 35 | 43 | 50 | 57 | 62 | 67 | 71 |
| 4000 | 9 | 22 | 32 | 40 | 47 | 54 | 59 | 64 | 69 |
| 4200 | 7 | 19 | 29 | 37 | 45 | 51 | 56 | 61 | 66 |
| 4400 | 4 | 16 | 26 | 34 | 42 | 48 | 53 | 58 | 63 |
| 4600 | 1 | 13 | 23 | 31 | 39 | 45 | 50 | 55 | 60 |
| 4800 | … | 10 | 20 | 28 | 35 | 42 | 47 | 52 | 57 |
| 5000 | … | 6 | 16 | 25 | 32 | 39 | 44 | 49 | 53 |
| 5200 | … | 3 | 13 | 22 | 29 | 35 | 41 | 46 | 50 |
| 5400 | … | … | 10 | 18 | 26 | 32 | 38 | 42 | 47 |
| 5600 | … | … | 6 | 15 | 22 | 29 | 34 | 39 | 43 |
| 5800 | … | … | 3 | 11 | 19 | 25 | 31 | 36 | 40 |

The allowable tight side tension must be evaluated for each sheave in the system (see Step 14). Values must be corrected by $K_f$ from Table 17.

## Table 15. Allowable Tight Side Tension for a CC Section

| Belt Speed (fpm) | Sheave Effective Diameter (in.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 7.0 | 8.0 | 9.0 | 10.0 | 11.0 | 12.0 | 13.0 | 14.0 | 15.0 |
| 200 | 121 | 158 | 186 | 207 | 228 | 244 | 257 | 268 | 278 |
| 400 | 99 | 135 | 164 | 187 | 206 | 221 | 234 | 246 | 256 |
| 600 | 85 | 122 | 151 | 173 | 192 | 208 | 221 | 232 | 242 |
| 800 | 75 | 112 | 141 | 164 | 182 | 198 | 211 | 222 | 232 |
| 1000 | 67 | 104 | 133 | 155 | 174 | 190 | 203 | 214 | 224 |
| 1200 | 60 | 97 | 126 | 149 | 167 | 183 | 196 | 207 | 217 |
| 1400 | 54 | 91 | 120 | 142 | 161 | 177 | 190 | 201 | 211 |
| 1600 | 48 | 85 | 114 | 137 | 155 | 171 | 184 | 196 | 205 |
| 1800 | 43 | 80 | 108 | 131 | 150 | 166 | 179 | 190 | 200 |
| 2000 | 38 | 75 | 103 | 126 | 145 | 160 | 174 | 185 | 195 |
| 2200 | 33 | 70 | 98 | 121 | 140 | 155 | 169 | 180 | 190 |
| 2400 | 28 | 65 | 93 | 116 | 135 | 150 | 164 | 175 | 185 |
| 2600 | 23 | 60 | 88 | 111 | 130 | 145 | 159 | 170 | 180 |
| 2800 | 18 | 55 | 83 | 106 | 125 | 140 | 154 | 165 | 175 |
| 3000 | 13 | 50 | 78 | 101 | 120 | 135 | 149 | 160 | 170 |
| 3200 | 8 | 45 | 73 | 96 | 115 | 130 | 144 | 155 | 165 |
| 3400 | 3 | 39 | 68 | 91 | 110 | 125 | 138 | 150 | 160 |
| 3600 | … | 34 | 63 | 86 | 104 | 120 | 133 | 145 | 154 |
| 3800 | … | 29 | 58 | 80 | 99 | 115 | 128 | 139 | 149 |
| 4000 | … | 24 | 52 | 75 | 94 | 109 | 123 | 134 | 144 |
| 4200 | … | 18 | 47 | 70 | 88 | 104 | 117 | 128 | 138 |
| 4400 | … | 12 | 41 | 64 | 83 | 98 | 112 | 123 | 133 |
| 4600 | … | 7 | 35 | 58 | 77 | 93 | 106 | 117 | 127 |
| 4800 | … | 1 | 29 | 52 | 71 | 87 | 100 | 111 | 121 |
| 5000 | … | … | 23 | 46 | 65 | 81 | 94 | 105 | 115 |
| 5200 | … | … | 17 | 40 | 59 | 75 | 88 | 99 | 109 |
| 5400 | … | … | 11 | 34 | 53 | 68 | 81 | 93 | 103 |
| 5600 | … | … | 5 | 27 | 46 | 62 | 75 | 86 | 96 |
| 5800 | … | … | … | 21 | 40 | 55 | 68 | 80 | 90 |

The allowable tight side tension must be evaluated for each sheave in the system (see Step 14). Values must be corrected by $K_f$ from Table 17.

**Table 16. Allowable Tight Side Tension for a DD Section**

| Belt Speed (fpm) | Sheave Effective Diameter (in.) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 12,0 | 13.0 | 14.0 | 15.0 | 16.0 | 17.0 | 18.0 | 19.0 | 20.0 |
| 200 | 243 | 293 | 336 | 373 | 405 | 434 | 459 | 482 | 503 |
| 400 | 195 | 245 | 288 | 325 | 358 | 386 | 412 | 434 | 455 |
| 600 | 167 | 217 | 259 | 297 | 329 | 358 | 383 | 406 | 426 |
| 800 | 146 | 196 | 239 | 276 | 308 | 337 | 362 | 385 | 405 |
| 1000 | 129 | 179 | 222 | 259 | 291 | 320 | 345 | 368 | 389 |
| 1200 | 114 | 164 | 207 | 244 | 277 | 305 | 331 | 353 | 374 |
| 1400 | 101 | 151 | 194 | 231 | 263 | 292 | 318 | 340 | 361 |
| 1600 | 89 | 139 | 182 | 219 | 251 | 280 | 305 | 328 | 349 |
| 1800 | 78 | 128 | 170 | 207 | 240 | 269 | 294 | 317 | 337 |
| 2000 | 67 | 117 | 159 | 196 | 229 | 258 | 283 | 306 | 326 |
| 2200 | 56 | 106 | 149 | 186 | 218 | 247 | 272 | 295 | 316 |
| 2400 | 45 | 95 | 138 | 175 | 208 | 236 | 262 | 284 | 305 |
| 2600 | 35 | 85 | 128 | 165 | 197 | 226 | 251 | 274 | 294 |
| 2800 | 24 | 74 | 117 | 154 | 187 | 215 | 241 | 263 | 284 |
| 3000 | 14 | 64 | 106 | 144 | 176 | 205 | 230 | 253 | 273 |
| 3200 | 3 | 53 | 96 | 133 | 165 | 194 | 219 | 242 | 263 |
| 3400 | … | 42 | 85 | 122 | 155 | 183 | 209 | 231 | 252 |
| 3600 | … | 31 | 74 | 111 | 144 | 172 | 198 | 220 | 241 |
| 3800 | … | 20 | 63 | 100 | 132 | 161 | 186 | 209 | 230 |
| 4000 | … | 9 | 51 | 89 | 121 | 150 | 175 | 198 | 218 |
| 4200 | … | … | 40 | 77 | 109 | 138 | 163 | 186 | 207 |
| 4400 | … | … | 28 | 65 | 97 | 126 | 152 | 174 | 195 |
| 4600 | … | … | 16 | 53 | 85 | 114 | 139 | 162 | 183 |
| 4800 | … | … | 3 | 40 | 73 | 102 | 127 | 150 | 170 |
| 5000 | … | … | … | 28 | 60 | 89 | 114 | 137 | 158 |
| 5200 | … | … | … | 15 | 47 | 76 | 101 | 124 | 145 |
| 5400 | … | … | … | 1 | 34 | 62 | 88 | 111 | 131 |
| 5600 | … | … | … | … | 20 | 49 | 74 | 97 | 118 |
| 5800 | … | … | … | … | 6 | 35 | 60 | 83 | 104 |

The allowable tight side tension must be evaluated for each sheave in the system (see Step 14). Values must be corrected by $K_f$ from Table 17.

**Table 17. Length-Flex Correction Factors $K_f$**

| $\frac{L_e}{n}$ | Belt Cross Section | | | | $\frac{L_e}{n}$ | Belt Cross Section | | | |
|---|---|---|---|---|---|---|---|---|---|
| | AA | BB | CC | DD | | AA | BB | CC | DD |
| 10 | 0.64 | 0.58 | … | … | 70 | … | 1.03 | 0.95 | 0.91 |
| 15 | 0.74 | 0.68 | … | … | 80 | … | 1.06 | 0.98 | 0.94 |
| 20 | 0.82 | 0.74 | 0.68 | … | 90 | … | 1.09 | 1.00 | 0.96 |
| 25 | 0.87 | 0.79 | 0.73 | 0.70 | 100 | … | 1.11 | 1.03 | 0.99 |
| 30 | 0.92 | 0.84 | 0.77 | 0.74 | 110 | … | … | 1.05 | 1.00 |
| 35 | 0.96 | 0.87 | 0.80 | 0.77 | 120 | … | … | 1.06 | 1.02 |
| 40 | 0.99 | 0.90 | 0.83 | 0.80 | 130 | … | … | 1.08 | 1.04 |
| 45 | 1.02 | 0.93 | 0.86 | 0.82 | 140 | … | … | 1.10 | 1.05 |
| 50 | 1.05 | 0.95 | 0.88 | 0.84 | 150 | … | … | 1.11 | 1.07 |
| 60 | … | 0.99 | 0.92 | 0.88 | … | … | … | … | … |

*Minimum Sheave Size:* The recommended minimum sheave size depends on the rpm of the faster shaft. Minimum sheave diameters for each cross-section belt are listed in Table 11.

*Tension Ratings:* The tension rating formulas are:

$$\text{AA} \quad T_r = 118.5 - \frac{318.2}{d} - 0.8380S^2 - 25.76\log S$$

$$\text{BB} \quad T_r = 186.3 - \frac{665.1}{d} - 1.269S^2 - 39.02\log S$$

$$\text{CC} \quad T_r = 363.9 - \frac{2060}{d} - 2.400S^2 - 73.77\log S$$

$$\text{DD} \quad T_r = 783.1 - \frac{7790}{d} - 5.078S^2 - 156.1\log S$$

where $T_r$ = The allowable tight side tension for a double-V belt drive, lbf (not corrected for tension ratio or length-flex correction factor)

$d$ = Pitch diameter of small sheave, inch

$S$ = Belt speed, fpm/1000

**Table 18. Tension Ratio/Arc of Contact Factors**

| Arc of Contact, θ (deg.) | Design $\frac{R}{R-1}$ | Arc of Contact, θ(deg.) | Design $\frac{R}{R-1}$ |
|---|---|---|---|
| 300 | 1.07 | 170 | 1.28 |
| 290 | 1.08 | 160 | 1.31 |
| 280 | 1.09 | 150 | 1.35 |
| 270 | 1.10 | 140 | 1.40 |
| 260 | 1.11 | 130 | 1.46 |
| 250 | 1.12 | 120 | 1.52 |
| 240 | 1.13 | 110 | 1.60 |
| 230 | 1.15 | 100 | 1.69 |
| 220 | 1.16 | 90 | 1.81 |
| 210 | 1.18 | 80 | 1.96 |
| 200 | 1.20 | 70 | 2.15 |
| 190 | 1.22 | 60 | 2.41 |
| 180 | 1.25 | 50 | 2.77 |

**Light Duty V-Belts ANSI/RMA IP-23.—**Light duty V-belts are typically used with fractional horsepower motors or small engines, and are designed primarily for fractional horsepower service. These belts are intended and specifically designed for use with small diameter sheaves and drives of loads and service requirements that are within the capacity of a single belt.

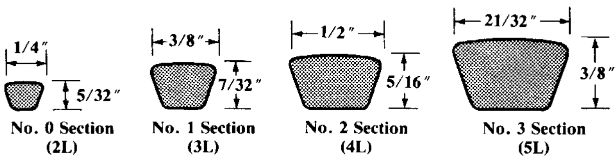



Fig. 8. Light Duty V-Belt Cross Sections

The four belt cross sections and sheave groove sizes are 2L, 3L, 4L, and 5L. The 2L is generally used only by OEMs and is not covered in the RMA standards.

**Belt Cross Sections.—**Nominal dimensions of the four cross sections are given in Fig. 8.

**Belt Size Designation.—**V-belt sizes are identified by a standard belt number, consisting of a letter-numeral combination. The first number and letter identify the cross section; the remaining numbers identify length as shown in Table 19. For example, a 3L520 belt has a 3L cross section and a length of 52.0 in.

