Construction, Installation and Maintenance of Power Transmission V-Belt Drives

By
K. P. Shah
Email: kpshah123[at]gmail.com (Please replace [at] with @)
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The information contained in this booklet represents a significant collection of technical information about construction, installation and maintenance of power transmission V-belt drives. This information will help to achieve increased reliability at a decreased cost. Assemblage of this information will provide a single point of reference that might otherwise be time consuming to obtain. Most of information given in this booklet is mainly derived from literature on the subject from sources as per the reference list given at the end of this booklet. For more information, please refer them. All information contained in this booklet has been assembled with great care. However, the information is given for guidance purposes only. The ultimate responsibility for its use and any subsequent liability rests with the end user. Please view the disclaimer uploaded on http://www.practicalmaintenance.net.

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Content

Power Transmission V-Belt Drives

V-belts have undergone tremendous technological development since their invention by John Gates in 1917. The evolution of belts has been remarkable. New materials, designs and manufacturing methods have increased working load limits and extended belt life. Today's belt drive is a very efficient and cost-effective method for transmitting power from one component to another.

V-belt drive systems (also called friction drives) are an economical option for transmitting power in industrial, automotive, commercial, agricultural and home appliance applications. There are two major types of v-belt construction, wrapped and raw edge. Wrap belts are molded into a "V" shape and have a cover fabric. Wrapped belts are also called covered belts because they have a cover fabric. Raw edge belts are cured and then cut into a "V" shape. Wrapped belts are workhorse for industrial applications and are particularly suitable for centrifugal pumps, fans, compressors, generators, crushers, vibrating screens, machine tools, etc.

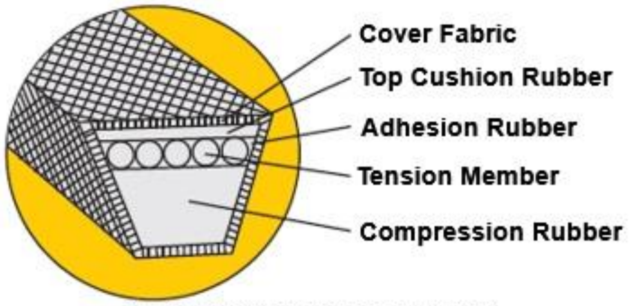
A well designed V-belt drive will transmit power for many years with a minimum of maintenance. However, to derive maximum benefit from a well-designed V-belt drive, it is important that the simple installation and maintenance procedures are closely followed. In view of this, information about construction, installation and maintenance of power transmission V-belt drives is given in this booklet.

Advantages of V-Belt Drives

The V-belt has a tapered cross-sectional shape that causes it to wedge firmly into the sheave groove under load. Its driving action takes place through frictional contact between the sides of the belt and the sheave groove surfaces. Mostly they are used to transmit power between two parallel shafts over comparatively long distances. As the designer has considerable flexibility in choosing the size and location of pulleys for the driver and driven, they permit a wide range of driven speeds, using standard electric motors. The design tolerances for these drives are not critical compared with gear drives. In many cases, their use simplifies the design of machine and substantially reduces the cost. They provide many other advantages as under.

- They cover extremely wide horsepower ranges.
- They are rugged - they give years of trouble-free performance when given minimal attention, even under adverse conditions.
- They are clean - they require no lubrication (chain and gear drive require lubrication).
- They are efficient - performing with 93-95% efficiency; raw edge cog-belts are 95-97% efficient. (As per SKF, efficiency of SKF Xtra Power Belts is up to 97%).
- They dampen vibration between driving and driven machines.
- They are quiet.
- They act as a "safety fuse" in the power train - Should a rotational component become blocked while in operation, belts slip preventing damage to the power train.
- Belts and sheaves wear gradually - making preventive and corrective maintenance simple and easy.

Construction of Wrapped Belts



Construction of Wrapped Belt

Above figure shows construction of a typical wrapped belt. The term “wrapped” indicates that the V-belt core is protected by one or more plies of fabric called cover fabric.

Bias cut cotton or polyester cover impregnated with high grade synthetic rubber provides oil, heat and abrasion resistance.

Top cushion rubber provides cushioning and protection to the tension members. The special rubber compound stretches/elongates as belt bends/wraps around the pulley/sheave.

Tension member, the power transmitting element is usually made up of high-strength, synthetic fiber cords and carry the load. These cords are pre-stretched to reduce stretch on the drive. The tension member is generally made up of polyester cords but Kevlar cords are also used in certain special belts and sometimes it consists of several plies of special cord fabric.

The synthetic fiber cords are coated with a high bond adhesion rubber compound to provide bond between them and also provide optimum adhesion to the top cushion rubber and compression rubber.

Compression rubber is designed to withstand compression and supports the tension members while bending around sheaves. It is made from a tough rubber compound that exerts a wedging force against the pulley groove to increase adherence without deformation for transmitting the tensional drive force from the tension members to the pulley.

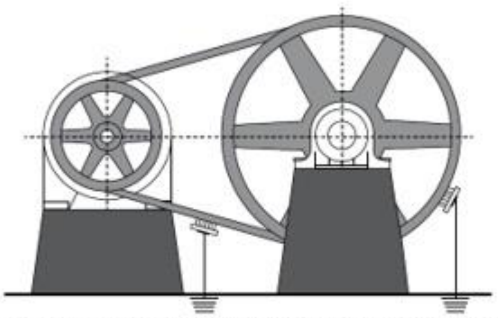
Standard Properties

All general purpose or standard wrapped V-belts are having heat, oil-resistant, anti-static and abrasion resistance properties as per the following.

Generally, ambient temperatures between −40°C and +70°C are permissible for wrapped belts (IS 2494, Part 1 and IS 14261 recommends for operation at ambient temperature between −18°C and +60°C). When the drive system is commissioned at a low temperature, the full flexibility of the V-belt is only attained after some flexing. Temperatures in excess of those stated by the manufacturer result in a reduced running period due to hardening.

Oil or grease acting on the belt briefly and only occasionally has no effect on efficiency and service life. However, constant exposure to lubricating oils or grease, to cooling oils and cutting oils results in swelling and disintegration and consequently in reduced efficiency.

All wrapped V-belts made in compliance with international standards are having antistatic properties as per ISO 1813. The antistatic properties ensure that electrostatic charges are conducted away safely to prevent any risk of sparking. However, all machines must be properly earthed as shown in the following figure.



V-Belt Drive Installation for Explosive Atmospheres

The surface of the cover fabric is highly abrasion resistant. Their abrasion resistance is especially relevant when they are subjected to the effects of dirt, grit etc., e.g. in cement plants, in agriculture and in mining.

Special Purpose Wrapped V-Belts

Product Features

As mentioned above, general purpose or standard wrapped V-belts, commonly with marking as shown in above figure are suitable for operating temperatures from −40°C to +70°C and for oil or grease acting on them briefly and only occasionally. Hence, they are not suitable for operation beyond −40°C to +70°C or if they are subjected to persistent oil sprays or vapours. They are also not suitable for use in fire hazardous areas like coal mines, thermal power plants, etc. Special purpose/duty wrapped V-belts need to be used for such conditions. For special conditions, most belt manufacturers are offering following two types of special purpose belts.

Oil and Heat Resistant V-Belts

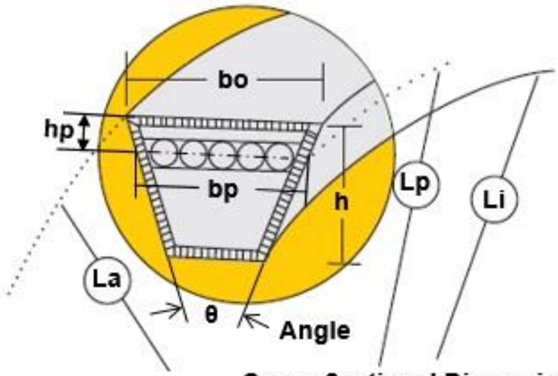
Oil and heat resistant V-belts are made with special oil resistant cover to protects them from oil/grease contamination. These belts have also been developed to work in ambient temperature up to 100°C.

It may be noted that generally, standard V-belts can safely withstand ambient temperatures up to 74°C (165°F). However, for every 8°C (18°F) increase in ambient temperature above this point, V-belt service life may be reduced by approximately half.

Fire Resistant and Anti-Static (FRAS) V-Belts

Certain working environments such as coal mines and sensitive petro chemical installations require V-belts having fire resistant properties in addition to normal anti-static properties. Fire resistant and anti-static v-belts are made to various standards. Two such standards are BS 3790 and IS 2494, Part 2. IS 2494, Part 2 covers the requirements for fire resistant and antistatic V-belts and the methods for determining the fire resistance and electrical surface resistance of V-belts.

V-Belts Size



Cross-Sectional Dimensions and Lengths of V-Belt

As shown in above figure, V-belt is a belt, the cross-section of which is shaped roughly like a trapezium. The latter is usually isosceles. On the cross section, the trapezium is outlined by base, sides and top of the belt. Angle (θ) of a V-belt is the included angle obtained by extending sides of the belt.

Size of a V-belt is shown/given by cross-section and length dimensions The cross-section indicates the top width, height (also called thickness or depth) and V angle dimensions. Length is measured in terms of either outside length (La), inside length (Li) or pitch length (Lp).

<u>Pitch length is now called datum length</u> because as per ISO, now pitch is called datum.

Top width of belt (bo) is the top width of the trapezium outlined on the belt's cross section. The pitch width of belt (bp), now called <u>datum width</u> is the width of the belt at its pitch zone.

- Outside length (La) is the length of a line circumscribing the belt along its periphery.
- Inside length (Li) is the length of a line circumscribing the belt along its inner circumference.
- Pitch length (Lp) is the length of a line circumscribing the belt along its pitch zone. It is now changed to datum length (please see the note given below)

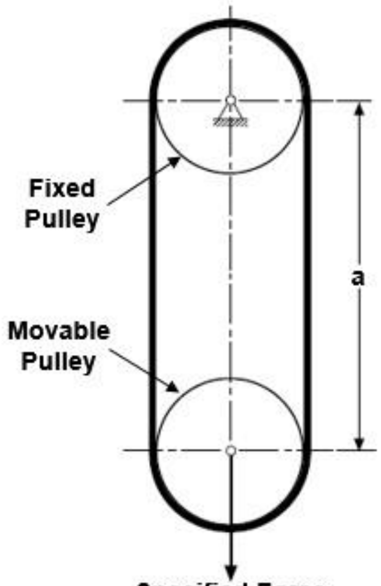
Pitch length is difficult to measure directly, primarily because it is based on the pitch line of the belt. According to ISO 1081:2013, the pitch line is "any circumferential line which keeps the same length when the belt is bent perpendicularly to its base." In other words, the pitch line is the line internal to the belt that does not change length when the belt is in use. The diameter that is formed on the pulley by the pitch line of the belt is the pulley's pitch diameter. Pitch (pitch zone) of a V-belt is the geometric zone containing all of the pitch lines. The pitch line is also called <u>neutral axis</u>.

Note:
A belt's pitch line typically corresponds to the location of its internal tensile cords. But improvements in belt construction have moved the tensile cord to a location higher in the belt. This resulted in changes to the belt's pitch length, and in turn, to the sheave's pitch diameter (This design change gives the tensile cord a larger moment arm and more support below it for transmitting forces to the sheave walls.).

In order to accommodate the changes in belt pitch length, and thus, sheave pitch diameter, the datum system was introduced. For most belts and sheaves, the dimensions formerly referred to as pitch length (belts) and pitch diameter (sheaves) are now referred to as datum length and datum diameter.

Precise Pitch/Datum Length Measurement of V-Belts

Precise measuring methods are specified in various standards/specifications. For example: in DIN 7753 Part 1 for narrow-section V-belts and in DIN 2215 for classical-section V-belts. For measuring pitch/datum length of a V-belt precisely, a length measuring fixture is used. As shown in the following figure, the length measuring fixture is having two equal-sized measuring pulleys (sheaves) whose diameter and groove are in accordance with an industry standard. One of the two pulley is fixed. The V-belt is laid over these pulleys and the movable measuring pulley is loaded in such a way that the specified force as per the industry standard acts on the V-belt. The belt is rotated through at least three complete revolutions to ensure that the tension is equalized around the belt and that the belt is seated in the grooves. The centre distance “a” between the two pulleys is then measured.



V-Belt’s Length Measuring Fixture

The pitch/datum length of the V-belt (Lp) is obtained by adding the pitch circumference of one measuring pulley to twice the center distance “a” between the two equal diameter pulleys at the specified tension (Lp = 2a + pitch circumference of one measuring pulley).

Effective Length of V-Belt

Effective length of a V-belt (Le) is the length of a line circumscribing a V-belt at the level of the effective diameter of the measuring pulleys while the V-belt is at a prescribed tension. The recommended method for measuring the effective length of a V-belt includes the use of a length measuring fixture having two pulleys of the same effective diameter (The outside diameter on a measuring pulley is the same as the effective diameter). The length measurement procedure for effective length measurement of a V-belt is similar to precise pitch/datum length measurement of a V-belt described above. The effective length can be obtained by adding the effective circumference of one pulley to twice the measured centre distance when the V-belt is tensioned to the prescribed value.

Belt Designation / Specification

A V-belt is generally designated by number of the standard, the cross-section symbol and nominal length along with symbol (La, Lp or Li) or is specified by manufacturer's brand name, cross-section symbol, nominal length along with symbol and standard compliance.

Belt Designation as per IS 2494, Part 1 (Example for Belt Designation as per Standard)

As per IS 2494, Part 1, V-belts shall be designated by the standard number, the cross section symbol and nominal pitch length along with symbol Lp.

Example:
A V-belt of cross section 'C' and of nominal pitch length of 3104 mm shall be designated as V-belt IS 2494 (Part 1) C 3104 Lp.

Belt Specification as per ContiTech Holding GmbH (Example for Manufacturer's Brand Name)

Belt specification CONTI MULTIFLEX® 17 x 2000 Li stands for CONTI MULTIFLEX® classical-section wrapped V-belt in section 17/B with inside length 2000 mm. It complies with DIN 2215 (the belt also complies with BS 3790 and ISO 4184).

It may be noted that if any one of the three lengths (La, Lp or Li) is known, the other two lengths can be calculated from the known length and the belt length differential value/factor (Δ L) that is fixed for each V-belt section.

Common Industrial V-Belts

Most V-belt drives used in industrial applications fall into two categories:

- Heavy-duty for industrial machinery, continuous operation, heavy loads and often harsh load conditions.

- Light-duty for fractional horsepower applications and intermittent usage.

V-belts are manufactured in various standard cross-sections, or profiles. The two types of heavy-duty V-belts cross-sections most commonly used in the industry are classical section V-belts and narrow section V-belts (space saver belts). However, many times they are classified into three types. The three types are: classical section V-belts, wedge section V-belts (space saver belts) and narrow section V-belts (space saver belts). It may be noted that constructionally, narrow section V-belts are similar to wedge section V-belts. However, they are called differently to indicate that the belt sections of narrow section V-belts are standardized and predominantly used in the USA and Canada.

Classical Section V-Belts

Classical section V-belts were the first of the V-belts to enter the power transmission scenario. These V-belts are most widely used for power transmission. They are economical and easily obtained for replacement. As shown in the following table, belts manufactured with classical section profile to BS, ISO, IS and JIS specifications come in several sections designated by letters (Z, A, B, C, D, E). In case of belts manufactured to DIN 2215, belt sections are designated by numbers (5, 6, 8,10, 13, 17, 20, 22, 25, 32, 40), indicating belt's top width in millimeters. It is recommended to avoid use of DIN sections 5, 8, 20 and 25.