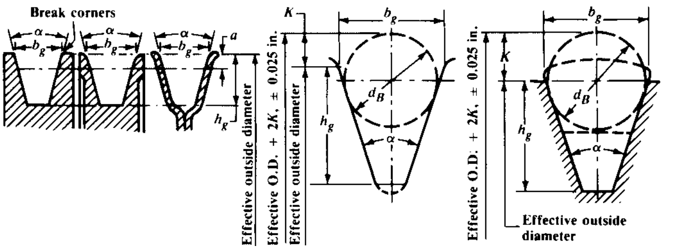
**Table 19. Light Duty V-Belt Standard Dimensions** *ANSI/RMA IP-23, 1968*

| Standard Effective Outside Length (in.) | | | | Permissible Deviation From Standard Effective Length (in.) | Standard Effective Outside Length (in.) | | | | Permissible Deviation From Standard Effective Length (in.) |
|---|---|---|---|---|---|---|---|---|---|
| Cross Section | | | | | Cross Section | | | | |
| 2L | 3L | 4L | 5L | | 2L | 3L | 4L | 5L | |
| 8 | … | … | … | +0.12, −0.38 | … | … | 53 | 53 | +0.25, −0.62 |
| 9 | … | … | … | +0.12, −0.38 | … | 54 | 54 | 54 | +0.25, −0.62 |
| 10 | … | … | … | +0.12, −0.38 | … | … | 55 | 55 | +0.25, −0.62 |
| 11 | … | … | … | +0.12, −0.38 | … | 56 | 56 | 56 | +0.25, −0.62 |
| 12 | … | … | … | +0.12, −0.38 | … | … | 57 | 57 | +0.25, −0.62 |
| 13 | … | … | … | +0.12, −0.38 | … | 58 | 58 | 58 | +0.25, −0.62 |
| 14 | 14 | … | … | +0.12, −0.38 | … | … | 59 | 59 | +0.25, −0.62 |
| 15 | 15 | … | … | +0.12, −0.38 | … | 60 | 60 | 60 | +0.25, −0.62 |
| 16 | 16 | … | … | +0.12, −0.38 | … | … | 61 | 61 | +0.31, −0.69 |
| 17 | 17 | … | … | +0.12, −0.38 | … | … | 62 | 62 | +0.31, −0.69 |
| 18 | 18 | 18 | … | +0.12, −0.38 | … | … | 63 | 63 | +0.31, −0.69 |
| 19 | 19 | 19 | … | +0.12, −0.38 | … | … | 64 | 64 | +0.31, −0.69 |
| 20 | 20 | 20 | … | +0.12, −0.38 | … | … | 65 | 65 | +0.31, −0.69 |
| … | 21 | 21 | … | +0.25, −0.62 | … | … | 66 | 66 | +0.31, −0.69 |
| … | 22 | 22 | … | +0.25, −0.62 | … | … | 67 | 67 | +0.31, −0.69 |
| … | 23 | 23 | … | +0.25, −0.62 | … | … | 68 | 68 | +0.31, −0.69 |
| … | 24 | 24 | … | +0.25, −0.62 | … | … | 69 | 69 | +0.31, −0.69 |
| … | 25 | 25 | 25 | +0.25, −0.62 | … | … | 70 | 70 | +0.31, −0.69 |
| … | 26 | 26 | 26 | +0.25, −0.62 | … | … | 71 | 71 | +0.31, −0.69 |
| … | 27 | 27 | 27 | +0.25, −0.62 | … | … | 72 | 72 | +0.31, −0.69 |
| … | 28 | 28 | 28 | +0.25, −0.62 | … | … | 73 | 73 | +0.31, −0.69 |
| … | 29 | 29 | 29 | +0.25, −0.62 | … | … | 74 | 74 | +0.31, −0.69 |
| … | 30 | 30 | 30 | +0.25, −0.62 | … | … | 75 | 75 | +0.31, −0.69 |
| … | 31 | 31 | 31 | +0.25, −0.62 | … | … | 76 | 76 | +0.31, −0.69 |
| … | 32 | 32 | 32 | +0.25, −0.62 | … | … | 77 | 77 | +0.31, −0.69 |
| … | 33 | 33 | 33 | +0.25, −0.62 | … | … | 78 | 78 | +0.31, −0.69 |
| … | 34 | 34 | 34 | +0.25, −0.62 | … | … | 79 | 79 | +0.31, −0.69 |
| … | 35 | 35 | 35 | +0.25, −0.62 | … | … | 80 | 80 | +0.62, −0.88 |
| … | 36 | 36 | 36 | +0.25, −0.62 | … | … | 82 | 82 | +0.62, −0.88 |
| … | 37 | 37 | 37 | +0.25, −0.62 | … | … | 84 | 84 | +0.62, −0.88 |
| … | 38 | 38 | 38 | +0.25, −0.62 | … | … | 86 | 86 | +0.62, −0.88 |
| … | 39 | 39 | 39 | +0.25, −0.62 | … | … | 88 | 88 | +0.62, −0.88 |
| … | 40 | 40 | 40 | +0.25, −0.62 | … | … | 90 | 90 | +0.62, −0.88 |
| … | 41 | 41 | 41 | +0.25, −0.62 | … | … | 92 | 92 | +0.62, −0.88 |
| … | 42 | 42 | 42 | +0.25, −0.62 | … | … | 94 | 94 | +0.62, −0.88 |
| … | 43 | 43 | 43 | +0.25, −0.62 | … | … | 96 | 96 | +0.62, −0.88 |
| … | 44 | 44 | 44 | +0.25, −0.62 | … | … | 98 | 98 | +0.62, −0.88 |
| … | 45 | 45 | 45 | +0.25, −0.62 | … | … | 100 | 100 | +0.62, −0.88 |
| … | 46 | 46 | 46 | +0.25, −0.62 | … | … | … | … | … |
| … | 47 | 47 | 47 | +0.25, −0.62 | … | … | … | … | … |
| … | 48 | 48 | 48 | +0.25, −0.62 | | | | | |
| … | 49 | 49 | 49 | +0.25, −0.62 | … | … | … | … | … |
| … | 50 | 50 | 50 | +0.25, −0.62 | … | … | … | … | … |
| … | … | 51 | 51 | +0.25, −0.62 | … | … | … | … | … |
| … | 52 | 52 | 52 | +0.25, −0.62 | … | … | … | … | … |

All dimensions in inches.

*Sheave Dimensions:* Groove angles and dimensions for sheaves and various sheave tolerances are given in Table 20.

**Table 20. Light Duty V-Belt Sheave and Groove Dimensions**
*ANSI/RMA IP-23, 1968*




| Belt Section | Effective Outside Diameter: Min. Recomm. | Effective Outside Diameter: Range | α Groove Angle ±0°20′ (deg) | $d_B$ Ball Diameter ±0.0005 | 2$K$ | $b_g$ (Ref) | $h_g$ (min) | 2$a$[a] |
|---|---|---|---|---|---|---|---|---|
| 2L | 0.8 | Less Than 1.50 | 32 | 0.2188 | 0.176 | 0.240 | 0.250 | 0.04 |
| | | 1.50 to 1.99 | 34 | | 0.182 | | | |
| | | 2.00 to 2.50 | 36 | | 0.188 | | | |
| | | Over 2.50 | 38 | | 0.194 | | | |
| 3L | 1.5 | Less Than 2.20 | 32 | 0.3125 | 0.177 | 0.364 | 0.406 | 0.06 |
| | | 2.20 to 3.19 | 34 | | 0.191 | | | |
| | | 3.20 to 4.20 | 36 | | 0.203 | | | |
| | | Over 4.20 | 38 | | 0.215 | | | |
| 4L | 2.5 | Less Than 2.65 | 30 | 0.4375 | 0.299 | 0.490 | 0.490 | 0.10 |
| | | 2.65 to 3.24 | 32 | | 0.316 | | | |
| | | 3.25 to 5.65 | 34 | | 0.331 | | | |
| | | Over 5.65 | 38 | | 0.358 | | | |
| 5L | 3.5 | Less Than 3.95 | 30 | 0.5625 | 0.385 | 0.630 | 0.580 | 0.16 |
| | | 3.95 to 4.94 | 32 | | 0.406 | | | |
| | | 4.95 to 7.35 | 34 | | 0.426 | | | |
| | | Over 7.35 | 38 | | 0.461 | | | |

[a] The diameter used in calculating speed ratio and belt speed is obtained by subtracting the 2*a* value from the Effective Outside Diameter of the sheave.

| Other Sheave Tolerances | | |
|---|---|---|
| Outside Diameters | Outside Diameter Eccentricity[a] | Groove Side Wobble & Runout[a] |
| For outside diameters under 6.0 in. ±0.015 in. | For outside diameters 10.0 in. and under 0.010 in. | For outside diameters 20.0 in. and under 0.0015 in. per inch of outside diameter. |
| For outside diameters 6.0 to 12.0 in. ±0.020 in. | For each additional inch of outside diameter, add 0.0005 in. | For each additional inch of outside diameter, add 0.0005 in. |
| For outside diameters over 12.0 in. ±0.040 in. | | |

[a] Total indicator reading.

All dimensions in inches.

*Horsepower Ratings:* The horsepower ratings for light duty V-belts can be calculated from the following formulas:

$$3L \quad HP = r\left(\frac{0.2164d^{0.91}}{r^{0.09}} - 0.2324 - 0.0001396r^2d^3\right)$$

$$4L \quad HP = r\left(\frac{0.4666d^{0.91}}{r^{0.09}} - 0.7231 - 0.0002286r^2d^3\right)$$

$$5L \quad HP = r\left(\frac{0.7748d^{0.91}}{r^{0.09}} - 1.727 - 0.0003641r^2d^3\right)$$

where $d = d_0 - 2a$; $d_0$ = effective outside diameter of small sheave, in.; $r$ = rpm of the faster shaft divided by 1000. The corrected horsepower rating is obtained by dividing the horsepower rating by the combined correction factor (Table 21), which accounts for drive geometry and service factor requirements.

**Table 21. Combined Correction Factors**

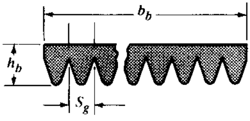
| Type of Driven Unit | Speed Ratio | |
|---|---|---|
| | Less than 1.5 | 1.5 and Over |
| Fans and blowers | 1.0 | 0.9 |
| Domestic laundry machines | 1.1 | 1.0 |
| Centrifugal pumps | 1.1 | 1.0 |
| Generators | 1.2 | 1.1 |
| Rotary compressors | 1.2 | 1.1 |
| Machine tools | 1.3 | 1.2 |
| Reciprocating pumps | 1.4 | 1.3 |
| Reciprocating compressors | 1.4 | 1.3 |
| Wood working machines | 1.4 | 1.3 |

**V-Ribbed Belts ANSI/RMA IP-26.**—V-ribbed belts are a cross between flat belts and V-belts. The belt is basically flat with V-shaped ribs projecting from the bottom, which guide the belt and provide greater stability than that found in a flat belt. The ribs operate in grooved sheaves.

V-ribbed belts do not have the wedging action of a V-belt and thus operate at higher tensions. This design provides excellent performance in high-speed and serpentine applications, and in drives that utilize small diameter sheaves. The V-ribbed belt comes in five cross sections: H, J, K, L, and M, specified by effective length, cross section and number of ribs.

*Belt Cross Sections:* Nominal dimensions of the five cross sections are given in Table 22.

**Table 22. Nominal Dimensions of V-Ribbed Belt Cross Sections**
*ANSI/RMA IP-26, 1977*

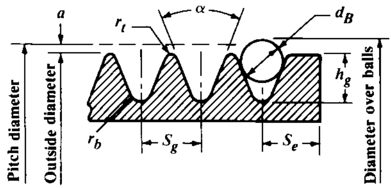



$b_b = N_r \times S_g$, where $N_r$ = number of ribs and $S_g$ is sheave groove spacing

| Cross Section | $h_b$ | $S_g$ | Standard Number of Ribs |
|---|---|---|---|
| H | 0.12 | 0.063 | … |
| J | 0.16 | 0.092 | 4, 6, 10, 16, 20 |
| K | 0.24 | 0.140 | … |
| L | 0.38 | 0.185 | 6, 8, 10, 12, 14, 16, 18, 20 |
| M | 0.66 | 0.370 | 6, 8, 10, 12, 14, 16, 18, 20 |

All dimensions in inches.

**Table 23. V-Ribbed Belt Sheave and Groove Dimensions** *ANSI / RMA IP-26, 1977*




Face width $= S_e (N_g - 1) + 2S_e$, where $N_g$ is number of grooves

| Cross Section | Minimum Recommended Outside Diameter | α Groove Angle ±0.25 (deg) | $S_g$ [a] | $r_t$ +0.005, −0.000 | $2a$ | $r_b$ | $h_g$ (min) | $d_B$ ±0.0005 | $S_e$ |
|---|---|---|---|---|---|---|---|---|---|
| H | 0.50 | 40 | 0.063 ±0.001 | 0.005 | 0.020 | 0.013 +0.000 −0.005 | 0.041 | 0.0469 | 0.080 +0.020 −0.010 |
| J | 0.80 | 40 | 0.092 ±0.001 | 0.008 | 0.030 | 0.015 +0.000 −0.005 | 0.071 | 0.0625 | 0.125 +0.030 −0.015 |
| K | 1.50 | 40 | 0.140 ±0.002 | 0.010 | 0.038 | 0.020 +0.000 −0.005 | 0.122 | 0.1093 | 0.125 +0.050 −0.000 |
| L | 3.00 | 40 | 0.185 ±0.002 | 0.015 | 0.058 | 0.015 +0.000 −0.005 | 0.183 | 0.1406 | 0.375 +0.075 −0.030 |
| M | 7.00 | 40 | 0.370 ±0.003 | 0.030 | 0.116 | 0.030 +0.000 −0.010 | 0.377 | 0.2812 | 0.500 +0.100 −0.040 |

[a] Summation of the deviations from $S_g$ for all grooves in any one sheave shall not exceed ±0.010 in.

| Other Sheave Tolerances[a] | | |
|---|---|---|
| Outside Diameter | Radial Runout[b] | Axial Runout[b] |
| Up through 2.9 in. outside diameter ±0.010 in. | Up through 2.9 in. outside diameter 0.005 in. | 0.001 in. per inch of outside diameter |
| Over 2.9 in. to and including 8.0 in. outside diameter ±0.020 in. | Over 2.9 in. to and including 10.0 in. outside diameter 0.010 in. | |
| For each additional inch of outside diameter over 8.0 in., add ±0.0025 in. | For each additional inch of outside diameter over 10.0 in., add 0.0005 in. | |

[a] Variations in pitch diameter between the grooves in any one sheave must be within the following limits: Up through 2.9 in. outside diameter and up through 6 grooves, 0.002 in. (add 0.001 in. for each additional groove); over 2.9 in. to and including 19.9 in. and up through 10 grooves, 0.005 in. (add 0.0002 in. for each additional groove); over 19.9 in. and up through 10 grooves, 0.010 in. (add 0.0005 in. for each additional groove). This variation can be obtained by measuring the distance across two measuring balls or rods placed in the grooves diametrically opposite each other. Comparing this “diameter-over-balls or -rods” measurement between grooves will give the variation in pitch diameter.

[b] Total indicator reading.

All dimensions in inches

*Belt Size Designation:* Belt sizes are identified by a standard belt number, which consists of belt effective length to the nearest tenth of an inch, a letter designating cross section, and the number of ribs. For example, 540L6 signifies a 54.0 in. effective length, L belt, six ribs wide.

*Sheave Dimensions.:* Groove angles and dimensions for sheaves and face widths of sheaves for multiple belt drives are given in Table 23, along with various tolerance values.

*Cross Section Selection.:* Use the chart (Fig. 9) as a guide to the V-ribbed belt cross section for any combination of design horsepower and speed of the faster shaft. When the intersection of the design horsepower and speed of the faster shaft falls near a line between two areas on the chart, the possibilities in both areas should be explored. Special circumstances (such as space limitations) may lead to a choice of belt cross section different from that indicated in the chart. H and K cross sections are not included because of their specialized use. Belt manufacturers should be contacted for specific data.

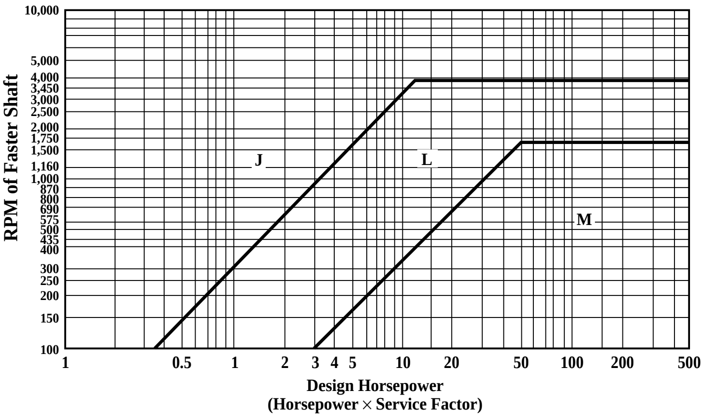



Fig. 9. Selection of V-Ribbed Belt Cross Section

*Horsepower Ratings.:* The horsepower rating formulas are:

$$\mathbf{J:}\ \mathrm{HP} = d_p r\left[\frac{0.1240}{(d_p r)^{0.09}} - \frac{0.08663}{d_p} - 0.2318\times10^{-4}(d_p r)^2\right] + 0.08663r\left[1 - \frac{1}{K_{SR}}\right]$$

$$\mathbf{L:}\ \mathrm{HP} = d_p r\left[\frac{0.5761}{(d_p r)^{0.09}} - \frac{0.8987}{d_p} - 1.018\times10^{-4}(d_p r)^2\right] + 0.8987r\left[1 - \frac{1}{K_{SR}}\right]$$

$$\mathbf{M:}\ \mathrm{HP} = d_p r\left[\frac{1.975}{(d_p r)^{0.09}} - \frac{6.597}{d_p} - 3.922\times10^{-4}(d_p r)^2\right] + 6.597r\left[1 - \frac{1}{K_{SR}}\right]$$

In these equations, $d_p$ = pitch diameter of the small sheave, in.; $r$ = rpm of the faster shaft divided by 1000; $K_{SR}$ = speed ratio factor given in the accompanying table. These formulas give the maximum horsepower per rib recommended, corrected for the speed ratio. To obtain the horsepower per rib for an arc of contact other than 180 degrees, and for belts longer or shorter than the average length, multiply the horsepower obtained from these formulas by the length correction factor (Table 25) and the arc of contact correction factor (Table 26).

**Table 24. V-Ribbed Belt Standard Effective Lengths** *ANSI/RMA IP-26, 1977*

| J Cross Section | | | L Cross Section | | | M Cross Section | | |
|---|---|---|---|---|---|---|---|---|
| Standard Length Designation[a] | Standard Effective Length | Permissible Deviation From Standard Length | Standard Length Designation[a] | Standard Effective Length | Permissible Deviation From Standard Length | Standard Length Designation[a] | Standard Effective Length | Permissible Deviation From Standard Length |
| 180 | 18.0 | +0.2, −0.2 | 500 | 50.0 | +0.2, −0.4 | 900 | 90.0 | +0.4, −0.7 |
| 190 | 19.0 | +0.2, −0.2 | 540 | 54.0 | +0.2, −0.4 | 940 | 94.0 | +0.4, −0.8 |
| 200 | 20.0 | +0.2, −0.2 | 560 | 56.0 | +0.2, −0.4 | 990 | 99.0 | +0.4, −0.8 |
| 220 | 22.0 | +0.2, −0.2 | 615 | 61.5 | +0.2, −0.5 | 1060 | 106.0 | +0.4, −0.8 |
| 240 | 24.0 | +0.2, −0.2 | 635 | 63.5 | +0.2, −0.5 | 1115 | 111.5 | +0.4, −0.9 |
| 260 | 26.0 | +0.2, −0.2 | 655 | 65.5 | +0.2, −0.5 | 1150 | 115.0 | +0.4, −0.9 |
| 280 | 28.0 | +0.2, −0.2 | 675 | 67.5 | +0.3, −0.6 | 1185 | 118.5 | +0.4, −0.9 |
| 300 | 30.0 | +0.2, −0.3 | 695 | 69.5 | +0.3, −0.6 | 1230 | 123.0 | +0.4, −1.0 |
| 320 | 32.0 | +0.2, −0.3 | 725 | 72.5 | +0.3, −0.6 | 1310 | 131.0 | +0.5, −1.1 |
| 340 | 34.0 | +0.2, −0.3 | 765 | 76.5 | +0.3, −0.6 | 1390 | 139.0 | +0.5, −1.1 |
| 360 | 36.0 | +0.2, −0.3 | 780 | 78.0 | +0.3, −0.6 | 1470 | 147.0 | +0.6, −1.2 |
| 380 | 38.0 | +0.2, −0.3 | 795 | 79.5 | +0.3, −0.6 | 1610 | 161.0 | +0.6, −1.2 |
| 400 | 40.0 | +0.2, −0.4 | 815 | 81.5 | +0.3, −0.7 | 1650 | 165.0 | +0.6, −1.3 |
| 430 | 43.0 | +0.2, −0.4 | 840 | 84.0 | +0.3, −0.7 | 1760 | 176.0 | +0.7, −1.4 |
| 460 | 46.0 | +0.2, −0.4 | 865 | 86.5 | +0.3, −0.7 | 1830 | 183.0 | +0.7, −1.4 |
| 490 | 49.0 | +0.2, −0.4 | 915 | 91.5 | +0.4, −0.7 | 1980 | 198.0 | +0.8, −1.6 |
| 520 | 52.0 | +0.2, −0.4 | 975 | 97.5 | +0.4, −0.8 | 2130 | 213.0 | +0.8, −1.6 |
| 550 | 55.0 | +0.2, −0.4 | 990 | 99.0 | +0.4, −0.8 | 2410 | 241.0 | +0.9, −1.6 |
| 580 | 58.0 | +0.2, −0.5 | 1065 | 106.5 | +0.4, −0.8 | 2560 | 256.0 | +1.0, −1.8 |
| 610 | 61.0 | +0.2, −0.5 | 1120 | 112.0 | +0.4, −0.9 | 2710 | 271.0 | +1.1, −2.2 |
| 650 | 65.0 | +0.2, −0.5 | 1150 | 115.0 | +0.4, −0.9 | 3010 | 301.0 | +1.2, −2.4 |

[a] To specify belt size, use the standard length designation, followed by the letter indicating belt cross section and the number of ribs desired. For example: 865L10.
All dimensions in inches.

**Table 25. Length Correction Factors**

| Std. Length Designation | Cross Section J | L | M | Std. Length Designation | Cross Section J | L | M |
|---|---|---|---|---|---|---|---|
| 180 | 0.83 | … | … | 1230 | … | 1.08 | 0.94 |
| 200 | 0.85 | … | … | 1310 | … | 1.10 | 0.96 |
| 240 | 0.89 | … | … | 1470 | … | 1.12 | 0.098 |
| 280 | 0.92 | … | … | 1610 | … | 1.14 | 1.00 |
| 320 | 0.95 | … | … | 1830 | … | 1.17 | 1.03 |
| 360 | 0.98 | … | … | 1980 | … | 1.19 | 1.05 |
| 400 | 1.00 | … | … | 2130 | … | 1.21 | 1.06 |
| 440 | 1.02 | … | … | 2410 | … | 1.24 | 1.09 |
| 500 | 1.05 | 0.89 | … | 2710 | … | … | 1.12 |
| 550 | 1.07 | 0.91 | … | 3010 | … | … | 1.14 |
| 610 | 1.09 | 0.93 | … | 3310 | … | … | 1.16 |
| 690 | 1.12 | 0.96 | … | 3610 | … | … | 1.18 |
| 780 | 1.16 | 0.98 | … | 3910 | … | … | 1.20 |
| 910 | 1.18 | 1.02 | 0.88 | 4210 | … | … | 1.22 |
| 940 | 1.19 | 1.02 | 0.89 | 4810 | … | … | 1.25 |
| 990 | 1.20 | 1.04 | 0.90 | 5410 | … | … | 1.28 |
| 1060 | … | 1.05 | 0.91 | 6000 | … | … | 1.30 |
| 1150 | … | 1.07 | 0.93 | … | … | … | … |

**Table 26. Arc of Contact Correction Factors**

| $\frac{D_o - d_o}{C}$ | Arc of Contact, θ, on Small Sheave, (deg) | Correction Factor |
|---|---|---|
| 0.00 | 180 | 1.00 |
| 0.10 | 174 | 0.98 |
| 0.20 | 169 | 0.97 |
| 0.30 | 163 | 0.95 |
| 0.40 | 157 | 0.94 |
| 0.50 | 151 | 0.92 |
| 0.60 | 145 | 0.90 |
| 0.70 | 139 | 0.88 |
| 0.80 | 133 | 0.85 |
| 0.90 | 127 | 0.83 |
| 1.00 | 120 | 0.80 |
| 1.10 | 113 | 0.77 |
| 1.20 | 106 | 0.74 |
| 1.30 | 99 | 0.71 |
| 1.40 | 91 | 0.67 |
| 1.50 | 83 | 0.63 |

*Number of Ribs:* The number of ribs required for an application is obtained by dividing the design horsepower by the corrected horsepower rating for one rib.

Arc of contact on the small sheave may be determined by the following formulas:

*Exact Formula:*

$$\text{Arc of Contact (deg)} = 2\cos^{-1}\left(\frac{D_o - d_o}{2C}\right)$$

*Approximate Formula:*

$$\text{Arc of Contact (deg)} = 180 - \frac{(D_o - d_o)60}{C}$$

where $D_o$ = Effective outside diameter of large sheave, in; $d_o$ = Effective outside diameter of small sheave, in; and, $C$ = Center distance, inch.

**Speed Ratio Correction Factors**

| Speed Ratio[a] | $K_{SR}$ |
|---|---|
| 1.00 to and incl. 1.10 | 1.0000 |
| Over 1.01 to and incl. 1.04 | 1.0136 |
| Over 1.04 to and incl. 1.08 | 1.0276 |
| Over 1.08 to and incl. 1.12 | 1.0419 |
| Over 1.12 to and incl. 1.18 | 1.0567 |
| Over 1.18 to and incl. 1.24 | 1.0719 |
| Over 1.24 to and incl. 1.34 | 1.0875 |
| Over 1.34 to and incl. 1.51 | 1.1036 |
| Over 1.51 to and incl. 1.99 | 1.1202 |
| Over 1.99 | 1.1373 |

[a] $D_p/d_p$, where $D_p$ ($d_p$) is the pitch diameter of the large (small) sheave.

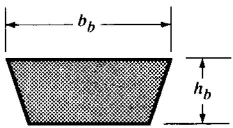
**Variable Speed Belts ANSI, RMA IP-25.—**For drives that require more speed variation than can be obtained with conventional industrial V-belts, standard-line variable-speed drives are available. These drives use special wide, thin belts. Package units of standard-line variable-speed belts and sheaves, combined with the motor and output gearbox are available in ranges from approximately ½ through 100 horsepower.

The speed ranges of variable-speed drives can be much greater than those drives using classical V-belts. Speed ranges up to 10:1 can be obtained on lower horsepower units.

This section covers 12 variable speed belt cross sections and sheave groove sizes designed 1422V, 1922V, 2322V 1926V, 2926V, 3226V, 2530V, 3230V, 4430V, 4036V, 4436V, and 4836V. The industry supplies many other sizes that are not listed in this section.