Section	Top Width 'bo' ≈ (mm)	Height 'h' ≈ (mm)	Pitch Width 'bp' (mm)	Top to Pitch 'hp' ≈ (mm)	Recommended Min. Pulley Pitch Dia. (mm)
5	5	3	4.2	1.3	20
6 / Y	6	4	5.3	1.6	28
8	8	5	6.7	2.0	40
10 / Z	10	6.0	8.5	2.5	50
13 / A	13	8.0	11.0	3.3	75
17 / B	17	11.0	14.0	4.2	125
20	20	12.5	17.0	4.8	160
22 / C	22	14.0	19.0	5.7	200
25	25	16.0	21.0	6.3	250
32 / D	32	19.0	27.0	8.1	355
40 / E	40 / 38	24.0 / 23.0	32.0	12.0	500

Note: Unless otherwise specified, nominal length considered is inside length (Li).

Included angle (θ) of these belts is 40°. The top width to height ratio of these belts is approximately 1.6:1. The maximum permissible belt speed is 30 m/sec. Permissible flex rate is (f) = 80 per second. These belts are manufactured as per DIN 2215, ISO 4184, BS 3790, IS 2494, JIS K 6323, RMA IP 20, etc.

Wedge Section V-Belts (also called Narrow Section Belts and Space Saver Belts)

Wedge section belts are the result of continuous thrust by the manufacturers and users on higher power transmissions with reduction in space requirements. Wedge section belts can transmit higher powers to extent of 1.5 to 2 times the classical belts with the same top width. Belts manufactured with wedge section profile come in several sections designated by letters (SPZ, SPA, SPB, SPC,) as per the following table. Probably, "SP" in the section designation stands for German words "**S**chmal**p**rofil" meaning "narrow profile".

Section	Top Width 'bo' ≈ (mm)	Height 'h' ≈ (mm)	Pitch Width 'bp' (mm)	Top to Pitch 'hp' ≈ (mm)	Recommended Min. Pulley Pitch Dia. (mm)
SPZ	10	8	8.5	2.0	63
SPA	13	10	11.0	2.75	90
SPB	17	14	14.0	3.5	140
SPC	22	18	19.0	4.8	224

Note: Unless otherwise specified, nominal length considered is pitch/datum length (Lp).

Included angle (θ) of these belts is 40°. The top width to height ratio of these belts is approximately 1.2:1. The maximum permissible belt speed is 42 m/sec. Permissible flex rate is (f) =100 per second. These belts are manufactured as per DIN 7753 Part 1, ISO 4184, BS 3790, IS 14261, etc.

Narrow Section V-Belts (Space Saver Belts)

Narrow section belts are manufactured in three sections designated by a numeral and letter combination (3V, 5V, 8V) as per the following table. Constructionally and properties wise the narrow section belts are similar to the wedge section belts. These narrow section belt profiles are standardized and predominantly used in the USA and Canada.

Section	Top Width 'bo' ≈ (mm)	Height 'h' ≈ (mm)	Recommended Min. Pulley Pitch Dia. (mm)
3V	9.7 [3/8"]	8.0	63
5V	15.8 [5/8"]	14.0	140
8V	25.4 [8/8" = 1"]	23.0	335

Note: Unless otherwise specified, nominal length considered is outside length (La).

Included angle (θ) of these belts is approximately 40°. The maximum permissible belt speed is 45 m/sec. Permissible flex rate is (f) =100 per second. These belts are manufactured as per RMA IP 22 and JIS K 6368. It may be noted that belt's section number indicates the number of 1/8 in. of top width of the belt. The "3V" belt has a top width of 3/8 in., the "5V" a top width of 5/8 in., and the "8V" a top width of 8/8 in. (full 1 in.).

The cross section dimensions of these belts only partially conform to the profiles of the wedge section belts to DIN 7753 Part 1. The profile 3V roughly corresponds to SPZ, and 5V to profile SPB. There is no comparable DIN/ISO wedge belt profile for 8V. It is possible to use belts having profiles 3V and 5V in SPZ or SPB pulleys, respectively; but the use of SPZ or SPB belts in RMA/MPTA standard pulleys is not generally recommended. The top width of the American pulley grooves is smaller than that of the corresponding DIN/ISO pulleys. This can cause wear on the upper edges of SPZ and SPB belts and can lead to premature failure. Profile 8V is primarily employed in very heavy duty drives such as mills or stone crushers. As these wedge belts transmit very high levels of power, they can sometimes form a more compact drive than the SPC profile. For this reason, the 8V profile is used in Europe for such applications.

For power ratings, nominal length range manufactured and belt length differential value/factor (Δ L) for classical section, wedge section and narrow section V-belts, please refer to manufacturer's catalogue / literature.

Recommended Minimum Pulley Diameter

When a V-belt bends around a pulley/sheave, compressive forces develop in the bottom of the belt and tension forces develop in the top of the belt. The magnitude of these forces is a function of the diameter of the pulley and the cross section of the belt. These forces increase with smaller diameters and larger cross sections. Therefore, recommended minimum pulley pitch diameters are developed for each belt cross section (ISO 4183). Recommended minimum pulley diameters should be adhered to because it has a significant impact on a belt's life. Pulley diameter below the recommended diameter will affect the service life of the V-belt.

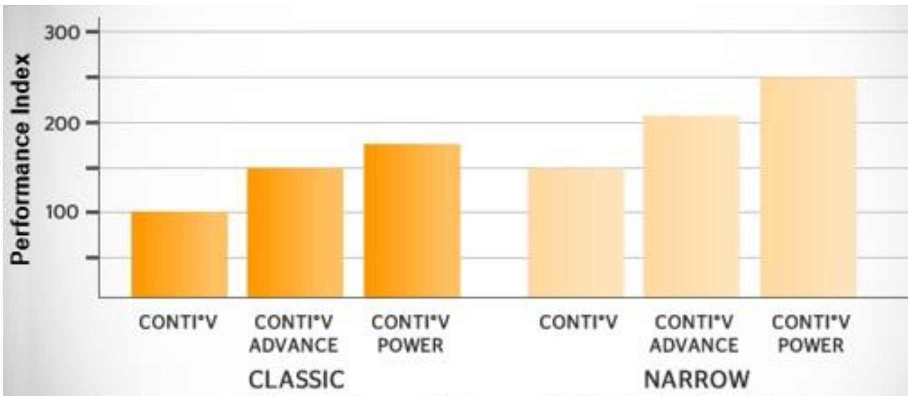
Belt Cross Reference between Various Standards

The following table shows belt cross reference between various standards.

Belt Cross Reference between Various Standards					
ISO	**IS**	**RMA**	**JIS**	**DIN**	**BS**
Y	-	-	-	6	Y
Z	Z	-	M	10	Z
A	A	A	A	13	A
B	B	B	B	17	B
C	C	C	C	22	C
D	D	D	D	32	D
E	E	E	E	40	-
-	-	3V	3V	-	-
-	-	5V	5V	-	-
-	-	8V	8V	-	-
SPZ	SPZ	-	-	SPZ	SPZ
SPA	SPA	-	-	SPA	SPA
SPB	SPB	-	-	SPB	SPB
SPC	SPC	-	-	SPC	SPC

Special Construction (Non-standard Design) Wrapped V-Belts

For demanding drives, most of the belt manufacturers are offering special construction wrapped V-belts (using reinforced or low-stretch tensile member and advanced compound) having higher/extra power ratings than required by the standards/specifications.



Performance Comparison of Wrapped V-Belts by ContiTech

Above figure compares performance (power rating) of wrapped V-belts by ContiTech AG. It can be seen that performance of CONTI®V ADVANCE classic V-belts is almost 50% better than that of CONTI®V classic (to DIN 2215) V-belts. It may be also noted that performance of CONTI®V narrow V-belts is almost 50% better than that of CONTI®V classic V-belts.

Pulleys and Pulley Groove Dimensions

Pulleys

How well a V-belt fits into the pulley/sheave determines how much power the belt drive can transmit and how efficiently it operates. Hence, use correct groove section and correct groove angle. It may be noted that the groove angle depends on the pitch diameter of the pulley. A well-engineered belt and a well-machined, matching pulley combination only will provide the most efficient drive operation.

Pulleys are standardized to ISO 4183, BS 3790, DIN 2211, DIN 2217, IS 3142, ANSI/RMA IP 20, ANSI/RMA IP 22 etc. specifications. It is recommended to select pulley diameter as large as possible considering its cost-effectiveness. Large pulley diameters have a positive effect on the service life of the V-belt. It is also essential that the recommended minimum pulley diameter is adhered to because pulley diameters below the recommended diameters affect the service life of the V-belt.

V-grooved pulleys are manufactured mainly from cast iron or from other materials to customers' specifications in different constructions. As per DIN 2211, pulley material should be GG 20 in accordance with DIN 1691 or other materials by agreement. As per IS 3142, pulleys shall preferably be made of grey cast iron conforming to Grade FG 200 of IS 210 (Tensile strength = 200 MPa, BHN = 160 to 220). Alternatively, the pulleys may also be made from carbon steel casting conforming to IS 1030.

As per IS 3142, if steel is used for pulleys, the groove surfaces shall have a Brinell hardness number (HB/BHN) not less than 130.

Machining of the face or periphery and of the bore shall be of fine finish and the sides of the grooves finished by a broad tool, so that no tool marks are visible and a polish is obtained. The top corners and bottom corners of all grooves shall be chamfered or radiused (file broken). The outside diameter of the pulley shall be constant throughout the whole of the width. As per IS 3142, the surface finish of the grooves unless otherwise specified shall have roughness value Ra = 6.3 µ (microns). As per Goodyear, it should not exceed 3.0 µ (microns).

After machining, pulleys are generally phosphated and treated with a rustproof oil.

As per IS 3142, the tolerances for side wobble and run-out (eccentricity) shall be as follows:

Pulley Diameter	Tolerances
Up to and including 500 mm	0.001 mm per mm of pulley diameter
Over 500 mm up to and including 1500 mm	0.0015 mm per mm over 500 mm pulley diameter
Over 1500 mm	0.002 mm per mm over 1500 mm pulley diameter

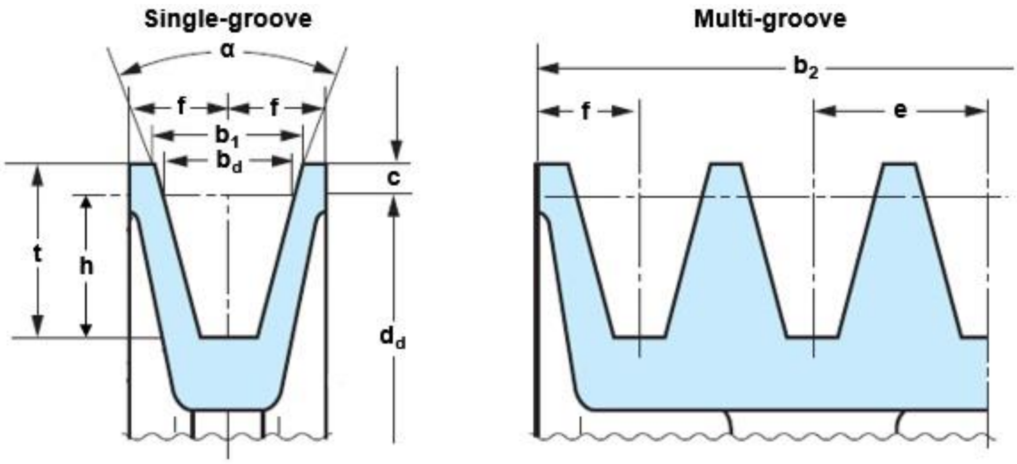
Pulleys manufactured for stock shall be balanced in one plane (statically) to quality level/index Q 16 as in VDI 2060. Balancing in two planes (dynamically) may be necessary for pulleys revolving relatively quickly or for pulleys with large face widths. Balancing in two planes to quality level Q 6.3 as in VDI 2060 becomes necessary if:

V > 30 m/s or
the ratio of datum/pitch diameter to pulley face width (d_d:b_2) is less than 4 for V > 20 m/s.

A properly designed and maintained V-belt drive should give pulley/sheave service of 10 to 20 years, depending on the application.

Pulley Groove Dimensions

In drives using V-belts, the dimensions of the pulley grooves can be defined either on the basis of the datum/pitch width or on the basis of the effective width. As a result, two systems for definition and description of the dimensions of pulleys have been developed as under.



Pulley Groove Dimensions for Classical Section and Wedge Section V-Belts

Reference to above figure, pulley groove dimensions (in mm) for classical section V-Belts and wedge section V-Belts (space saver V-belts) as per DIN 2211 Part 1, DIN 2217 Part 1, BS 3790, ISO 4183 and IS 3142 are given in the following table.

Classical Section Belt			**5**	**6 / Y**	**8**	**10 / Z**	**13 / A**	**17 / B**	**20**	**22 / C**	**25**	**32 / D**	**40 / E**
Wedge Section Belt			**-**	**-**	**-**	**SPZ**	**SPA**	**SPB**	**-**	**SPC**	**-**	**-**	**-**
Datum/Pitch width, b_d			4.2	5.3	6.7	8.5	11.0	14.0	17.0	19.0	21.0	27.0	32.0
Top groove width, b_1 ≈			5.0	6.3	8.0	9.7	12.7	16.3	20.0	22.0	25.0	32.0	40 / 38.2
c			1.3	1.6	2.0	2.0	2.8	3.5	5.1	4.8	6.3	8.1	12 / 9.6
h for Classical Section			-	4.7	-	7.0	8.7	10.8	-	14.3	-	19.9	23.4
h for Wedge Section			-	-	-	9.0	11.0	14.0	-	19.0	-	-	-
Depth for Classic, t ≈			6	7	9	9.0	11.5	14.3	18	19.1	22	28	33
Depth for Wedge, t			-	-	-	11	13.8	17.5	-	23.8	-	-	-
Groove spacing, e			6 ± 0.3	8 ± 0.3	10 ± 0.3	12 ± 0.3	15 ± 0.3	19 ± 0.4	23 ± 0.4	25.5± 0.5	29 ± 0.5	37 ± 0.6	44.5 ± 0.7
f			5 ± 0.5	6 ± 0.5	7 ± 0.6	8 ± 0.6	10 ± 0.6	12.5 ± 0.8	15 ± 0.8	17 ± 1.0	19 ± 1.0	24 ± 2.0	29 ± 2.0
α	32°	For datum diameter, d_d	≤ 50	≤ 63	≤ 75	-	-	-	-	-	-	-	-
	34°		-	-	-	≤ 80	≤ 118	≤ 190	≤ 250	≤ 315	≤ 355	-	-
	36°		> 50	> 63	> 75	-	-	-	-	-	-	≤ 500	≤ 630
	38°		-	-	-	> 80	> 118	> 190	> 250	> 315	> 355	> 500	> 630
Tolerance for α			± 1°	± 1°	± 1°	± 1°	± 1°	± 1°	± 1°	± 30’	± 30’	± 30’	± 30’

Note: Tolerance for groove depth (t) = + 0.6 / − 0.0 mm.

For multi-groove pulleys, pulley width, $b_2 = (x - 1) e + 2 f$ where x = number of grooves.

Notes:

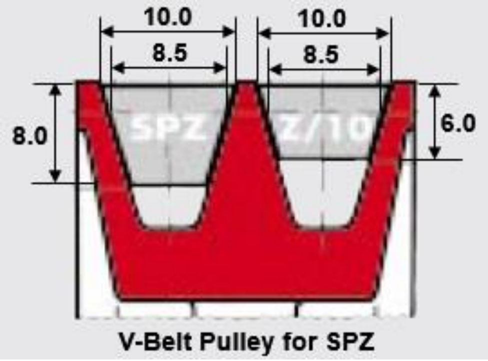
In above table, the datum/pitch width is regarded as the basic dimension of standardization for the groove and for the corresponding classical and wedge/narrow V-belts considered as a whole.

Knowledge of the datum diameter is also essential for defining the groove profile (angle). It may be noted that groove angle (α) will affect the width of the top groove, b_1. Minimum values of b_1 are shown in the above table.

ISO gives different value of h for classical V-belts (sections Z, A, B and C) and wedge V-belts (sections SPZ, SPA SPB and SPC) as shown in above table. However, it does not give value for top groove width, b1.

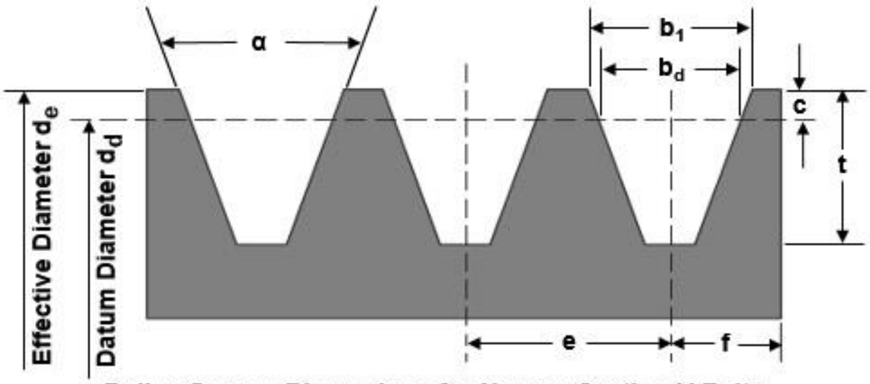
For groove depth, ISO specifies c and h whereas DIN specifies c and t.

Since the value of c is different in DIN and ISO standard (c = 12 and 9.6 for DIN and ISO respectively) value for both of them is shown in the table. Different value is shown for top groove width, b_1 in the table (b_1 = 40 and 38.2 for DIN and ISO respectively) because different value of c results in different value for b_1. As noted above, though ISO does not give value for top groove width (b_1), it is shown in the table to high light this difference.



V-Belt Pulley for SPZ

V-belt pulleys with grooves for wedge belts to BS 3790, DIN 7753 Part 1 and ISO 4183 are also suitable for classical V-belts with the same datum width b_d to BS 3790, DIN 2215 and ISO 4183. These are known as dual duty pulleys (As shown in above figure, showing dimensions for belt sections, pulley for section SPZ can be also used for section Z / 10). However, wedge/narrow belts are not used with pulleys uniquely designed for classical belts.



Pulley Groove Dimensions for Narrow Section V-Belts

Reference to above figure, pulley groove dimensions (in mm) for narrow section V-belts as per RMA IP 22 are given in the following table.

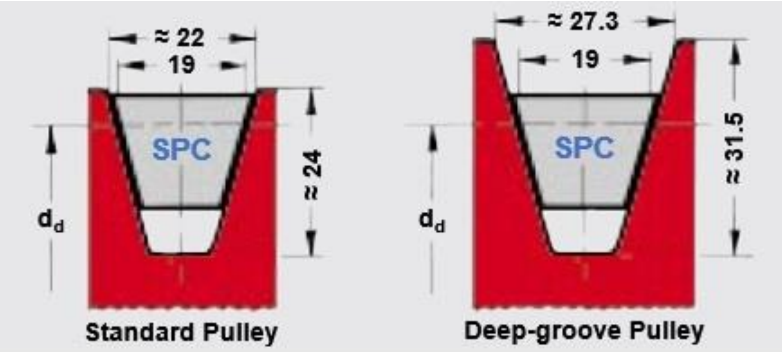
Belt Section	Effective Diameter (d_e) Range	α°	Effective Width, b_1	Groove Depth, t (Minimum)	Datum (Pitch) Width, b_d	e	f	c
3V	≤ 90	36 ± 0.5	8.89 ± 0.13	8.6	8.45	10.32 ± 0.4	8.73 (+2.4 / −0)	0.65
	90 < d_e ≤ 150	38 ± 0.5						
	150 < d_e ≤ 300	40 ± 0.5						
	> 300	42 ± 0.5						
5V	≤ 250	38 ± 0.5	15.24 ± 0.13	15.0	14.40	17.46 ± 0.4	12.7 (+3.2 / −0)	1.25
	250 < d_e ≤ 400	40 ± 0.5						
	> 400	42 ± 0.5						
8V	≤ 400	38 ± 0.5	25.4 ± 0.13	25.1	23.65	28.58 ± 0.4	19.05 (+6.3 / −0)	2.54
	400 < d_e ≤ 560	40 ± 0.5						
	> 560	42 ± 0.5						

It may be noted that for RMA IP 22, the three narrow/wedge section belt profiles standardized and predominantly used in the USA and Canada, effective width (width at outside diameter of the pulley called effective diameter) is regarded as the basic dimension of standardization.

Deep-groove Pulleys

Deep grooved pulleys are employed for special drive situations such as:

- as idler pulleys
- with vertical shafts
- with twisted drives
- with strongly oscillating drives



Comparison of Standard and Deep-groove Pulley

As shown in above figure, deep-groove pulleys have extended/increased grooves to provide a greater top groove width and groove depth. This enhances running properties considerably under the special operating conditions. The belt runs more smoothly onto the pulley and is less susceptible to twisting/turnover and to slipping off (run out of) the pulley. For comparison between standard and deep-groove pulley, pulley dimensions for standard pulley and deep-groove pulley for belt section SPC are shown in above figure.

Standards for Industrial V-Belt Drives

Various common standards for industrial V-belt drives are as under.

ISO 4184: Classical and narrow V-belts; Lengths.
ISO 4183: Grooved pulleys for classical and narrow V-belts.
ISO 1081: Belt drives - V-belts and V-ribbed belts, and corresponding grooved pulleys - Vocabulary.

DIN 2215: Endless V-belts; Dimensions
DIN 7753 Part 1: Endless Narrow V-belts for industrial Purposes; Dimensions
DIN 2211 Part 1: Driving Elements; Grooved Pulleys for Narrow V-belts; dimensions; material
DIN 2217 Part 1: Driving Elements; V-belt Pulleys; Dimensions, Material

BS 3790: Specification for endless wedge belt drives and endless V-belt drives.

IS 2494 (Part 1): V-Belts - Endless V-Belts for Industrial Purposes.
IS 14261: Transmission Devices - V-Belts - Endless Narrow V-Belts for Industrial Use - Specification
IS 3142: Pulleys - V-Grooved Pulleys for Endless V-Belts Sections Z, A, B, C, D and E and Endless Wedge Belts Sections SPZ, SPA, SPB and SPC - Specification.
IS 7923: Glossary of Terms and Definitions Relating to Drives Using V-Belts and Grooved Pulleys

RMA* IP 20: Specification for Drives Using Classical V-Belts and Sheaves.
RMA IP 22: Specifications for Drives Using Narrow V-Belts and Sheaves
RMA IP-23 Specifications for Drives Using Light Duty Single V-Belts

* Rubber Manufacturers Association (RMA) is now ARPM (Association for Rubber Products Manufacturers).

JIS K 6323: Classical V-belts for power transmission
JIS B 1854: Grooved pulleys for classical V-belts

Fractional Horsepower (FHP) Belts

Fractional horsepower (FHP) belts, also called light duty belts are used most often as single belt on fractional horsepower (less than 1 horsepower) drives. They are designed for intermittent and relatively light loads. Typical applications are domestic washing machines, refrigerators, small fans, blowers, centrifugal pumps, garage equipment, metal and wood working machines etc. As shown in the following table, these belts are manufactured to RMA IP 23, “Specifications for Drives Using Light Duty Single V-Belts” in four cross sectional sizes (2L, 3L, 4L, and 5L). Size of Matric belts are shown in the brackets.

Section	**2L**	**3L**	**4L**	**5L**
Top Width (bo)	1/4”	3/8” (10 mm)	1/2” (13 mm)	21/32” (17 mm)
Height/Thickness (h)	5/32”	7/32” (6 mm)	5/16” (8 mm)	3/8” (11 mm)
Angle	40°	40°	40°	40°

Note: Unless otherwise specified, nominal length considered is outside length (La).

The 2L belts are mostly used by OEMs. Generally, 3L belts are only used on drives of 1 horsepower or less. Series 2000 fractional horse power belts by Fenner has cross sectional size 9.5 x 5.5 mm (top width = 9.5 mm and height = 5.5 mm), which is almost equivalent to inch size 3L.

It may be noted that if required, Metric classical belt sections Z, A and B may be used instead of 3L, 4L and 5L respectively as their sizes are identical.

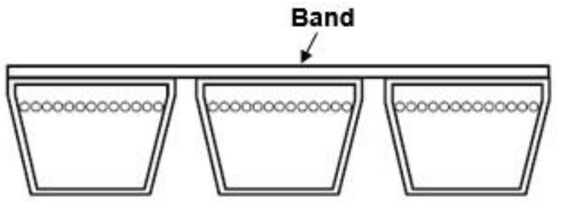
Banded, Double-V and Raw Edge Belts

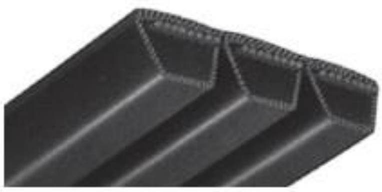
Banded Belts / Joined V-belts

In most of the applications, V-belts can meet the drive requirements. However, under certain operating conditions, belt whipping or vibration may become a critical problem, causing belts ultimately to come off the drive. Possible causes include the following:

- Load vibration occurs periodically either on the driver side or at the drive unit, e.g. internal combustion engine, air compressor, etc.
- There is excessively large load vibration or shock load, e.g. hoist, press, crusher, etc.
- Long span.
- Vertical shaft drives.

In above conditions single matched sets of belts will be out of alignment in entering the pulley and will be damaged, turned over or thrown off the drive. Banded V-belts are recommended for use under such conditions as they can stand lateral stress, and belt vibration is virtually eliminated, resulting in longer belt life expectancy.





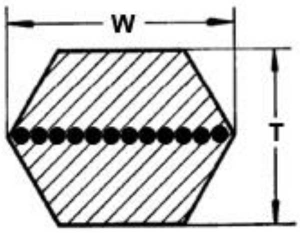
Banded Belt

As shown in above figure, a banded V-belt is made up of 2 to 5 standard V-belts joined together into one unit by means of an overlaying band at top. No special pulley is needed for them as the individual belts have the same cross section and spacing as those which operate on standard pulleys. As the band at top does not come in contact with top of the pulleys, each banded belt produces the same wedge effect as a single belt.

Accumulation of manufacturing tolerances on pulley groove pitch can result in incorrect belt seating when more than 5 belts are used in a single band. Hence, it is a normal practice to use no more than five belts in one band. When more than 5 belts are needed, it is recommended to use two or more matched banded belts.

Double-V (Hexagonal) Belts

Double V-belts, also known as hexagonal belts, can be in simple terms be considered as two classical section V-belts joined back to back. The neutral axis containing the tension member is exactly half way up the section. The polyester tension cord placed at the centre of the construction provides the belt extreme flexibility and low stretch properties.

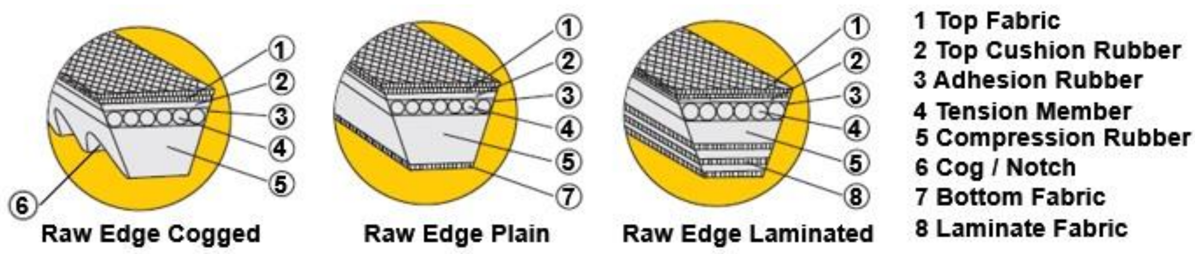
Double-V (Hexagonal) Belt

Double V-belts are used when power input or takeoff is required on both sides of the belt. This belt type has been designed for use on the so-called "serpentine" drives, which consist of more than two pulleys and in which the direction of rotation of at least one shaft is reversed. These belts are generally intended for use on agricultural machinery (specially on harvester-thresher machines). However, of late these belts are rapidly finding its application in industrial drives.

Section	AA	BB	CC
Width (W), mm	13 (1/2")	17 (21/32")	22 (7/8")
Height (T), mm	10 (13/32")	13 (17/32")	17 (23/32")
Angle	40°	40°	40°
Min. Pulley Diameter, mm	75	125	200

As shown in above table, these belts are available in AA, BB and CC cross sections as per ISO 5289, DIN 7722, IS 11038 and RMA IP 21. They operate in standard classical pulleys. They are specified by cross section and nominal length.

Raw Edge Belts



Raw Edge Belts

Raw edge belts have no fabric cover on the sides of the belt profile. However, as shown in above figure they are provided with a top fabric. Compared to wrapped belts, the raw edge construction allows more width for tension members. A special rubber compound ensures that this belt type has a greater resistance to wear than wrapped V-belts. Also, it is characteristic of raw edge belts that they keep a constant friction level for the remainder of their life after running in. They are made in three types: cogged, plain and laminated.

Raw Edge Cogged Belt

Raw Edge Cogged Belt

Compared to wrapped belts, raw edge cogged belts are usually rated higher in horsepower.

As shown in above figure, a raw edge cogged (also called notched) belt is manufactured with cogs/notches on the inside circumference of the belt. The cogs allow the belt to be more flexible in bending and may therefore be used on drives where smaller pulleys are required. The teeth type construction at the base also leads to better heat dissipation and the belts run cooler. Hence, these belts can be operated at higher ambient temperature (up to 90°C) than wrapped V-belts.

This design is used for both classical and wedge/narrow V-belts. Generally classical V-belts in the raw edge cogged design are designated with "X" after the ordinary section designation, for example BX and wedge section V-belts of the raw edge cogged type are designated by changing the SP before the section designation to XP, for example XPA.

Synchronous Belts

Some slip is inherent in V-belts, and so the angular velocity ratio between the driver and driven is neither constant nor equal to the ratio of the pulley diameters.

Synchronous Belts

Synchronous belts are toothed belts in which power is transmitted through positive engagement between belt teeth and pulley or sprocket grooves (like in chain drives) rather than by the wedging friction of V-belts. This positive engagement of belt teeth with pulley grooves eliminates slippage and speed variations. Hence, synchronous belts are often used to transfer motion for indexing or timing purposes. As these belts are used for timing purposes, they are also called timing belts.

Synchronous Belt Profiles

As shown in above figure, the three general profiles of synchronous belts teeth are trapezoidal, curvilinear modified and curvilinear. The positive drive characteristics of these belts provide exact synchronization between driver and driven shafts and also increase power transmission efficiency. Other advantages of synchronous belts over other modes of power transmission include a wider load/speed range, lower maintenance, increased wear resistance, and a smaller amount of required takeup.

Synchronous belts are especially well-suited for low-speed, high-torque applications. Small pitch synchronous drives operating at speeds of 0.25 m/s (50 ft/min) or less are considered to be low-speed. Synchronous belt drives are often used in high-speed applications even though V-belt drives are typically better suited. They are often used because of their positive driving characteristic, no creep or slip and because they require minimal maintenance (belts don't stretch significantly). However, a significant drawback of high-speed synchronous drives is drive noise.

For more information on synchronous belts please see Maintenance Engineering Handbook by R. Keith Mobley Editor in Chief, Lindley R. Higgins and Darrin J. Wikoff; published by The McGraw-Hill Companies, Inc., USA.