*Belt Cross Sections and Lengths:* Nominal dimensions of the 12 cross sections are given in Table 27, and lengths in Table 28.

**Table 27. Normal Variable-Speed Belt Dimensions** *ANSI/RMA IP-25, 1982*




| Cross Section | $b_b$ | $h_b$ | $h_b/b_b$ | Cross Section | $b_b$ | $h_b$ | $h_b/b_b$ |
|---|---|---|---|---|---|---|---|
| 1422V | 0.88 | 0.31 | 0.35 | 2530V | 1.56 | 0.59 | 0.38 |
| 1922V | 1.19 | 0.38 | 0.32 | 3230V | 2.00 | 0.62 | 0.31 |
| 2322V | 1.44 | 0.44 | 0.31 | 4430V | 2.75 | 0.69 | 0.25 |
| 1926V | 1.19 | 0.44 | 0.37 | 4036V | 2.50 | 0.69 | 0.28 |
| 2926V | 1.81 | 0.50 | 0.28 | 4436V | 2.75 | 0.72 | 0.26 |
| 3226V | 2.0 | 0.53 | 0.27 | 4836V | 3.00 | 0.75 | 0.25 |

All dimensions in inches.

## Table 28. Variable-Speed V-Belt Standard Belt Lengths *ANSI/RMA IP-25, 1982*

| Standard Pitch Length Designation | Standard Effective Lengths | | | | | | | | | | | | Permissible Deviations From Standard Length |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cross Section | | | | | | | | | | | | |
| | 1422V | 1922V | 2322V | 1926V | 2926V | 3226V | 2530V | 3230V | 4430V | 4036V | 4436V | 4836V | |
| 315 | 32.1 | … | … | … | … | … | … | … | … | … | … | … | ±0.7 |
| 335 | 34.1 | … | … | … | … | … | … | … | … | … | … | … | ±0.7 |
| 355 | 36.1 | 36.2 | … | 36.3 | … | … | … | … | … | … | … | … | ±0.7 |
| 375 | 38.1 | 38.2 | … | 38.3 | … | … | … | … | … | … | … | … | ±0.7 |
| 400 | 40.6 | 40.7 | 40.8 | 40.8 | … | … | … | … | … | … | … | … | ±0.7 |
| 425 | 43.1 | 43.2 | 43.3 | 43.3 | … | … | … | … | … | … | … | … | ±0.8 |
| 450 | 45.6 | 45.7 | 45.8 | 45.8 | … | … | … | … | … | … | … | … | ±0.8 |
| 475 | 48.1 | 48.2 | 48.3 | 48.3 | … | … | … | … | … | … | … | … | ±0.8 |
| 500 | 50.6 | 50.7 | 50.8 | 50.8 | … | … | 50.9 | … | … | … | … | … | ±0.8 |
| 530 | 53.6 | 53.7 | 53.8 | 53.8 | 53.9 | … | 53.9 | … | … | … | … | … | ±0.8 |
| 560 | 56.6 | 56.7 | 56.8 | 56.8 | 56.9 | 56.9 | 56.9 | 57.1 | 57.3 | 57.3 | 57.3 | 57.4 | ±0.9 |
| 600 | 60.6 | 60.7 | 60.8 | 60.8 | 60.9 | 60.9 | 60.9 | 61.1 | 61.3 | 61.3 | 61.3 | 61.4 | ±0.9 |
| 630 | 63.6 | 63.7 | 63.8 | 63.8 | 63.9 | 63.9 | 63.9 | 64.1 | 64.3 | 64.3 | 64.3 | 64.4 | ±0.9 |
| 670 | 67.6 | 67.7 | 67.8 | 67.8 | 67.9 | 67.9 | 67.9 | 68.1 | 68.3 | 68.3 | 68.3 | 68.4 | ±0.9 |
| 710 | 71.6 | 71.7 | 71.8 | 71.8 | 71.9 | 71.9 | 71.9 | 72.1 | 72.3 | 72.3 | 72.3 | 72.4 | ±0.9 |
| 750 | 75.6 | 75.7 | 75.8 | 75.8 | 75.9 | 75.9 | 75.9 | 76.1 | 76.3 | 76.3 | 76.3 | 76.4 | ±1.0 |
| 800 | … | 80.7 | 80.8 | 80.8 | 80.9 | 80.9 | 80.9 | 81.1 | 81.3 | 81.3 | 81.3 | 81.4 | ±1.0 |
| 850 | … | 85.7 | 85.8 | 85.8 | 85.9 | 85.9 | 85.9 | 86.1 | 86.3 | 86.3 | 86.3 | 86.4 | ±1.1 |
| 900 | … | 90.7 | 90.8 | 90.8 | 90.9 | 90.9 | 90.9 | 91.1 | 91.3 | 91.3 | 91.3 | 91.4 | ±1.1 |
| 950 | … | 95.7 | 95.8 | 95.8 | 95.9 | 95.9 | 95.9 | 96.1 | 96.3 | 96.3 | 96.3 | 96.4 | ±1.1 |
| 1000 | … | 100.7 | 100.8 | 100.8 | 100.9 | 100.9 | 100.9 | 101.1 | 101.3 | 101.3 | 101.3 | 101.4 | ±1.2 |
| 1060 | … | 106.7 | 106.8 | 106.8 | 106.9 | 106.9 | 106.9 | 107.1 | 107.3 | 107.3 | 107.3 | 107.4 | ±1.2 |
| 1120 | … | 112.7 | 112.8 | 112.8 | 112.9 | 112.9 | 112.9 | 113.1 | 113.3 | 113.3 | 113.3 | 113.4 | ±1.2 |
| 1180 | … | 118.7 | 118.8 | 118.8 | 118.9 | 118.9 | 118.9 | 119.1 | 119.3 | 119.3 | 119.3 | 119.4 | ±1.3 |
| 1250 | … | … | … | … | 125.9 | 125.9 | 125.9 | 126.1 | 126.3 | 126.3 | 126.3 | 126.4 | ±1.3 |
| 1320 | … | … | … | … | … | 132.9 | … | 133.1 | 133.3 | 133.3 | 133.3 | 133.4 | ±1.3 |

All dimensions in inches.

The lengths given in this table are not necessarily available from all manufacturers. Availability should be investigated prior to design commitment.

## Table 29. Variable-Speed Sheave and Groove Dimensions

| | Standard Groove Dimensions | | | | | | | | | Drive Design Factors | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Variable | | | | | Companion | | | | | | | |
| Cross Section | α Groove Angle ±0.67 (deg) | $b_g$[a] Closed +0.000 −0.030 | $b_{go}$ Open Max | $h_{gv}$ Min | $S_g$ ±0.03 | α Groove Angle ±0.33 (deg) | $b_g$ ±0.010 | $h_g$ Min | $S_g$ ±0.03 | Min. Recomm. Pitch Diameter | $2a$ | $2av$ Max | $CL$ Min |
| 1422V | 22 | 0.875 | 1.63 | 2.33 | 1.82 | 22 | 0.875 | 0.500 | 1.82 | 2.0 | 0.20 | 3.88 | 0.08 |
| 1922V | 22 | 1.188 | 2.23 | 3.14 | 2.42 | 22 | 1.188 | 0.562 | 2.42 | 3.0 | 0.22 | 5.36 | 0.08 |
| 2322V | 22 | 1.438 | 2.71 | 3.78 | 2.89 | 22 | 1.438 | 0.625 | 2.89 | 3.5 | 0.25 | 6.52 | 0.08 |
| 1926V | 26 | 1.188 | 2.17 | 2.65 | 2.36 | 26 | 1.188 | 0.625 | 2.36 | 3.0 | 0.25 | 4.26 | 0.08 |
| 2926V | 26 | 1.812 | 3.39 | 4.00 | 3.58 | 26 | 1.812 | 0.750 | 3.58 | 3.5 | 0.30 | 6.84 | 0.08 |
| 3226V | 26 | 2.000 | 3.75 | 4.41 | 3.96 | 26 | 2.000 | 0.781 | 3.96 | 4.0 | 0.30 | 7.60 | 0.08 |
| 2530V | 30 | 1.562 | 2.81 | 3.01 | 2.98 | 30 | 1.562 | 0.844 | 2.98 | 4.0 | 0.30 | 4.64 | 0.10 |
| 3230V | 30 | 2.000 | 3.67 | 3.83 | 3.85 | 30 | 2.000 | 0.875 | 3.85 | 4.5 | 0.35 | 6.22 | 0.10 |
| 4430V | 30 | 2.750 | 5.13 | 5.23 | 5.38 | 30 | 2.750 | 0.938 | 5.38 | 5.0 | 0.40 | 8.88 | 0.10 |
| 4036V | 36 | 2.500 | 4.55 | 3.95 | 4.80 | 36 | 2.500 | 0.938 | 4.80 | 4.5 | 0.40 | 6.32 | 0.10 |
| 4436V | 36 | 2.750 | 5.03 | 4.33 | 5.30 | 36 | 2.750 | 0.969 | 5.30 | 5.0 | 0.40 | 7.02 | 0.10 |
| 4836V | 36 | 3.000 | 5.51 | 4.72 | 5.76 | 36 | 3.000 | 1.000 | 5.76 | 6.0 | 0.45 | 7.74 | 0.10 |

[a] The effective width ($b_e$), a reference dimension, is the same as the ideal top width of closed variable-speed sheave ($b_g$) and the ideal top width of the companion sheave ($b_g$).

| Other Sheave Tolerances | | |
|---|---|---|
| Outside Diameter | Radial Runout[a] | Axial Runout[a] |
| Up through 4.0 in. outside diameter ±0.020 in. | Up through 10.0 in. outside diameter 0.010 in. | Up through 5.0 in. outside diameter 0.005 in. |
| For each additional inch of outside diameter add ±0.005 in. | For each additional inch of outside diameter add 0.0005 in. | For each additional inch of outside diameter add 0.001 in. |

[a] Total indicator reading.

| Surface Finish | | | |
|---|---|---|---|
| Machined Surface Area | Max Surface Roughness Height, $R_a$ (AA) (μ in.) | Machined Surface Area | Max Surface Roughness Height, $R_a$ (AA) (μ in.) |
| V-Sheave groove sidewalls | 125 | Straight bores with 0.002 in. or less total tolerance | 125 |
| Rim edges and ID, Hub ends and OD | 500 | Taper and straight bores with total tolerance over 0.002 in. | 250 |

All dimensions in inches, except where noted.

*Belt Size Designation:* Variable-speed belt sizes are identified by a standard belt number. The first two digits denote the belt top width in sixteenths of an inch; the third and fourth digits indicate the angle of the groove in which the belt is designed to operate. The letter V (for variable) follows the first four digits. The digits after the V indicate the pitch length to the nearest 0.1 in. For example, 1422V450 is a belt of $\frac{7}{8}$ in. ($\frac{14}{16}$ in.) nominal top width designed to operate in a sheave of 22 degree groove angle and having a pitch length of 45.0 in.

*Sheave Groove Data:* A variable speed sheave is an assembly of movable parts, designed to permit one or both flanges of the sheave to be moved axially causing a radial movement of the variable speed belt in the sheave groove. This radial movement permits stepless speed variation within the physical limits of the sheave and the belt. A companion sheave may be a solid sheave having a constant diameter and groove profile or another variable sheave. Variable speed sheave designs should conform to the dimensions in Table 29 and Fig. 10. The included angle of the sheaves, top width, and clearance are boundary dimensions. Groove angles and dimensions of companion sheaves should conform to Table 29 and Fig. 11. Various tolerance values are also given in Table 29.

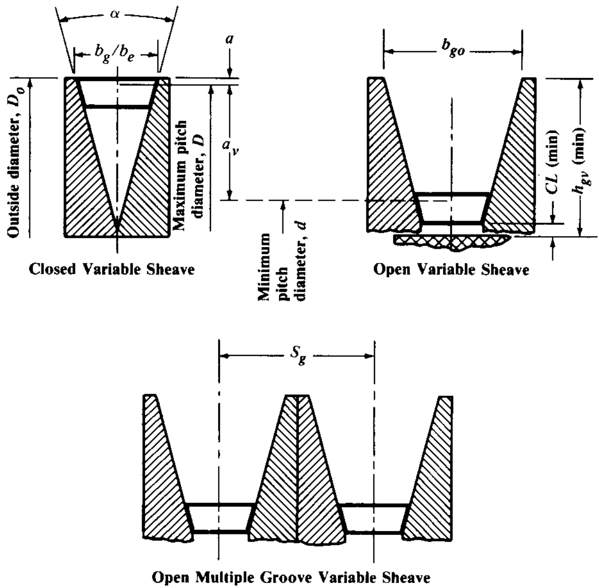



Fig. 10. Variable Sheaves

*Variable-Speed Drive Design:* Variable-speed belts are designed to operate in sheaves that are an assembly of movable parts. The sheave design permits one or both flanges of the sheave to be moved axially, causing a radial movement of the variable-speed belt in the sheave groove. The result is a stepless speed variation within the physical limits of the sheave and the variable-speed belt. Therefore, besides transmitting power, variable-speed belt drives provide speed variation.