Matched Belts and Matchless Belts

Matched Belts

Satisfactory operation of multiple belt drives requires that each belt carry its share of the load. To accomplish this, all belts in a drive must be essentially of equal length.

Because it is not economically practical to manufacture belts to exact length, manufacturing tolerances are provided for the nominal length of a belt. For an example, following table shows permissible deviation for pitch length of classical section V-belts as per IS 2494, Part 1 (Note: the table shows some pitch lengths only).

Nominal Pitch Length (mm)	**Permissible Deviation (mm)**	
Over 1000 to 1250 including	+ 14	− 10
Over 1250 to 1600 including	+ 16	− 10
Over 1600 to 2000 including	+ 18	− 12
Over 2000 to 2500 including	+ 30	− 16
Over 2500 to 3150 including	+ 34	− 18

It may be noted that the range of permissible deviation of nominal pitch length is quite large due to the nature of material - textiles and polymers used and the technology adopted.

If the belts on a multiple belt drive are not of the same length, shorter belts would be under tension and bear the entire load while the longer ones run slack and contribute little to the power transmission. The drive is therefore under belted in effect and would result in short belt life as shown in the following table, even though the drive was properly designed and apparently installed correctly.

Effects of Under-Belting (Assuming drive design requiring 10 belts for 100% life)	
Number of V-Belts	**Percent Life**
10 (Normal number of V-belts)	100
9	70
8	45
7	28
6	17

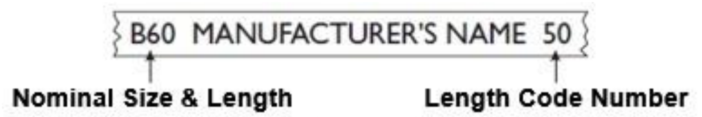
As the range of permissible deviation of nominal length is quite large, use of the belts on a multiple belt drive based only on same nominal length belts could be under belted in effect. To overcome the problem, the belts running on a multiple belt drive shall be matched belts, (in order to avoid uneven distribution of load) as recommended by a standard/specification or belt manufacturer. Requirement for matching belts as per IS Standards is as under.

Requirement for Matching Set of Classical Section Belts (IS 2494, Part 1: 1999)

The following system of coding is recommended:

The belts should be stamped (by belt manufacturer) with length code No. 50 if the measured pitch length is equal to the nominal pitch length. A deviation of 2.5 mm in length from the nominal pitch lengths is to be represented by one unit and the length code number will increase or decrease, as the length is more or less.

Example: A belt designation, V-belt IS 2494 (Part 1) C 3104 Lp having an actual pitch length of 3104 mm shall be coded 50. If the actual pitch length is 3101.5 mm, it shall be coded 49. If the actual pitch length is 3109 mm it shall be coded 52.



Typical Code Marking

Above figure shows typical code marking on a belt for making a matched set.

Belt Matching Tolerances:

The variation in length within a matched set shall not exceed the values given in the following table.

Belt Matching Tolerances for Classical Section Belts		
Nominal Pitch Length (mm) Lp	Maximum Difference Between the Lengths of Belts of the Same Set (mm)	Allowable Consecutive Code Number
1250 or less	2.5	One length code number
Over 1250 to 2000 including	5.0	Two length code number
Over 2000 to 3150 including	7.5	Three length code number
Over 3150 to 5000 including	10.0	Four length code number
Over 5000 to 8000 including	12.5	Five length code number
Over 8000 to 12500 including	15.0	Six length code number
Over 12500	17.5	Seven length code number

Examples:

- In a belt set with the pitch length Lp 1500 mm, a maximum of two tolerance groups may be used, for example: 49, 50 or 51, 52.
- If the pitch length Lp is 4000 mm, a maximum of four tolerance groups may be used, for example: 47, 48, 49, 50 or 51, 52, 53, 54.

Requirement for Matching Set of Narrow/Wedge Section Belts (IS 14261: 2005)

The following system of coding is recommended:

The belts should be stamped (by belt manufacturer) with length code No. 50 if the measured pitch length is equal to the nominal pitch length. A deviation of 2.0 mm in length from the nominal pitch lengths is to be represented by one unit and the length code number will increase or decrease, as the length is more or less.

Example: A belt designation, Narrow V-belt IS 14261 SPZ 630 having an actual pitch length of 630 mm shall be coded 50. If the actual pitch length is 628 mm, it shall be coded 49. If the actual pitch length is 634 mm it shall be coded 52.

Belt Matching Tolerances:

The variation in length within a matched set shall not exceed the values given in the following table.

Belt Matching Tolerances for Narrow/Wedge Section Belts		
Nominal Pitch Length (mm) Lp	Maximum Difference Between the Lengths of Belts of the Same Set (mm)	Allowable Consecutive Code Number
2000 or less	2	One length code number
Over 2000 to 3150 including	4	Two length code number
Over 3150 to 5000 including	6	Three length code number
Over 5000 to 8000 including	10	Five length code number
Over 8000 to 12500 including	16	Eight length code number

Notes:
1. Age and storage may alter the belt length.
2. It is recommended that belts from different manufacturers should be mixed on the same drive.

Matchless Belts

Now top belt manufacturers have improved their process of making "V" belts. Tighter tolerances on the rubber, fiber, carbon, and other raw ingredients, plus much closer process control in making and curing the belts, have led to a whole new class of "matchless" belts. Matchless belt does not require length matching because the V-belts have been manufactured and checked according to the standard for length tolerance in a matched belt set. Simply stated, matchless belts are manufactured by process that holds v-belt lengths within tolerances for a matched set.

Labels for "Matchless" Belts

As shown in above figure, different manufacturers are labelling such belts by different names (PB indicating Precision Built and TS indicating Tolerance Stable) indicating that they are "matchless" type belts.

Like matched belts, matchless type belts need to be checked and corrected for the recommended/required tension after running them for approximately 24 hours after their installation. However, it is claimed that normally no further retensioning is required for them in future unlike matched belts which need to be checked periodically and adjusted for recommended tension.

It is recommended not to purchase "matchless" belts from different manufacturers for use on the same machine because the standards of each manufacturer for "matchless" belts will vary.

It is also recommended that in the event of a failure of a single V-belt on a multiple belt drive, all belts should be replaced.

Use of Idlers

An idler as used on V-belt drives, is a wheel that is not loaded and may be either a grooved or a flat pulley. Idlers are used on V-belt drives for the following reasons:

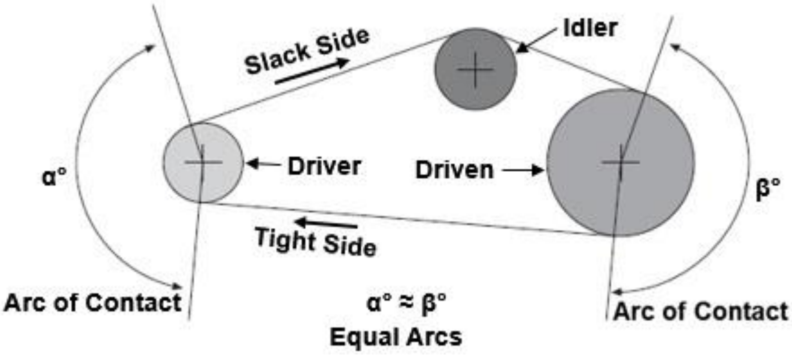
- To provide installation and takeup allowances for drives with fixed centre distance.
- As hydraulically, pneumatically or spring loaded idlers to maintain the constant tension in the drive.
- As dampers and guides on long spans where belt vibration may be a problem.
- To clear obstructions.
- As outside idler when the arc of contact on one of the drive pulleys is too low. It also helps in reducing the slippage and the need to increase the number of required belts.
- As guide idlers where the drive system pulleys are not in the same plane.
- To act as a clutching device to engage or disengage the driven pulley.

The use of idlers should be as far as possible avoided as they generate additional bending stresses in the belt, leading to reduction in the belt life. However, under the conditions listed above where it may be absolutely essential to use the idlers the following principal rules must be observed when designing the drive.

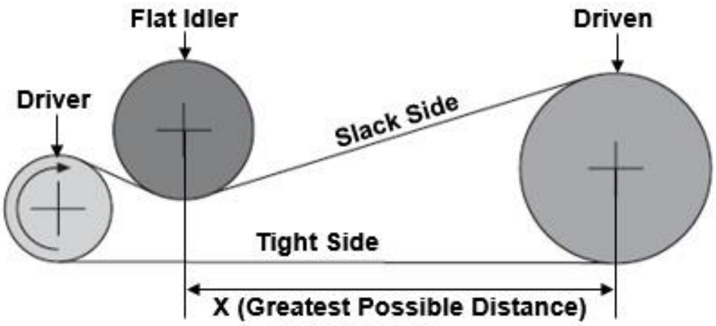
If possible, the idler should be placed (act) on the slack side of the belt drive. This will reduce the load on the idler system and the belts to a minimum. This means that tensioning idlers should not be used in reversible drives.

Idlers can be placed inside or outside depending on the drive conditions. However, it is preferable to use an idler on the inside, not the outside because the reverse bending caused by the outside idler reduces the life of the belt.

The inside idler can be either flat or grooved pulley depending on the type of belt used in the drive system. It is suggested that the flat inside idler be used only when classical section belt is used while in all other cases a grooved pulley be used.

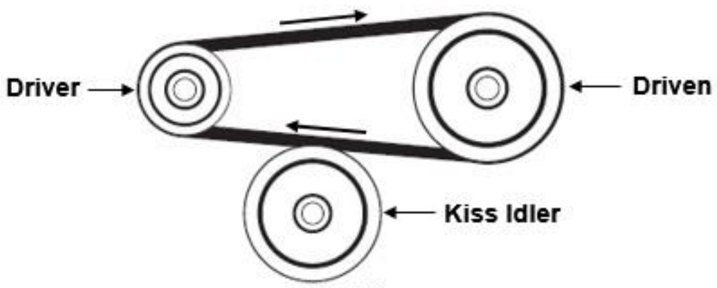


In the case of inside idler, grooved pulley can be placed anywhere in the entire span length on the slack side of the drive. As an inside idler reduces the arc of contact on the pulleys, to obtain the best from the drive it is suggested that wherever possible the idler should be located such that it results in nearly equal arcs of contact ($\alpha° \approx \beta° \approx 160°$) on both pulleys as shown in above figure. It may be noted that some belt manufacturers recommend to place the inside idler near the large pulley to prevent the arc of contact becoming smaller for the driving pulley which may result in belt slip.



Outside Idler

As shown in above figure, an outside idler (also called back side idler) increases the arc of contact but the amount of takeup is limited by the span on the opposite side. Outside idlers are always flat pulleys with a cylindrical face because they run on the back of the belt. The idler should be placed with the greatest possible distance (X), from the pulley where the belts are running in.



Kiss Idler

Unlike the outside idler, the kiss idler does not penetrate the belt span and create a back bend. Consequently, the kiss idler does not contribute to premature failure. The kiss idler can help control belt vibration and whip on drives subject to shock and pulsating loads.

A flat idler pulley, whether it is inside or outside should be located as far as is practical from the next pulley the belt is entering. This is because V-belts move slightly sideways back and forth on a flat pulley, and locating it as far away from the next pulley minimizes the possibility of the belt entering that pulley in a misaligned condition.

The use of flat idler pulleys on long span (large centre distance) drives can cause severe belt whip, and should be avoided if possible. It is suggested to use a grooved pulley because the usage of flat idler can also result in sideway vibrations leading to the belt turnover.

Flat idlers for V-belt drives should not be crowned (not convex). Flanging of idlers, however, is good practice. If flanging is used, the inside bottom corners should not be rounded since this may cause the belt to climb off the pulley. A general rule to determine the face width of a flat idler (between the flanges if flanged) is to add 1.5 times the nominal belt top width to the face width of the grooved pulley used.

Idler Diameters

Inside idlers should be at least as large as the smallest power transmitting pulley. Outside idlers should be at least 50% larger than the smallest power transmitting pulley. Belt power ratings or belt life are reduced significantly when using idlers that are too small.

Storage of V-Belts

Rubber belts can be stored up to 10 years. However, in real world practice it is suggest not to store them for more than 7 years. The quality of good quality belts is expected to remain unchanged for 7 years if they are stored according to the following recommendations.

Storage Premises

The storage premises should be cool, dry and well ventilated but not draughty.

The temperature should be kept between 15°C and 25°C. The temperature should not be above 30°C. Every increase of 8°C above 30°C temperature reduces the expected shelf life by half. Storage temperatures above 46°C are not allowed at all.

Relative humidity should be below 70%. An increase in humidity will not cause serious material damage but could lead to higher initial stretch of the belt on the drive.

Belts should not be stored near windows, which may expose the belts to direct sunlight or moisture. Belts should be keep away from strong artificial light with a high ultraviolet content.

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

Belts should not be stored near any devices that generate ozone. Ozone generating devices include transformers and electric motors.

Inflammable materials, lubricants, acids, solvents and other aggressive materials should not be kept in V-belt storage premises. Elastomers and fabrics may be affected or even irreparably damaged by such agents.

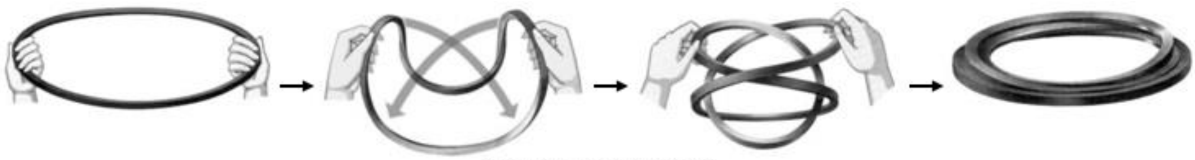
Storage Method

In order to save space, V-belts can be stored by suspending them on "saddles" or tubular brackets with a large diameter. The diameter should be at least 10 x height of belt cross section. Hooks and nails are unsuitable for suspending V-belts for storage purposes.

Do not use ties or tape to pull belt spans tightly together near the “end” of the belt.

Shorter V-belts can be stored on shelves. Stacks should not be more than 300 mm high, as the bottom belts may otherwise be deformed.

Do not crimp belts during handling or while stored. Belts are crimped by bending them to a diameter smaller than the minimum recommended diameter pulley/sheave.



Coiling Long V-Belts

Long V-belts can be coiled in loops for storage purposes, provided that they are correctly coiled as shown in above figure. Each coil results in a number of loops. One coil results in three loops, two coils result in five loops, etc. The maximum number of coils that can be used depends on the belt length. Follow the limits shown in the following table for coiling a belt for storage.

Belt Cross Section	Belt Length (in)	Belt Length (mm)	Number of Coils	Number of Loops
3L, 4L, 5L, Z, A, B, SPZ, SPA, 3V,	Under 60	Under 1500	0	1
	60 up to 120	1500 up to 3000	1	3
	120 up to 180	3000 up to 4600	2	5
	180 and over	4600 and over	3	7
C, 5V, SPB	Under 75	Under 1900	0	1
	75 up to 144	1900 up to 3700	1	3
	144 up to 240	3700 up to 6000	2	5
	240 and over	6000 and over	3	7
D, SPC	Under 120	Under 3000	0	1
	120 up to 240	3000 up to 6100	1	3
	240 up to 330	6100 up to 8400	2	5
	330 up to 420	8400 up to 10,600	3	7
	420 and over	10,600 and over	4	9
E, 8V	Under 180	Under 4600	0	1
	80 up to 270	4600 up to 6900	1	3
	270 up to 390	6900 up to 9900	2	5
	390 up to 480	9900 up to 12,200	3	7
	Over 480	12,200 and over	4	9

Note:
Standard practice for storage, cleaning and maintenance of rubber products is detailed in DIN standard 7716.

Strictly practice use of the stock on **“first in - first out”** basis.

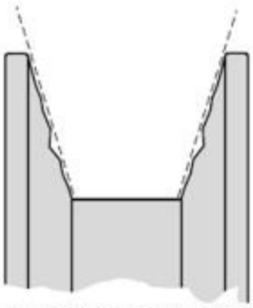
Installation of V-Belts

To prevent premature failure of the belts, good contact between V-belts and pulley grooves is essential. To ensure it, check groove dimensions for the pulleys. They should conform to the relevant standard (BS, ISO, RMA, etc.).

Check the pulleys for rust, oil, grease, dust, dirt and other foreign materials. Clean them if required. Dirty or rusty pulleys abrade belts, which may result in premature failure of the belts. Dust and dirt also leads to slippage. Oil and grease reduce belt traction and destroy the belt surface.

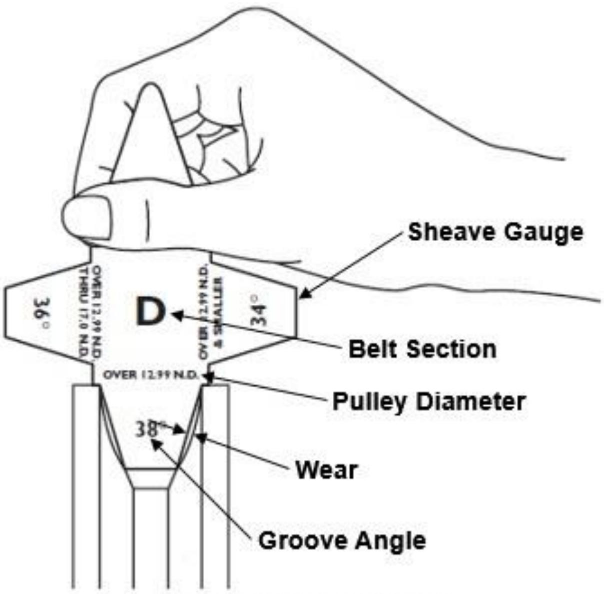
Inspect pulleys. Particular attention should be given to the following conditions:

- Damaged pulleys
- Worn groove sidewalls
- Shiny pulley groove bottom
- Wobbling pulleys



Pulley with Scores and Sharp Edges

Pulley grooves should be in good condition, free from scores or sharp edges. As shown in above figure, if scores or sharp edges are there, the pulley should be replaced.



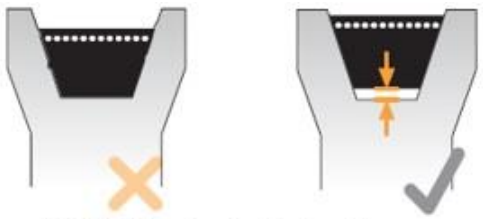
Checking Groove Wear

All “V” belts and pulleys/sheaves will wear to some extent with use. As wear occurs, the belts will ride lower in the grooves. While belt wear is usually noticed, wear of pulley grooves is often overlooked.

As wear occurs at the contact surfaces on the sides of the grooves, a dished condition develops. This results in reduction of wedging action, loss of gripping, loss of power, and accelerated wear as slippage occurs. Installing new belts in worn grooves will give temporary improvement in operation, but belt wear will be rapid. Therefore, when changing belts, wear of pulley grooves should be checked with gauges or templates.

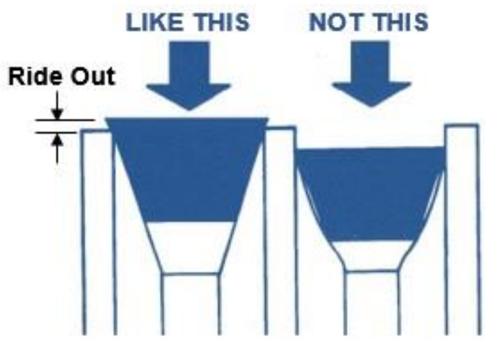
As shown in above figure, wear of pulley grooves can be checked using a sheave gauge. To check the wear, select the proper sheave gauge and insert the correct angle, based on the pulley’s diameter, into the groove. A flashlight held behind the gauge, when placed in the groove, will help you observe the amount of wear.

The more heavily loaded a drive, the greater the effect of groove wear on its operation. It is recommended that wear should not exceed 0.8 mm (1/32”) for light to moderately loaded pulley drives and 0.4 mm (1/64”) for heavily loaded or banded belt drives.



Belt Bottoming in Pulley Groove

As shown in above figure, extreme wear can lead to belts bottoming in grooves. It results in slippage and excessive heat buildup leading to burn belts.



V-Belt Ride Out

As shown in above figure, V-belts should ride at least flush with the top of the pulley or may ride out up to 2.5 mm (0.1”).

Dirty V-belts can be cleaned using a 1:10 mixture of glycerine and methylated spirits. Solvents such as petrol, benzene, turpentine and the like should not be used. In addition, use of sharp objects, wire brushes, emery paper etc. must, under all circumstances, be avoided as these can cause damage to the belt.

The taper bush is the starting point when it comes to installation/assembly of V-belt drives. Pulleys/sheaves are commonly mounted to a shaft with a tapered bushing that fits a mating tapered bore in the pulley/sheave. Usually either a Taper Lock® or QD® Bushing is used to hold pulley on the shaft. Taper Lock® is a registered trademark of Reliance Electric and QD®

is a registered trademark of Emerson Electric. Follow the steps set out on the installation leaflet provided with the taper bush. Incase installation leaflet is not available, following instructions may be followed for their installation.

Taper Lock® Bushing

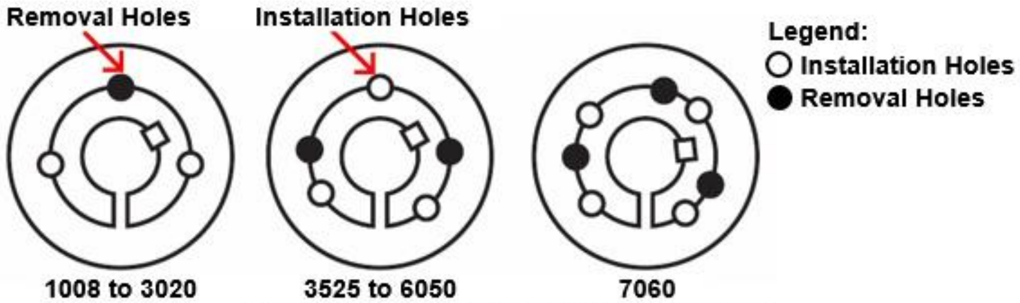
Taper Lock Bushing

The taper lock bushing size is defined by 4 digits representing two numbers. The first two digits represent the maximum bore size and the second two digits represent the bushing length. For example, bushing number 2012 has a max. bore of 2.0" and a total length of 1.2".

In case the bore of the bushing is machined to a bore size, it is marked after the bushing number. For example, 2012 x 1-3/8 indicated that the bore of the bushing is machined to 1-3/8". Metric bore sizes are designated with "MM" after the metric dimension (X25MM).

Installation of Taper Lock® Bushings

Clean the shaft, bore of bushing, outside of bushing and the pulley/sheave hub bore of all oil, paint and dirt. File away any burrs.



Taper Lock Bushing Installation Diagrams

As shown in above figure, insert the bushing into the pulley/sheave hub and align the holes. All of the holes should be half threaded. The installation holes will be threaded on the pulley side, but not the bushing side. The removal holes will be threaded on the bushing side, but not the pulley side.

"LIGHTLY" oil the bolts and thread them into the half-threaded installation holes indicated by the white installation holes.

Note: Do not lubricate the bushing taper, hub taper, bushing bore, or the shaft. Doing so may result in pulley/sheave hub fracture.

With the key resting in the shaft keyway, position the pulley/sheave and bushing assembly onto the shaft allowing for small axial movement of the pulley/sheave which will occur during the tightening process.

Note: When mounting pulley/sheave on a vertical shaft, precaution must be taken to positively prevent the pulley/sheave and/or bushing from falling during installation.

Alternately torque the bushing bolts until the pulley/sheave and bushing tapers are completely seated together (use approx. half of the recommended bolt tightening torque as specified in the following table).

Recommended Torque Values for Taper Lock® Bushing				
Bushing Style / No.	Bolts		Torque Wrench	
	Quantity	Size	lb-ft	lb-in
1008	2	1/4" Set Screws	4.6	55
1108	2	1/4" Set Screws	4.6	55
1210	2	3/8" Set Screws	14.6	175
1610	2	3/8" Set Screws	14.6	175
2012	2	7/16" Set Screws	23.3	280
2517	2	1/2" Set Screws	35.8	430
3020	2	5/8" Set Screws	66.7	800
3525	3	1/2" Cap Screws	83.3	1000
4030	3	5/8" Cap Screws	141.7	1700
4535	3	3/4" Cap Screws	204.2	2450
5040	3	7/8" Cap Screws	258.3	3100
6050	3	1 1/4" Cap Screws	651.7	7820
7060	4	1 1/4" Cap Screws	651.7	7820

Check the axial run out (wobble) of the pulley/sheave and correct as necessary.

Continue alternate tightening of the bolts to the recommended torque values (as per above table).

To increase gripping force of the bushing, firmly tap the face (large end) of the bushing using a brass rod (or hammer with a block or sleeve. Do not hit the bushing directly with the hammer). This will also ensure that the bush is seated squarely in the bore.

Re-torque the bushing bolts after firmly tapping/hammering of the bushing face. Repeat this alternate tapping/hammering and bolts tightening once or twice to achieve maximum grip on the shaft.

Fill remaining holes with grease to prevent dirt buildup.

If two bushings are used on same component and shaft, fully tighten one bushing before working on the other.

Recheck all bolt torque values after the initial drive run-in, and periodically thereafter.

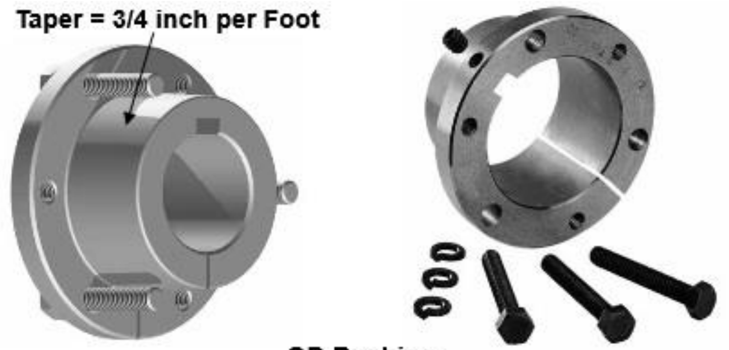
Removal of Taper-Lock® Bushings

Loosen and remove all mounting bolts.

Insert bolts into all jack screw holes indicated by dark removal holes in above figure (Taper Lock Bushing Installation Diagrams).

Loosen the bushing by alternately tightening the bolts in small but equal increments until the tapered pulley/sheave and bushing surfaces disengage.

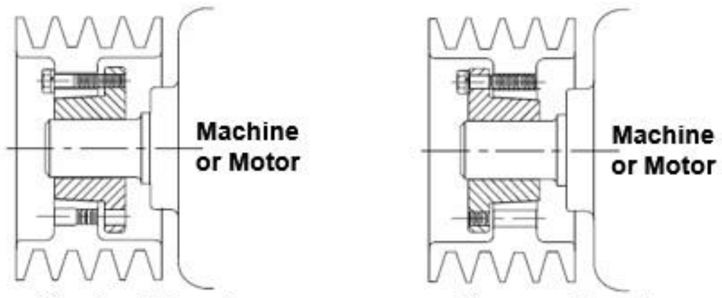
QD® Bushing



QD Bushing

The “Quick Detachable”, QD® bushings are easy to install and remove. They are split through flange having 3/4" taper per foot on the diameter as shown in above figure to provide a true clamp on the shaft that is the equivalent of a shrink fit. Bushing sizes/styles are designated by alphabetical characters. Most sizes have a set screw over the key to help maintain the bushings position on the shaft until the cap screws are securely tightened.

These bushings, as well as the pulleys / sheaves for them, are each drilled with six holes (three drilled and three tapped) to allow pull-up bolts to be inserted from either side. This enables variations of mounting characteristics to suit a particular installation.



QD Bushing Mounting

As shown in above figure, QD bushings can be mounted in two ways: standard/conventional mounting and reverse mounting.

Standard mounting is accomplished by placing the bolts through the pulley/sheave first and then threading into the bushing. The assembly is then placed onto the shaft with the bushing flange facing inward (towards machine or motor) and the bolt heads facing outward.

Reverse mounting is accomplished by placing the bolts through the bushing first and then threading into the pulley/sheave. The assembly is then placed onto the shaft with the pulley/sheave facing inward (towards machine or motor) and the bolt heads facing outward. Standard mounting is generally the preferred method.

Installation of QD® Type Bushings

Clean the shaft, bushing bore, outside of bushing and the pulley/sheave hub bore of all oil, paint and dirt. File away any burrs.

Note: Do not lubricate the bushing taper, hub taper, bushing bore or the shaft. Doing so may result in pulley/sheave hub fracture.

For a standard/conventional mount, assemble the pulley/sheave and bushing combination by sliding the pulley/sheave taper bore into position over the mating tapered bushing surface. Align the unthreaded holes in the pulley/sheave hub with the threaded holes in the flange of the bushing. Hand tighten the cap screws with lock washers installed. Mount the pulley/sheave and bushing assembly onto the shaft with the bushing flange facing inward. If the bushing does not freely slide on the shaft, insert a screwdriver or similar object into the flange saw-cut to act as a wedge to open the bushing's bore (Note: Excessive wedging will split the bushing). Some pulley/sheave assemblies will allow a reverse mount procedure. This results in the bushing flange facing outward, but still allows the cap screw installation from the outside of the assembly. The cap screws fit through the unthreaded holes of the bushing flange and into the threaded holes of the pulley/sheave hub.

With the key resting in the shaft keyway, position the assembly onto the shaft allowing for small axial movement of the pulley/sheave.

When installing large or heavy parts in a standard mount, it may be easier to mount the key and bushing on the shaft first, then place the pulley/sheave on the bushing and align the holes.

Note: When mounting pulley/sheave on a vertical shaft, precaution must be taken to prevent the pulley/sheave and/or bushing from falling during installation.

Tighten the cap screws evenly and progressively in rotation until the pulley/sheave and bushing tapers are completely seated together (use approx. half of the recommended bolt torque given in the following table).

Check the axial run out (wobble) of the pulley/sheave, and correct as necessary.

Continue evenly tightening of the cap screws to the recommended torque values specified in the following table. Do not tighten cap screws further once the recommended torque is reached.

Note: Excessive bolt torque can cause pulley/sheave and/or bushing breakage. When properly mounted, a gap between the bushing flange and pulley/sheave should exist. This gap must not be closed. If the gap is closed (i.e. there is no gap) under normal tightening, it shows that the shaft is seriously undersized.

Recommended Torque Values for QD® Bushing (Normal Applications*)				
Bushing Style / No.	Bolts (inch)		Torque Wrench	
	Quantity	Size	lb-ft	lb-in
H	2	1/4 x 3/4	7.9	95
JA	3	10-24 x 1	4.5	54
SH and SDS	3	1/4-20 x 1 3/8	9.0	108
SD	3	1/4-20 x 1 7/8	9.0	108
SK	3	5/16-18 x 2	15.0	180
SF	3	3/8-16 x 2	30.0	360
E	3	1/2-13 x 2 3/4	60.0	720
F	3	9/16-12 x 3 5/8	75.0	900
J	3	5/8-11 x 4 1/2	135.0	1620
M	4	3/4-10 x 6 3/4	225.0	2700
N	4	7/8-9 x 8	300.0	3600
P	4	1-8 x 9 1/2	450.0	5400
W	4	1 1/8-7 x 11 1/2	600.0	7200
S	5	1 1/4-7 x 15 1/2	750.0	9000

* For severe applications (e.g. rock-crusher) these values can be increased by a maximum of 50%.