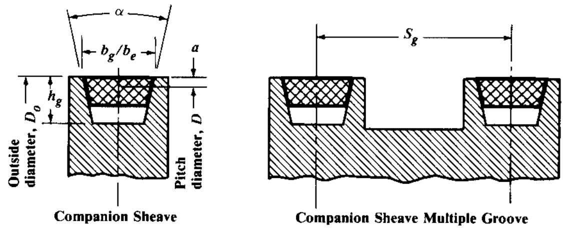



Fig. 11. Companion Sheaves

The factors that determine the amount of pitch diameter change on variable-speed sheaves are belt top width, belt thickness, and sheave angle. This pitch diameter change, combined with the selected operating pitch diameters for a sheave, determines the possible speed variation.

The range of output speeds from a variable-speed sheave drive is established by the companion sheave and is a function of the ratio of the pitch diameter of the companion sheave to the maximum and minimum pitch diameters of the variable sheave. Speed variation is usually obtained by varying the center distance between the two sheaves. This type of drive seldom exceeds a speed variation of 3:1.

For a single variable-speed sheave drive, the speed variation

$$\text{Speed variation} = \frac{\text{PD Max}}{\text{PD Min}} \text{ (of variable sheave)}$$

For a dual variable-speed sheave drive, which is frequently referred to as a compound drive because both sheaves are variable, the speed variation is

$$\text{Speed variation} = \frac{DR(DN)}{dr(dn)}$$

where *DR* = Max driver PD

*DN* = Max driven PD

*dr* = Min driver PD

*dn* = Min driven PD

With this design, the center distance is generally fixed and speed variation is usually accomplished by mechanically altering the pitch diameter of one sheave. In this type of drive, the other sheave is spring loaded to make an opposite change in the pitch diameter and to provide the correct belt tension. Speed variations of up to 10: 1 are common on this type of drive.

*Speed Ratio Adjustment:* All speed ratio changes must be made while the drives are running. Attempting to make adjustments while the unit is stopped creates unnecessary and possibly destructive forces on both the belt and sheaves. In stationary control drives, the belt tension should be released to allow the flanges to adjust without belt force interference.

*Cross Section Selection:* Selection of a variable speed belt cross section is based on the drive design horsepower and speed variation. Table 29 shows the maximum pitch diameter variation (2*av*) that each cross section can attain.

*Horsepower Ratings:* The general horsepower formulas for variable-speed belts are:

$$1422\text{V HP} = d_p r\left[0.4907(d_p r)^{-0.09} - \frac{0.8378}{d_p} - 0.000337(d_p r)^2\right] + 0.8378r\left(1 - \frac{1}{K_{SR}}\right)$$

$$1922 VHP = d_p r\left[0.8502(d_p r)^{-0.09} - \frac{1.453}{d_p} - 0.000538(d_p r)^2\right] + 1.453r\left(1 - \frac{1}{K_{SR}}\right)$$

$$2322 VHP = d_p r\left[1.189(d_p r)^{-0.09} - \frac{2.356}{d_p} - 0.000777(d_p r)^2\right] + 2.356r\left(1 - \frac{1}{K_{SR}}\right)$$

$$1926 VHP = d_p r\left[1.046(d_p r)^{-0.09} - \frac{1.833}{d_p} - 0.000589(d_p r)^2\right] + 1.833r\left(1 - \frac{1}{K_{SR}}\right)$$

$$2926 VHP = d_p r\left[1.769(d_p r)^{-0.09} - \frac{4.189}{d_p} - 0.001059(d_p r)^2\right] + 4.189r\left(1 - \frac{1}{K_{SR}}\right)$$

$$3226 VHP = d_p r\left[2.073(d_p r)^{-0.09} - \frac{5.236}{d_p} - 0.001217(d_p r)^2\right] + 5.236r\left(1 - \frac{1}{K_{SR}}\right)$$

$$2530 VHP = d_p r\left[2.395(d_p r)^{-0.09} - \frac{6.912}{d_p} - 0.001148(d_p r)^2\right] + 6.912r\left(1 - \frac{1}{K_{SR}}\right)$$

$$3230 VHP = d_p r\left[2.806(d_p r)^{-0.09} - \frac{7.854}{d_p} - 0.001520(d_p r)^2\right] + 7.854r\left(1 - \frac{1}{K_{SR}}\right)$$

$$4430 VHP = d_p r\left[3.454(d_p r)^{-0.09} - \frac{7.854}{d_p} - 0.002196(d_p r)^2\right] + 9.818r\left(1 - \frac{1}{K_{SR}}\right)$$

$$4036 VHP = d_p r\left[3.566(d_p r)^{-0.09} - \frac{9.687}{d_p} - 0.002060(d_p r)^2\right] + 9.687r\left(1 - \frac{1}{K_{SR}}\right)$$

$$4436 VHP = d_p r\left[4.041(d_p r)^{-0.09} - \frac{11.519}{d_p} - 0.002297(d_p r)^2\right] + 11.519r\left(1 - \frac{1}{K_{SR}}\right)$$

$$4836 VHP = d_p r\left[4.564(d_p r)^{-0.09} - \frac{13.614}{d_p} - 0.002634(d_p r)^2\right] + 13.614r\left(1 - \frac{1}{K_{SR}}\right)$$

In these equations, $d_p$ = pitch diameter of small sheave, in.; $r$ = rpm of faster shaft divided by 1000; $K_{SR}$ = speed ratio factor given in the accompanying table. These formulas give the basic horsepower rating, corrected for the speed ratio. To obtain the horsepower for arcs of contact other than 180 degrees and for belts longer or shorter than average length, multiply the horsepower obtained from these formulas by the arc of contact correction factor (Table 30) and the length correction factor (Table 31).

**Table 30. Arc of Contact Correction Factors**

| $\frac{D-d}{C}$ | Arc of Contact, θ, on Small Sheave, (deg) | Correction Factor | $\frac{D-d}{C}$ | Arc of Contact, θ, on Small Sheave, (deg) | Correction Factor |
|---|---|---|---|---|---|
| 0.00 | 180 | 1.00 | 0.80 | 0.80 | 0.87 |
| 0.10 | 174 | 0.99 | 0.90 | 0.90 | 0.85 |
| 0.20 | 169 | 0.97 | 1.00 | 1.00 | 0.82 |
| 0.30 | 163 | 0.96 | 1.10 | 1.10 | 0.80 |
| 0.40 | 157 | 0.94 | 1.20 | 1.20 | 0.77 |
| 0.50 | 151 | 0.93 | 1.30 | 1.30 | 0.73 |
| 0.60 | 145 | 0.91 | 1.40 | 1.40 | 0.70 |
| 0.70 | 139 | 0.89 | 1.50 | 1.50 | 0.65 |

## Table 31. Length Correction Factors

| Standard Pitch Length Designation | Cross Section | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1422V | 1922V | 2322V | 1926V | 2926V | 3226V | 2530V | 3230V | 4430V | 4036V | 4436V | 4836V |
| 315 | 0.93 | … | … | … | … | … | … | … | … | … | … | … |
| 335 | 0.94 | … | … | … | … | … | … | … | … | … | … | … |
| 355 | 0.95 | 0.90 | … | 0.90 | … | … | … | … | … | … | … | … |
| 375 | 0.96 | 0.91 | … | 0.91 | … | … | … | … | … | … | … | … |
| 400 | 0.97 | 0.92 | 0.90 | 0.92 | … | … | … | … | … | … | … | … |
| 425 | 0.98 | 0.93 | 0.91 | 0.93 | … | … | … | … | … | … | … | … |
| 450 | 0.99 | 0.94 | 0.92 | 0.94 | … | … | … | … | … | … | … | … |
| 475 | 1.00 | 0.95 | 0.93 | 0.95 | … | … | … | … | … | … | … | … |
| 500 | 1.01 | 0.95 | 0.94 | 0.95 | … | … | 0.90 | … | … | … | … | … |
| 530 | 1.02 | 0.96 | 0.95 | 0.96 | 0.92 | … | 0.92 | … | … | … | … | … |
| 560 | 1.03 | 0.97 | 0.96 | 0.97 | 0.93 | 0.92 | 0.93 | 0.91 | 0.90 | 0.91 | 0.91 | 0.92 |
| 600 | 1.04 | 0.98 | 0.97 | 0.98 | 0.94 | 0.93 | 0.94 | 0.93 | 0.92 | 0.93 | 0.92 | 0.93 |
| 630 | 1.05 | 0.99 | 0.98 | 0.99 | 0.95 | 0.94 | 0.95 | 0.94 | 0.93 | 0.94 | 0.93 | 0.94 |
| 670 | 1.06 | 1.00 | 0.99 | 1.00 | 0.97 | 0.95 | 0.96 | 0.95 | 0.94 | 0.95 | 0.95 | 0.95 |
| 710 | 1.07 | 1.01 | 1.00 | 1.01 | 0.98 | 0.96 | 0.98 | 0.96 | 0.96 | 0.96 | 0.96 | 0.96 |
| 750 | 1.08 | 1.02 | 1.01 | 1.02 | 0.99 | 0.98 | 0.99 | 0.97 | 0.97 | 0.97 | 0.97 | 0.98 |
| 800 | … | 1.03 | 1.02 | 1.03 | 1.00 | 0.99 | 1.00 | 0.99 | 0.99 | 0.99 | 0.99 | 0.99 |
| 850 | … | 1.04 | 1.03 | 1.04 | 1.01 | 1.00 | 1.01 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| 900 | … | 1.05 | 1.04 | 1.05 | 1.02 | 1.01 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.01 |
| 950 | … | 1.06 | 1.05 | 1.06 | 1.03 | 1.02 | 1.04 | 1.02 | 1.03 | 1.02 | 1.02 | 1.02 |
| 1000 | … | 1.07 | 1.06 | 1.07 | 1.04 | 1.03 | 1.05 | 1.03 | 1.04 | 1.03 | 1.04 | 1.03 |
| 1060 | … | 1.08 | 1.07 | 1.07 | 1.06 | 1.04 | 1.06 | 1.05 | 1.06 | 1.05 | 1.05 | 1.04 |
| 1120 | … | 1.09 | 1.08 | 1.08 | 1.07 | 1.06 | 1.07 | 1.06 | 1.07 | 1.06 | 1.06 | 1.06 |
| 1180 | … | 1.09 | 1.09 | 1.09 | 1.08 | 1.07 | 1.08 | 1.07 | 1.08 | 1.07 | 1.07 | 1.07 |
| 1250 | … | … | … | … | 1.09 | 1.08 | 1.10 | 1.08 | 1.10 | 1.08 | 1.09 | 1.08 |
| 1320 | … | … | … | … | … | 1.09 | … | 1.09 | 1.11 | 1.09 | 1.10 | 1.09 |

*Rim Speed:* The material and design selected for sheaves must be capable of withstanding the high rim speeds that may occur in variable-speed drives. The rim speed is calculated as follows: Rim speed (fpm) = $(\pi/12)(D_o)$ (rpm).

**60 Degree V-Belts.—**60 degree V-belts are ideal for compact drives. Their 60 degree angle and ribbed top are specifically designed for long life on small diameter sheaves. These belts offer extremely smooth operation at high speeds (in excess of 10,000 rpm) and can be used on drives with high speed ratios. They are available in 3M, 5M, 7M, and 11M (3, 5, 7, 11 mm) cross sections (top widths) and are commonly found in the joined configuration, which provides extra stability and improved performance. They are specified by cross section and nominal length; for example, a 5M315 designation indicates a belt having a 5 mm cross section and an effective length of 315 mm.

**Speed Ratio Correction Factors**

| Speed Ratio[a] | $K_{SR}$ | Speed Ratio[a] | $K_{SR}$ |
|---|---|---|---|
| 1.00–1.01 | 1.0000 | 1.19–1.24 | 1.0719 |
| 1.02–1.04 | 1.0136 | 1.25–1.34 | 1.0875 |
| 1.05–1.08 | 1.0276 | 1.35–1.51 | 1.1036 |
| 1.09–1.12 | 1.0419 | 1.52–1.99 | 1.1202 |
| 1.13–1.18 | 1.0567 | 2.0 and over | 1.1373 |

[a] $D_p/d_p$, where $D_p$ ($d_p$) is the pitch diameter of the large (small) sheave.

Arc of contact on the small sheave may be determined by the formulas:

*Exact Formula:* $$\text{Arc of Contact (deg)} = 2\cos^{-1}\left(\frac{D-d}{2C}\right)$$

*Approximate Formula:*

$$\text{Arc of Contact (deg)} = 180 - \frac{(D-d)60}{C}$$

where $D$ = Pitch diameter of large sheave or flat pulley, inch

$d$ = Pitch diameter of small sheave, inch

$C$ = Center distance, inch

Industry standards have not yet been published for 60 degree V-belts. Therefore, belt manufacturers should be contacted for specific applications, specifications, and additional information.

**Synchronous Belts ANSI/RMA IP-24.—**Synchronous belts are also known as timing or positive-drive belts. These belts have evenly spaced teeth on their surfaces, which mesh with teeth on pulleys or sprockets to produce a positive, no-slip transmission of power. Such designs should not be confused with molded notched V-belts, which transmit power by means of the wedging action of the V-shape.

Synchronous belts are used where driven shaft speeds must be synchronized to the rotation of the driver shaft and to eliminate the noise and maintenance problems of chain drives.

*Standard Timing Belts:* Conventional trapezoidal, or rectangular tooth, timing belts come in six cross sections, which relate to the pitch of the belt. Pitch is the distance from center to center of the teeth. The six basic cross sections or pitches are MXL (mini extra light), XL (extra light), L (light), H (heavy), XH (extra heavy), and XXH (double extra heavy) (Fig. 12). Belts are specified by pitch length, cross section (pitch), and width.