Note: Some manufacturers recommend not to use lubricant on the cap screws!

Tighten the set screw, if provided, to hold the key securely during operation.

Removal of QD® Type Bushings

Loosen and remove all mounting bolts.

Insert cap screws into all threaded jack screw holes.

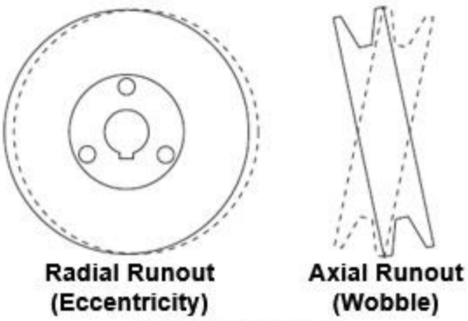
To avoid cracking the bushing, loosen the bushing by first tightening the screw furthest from the bushing saw slot, then, alternately tighten remaining screws. Keep tightening the screws in small but equal increments until the tapered pulley/sheave and bushing disengage.

Note: Excessive or unequal pressure on the bolts can break the bushing flange, making removal impossible without destroying the pulley/sheave.

Alignment

Pulleys should be correctly aligned prior to belt installation because one of the most important installation factors influencing operating life of a belt is alignment. Improper pulley alignment produces uneven wear on one side of the belt, causing the belt to roll over in the groove or throw the entire load on one side of the belt, stretching or breaking the cords on that side. Incorrectly aligned pulleys also cause excessive noise.

However, before carrying out pulleys alignment, check runout of the pulleys/sheaves.



Runout Checking

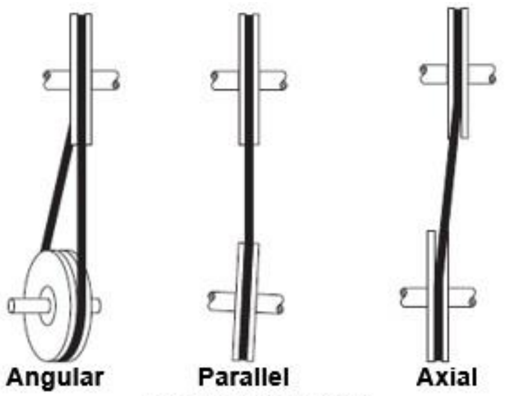
As shown in above figure, check pulleys for radial runout (also called eccentricity or outside diameter runout) and axial runout (also called wobble or face runout).

Improperly bored hubs, bent shafts, or improperly installed bushings are the common causes for radial runout and axial runout.

When checking runouts using a dial indicator, following limits are recommended.

Radial runout (eccentricity) limits for pulleys/sheaves:
Up through 10 in. diameter - 0.010 in. maximum
For each additional inch of diameter - Add 0.005 in.

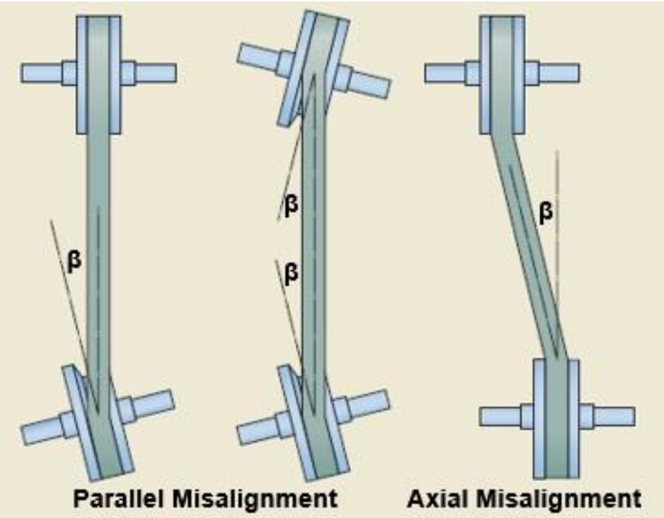
Axial runout (wobble) limits for pulleys/sheaves:
Up through 5 in. diameter - 0.005 in. maximum
For each additional inch of diameter - Add 0.001 in.



Pulleys Alignment

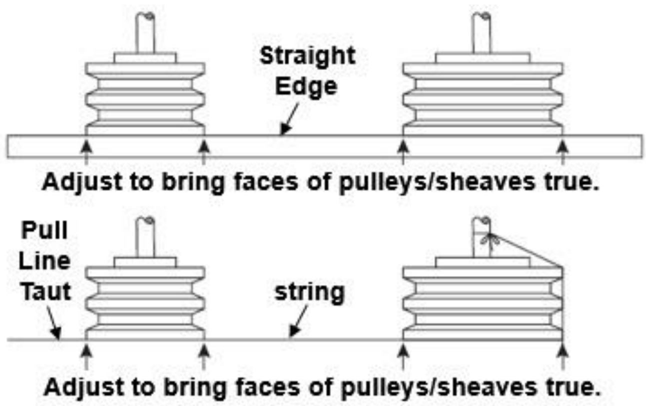
As shown in above figure, misalignment of belt drives results from shafts being out of angular, parallel or axial (sheave grooves being out of axial alignment) alignment.

As the shafts of most V-belt drives are in a horizontal plane, angular shaft alignment is easily obtained by leveling the shafts. In cases where shafts are not horizontal, a careful check must be made to ensure that the angle of inclination of both shafts is the same.



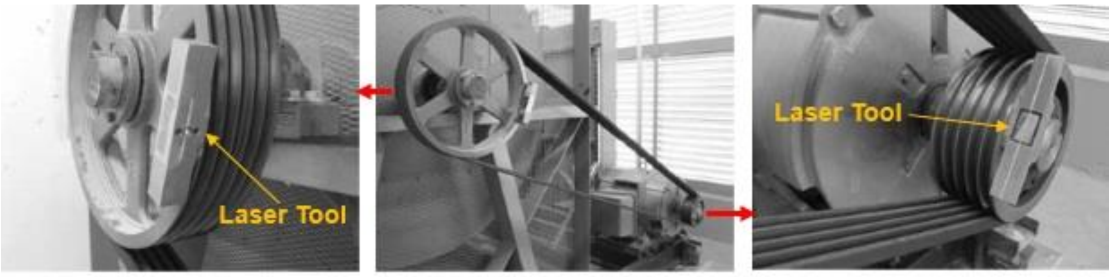
Fleeting Angle (β)

As shown in above figure, fleeting angle (β) is the angle made by the belt with the pulley/sheave. The recommended maximum allowable misalignment is, fleeting angle (β) = 0.3° or 5 mm per 1 m (1000 mm) of centre distance.



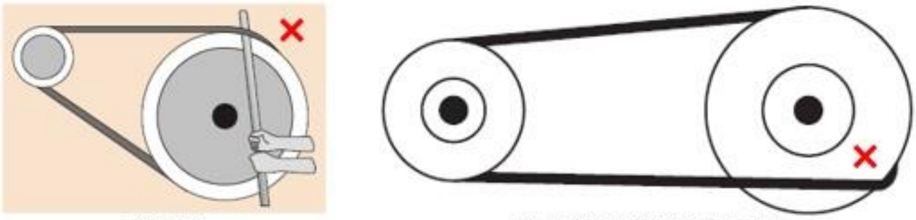
Alignment Checking

Check for shaft tilting or angular misalignment by using a bubble level. For proper alignment, the bubble should be in the same position as measured on each shaft. Parallel and axial misalignment can be checked and corrected using a straight edge or a taut line (string). For checking and correcting alignment, use a straight edge or string along the outside face of both the pulleys/sheaves as shown in above figure. If the drive is properly aligned, the straight edge or string will contact each pulley/sheave evenly. The straight edge or string (pulled tight) should touch the two outer edges of each pulley/sheave for a total of four points of contact. Misalignment of pulleys/sheaves will show up as a gap between the outside face of the pulley/sheave and the straight edge or string. For correcting the misalignment, adjust pulleys/sheaves to bring their faces true. As shown in the following figure, a more precise, quick and easy way to check alignment, particularly over long distances, is to use a laser alignment tool on both the pulleys.



Laser Alignment

Belt Installation

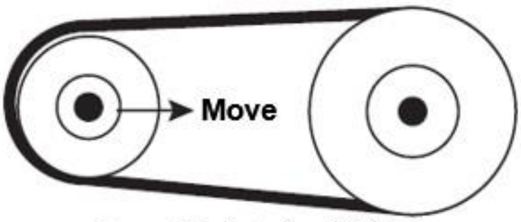


Prying

Running On to Pulley

Never Stretch Belts Over Pulleys

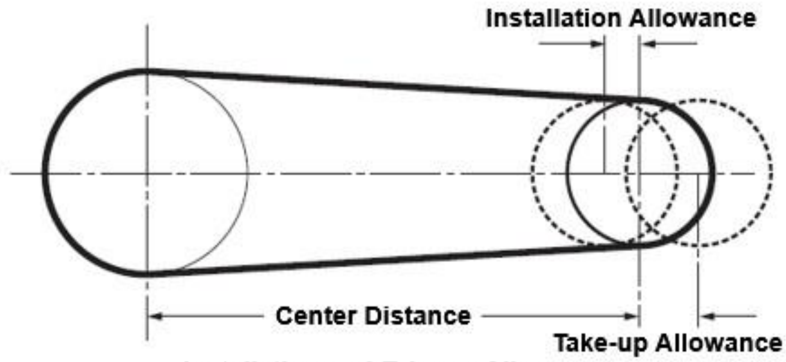
For installation of V-belts, one should not pry (lever) them or "run/roll on" them to pulleys/sheaves as shown in above figure. The severe stresses placed upon V-belts when they are forced over the pulleys/sheaves can damage the cover fabric and the high quality, low stretch tension members. A belt damaged in this manner will flop under the load and turn over in the sheave groove.



Correct Installation Method

As shown in above figure, the correct installation method is to loosen the adjustable mount, reduce the center distance, and slip the belts loosely into the sheave grooves.

The installation allowance given in the following table is the minimum recommended reduction in centre distance for the various belt sections and datum lengths to allow for correct installation.



Installation and Take-up Allowance

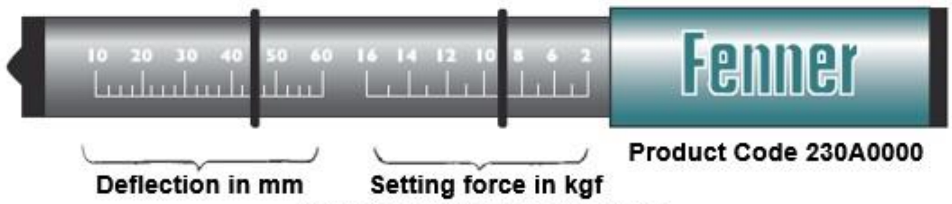
Minimum Installation and Take-up Allowances for Single V-Belts													
Datum Length (mm)	Minimum Take-up Allowance (mm)	Minimum Installation Allowance (mm) - for belts fitting											
		M	Z	A	B	C	D	E	SPZ 3V	SPA	SPB 5V	SPC	8V
400-1199	25	15	15	20	25	40	-	-	15	20	-	-	-
1200-2099	35	20	20	20	30	40	50	-	20	25	25	-	-
2100-2799	40	-	20	25	30	40	50	-	20	25	25	35	40
2800-3399	45	-	-	25	30	40	50	-	20	25	25	35	40
3400-4399	55	-	-	25	30	50	55	65	20	25	25	35	40
4400-5399	65	-	-	25	40	50	60	65	-	25	25	35	45
5400-6399	85	-	-	25	40	50	60	65	-	-	35	40	45
6400-7799	95	-	-	-	40	50	65	75	-	-	35	40	45
7800-9999	110	-	-	-	40	50	65	75	-	-	35	40	50
10000-	130	-	-	-	40	50	65	90	-	-	45	50	50

Above table also shows recommended take-up allowance to be provided in a drive to allow for the belt stretching.

Belt Tensioning

V-belt drives must be tensioned with great care. Insufficient belt tension leads to inadequate power transmission and premature wear of both belts and sheave grooves due to excessive slip. Over tensioning causes excessive elongation, unnecessary flexing combined with high temperatures and thus a reduction in service life. The shaft bearings are also subjected to unnecessarily excessive loads.

Generally, V-belts are tensioned by force-deflection method. In this method, the spring scale type tester measures how much force is required to deflect the belt a specified distance at the center of its span (centre distance). The deflection force is a calculated value that is based on the amount of static tension required in the belt. It is recommended to use a spring loaded belt tension indicator to obtain the correct tension for the drive.



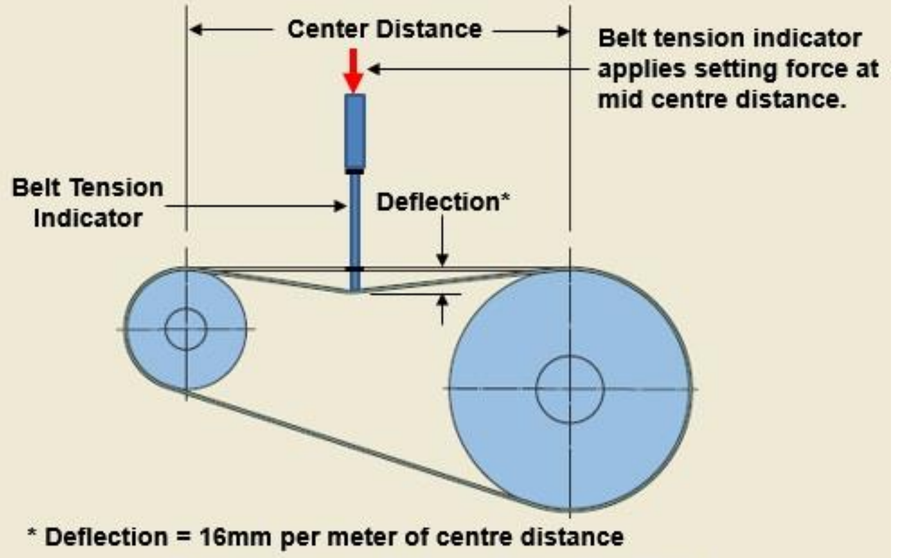
Fenner Belt Tension Indicator

Above figure shows a spring loaded belt tension indicator by Fenner. It may be noted that many belt manufacturers are supplying such spring loaded belt tension indicators.

Tension the belts as per the belt manufacturer's recommendations. In case belt manufacturer's recommendations are not available, belts may be tensioned using spring loaded belt tension indicator as per steps/method given below.

After installing the belts loosely into the sheave grooves as explained above, tighten the belts to be a snug fit around the pulleys.

Rotate the pulleys a few (3 to 4) revolutions to allow the belts to sit correctly in the pulley grooves. Be careful not to trap fingers!



Belts Tensioning by Force-Deflection Method

See above figure. Calculate the required deflection in mm on basis of 16 mm per metre of centre distance (1/64 inch per inch of centre distance).

Set the lower black rubber ring at the required deflection in mm on the lower scale of the belt tension indicator.

Set the upper ring against the bottom edge of the top tube of the belt tension indicator.

Place the belt tension indicator on top of the belt at the middle of the centre distance and apply a force at right angles to the belt, deflecting it to the point where the lower rubber ring is in level with the top of an adjacent belt.

For single belt drives a straight edge should be placed across the two pulleys to act as a datum for measuring the amount of deflection.

Read off the tensioning force value indicated by the top edge of the upper rubber ring

Compare this force to the value in the following table and adjust the tension until the correct value is attained. A measured force below the basic setting value indicates under tensioning.

A new drive should be tensioned to the 1.25 × setting force to allow for the normal drop in tension during the running-in (bedding-in) period.