Double-sided timing belts have identical teeth on both sides of the belt and are used where synchronization is required from each belt face. They are available in XL, L, and H cross sections.

*Size Designations:* Synchronous belt sizes are identified by a standard number. The first digits specify the belt length to 0.1 in. followed by the belt section (pitch) designation. The digits following the belt section designation represent the nominal belt width times 100. For example, an L section belt 30.000 in. pitch length and 0.75 in. in width would be specified as a 300L075 synchronous belt.

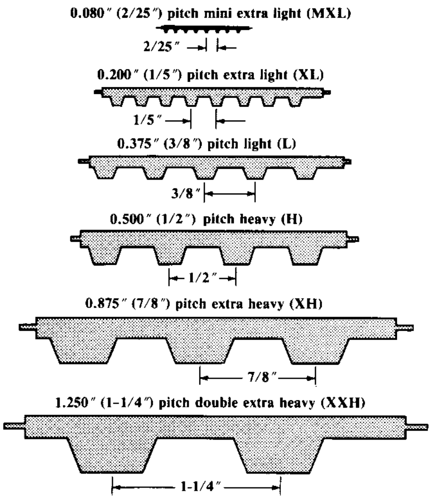


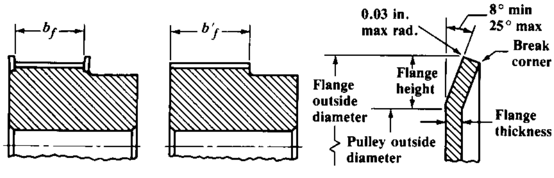

Fig. 12. Standard Synchronous Belt Sections

The RMA nomenclature for double-sided belts is the same as for single-sided belts with the addition of the prefix “D” in front of the belt section. However, some manufacturers use their own designation system for double-sided belts.

*Standard Sections:* Belt sections are specified in terms of pitch. Table 33 gives the Standard Belt Sections and their corresponding pitches.

*Pitch Lengths:* Standard belt pitch lengths, belt length designations, and numbers of teeth are shown in Table 34. Belt length tolerances are also given in this table; these tolerances apply to all belt sections and represent the total manufacturing tolerance on belt length.

**Table 32. Synchronous Belt Standard Pulley and Flange Dimensions**
*ANSI/RMA IP-24, 1983*

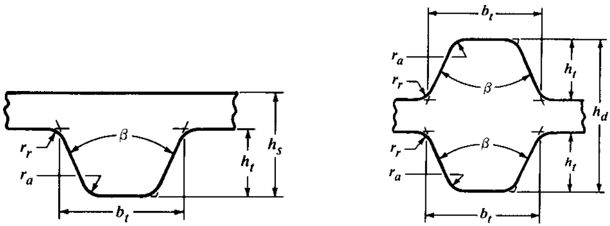



Flanged Pulley    Unflanged Pulley    Flange Dimensions

| Belt Section | Standard Nominal Pulley Width | Standard Pulley Width Designation | Minimum Pulley Width | | Flange | |
|---|---|---|---|---|---|---|
| | | | Flanged $b_f$ | Unflanged $b'_f$ | Thickness (min) | Height[a] (min) |
| MXL | 0.25 | 025 | 0.28 | 0.35 | 0.023 | 0.020 |
| XL | 0.38 | 037 | 0.41 | 0.48 | 0.029 | 0.040 |
| L | 0.50 | 050 | 0.55 | 0.67 | 0.050 | 0.065 |
| | 0.75 | 075 | 0.80 | 0.92 | | |
| | 1.00 | 100 | 1.05 | 1.17 | | |
| H | 1.00 | 100 | 1.05 | 1.23 | 0.050 | 0.080 |
| | 1.50 | 150 | 1.55 | 1.73 | | |
| | 2.00 | 200 | 2.08 | 2.26 | | |
| | 3.00 | 300 | 3.11 | 3.29 | | |
| XH | 2.00 | 200 | 2.23 | 2.46 | 0.098 | 0.190 |
| | 3.00 | 300 | 3.30 | 3.50 | | |
| | 4.00 | 400 | 4.36 | 4.59 | | |
| XXH | 2.00 | 200 | 2.23 | 2.52 | 0.127 | 0.245 |
| | 3.00 | 300 | 3.30 | 3.59 | | |
| | 4.00 | 400 | 4.36 | 4.65 | | |
| | 5.00 | 500 | 5.42 | 5.72 | | |

*Nominal Tooth Dimensions:* Table 33 shows the nominal tooth dimensions for each of the standard belt sections. Tooth dimensions for single- and double-sided belts are identical.

**Table 33. Synchronous Belt Nominal Tooth and Section Dimensions**
*ANSI/RMP IP-24, 1983*




Single-Sided Belts    Double-Sided Belts

| Belt Section (Pitch) | β Tooth Angle(deg) | $h_t$ | $b_t$ | $r_a$ | $r_r$ | $h_s$ | $h_d$ |
|---|---|---|---|---|---|---|---|
| MXL (0.080) | 40 | 0.020 | 0.045 | 0.005 | 0.005 | 0.045 | … |
| XL (0.200) | 50 | 0.050 | 0.101 | 0.015 | 0.015 | 0.090 | … |
| L (0.375) | 40 | 0.075 | 0.183 | 0.020 | 0.020 | 0.14 | … |
| H (0.500) | 40 | 0.090 | 0.241 | 0.040 | 0.040 | 0.16 | … |
| XH (0.875) | 40 | 0.250 | 0.495 | 0.047 | 0.062 | 0.44 | … |
| XXH (1.250) | 40 | 0.375 | 0.750 | 0.060 | 0.090 | 0.62 | … |
| DXL (0.200) | 50 | 0.050 | 0.101 | 0.015 | 0.015 | … | 0.120 |
| DL (0.375) | 40 | 0.075 | 0.183 | 0.020 | 0.020 | … | 0.180 |
| DH (0.500) | 40 | 0.090 | 0.241 | 0.040 | 0.040 | … | 0.234 |

All dimensions in inches.

**Table 34. Synchronous Belt Standard Pitch Lengths and Tolerances** *ANSI/RMA IP-24, 1983*

| Belt Length Designation | Pitch Length | Permissible Deviation From Standard Length | Number of Teeth for Standard Lengths | | | | | | Belt Length Designation | Pitch Length | Permissible Deviation From Standard Length | Number of Teeth for Standard Lengths | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MXL (0.080) | XL (0.200) | L (0.375) | H (0.500) | XH (0.875) | XXH (1.250) | | | | MXL (0.080) | XL (0.200) | L (0.375) | H (0.500) | XH (0.875) | XXH (1.250) |
| 36 | 3.600 | ±0.016 | 45 | | | | | | 230 | 23.000 | ±0.024 | … | 115 | … | … | | |
| 40 | 4.000 | ±0.016 | 50 | | | | | | 240 | 24.000 | ±0.024 | … | 120 | 64 | 48 | | |
| 44 | 4.400 | ±0.016 | 55 | | | | | | 250 | 25.000 | ±0.024 | … | 125 | … | … | | |
| 48 | 4.800 | ±0.016 | 60 | | | | | | 255 | 25.500 | ±0.024 | … | … | 68 | … | | |
| 56 | 5.600 | ±0.016 | 70 | | | | | | 260 | 26.000 | ±0.024 | … | 130 | … | … | | |
| 60 | 6.000 | ±0.016 | 75 | 30 | | | | | 270 | 27.000 | ±0.024 | … | … | 72 | 54 | | |
| 64 | 6.400 | ±0.016 | 80 | … | | | | | 285 | 28.500 | ±0.024 | … | … | 76 | … | | |
| 70 | 7.000 | ±0.016 | … | 35 | | | | | 300 | 30.000 | ±0.024 | … | … | 80 | 60 | | |
| 72 | 7.200 | ±0.016 | 90 | … | | | | | 322 | 32.250 | ±0.026 | … | … | 86 | … | | |
| 80 | 8.000 | ±0.016 | 100 | 40 | | | | | 330 | 33.000 | ±0.026 | … | … | … | 66 | | |
| 88 | 8.800 | ±0.016 | 110 | … | | | | | 345 | 34.500 | ±0.026 | | | 92 | … | | |
| 90 | 9.000 | ±0.016 | … | 45 | | | | | 360 | 36.000 | ±0.026 | | | … | 72 | | |
| 100 | 10.000 | ±0.016 | 125 | 50 | | | | | 367 | 36.750 | ±0.026 | | | 98 | … | | |
| 110 | 11.000 | ±0.018 | … | 55 | | | | | 390 | 39.000 | ±0.026 | | | 104 | 78 | | |
| 112 | 11.200 | ±0.018 | 140 | … | | | | | 420 | 42.000 | ±0.030 | | | 112 | 84 | | |
| 120 | 12.000 | ±0.018 | … | 60 | … | | | | 450 | 45.000 | ±0.030 | | | 120 | 90 | … | |
| 124 | 12.375 | ±0.018 | … | … | 33 | | | | 480 | 48.000 | ±0.030 | | | 128 | 96 | … | |
| 124 | 12.400 | ±0.018 | 155 | … | … | | | | 507 | 50.750 | ±0.032 | | | … | … | 58 | |
| 130 | 13.000 | ±0.018 | … | 65 | … | | | | 510 | 51.000 | ±0.032 | | | 136 | 102 | … | |
| 140 | 14.000 | ±0.018 | 175 | 70 | … | | | | 540 | 54.000 | ±0.032 | | | 144 | 108 | … | |
| 150 | 15.000 | ±0.018 | … | 75 | 40 | | | | 560 | 56.000 | ±0.032 | | | … | … | 64 | |
| 160 | 16.000 | ±0.020 | 200 | 80 | … | | | | 570 | 57.000 | ±0.032 | | | … | 114 | … | |
| 170 | 17.000 | ±0.020 | … | 85 | … | | | | 600 | 60.000 | ±0.032 | | | 160 | 120 | … | |
| 180 | 18.000 | ±0.020 | 225 | 90 | … | | | | 630 | 63.000 | ±0.034 | | | … | 126 | 72 | |
| 187 | 18.750 | ±0.020 | … | … | 50 | | | | 660 | 66.000 | ±0.034 | | | … | 132 | … | |
| 190 | 19.000 | ±0.020 | … | 95 | … | | | | 700 | 70.000 | ±0.034 | | | | 140 | 80 | 56 |
| 200 | 20.000 | ±0.020 | 250 | 100 | … | | | | 750 | 75.000 | ±0.036 | | | | 150 | … | … |
| 210 | 21.000 | ±0.024 | … | 105 | 56 | | | | 770 | 77.000 | ±0.036 | | | | … | 88 | … |
| 220 | 22.000 | ±0.024 | … | 110 | … | | | | 800 | 80.000 | ±0.036 | | | | 160 | … | 64 |
| 225 | 22.500 | ±0.024 | … | … | 60 | | | | 840 | 84.000 | ±0.038 | | | | … | 96 | … |

All dimensions in inches.

*Widths.:* Standard belt widths, width designations, and width tolerances are shown in Table 35.

**Table 35. Synchronous Belt Standard Widths and Tolerances**
*ANSI/RMA IP-24, 1983*

| Belt Section | Standard Belt Widths | | Tolerances on Width for Belt Pitch Lengths | | |
|---|---|---|---|---|---|
| | Designation | Dimensions | Up to and including 33 in. | Over 33 in. up to and including 66 in. | Over 66 in. |
| MXL (0.080) | 012<br>019<br>025 | 0.12<br>0.19<br>0.25 | +0.02<br>−0.03 | … | … |
| XL (0.200) | 025<br>037 | 0.25<br>0.38 | +0.02<br>−0.03 | … | … |
| L (0.375) | 050<br>075<br>100 | 0.50<br>0.75<br>1.00 | +0.03<br>−0.03 | +0.03<br>−0.05 | … |
| H (0.500) | 075<br>100<br>150 | 0.75<br>1.00<br>1.50 | +0.03<br>−0.03 | +0.03<br>−0.05 | +0.03<br>−0.05 |
| | 200 | 2.00 | +0.03<br>−0.05 | +0.05<br>−0.05 | +0.05<br>−0.06 |
| | 300 | 3.00 | +0.05<br>−0.06 | +0.06<br>−0.06 | +0.06<br>−0.08 |
| XH (0.875) | 200<br>300<br>400 | 2.00<br>3.00<br>4.00 | … | +0.19<br>−0.19 | +0.19<br>−0.19 |
| XXH (1.250) | 200<br>300<br>400<br>500 | 2.00<br>3.00<br>4.00<br>5.00 | … | … | +0.19<br>−0.19 |

*Length Determination.:* The pitch length of a synchronous belt is determined by placing the belt on a measuring fixture having two pulleys of equal diameter, a method of applying force, and a means of measuring the center distance between the two pulleys. The position of one of the two pulleys is fixed and the other is movable along a graduated scale.

*Synchronous Belt Pulley Diameters:* Table 36 lists the standard pulley diameters by belt section (pitch). Fig. 13 defines the pitch, pitch diameter, outside diameter and pitch line differential.

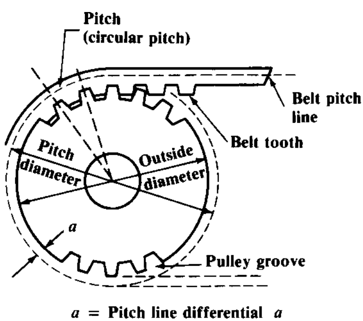



Fig. 13. Synchronous Belt Pulley Dimensions

## Table 36. Synchronous Belt Standard Pulley Diameters *ANSI/RMA IP-24, 1983*

| Number of Grooves | Belt Section | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MXL (0.080) | | XL (0.200) | | L (0.375) | | H (0.500) | | XH (0.875) | | XXH (1.250) | |
| | Diameters | | Diameters | | Diameters | | Diameters | | Diameters | | Diameters | |
| | Pitch | Outside | Pitch | Outside | Pitch | Outside | Pitch | Outside | Pitch | Outside | Pitch | Outside |
| 10 | 0.255 | 0.235 | 0.637 | 0.617 | 1.194[a] | 1.164 | … | … | … | … | … | … |
| 12 | 0.306 | 0.286 | 0.764 | 0.744 | 1.432[a] | 1.402 | … | … | … | … | … | … |
| 14 | 0.357 | 0.337 | 0.891 | 0.871 | 1.671 | 1.641 | 2.228[a] | 2.174 | … | … | … | … |
| 16 | 0.407 | 0.387 | 1.019 | 0.999 | 1.910 | 1.880 | 2.546 | 2.492 | … | … | … | … |
| 18 | 0.458 | 0.438 | 1.146 | 1.126 | 2.149 | 2.119 | 2.865 | 2.811 | 5.013 | 4.903 | 7.162 | 7.042 |
| 20 | 0.509 | 0.489 | 1.273 | 1.253 | 2.387 | 2.357 | 3.183 | 3.129 | 5.570 | 5.460 | 7.958 | 7.838 |
| 22 | 0.560 | 0.540 | 1.401 | 1.381 | 2.626 | 2.596 | 3.501 | 3.447 | 6.127 | 6.017 | 8.754 | 8.634 |
| 24 | 0.611 | 0.591 | 1.528 | 1.508 | 2.865 | 2.835 | 3.820 | 3.766 | 6.685 | 6.575 | 9.549 | 9.429 |
| 26 | 0.662 | 0.642 | … | … | 3.104 | 3.074 | 4.138 | 4.084 | 7.242 | 7.132 | 10.345 | 10.225 |
| 28 | 0.713 | 0.693 | 1.783 | 1.763 | 3.342 | 3.312 | 4.456 | 4.402 | 7.799 | 7.689 | … | … |
| 30 | 0.764 | 0.744 | 1.910 | 1.890 | 3.581 | 3.551 | 4.775 | 4.721 | 8.356 | 8.246 | 11.937 | 11.817 |
| 32 | 0.815 | 0.795 | 2.037 | 2.017 | 3.820 | 3.790 | 5.093 | 5.039 | 8.913 | 8.803 | … | … |
| 34 | 0.866 | 0.846 | … | … | … | … | … | … | … | … | 13.528 | 13.408 |
| 36 | 0.917 | 0.897 | 2.292 | 2.272 | 4.297 | 4.267 | 5.730 | 5.676 | … | … | … | … |
| 40 | 1.019 | 0.999 | 2.546 | 2.526 | 4.775 | 4.745 | 6.366 | 6.312 | 11.141 | 11.031 | 15.915 | 15.795 |
| 42 | 1.070 | 1.050 | 2.674 | 2.654 | … | … | … | … | … | … | … | … |
| 44 | 1.120 | 1.100 | 2.801 | 2.781 | 5.252 | 5.222 | 7.003 | 6.949 | … | … | … | … |
| 48 | 1.222 | 1.202 | 3.056 | 3.036 | 5.730 | 5.700 | 7.639 | 7.585 | 13.369 | 13.259 | 19.099 | 18.979 |
| 60 | 1.528 | 1.508 | 3.820 | 3.800 | 7.162 | 7.132 | 9.549 | 9.495 | 16.711 | 16.601 | 23.873 | 23.753 |
| 72 | 1.833 | 1.813 | 4.584 | 4.564 | 8.594 | 8.564 | 11.459 | 11.405 | 20.054 | 19.944 | 28.648 | 28.528 |
| 84 | … | … | … | … | 10.027 | 9.997 | 13.369 | 13.315 | 23.396 | 23.286 | … | … |
| 90 | … | … | … | … | … | … | … | … | … | … | 35.810 | 35.690 |
| 96 | … | … | … | … | … | … | 15.279 | 15.225 | 26.738 | 26.628 | … | … |
| 120 | … | … | … | … | … | … | 19.099 | 19.045 | 33.423 | 33.313 | … | … |

All dimensions in inches.

* Usually not available in all widths — consult supplier.

*Widths:* Standard pulley widths for each belt section are shown in Table 32. The nominal pulley width is specified in terms of the maximum standard belt width the pulley will accommodate. The minimum pulley width, whether flanged or unflanged, is also shown in Table 32, along with flange dimensions and various pulley tolerances.

*Pulley Size Designation:* Synchronous belt pulleys are designated by the number of grooves, the belt section, and a number representing 100 times the nominal width. For example, a 30 groove L section pulley with a nominal width of 0.75 in. would be designated by 30L075. Pulley tolerances are shown in Table 37.

**Table 37. Pulley Tolerances (All Sections)**

| Outside Diameter Range | Outside Diameter Tolerance | Pitch to Pitch Tolerance | |
|---|---|---|---|
| | | Adjacent Grooves | Accumulative Over 90 Degrees |
| Up thru 1.000 | +0.002 −0.000 | ±0.001 | ±0.003 |
| Over 1.000 to and including 2.000 | +0.003 −0.000 | ±0.001 | ±0.004 |
| Over 2.000 to and including 4.000 | +0.004 −0.000 | ±0.001 | ±0.005 |
| Over 4.000 to and including 7.000 | +0.005 −0.000 | ±0.001 | ±0.005 |
| Over 7.000 to and including 12.000 | +0.006 −0.000 | ±0.001 | ±0.006 |
| Over 12.000 to and including 20.000 | +0.007 −0.000 | ±0.001 | ±0.007 |
| Over 20.000 | +0.008 −0.000 | ±0.001 | ±0.008 |

| Radial Runout[a] | Axial Runout[b] |
|---|---|
| For outside diameters 8.0 in. and under 0.005 in. | For outside diameters 1.0 in. and under 0.001 in. |
| For each additional inch of outside diameter add 0.0005 in. | For each additional inch of outside diameter up through 10.0 in., add 0.001 in. |
| | For each additional inch of outside diameter over 10.0 in., add 0.0005 in. |

[a] Flange outside diameter equals pulley outside diameter plus twice flange height.
[b] Total indicator reading.
All dimensions in inches.

*Cross Section Selection:* The chart (Fig. 14) may be used as a guide to the selection of a synchronous belt for any combination of design horsepower and speed of the faster shaft. When the intersection of the design horsepower and speed of the faster shaft falls near a line between two areas on the chart, the possibilities in both areas should be explored. Special circumstances (such as space limitations) may result in selection of a belt cross section different from that indicated in the chart. Belt manufacturers should be contacted for specific data.

*Torque Ratings:* It is customary to use torque load requirements rather than horsepower load when designing drives using the small pitch MXL section belts. These belts operate on small diameters resulting in relatively low belt speeds, so torque is essentially constant for all rpm. The torque rating formulas for MXL sections are:

$$Q_r = d[1.13 - 1.38\times10^{-3}d^2] \text{ for belt width } = 0.12 \text{ in.}$$

$$Q_r = d[1.88 - 2.30\times10^{-3}d^2] \text{ for belt width } = 0.19 \text{ in.}$$

$$Q_r = d[2.63 - 3.21\times10^{-3}d^2] \text{ for belt width } = 0.25 \text{ in.}$$

where $Q_r$ = the maximum torque rating (lbf-in.) for a belt of specified width having six or more teeth in mesh and a pulley surface speed of 6500 fpm or less. Torque ratings for drives with less than six teeth in mesh must be corrected as shown in Table 38. $d$ = pitch diameter of smaller pulley, inch.

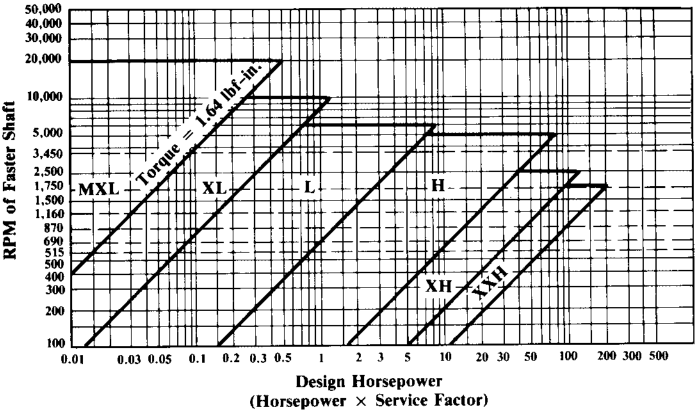



Fig. 14. Selection of Synchronous Belt Cross Section

**Table 38. Teeth in Mesh Factor**

| Teeth in Mesh | Factor $K_z$ | Teeth in Mesh | Factor $K_z$ |
|---|---|---|---|
| 6 or more | 1.00 | 3 | 0.40 |
| 5 | 0.80 | 2 | 0.20 |
| 4 | 0.60 | | |

*Horsepower Rating Formulas:* The horsepower rating formulas for synchronous belts, other than the MLX section, are determined from the following formulas, where the number in parentheses is the belt width in inches.

$$\mathrm{XL}(0.38)\mathrm{HP} = dr[0.0916 - 7.07\times10^{-5}(dr)^2]$$

$$\mathrm{L}(1.00)\mathrm{HP} = dr[0.436 - 3.01\times10^{-4}(dr)^2]$$

$$\mathrm{H}(3.00)\mathrm{HP} = dr[3.73 - 1.41\times10^{-3}(dr)^2]$$

$$\mathrm{XH}(4.00)\mathrm{HP} = dr[7.21 - 4.68\times10^{-3}(dr)^2]$$

$$\mathrm{XXH}(5.00)\mathrm{HP} = dr[11.4 - 7.81\times10^{-3}(dr)^2]$$

where HP = the maximum horsepower rating recommended for the specified standard belt width having six or more teeth in mesh and a pulley surface speed of 6500 fpm or less. Horsepower ratings for drives with less than six teeth in mesh must be corrected as shown in Table 38. $d$ = pitch diameter of smaller pulley, in. $r$ = rpm of faster shaft divided by 1000. Total horsepower ratings are the same for double-sided as for single-sided belts. Contact manufacturers for percentage of horsepower available for each side of the belt.

*Finding the Required Belt Width:* The belt width should not exceed the small pulley diameter or excessive side thrust will result.

*Torque Rating Method (MXL Section):* Divide the design torque by the teeth in mesh factor to obtain the corrected design torque. Compare the corrected design torque with the torque rating given in Table 39 for the pulley diameter being considered. Select the narrowest belt width that has a torque rating equal to or greater than the corrected design torque.

**Table 39. Torque Rating for MXL Section (0.080 in. Pitch)**

| Belt Width, (in.) | Rated Torque (lbf-in.) for Small Pulley (Number of Grooves and Pitch Diameter, in.) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10MXL 0.255 | 12MXL 0.306 | 14MXL 0.357 | 16MXL 0.407 | 18MXL 0.458 | 20MXL 0.509 | 22MXL 0.560 | 24MXL 0.611 | 28MXL 0.713 | 30MXL 0.764 |
| 0.12 | 0.29 | 0.35 | 0.40 | 0.46 | 0.52 | 0.57 | 0.63 | 0.69 | 0.81 | 0.86 |
| 0.19 | 0.48 | 0.58 | 0.67 | 0.77 | 0.86 | 0.96 | 1.05 | 1.15 | 1.34 | 1.44 |
| 0.25 | 0.67 | 0.80 | 0.94 | 1.07 | 1.20 | 1.34 | 1.47 | 1.61 | 1.87 | 2.01 |

*Horsepower Rating Method (XL, L, H, XH, and XXH Sections):* Multiply the horsepower rating for the widest standard belt of the selected section by the teeth in mesh factor to obtain the corrected horsepower rating. Divide the design horsepower by the corrected horsepower rating to obtain the required belt width factor. Compare the required belt width factor with those shown in Table 40. Select the narrowest belt width that has a width factor equal to or greater than the required belt width factor.

**Table 40. Belt Width Factor**

| Belt Section | Belt Width (in.) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.12 | 0.19 | 0.25 | 0.38 | 0.50 | 0.75 | 1.00 | 1.50 | 2.00 | 3.00 | 4.00 | 5.00 |
| MXL (0.080) | 0.43 | 0.73 | 1.00 | | | | | | | | | |
| XL (0.200) | | | 0.62 | 1.00 | | | | | | | | |
| L (0.375) | | | | | 0.45 | 0.72 | 1.00 | | | | | |
| H (0.500) | | | | | | 0.21 | 0.29 | 0.45 | 0.63 | 1.00 | | |
| XH (0.875) | | | | | | | | | 0.45 | 0.72 | 1.00 | |
| XXH (1.250) | | | | | | | | | 0.35 | 0.56 | 0.78 | 1.00 |

*Drive Selection:* Information on design and selection of synchronous belt drives is available in engineering manuals published by belt manufacturers. Manufacturers should be consulted on such matters as preferred stock sizes, desirable speeds, center distances, etc.