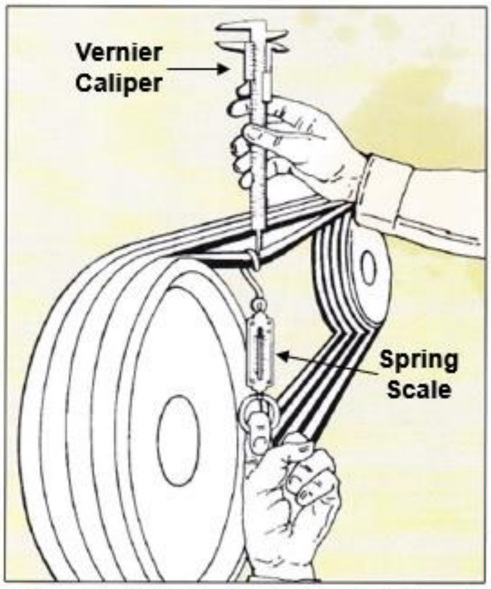
Note: For short centre distance drives, where the deflection of the belt is too small to measure accurately, it is recommended that both deflection and setting force be doubled.

After approximately 30 minutes of running under load, stop the drive and check tension. Reset tension to the basic value if necessary.

Run the drive under load for 4 hours and then stop the drive. Check tension and reset to the basic value if necessary.

The V-belt tension should be checked periodically thereafter.

Belt Section	**Setting Force to Deflect Belt - 16 mm per meter of Centre Distance (Span)**				
	Small Pulley Diameter (mm)	Basic Setting Force		1.25 x Setting Force	
		Newtons (N)	Kilograms (kgf)	Newtons (N)	Kilograms (kgf)
SPZ	56 to 71	16	1.6	20	2.0
	75 to 90	18	1.8	22	2.2
	95 to 125	20	2.0	25	2.5
	over 125	22	2.2	28	2.8
SPA	80 to 100	22	2.2	28	2.8
	106 to 140	30	3.0	38	3.9
	150 to 200	36	3.7	45	4.6
	over 200	40	4.0	50	5.1
SPB	112 to 160	40	4.0	50	5.1
	170 to 224	50	5.1	62	6.3
	236 to 355	62	6.3	77	7.9
	over 355	65	6.6	81	8.3
SPC	224 to 250	70	7.1	87	8.9
	265 to 355	92	9.4	115	12.0
	over 375	115	12.0	144	15.0
8V	Up to 355	104	10.6	130	13.3
	356 to 560	136	13.9	170	17.4
	561 to 800	154	15.7	192	19.6
Z	56 to 100	5 to 7.5	0.5 to 0.8	-	-
A	80 to 140	10 to 15	1.0 to 1.5	-	-
B	125 to 200	20 to 30	2.0 to 3.1	-	-
C	200 to 400	40 to 60	4.1 to 6.1	-	-
D	355 to 600	70 to 105	7.1 to 10.7	-	-
E	500 and above	95 to 140	9.6 to 14.3	-	-



Use of Spring Scale for Belt Tensioning

As shown in above figure, if a spring loaded belt tension indicator is not available, a spring scale/balance and a vernier caliper (or rule) will suffice to tension belts.

Belt Tensioning of Banded V-Belts

As per Fenner, spring loaded belt tension indicator can be used, as for individual belts but with the same setting force MULTIPLIED by the number of belts in a band (2, 3, 4 or 5). To ensure even deflection of all belts in the band, it is recommended to place a piece of rigid bar across the band width.

As per some manufacturers, the usual tensioning method by deflection load may not be usable for the accurate tensioning of banded V-belts. They recommend tensioning of the belts by the elongation method. Please follow the method recommended by the belt manufacturer.

Sonic/Frequency Tension Meter

Sonic Tension Meter

V-belts can be tensioned using sonic/frequency tension meter also because a belt vibrates at a particular frequency based on its tension, mass and span length. The tension meter transforms this frequency into a tension value.

The sonic tension meter measures belt tension by analyzing the vibration frequency of sound waves which the belt produces when strummed/plucked. This is the span vibration method of tensioning belts.

Sonic tension meters are made by Gates Corporation (www.gates.com). For more details on the use of Gates' sonic tension meter, please see Gates' sonic tension meter manual.

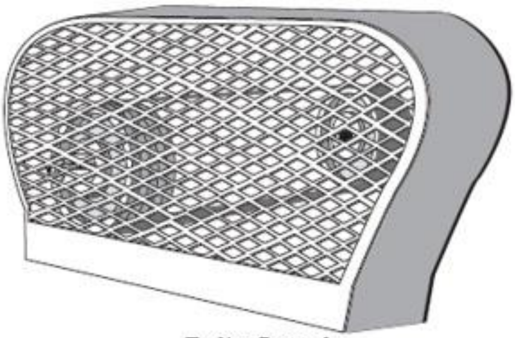
The tension meter based on belt's vibration measurement by SKF is called belt frequency meter. For more information on belt frequency meter contact SKF (www.skf.com).

Guards

For safety, every belt drive must be guarded when in operation. Guard must be designed and installed according to OSHA standards.

A properly designed guard has the following features:

- It completely encloses the drive.
- It is equipped with grills or vents for good ventilation.
- Has adequate size of the openings, i.e. small enough to prevent "pinch points”.
- Has accessible inspection door or panels.
- Can easily be removed and replaced if damaged.
- Where necessary, should protect the drive from weather, debris and damage.



Belts Guard

When guard is fitted to a drive, it is essential that it allow the free movement of air in order to avoid unnecessary heat buildup. As shown in above figure, preferably the guard should be of wire mesh design. A closed-at-the-top belt guard should be provided for dirty environment.

Maintenance and Troubleshooting of V-Belts

Compared to chain drives (with constant lubrication problems), or gear drives (with mechanical problems and high costs), belt drives are the most cost-effective and reliable means of power transmission. However, this reliability can only be obtained by preventive maintenance of the belt drive.

Preventive Maintenance

Preventive maintenance of the belt drive includes shorter preventive inspections and thorough inspections with a longer period of machine shutdown.

Shorter Preventive Inspections

With most drives, shorter preventive inspection (a quick visual and hearing inspection) should be performed once a month. However, for critical drives, it may be needed every one to two weeks.

In shorter preventive inspection, listen for any unusual vibration or sound while observing the guarded drive in operation and look for the following.

Inspect the guard for looseness or damage. Keep it free of debris and grime buildup. Any accumulation of material on the guard will act as insulation and could cause the drive to run hotter.

Look for oil or grease dripping from the guard. This may indicate defective oil seals / O-Rings or over-lubricated bearings. Oil and grease attack rubber compounds, causing them to swell and distort. This will lead to early belt failure.

Check motor mounts for proper tightness. Check takeup slots or rails to see that they are clean and lightly lubricated.

Thorough Inspections

A drive should be shut down for a thorough inspection of belts, pulleys and other drive components every three to six months. In thorough inspections, check the following.

- Remove and inspect guard. Check for signs of wear or rubbing against drive components. Clean guard as needed.
- Inspect belt for wear or damage. Replace if needed.
- Inspect pulleys for wear or damage. Replace if worn.
- Inspect other drive components such as bearings, shafts, motor mounts and takeup rails.
- Inspect static conductive earthing system (if used) and replace components if needed.
- Check pulley alignment and correct if required.
- Check belt tension and adjust if needed.

After thorough inspection, start the drive. Look and listen for anything unusual.

Troubleshooting Tools

To determine the cause of a drive problem, you may use following tools.

Eyes, Ears, Nose and Hands

Observing the drive in operation or at rest may indicate problem areas.

When the drive is in operation, look for anything unusual about the way the belt travels around the drive. Look for the drive frame flexing under load. Smell for warm rubber. Hear for chirping, squealing or grinding noises.

Once the drive is shut down, you can use your hands. Your hand can tolerate up to about 60°C (140°F), the maximum temperature at which a properly maintained belt should operate. If you cannot touch the belt after operation, it indicates a problem which causes heat buildup.

Feel the pulley grooves. They should be smooth, free of nicks and debris. Inspect the belt for unusual wear patterns, signs of burning or cracking.

Ball of String

Variation in drive centre distance, often caused by a weak supporting structure, can cause vibration and shorten the belt life. To determine if centre distance variation exists, turn off the drive and tightly tie a piece of string from the driver to the driven shaft. Now start the drive and note if the string stretches almost to the point of breaking, or goes slack. If either is the case, the problem could be centre distance variation. However, it is important to observe the string at the moment of start-up, when the loads are highest. String can also be used to check pulley alignment.

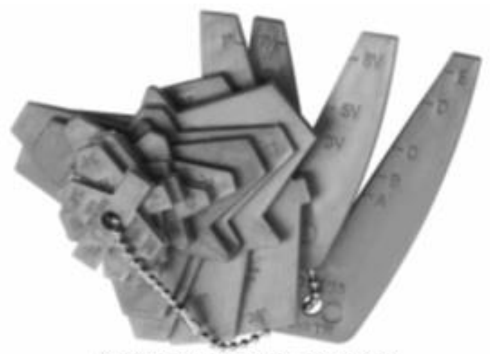
Long Straight Edge

A long straight edge can be used to quickly check pulley alignment.

Laser Alignment Tool

A more precise, quick and easy way to check alignment, particularly over long distances, is to use a laser alignment tool on both the pulleys.

Belt and Sheave Gauges



Belt and Sheave Gauges

Belt and sheave gauges can be used to check dimensions. These are handy for identifying a belt cross-section for replacements and for checking pulley grooves for wear.

Tension Meter

Improper belt tension, either too high or too low, can cause belt problems. Although the "experienced thumb" will suit ordinary V-belt drives, it is recommended the use of the tension meter/gauge for critical drives. Several tension meter types are available. The pencil type suits most situations.

Infrared Thermometer

While hands can be the first check for belt temperature problems, the infrared thermometer allows you to measure belt temperatures more accurately.

Strobe Tachometer

You cannot always see what is happening to a drive while it is in operation. Strobe tachometer allows you to stop the action to get a better idea of the dynamic forces affecting the drive.

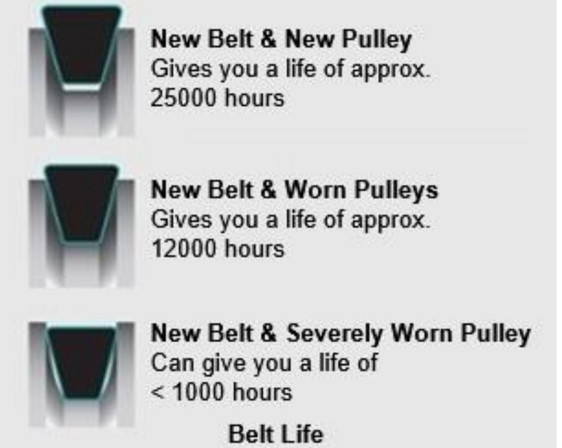
Troubleshooting of V-Belts

When troubleshooting a V-belt drive problem, you have to identify the cause(s) and then to take appropriate corrective action.

For troubleshooting, think about the problem:

- What is wrong?
- When did it happen?
- How often does it happen?
- What is the drive application (normal or severe)?
- Have the machine operations or output changed?
- What kind(s) of belts are specified and what kind of belts were used?
- What are your expectations for belt performance (efficiency, life, etc.) in this application?

Belt Life



Belt Life

V-belts are generally designed for a life of approximately 25000 hours (3 to 5 years). Critical application may require belt replacement every year. Above figure shows life of a V-belt with different pulley conditions. Premature belt failure can often be traced back to faulty installation or maintenance.

Use the following table for troubleshooting a V-belt drive problem.

Problem / Symptom	Probable Cause	Solution
Broken belt(s)	Drive under designed	Check drive design.
	Belt rolled or pried onto pulley	Use drive takeup when installing.
	Severe shock load	Redesign to accommodate shock load.
	Drive blocked	Remove cause.
Edge cord failure	Pulley misalignment	Check and correct alignment.
	Damaged tensile member	Use drive takeup when installing.
Belt delamination or under cord separation	Pulleys too small	Check drive design, replace with separation larger pulleys.
	Back side idler too small	Increase size of back side idler.
Belt fails to carry load (slip)	Drive under tensioned	Tension properly.
	Drive overload	Redesign the drive.
	Worn pulley grooves (belt bottom in groove)	Check for groove wear, replace as needed.
	Centre distance movement	Check drive for centre distance movement during operation.
	Excessive oil or grease	Provide better shielding on drive.
Multiple belts stretches unequally beyond available takeup	Misaligned drive	Realign and retension drive.
	Debris in pulleys	Clean pulleys.
	Broken tensile member or cord damaged	Replace all belts, install properly.
	Mismatched belt set	Install matched belt set.
Belt/s stretches evenly beyond available takeup	Insufficient takeup allowance	Check takeup. Use specified allowance.
	Grossly overloaded or under designed drive	Redesign drive.
	Broken tensile members	Replace belt, install properly.
Wear on belt top surface	Rubbing against guard	Repair/replace guard.
	Idler malfunction	Replace idler.
Wear on belt top or bottom corner	Belt-to-pulley fit incorrect	Use correct belt-to-pulley combination.
Wear on belt sidewalls	Belt slip	Retension until slipping stops.
	Misalignment	Realign pulleys.
	Rough side walls or worn pulleys	Replace pulleys.
	Incorrect belt	Replace with correct belt size.
Wear on belt bottom surface	Belt bottoming on pulley groove	Use correct belt/pulley match.
	Worn pulleys	Replace pulleys.
	Debris in pulleys	Clean pulleys.
Under cord cracking (Cuts and splits in the base)	Pulley diameter too small	Use larger diameter pulleys.
	Belt slip	Retension.
	Outside idler too small	Use larger diameter outside idler.
	Improper storage	Do not coil belt too tightly, kink or bend. Avoid heat and direct sunlight.
Burn or hardening on bottom or sidewall	Belt slip	Retension until slipping stops.
	Worn pulleys	Replace pulleys.
	Shaft movement	Check for centre distance changes.
Extensive hardening of belt exterior	Hot drive environment	Improve ventilation to drive.
Belt surface flaking, sticky or swollen	Oil or chemical contamination	Eliminate sources of oil, grease or chemical contamination. Do not use belt dressing.
V-belts turn over or come off drive	Shock loading or vibration	Check drive design.
	Foreign material in grooves	Shield grooves and drive.
	Misaligned pulleys	Realign pulleys.
	Worn pulley grooves	Replace pulleys.

	Damaged tensile member	Use correct installation and belt storage procedure.
	Mismatched belt set	Replace with new set of matched belts. Do not mix old and new belts.
Squeal or “chirp”	Belt slip	Retension.
	Contamination	Clean belts and pulleys.
Slapping noise (Belts flapping)	Loose belts	Retension.
	Mismatched set	Install matched belt set.
	Misalignment	Realign pulleys so all belts share load equally.
Rubbing sound	Guard interference	Repair or redesign guard.
Grinding sound	Damaged bearings	Replace, align and lubricate.
Unusually loud drive	Incorrect belt	Use correct belt size.
	Worn pulleys	Replace pulleys.
	Debris in pulleys	Clean pulleys.
	Overloaded drive	Redesign drive.
Excessive vibration	Resonant condition	Change drive dimensions (increase / decrease centre distance), use idler on belt slack side.
	Centre distance too long	Reduce centre distance.
	Pulley not balanced	Provide dynamically balanced pulleys.
	High shock load	Increase tension. Use banded belts.
	Loose or under design drive components	Check structure, machine components, guards, motor mounts, brackets, framework etc. for stability and adequate design strength.
Cutting through the top band in banded/joined belts	Worn sheave grooves allow the banded/joined belt to ride too low cutting through to the top band.	Replace sheaves and maintain proper belt tension and sheave alignment.
Broken or damaged pulley	Incorrect pulley installation	Do not tighten bushing bolts beyond recommended torque values.
	Foreign objects falling into drive	Use adequate drive guard.
	Excessive rim speeds	Keep pulley rim speeds below maximum recommended values.
	Incorrect belt installation	Do not prey belts onto pulleys.
Rapid wear of pulley groove	Excessive belt tension	Retension.
	Sand, debris or contamination	Clean and shield drive.
Bent or broken shaft	Belts extremely over tensioned	Repair or replace shaft and correctly tension the belts.
	Machine design error	Check machine design.
Hot bearings	Belts over tensioned on account of belts bottoming due to worn grooves and does not transmit power until over tensioned	Replace pulleys and retension properly.
	Sheaves too small	Follow motor manufacturer`s recommendation for sheave diameter.
	Bearing under designed	Check bearing design.
	Pulleys too far out on shaft	Place pulleys as close as possible to bearings.
	Bearing not properly maintained	Align and lubricate bearing.

Squeal and Chirp

A squealing noise (prolonged, sharp sound) is an indication of belt slip and is most often due to insufficient belt tension. If the drive is properly tensioned, the squealing could be due to dirt, oil, grease, misalignment or belt overload. A belt “chirp” sounds somewhat like a chirping bird (short, sharp sound), hence the name, and is often caused by misalignment.

Dust can also be a contributing factor. Extremely wet or dry conditions can also cause chirp. Chirps are often annoying but do not significantly shorten belt life.

Maintenance Tips

Drive Alignment

Drive alignment is one of the most common causes of short V-belt life.

Identification of Slippage

V-belts don't always squeal when they are slipping. If slippage is suspected, a sure way of determining it is by stopping the drive (lock it out!) and placing your bare finger against the inside of a pulley / sheave groove. If slippage is present, it will generate enough heat (temperature will be > 60°C) so that you can't keep you finger on the groove. If this is true, and there is no outside heat source, then the drive is probably slipping.

The drive should be tightened if pulleys / sheaves are not worn. If the pulleys / sheaves are worn, replace them and then tension the drive.

The ideal tension is the lowest tension at which the belts will not slip under peak load conditions.

Belt Dressings

Belt dressings can temporarily increase friction between the belt and pulley. However, this is a temporary fix until the cause of slippage can be identified and corrected.

As belt dressings are usually made from a petroleum derivative, they degrade the surface of the belt and shorten belt life. In view of this, never apply belt dressings to new V-belts.

Belt Replacement

Should an individual belt in a matched set require replacement for any reason, a complete new set must be fitted. Never mix new and used V-belts because it will result in uneven load sharing. Belts from different manufacturers must not be mixed on the same drive to prevent uneven load sharing.

Use the correct belt cross section to the pulley / sheave groove (e.g.: Use belt section A with pulley groove A).

Don't replace "A" or "B" heavy duty V-belts with "4L" or "5L" light duty (FHP) V-belts. FHP belts are built for Fractional Horsepower applications, and usually run singly. Most multiple drives require heavy duty belts.

Correcting Under-belting

Using fewer belts than recommended by good design practice results in excessive tension in each belt on the drive. This is commonly evidenced by excessive stretching which requires frequent take-ups to prevent slippage. Another warning sign can be repeated belt breakage.

In many cases, under-belting can be corrected simply by using raw edge, cogged V-belts which have a higher horsepower rating.

Glossary of Terms for V-Belt Drives

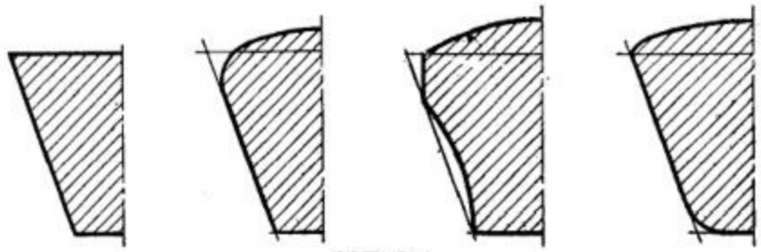
The ISO 1081 standard describes two systems for defining pulleys and V-belts: datum system and effective system. This means that three concepts are now being used for describing drives with V-belts: datum and effective as well as the traditional term, pitch.

With the introduction of the datum system and effective system, the grooves and diameters of pulleys as well as V-belt lengths have been determined in a way that is clear and unambiguous. Pitch is used only for calculating the speed ratio and the belt speed of the drive.

In view of above, information on selected terms and definitions relating to drives using V-belts and grooved pulleys is as under.

General Terms and Definitions

V-Belt



V-Belts

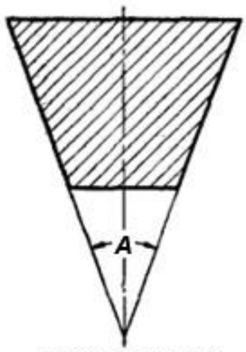
A belt, the cross-section of which is shaped roughly like a trapezium. The latter is usually isosceles.

On a cross-section of a straight-sided belt, the trapezium is outlined by the base, sides and top of the belt.

The intersection of the extended profiles of the base, side and top is considered when the edges are cut short or rounded.

Note: In an extreme case, the base comes to a point and this gives a triangular belt.

Angle of a V-Belt



Angle of V-Belt

The included angle (*A*) obtained by extending the sides of the belt is called angle of a V-belt.

Pitch Line and Pitch Zone of a V-Belt

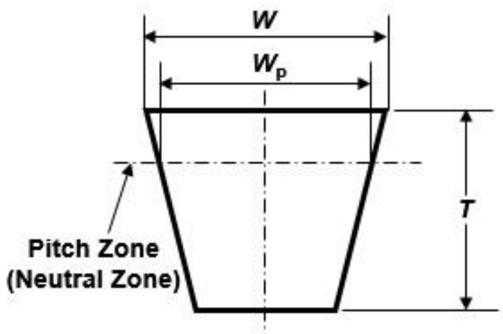
Pitch Line and Pitch Zone of a V-Belt

Any circumferential line in the belt which keeps the same length when the belt is bent perpendicularly to its base is called a pitch line.

Geometric zone containing all of the pitch lines is called the pitch zone.

Note: Tensile and compressive stresses occur in the cross section of the belt profile during the bending of the belt in the pulley groove. The line in which these stresses will decrease to "0" (zero) is termed pitch, pitch line, pitch zone or neutral axis.

Pitch Width, Top Width and Height of a V-Belt



Pitch Width, Top Width and Height of V-Belt

Pitch width (W_P) of a V-belt is the width of the belt at its pitch zone (neutral zone). The width remains unchanged when the belt is bent perpendicularly to its base.

Top width (W) of a V-belt is the larger width of the trapezium outlined on a cross-section.

Height (T) of a V-belt is the height of the trapezium outlined on a cross-section.

The **relative height of a V-belt** is non-dimensional characteristic calculated as the ratio of height to pitch width (T / W_P)

The approximate relative height of the narrow type and classical type of V-belt is as follows:
Narrow type V-belt: 0.9
Classical type V-belt: 0.7

Outside Length of a V-Belt

Outside length of a V-belt (L_o) is the circular length measured along the outside of the belt when the belt is in a normal untensioned condition. Generally, the outside length of the V-belt is measured with a measuring tape on the outside of the belt while the belt is installed in the measuring machine.

Inside Length of a V-Belt

Inside length of a V-belt (L_i) is the circular length measured along the inside of the belt when the belt is in a normal untensioned condition.

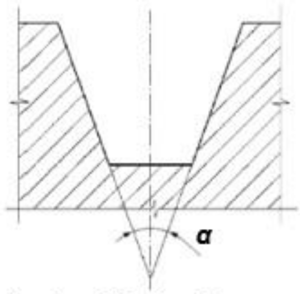
Inside length is generally measured over two plane pulleys with the diameter d (mm), centre distance e (mm) and is calculated as follows:

Inside Length = $2 \times e + \pi \times d$ (mm)

V-grooved Pulleys

A pulley with one or more grooves (which, in most cases, have an identical profile in the shape of a truncated or non-truncated symmetrical V) obtained by rotation of the groove profile around the pulley axis.

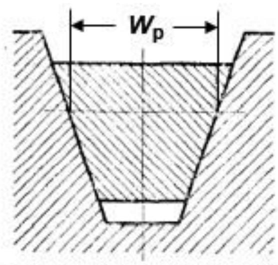
Angle of Pulley Groove



Angle of Pulley Groove

Angle of pulley groove is the angle (α) included by the sides of the groove cross-section. For any given profile, the pulley groove angle may have several different values depending upon the pulley diameter.

Pitch Width of a Pulley Groove



Pitch Width of a Pulley Groove

Pitch width (W_p) of a pulley groove is that width of the pulley groove which has the same dimensions as the pitch width of the belt used with this pulley.

Pitch Diameter of a Grooved Pulley

Pitch diameter of a grooved pulley (d_p) is the diameter of the pulley measured at the level where the width of the groove is equal to the pitch width of the corresponding belt.

V-Belt Drive

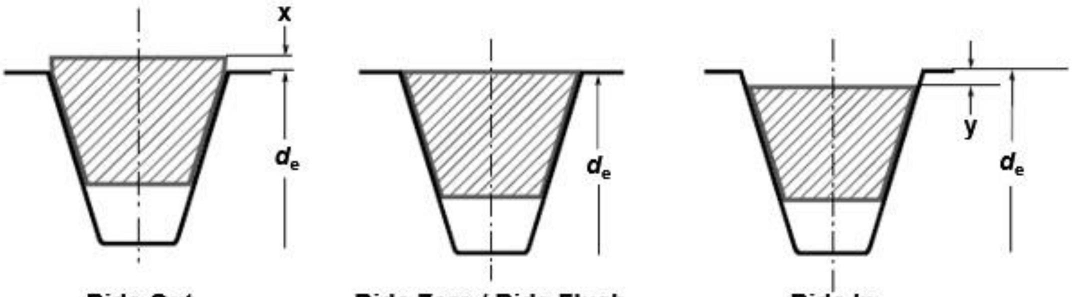
A drive which consists of one or more V-belts mounted on grooved pulleys. The profiles of the belts and of the pulley grooves are such that the belts come into contact only with the sides of the pulley grooves and not with the base of the grooves.

Speed Ratio of V-Belt Drive

The ratio of angular velocities of the pulleys, as calculated from the ratio of the pitch diameters of the pulleys and making no allowance for the slip and creep.

Ride

The placement of a V-belt section in the groove of the standard pulley designed for it is described with the term "Ride". This is the distance from the top of the section to the outside diameter (d_e) of the pulley. The permissible maximum/minimum distance/ride is specified in standards.



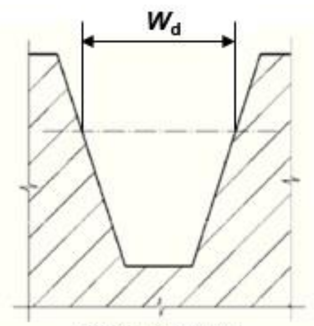
Ride out is the distance (x) from the top of the V-belt section to the outside diameter (d_e) of the pulley.

When the top of the V-belt section is flush with the outside diameter (d_e) of the pulley, it is called ride zero / ride flush.

Ride in is the distance (y) from the top of the V-belt section to the outside diameter (d_e) of the pulley.

Terms and Definitions Relating to The System Based On Datum Widths

Datum Width



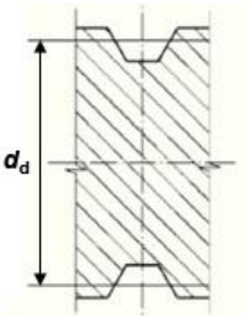
Datum Width

Datum width (W_d) is the groove width characterizing the groove profile of a V-belt pulley. It is a defined value not subject to tolerance and is usually located at the level of the pitch zone of the V-belt for which the pulley groove is preferably intended. It should coincide with the pitch width of that V-belt within reasonable tolerances.

The datum width of a pulley groove was previously designated as *pitch width*. However, the datum width is equal to the pitch width only when the pitch zone on the V-belt is located at the level of the datum width of the pulley groove.

If different angles of pulley groove are required, the groove flanks shall be assumed to hinge round both ends of the datum width.

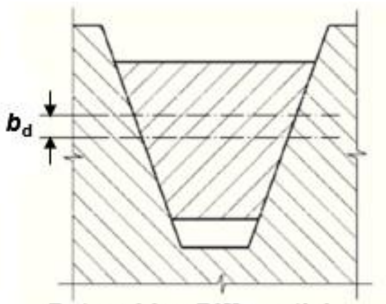
Datum Diameter



Datum Diameter

Datum diameter (d_d) is diameter of the pulley at the datum width of the pulley groove.

Datum Line Differential



Datum Line Differential

Datum line differential (b_d) is the radial displacement between the levels of the pitch width and the datum width.

The datum line differential is a correction term used for calculating the speed ratio when the datum line is given. The datum line differential is zero if the pitch zone of the V-belt and the level of the datum width of the pulley are coincident.

Datum Length

Datum length (L_d) is the length of a line circumscribing a V-belt at the level of the datum diameter of the measuring pulleys whilst the V-belt is at a specified tension.

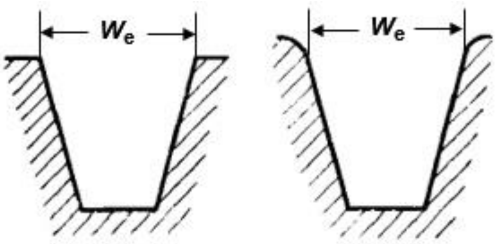
The datum length was previously designated as pitch length, L_p.

The recommended method for measuring the datum length of a V-belt includes the use of a measuring fixture having two pulleys of the same datum diameter. The datum length is obtained by adding the datum circumference of one pulley to twice the measured distance between the pulley centers.

Note:
In short, ISO has determined that the datum groove width (W_d) of pulleys shall be identical with the formerly standardized pitch groove widths. In practice, the pitch diameter (d_p) of the pulleys is now termed datum diameter (d_d) and that the pitch length (L_p) of the V-belts is changed into a datum belt length (L_d).

Terms and Definitions Relating to The System Based On Effective Width

Effective Width



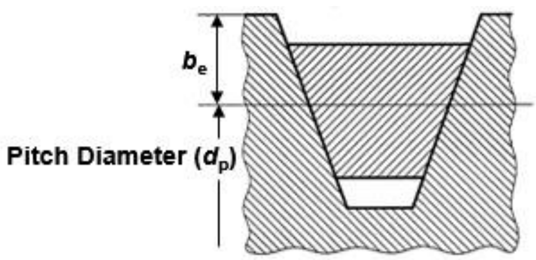
Effective Width

Effective width (W_e) is the groove width characterizing the groove profile. It is a defined value not subject to tolerance. It is usually located at the outermost extremities of the straight side walls of the groove. For all belt-measuring pulleys and for most machined-type pulleys, it coincides with the actual top width of the groove within reasonable tolerances. If different angles of pulley groove are required, the groove flanks shall be assumed to hinge round both ends of the effective width.

Effective Diameter

Effective diameter (d_e) is the diameter of the pulley at the effective width of the pulley groove.

Effective Line Differential



Effective Line Differential

Effective line differential (b_e) is the radial displacement between the levels of the pitch width and the effective width. The effective line differential is a correction term used for calculating the speed ratio when the effective diameter is given.

Effective Length

Effective length (L_e) is the length of a line circumscribing a V-belt at the level of the effective diameter of the measuring pulleys whilst the V-belt is at a specified tension.

The recommended method for measuring the effective length of a V-belt includes the use of a measuring fixture having two pulleys of the same effective diameter. The effective length is obtained by adding the effective circumference of one pulley to twice the measured distance between the pulley centers.

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