*Minimum Pulley Size:* The recommended minimum pulley size depends on the rpm of the faster shaft. Minimum sheave diameters for each cross-section belt are listed in Table 36.

*Selection of Flanged Pulleys:* To determine when to use flanged pulleys, consider the following conditions:

1) On all two-pulley drives, the minimum flanging requirements are two flanges on one pulley, or one flange on each pulley on opposite sides.

2) On drives where the center distance is more than eight times the diameter of the small pulley, both pulleys should be flanged on both sides.

3) On vertical shaft drives, one pulley should be flanged on both sides and other pulleys in the system should be flanged on the bottom side only.

4) On drives with more than two pulleys, the minimum flanging requirements are two flanges on every other pulley, or one flange on every pulley, alternating sides around the system.

*Service Factors:* Service factors for V-belts are listed in Table 41 and for synchronous belts in Table 42.

**Belt Storage and Handling.—**To achieve maximum belt performance, proper belt storage procedures should always be practiced. If belts are not stored properly, their performance can be adversely affected. Four key rules are:

1) Do not store belts on floors unless they are protected by appropriate packaging.

2) Do not store belts near windows where the belts may be exposed to direct sunlight or moisture.

3) Do not store belts near electrical devices that may generate ozone (transformers, electric motors, etc.).

4) Do not store belts in areas where solvents or chemicals may be present in the atmosphere.

**Table 41. Service Factors for V-Belts**

| Driving Unit | *AC Motors:* Normal Torque, Squirrel Cage, Synchronous and Split Phase.<br>*DC Motors:* Shunt Wound.<br>*Engines:* Multiple Cylinder Internal Combustion. | | |
|---|---|---|---|
| Types of Driven Machines | Intermittent Service (3–5 hours daily or seasonal) | Normal Service (8–10 hours daily) | Continuous Service (16–24 hours daily) |
| Agitators for liquids; Blowers and exhausters; Centrifugal pumps & compressors; Fans up to 10 horsepower; Light duty conveyors | 1.1 | 1.2 | 1.3 |
| Belt conveyors for sand, grain, etc.; Dough mixers; Fans over 10 horsepower; Generators; Line shafts; Laundry machinery; Machine tools; Punches, presses, shears; Printing machinery; Positive displacement rotary pumps; Revolving and vibrating screens | 1.2 | 1.3 | 1.4 |
| Brick machinery; Bucket elevators; Exciters; Piston compressors; Conveyors (drag, pan, screw); Hammer mills; Paper mill beaters; Piston pumps; Positive displacement blowers; Pulverizers; Saw mill and woodworking machinery; Textile machinery | 1.4 | 1.5 | 1.6 |
| Crushers (gyratory, jaw, roll); Mills (ball, rod, tube); Hoists; Rubber calendars, extruders, mills | 1.5 | 1.6 | 1.8 |
| Driving Unit | *AC Motors:* High Torque, High Slip, Repulsion-Induction, Single Phase, Series Wound, Slip Ring.<br>*DC Motors:* Series Wound, Compound Wound.<br>*Engines:* Single Cylinder Internal Combustion. *Line Shafts*, *Clutches* | | |
| Types of Driven Machines | Intermittent Service (3–5 hours daily or seasonal) | Normal Service (8–10 hours daily) | Continuous Service (16–24 hours daily) |
| Agitators for liquids; Blowers and exhausters; Centrifugal pumps & compressors; Fans up to 10 horsepower; Light duty conveyors | 1.1 | 1.2 | 1.3 |
| Belt conveyors for sand, grain, etc.; Dough mixers; Fans over 10 horsepower; Generators; Line shafts; Laundry machinery; Machine tools; Punches, presses, shears; Printing machinery; Positive displacement rotary pumps; Revolving and vibrating screens | 1.2 | 1.3 | 1.4 |
| Brick machinery; Bucket elevators; Exciters; Piston compressors; Conveyors (drag, pan, screw); Hammer mills; Paper mill beaters; Piston pumps; Positive displacement blowers; Pulverizers; Saw mill and woodworking machinery; Textile machinery | 1.4 | 1.5 | 1.6 |
| Crushers (gyratory, jaw, roll); Mills (ball, rod, tube); Hoists; Rubber calendars, extruders, mills | 1.5 | 1.6 | 1.8 |

The machines listed above are representative samples only. Select the group listed above whose load characteristics most closely approximate those of the machine being considered.

Belts should be stored in a cool, dry environment. When stacked on shelves, the stacks should be short enough to avoid excess weight on the bottom belts, which may cause distortion. When stored in containers, the container size and contents should be sufficiently limited to avoid distortion.

*V-Belts:* A common method is to hang the belts on pegs or pin racks. Very long belts stored this way should use sufficiently large pins or crescent shaped “saddles” to prevent their weight from causing distortion.

*Joined V-belts, Synchronous Belts, V-Ribbed Belts:* Like V-belts, these belts may be stored on pins or saddles with precautions taken to avoid distortion. However, belts of this type up to approximately 120 in. are normally shipped in a “nested” configuration and should be stored in the same manner. Nests are formed by laying a belt on its side on a flat surface and placing as many belts inside the first belt as possible without undue force. When the nests are tight and are stacked with each rotated 180° from the one below, they may be stacked without damage.

Belts of this type over 120 in. may be “rolled up” and tied for shipment. These rolls may be stacked for easy storage. Care should be taken to avoid small bend radii which could damage the belts.

**Table 42. Service Factors for Synchronous Belt Drives**

| Driving Units | *AC Motors:* Normal Torque, Squirrel Cage, Synchronous and Split Phase. *DC Motors:* Shunt Wound. *Engines:* Multiple Cylinder Internal Combustion. | | |
|---|---|---|---|
| Types of Driven Machines | Intermittent Service (3–5 hours daily or seasonal) | Normal Service (8–10 hours daily) | Continuous Service (16–24 hours daily) |
| Display, Dispensing, Projection, Medical equipment; Instrumentation; Measuring devices | 1.0 | 1.2 | 1.4 |
| Appliances, sweepers, sewing machines; Office equipment; Wood lathes, band saws | 1.2 | 1.4 | 1.6 |
| Conveyors: belt, light package, oven, screens, drums, conical | 1.3 | 1.5 | 1.7 |
| Agitators for liquids; Dough mixers; Drill presses, lathes; Screw machines, jointers; Circular saws, planes; Laundry, Paper, Printing machinery | 1.4 | 1.6 | 1.8 |
| Agitators for semiliquids; Brick machinery (except pug mills); Conveyor belt: ore, coal, sand; Line shafts; Machine tools: grinder, shaper, boring mill, milling machines; Pumps: centrifugal, gear, rotary | 1.5 | 1.7 | 1.9 |
| Conveyor: apron, pan, bucket, elevator; Extractors, washers; Fans, blowers; centifugal, induced draft exhausters; Generators & exciters; Hoists, elevators; Rubber calenders, mills, extruders; Saw mill, Textile machinery inc. looms, spinning frames, twisters | 1.6 | 1.8 | 2.0 |
| Centrifuges; Conveyors: flight, screw; Hammer mills; Paper pulpers | 1.7 | 1.9 | 2.1 |
| Brick & clay pug mills; Fans, blowers, propeller mine fans, positive blowers | 1.8 | 2.0 | 2.2 |

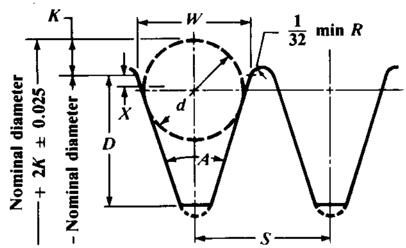
| Driving Units | *AC Motors:* High Torque, High Slip, Repulsion-Induction, Single Phase Series Wound and Slip Ring. *DC Motors:* Series Wound and Compound Wound. *Engines:* Single Cylinder Internal Combustion. *Line Shafts*. *Clutches*. | | |
|---|---|---|---|
| Types of Driven Machines | Intermittent Service (3–5 hours daily or seasonal) | Normal Service (8–10 hours daily) | Continuous Service (16–24 hours daily) |
| Display, Dispensing, Projection, Medical equipment; Instrumentation; Measuring devices | 1.2 | 1.4 | 1.6 |
| Appliances, sweepers, sewing machines; Office equipment; Wood lathes, band saws | 1.4 | 1.6 | 1.8 |
| Conveyors: belt, light package, oven, screens, drums, conical | 1.5 | 1.7 | 1.9 |
| Agitators for liquids; Dough mixers; Drill presses, lathes; Screw machines, jointers; Circular saws, planes; Laundry, Paper, Printing machinery | 1.6 | 1.8 | 2.0 |
| Agitators for semiliquids; Brick machinery (except pug mills); Conveyor belt: ore, coal, sand; Line shafts; Machine tools:grinder, shaper, boring mill, milling machines; Pumps: centrifugal, gear, rotary | 1.7 | 1.9 | 2.1 |
| Conveyor: apron, pan, bucket, elevator; Extractors, washers; Fans, blowers; centifugal, induced draft exhausters; Generators & exciters; Hoists, elevators; Rubber calenders, mills, extruders; Saw mill, Textile machinery inc. looms, spinning frames, twisters | 1.8 | 2.0 | 2.2 |
| Centrifuges; Conveyors: flight, screw; Hammer mills; Paper pulpers | 1.9 | 2.1 | 2.3 |
| Brick & clay pug mills; Fans, blowers, propeller mine fans, positive blowers | 2.0 | 2.2 | 2.4 |

Synchronous belts will not slip, and therefore must be belted for the highest loadings anticipated in the system. A minimum service factor of 2.0 is recommended for equipment subject to chocking.

*Variable Speed Belts:* Variable speed belts are more sensitive to distortion than most other belts, and should not be hung from pins or racks but stored on shelves in the sleeves in which they are shipped.

**SAE Standard V-Belts.—**The data for V-belts and pulleys shown in Table 43 cover nine sizes, three of which — 0.250, 0.315, and 0.440 — were added in 1977 to conform to existing practice. This standard was reaffirmed in 1987.

**Table 43. SAE V-Belt and Pulley Dimensions**




| SAE Size | Recommended Min. Eff Dia[a] | *A* Groove Angle (deg) ±0.5 | *W* Eff. Groove Width | *D* Groove Depth Min | *d* Ball or Rod Dia (±0.0005) | 2*K* 2 × Ball Extension | 2*X*[b] | *S* Groove[c] Spacing (±0.015) |
|---|---|---|---|---|---|---|---|---|
| 0.250 | 2.25 | 36 | 0.248 | 0.276 | 0.2188 | 0.164 | 0.04 | 0.315 |
| 0.315 | 2.25 | 36 | 0.315 | 0.354 | 0.2812 | 0.222 | 0.05 | 0.413 |
| 0.380 | 2.40 | 36 | 0.380 | 0.433 | 0.3125 | 0.154 | 0.06 | 0.541 |
| 0.440 | 2.75 | 36 | 0.441 | 0.512 | 0.3750 | 0.231 | 0.07 | 0.591 |
| 0.500 | 3.00 | 36 | 0.500 | 0.551 | 0.4375 | 0.314 | 0.08 | 0.661 |
| 11⁄16 | 3.00 | 34 | 0.597 | 0.551 | 0.500 | 0.258 | 0.00 | 0.778 |
| | Over 4.00 | 36 | | | | 0.280 | | |
| | Over 6.00 | 38 | | | | 0.302 | | |
| 3⁄4 | 3.00 | 34 | 0.660 | 0.630 | 0.5625 | 0.328 | 0.02 | 0.841 |
| | Over 4.00 | 36 | | | | 0.352 | | |
| | Over 6.00 | 38 | | | | 0.374 | | |
| 7⁄8 | 3.50 | 34 | 0.785 | 0.709 | 0.6875 | 0.472 | 0.04 | 0.966 |
| | Over 4.50 | 36 | | | | 0.496 | | |
| | Over 6.00 | 38 | | | | 0.520 | | |
| 1 | 4.00 | 34 | 0.910 | 0.827 | 0.8125 | 0.616 | 0.06 | 1.091 |
| | Over 6.00 | 36 | | | | 0.642 | | |
| | Over 8.00 | 38 | | | | 0.666 | | |

[a] Pulley effective diameters below those recommended should be used with caution, because power transmission and belt life may be reduced.

[b] The *X* dimension is radial; 2*X* is to be subtracted from the effective diameter to obtain "pitch diameter" for speed ratio calculations.

[c] These values are intended for adjacent grooves of the same effective width (*W*). Choice of pulley manufacture or belt design parameter may justify variance from these values. The *S* dimension should be the same on all multiple groove pulleys in a drive using matched belts. © 1990, SAE, Inc.

All dimensions in inches.

V-belts are produced in a variety of constructions in a basic trapezoidal shape and are to be dimensioned in such a way that they are functional in pulleys dimensioned as described in the standard. Standard belt lengths are in increments of ½ inch up to and including 80 inches. Standard lengths above 80 inches up to and including 100 inches are in increments of 1 inch, without fractions. Standard belt length tolerances are based on the center distance and are as follows: For belt lengths of 50 inches or less, ± 0.12 inch; over 50 to 60 inches, inclusive, ± 0.16 inch; over 60 to 80 inches, inclusive, ± 0.19; and over 80 to 100 inches, inclusive, ± 0.22.