Pitfalls of interchanging U.S. and metric standard V-belts

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Specification numbers for V-belts manufactured to different international standards (U.S. and metric) and with different units of measure (inches and millimeters) may indicate that they are interchangeable. But their dimensions can differ enough to cause poor performance.

According to engineering standards, V-belts designated with the same cross section should operate interchangeably with sheaves that have grooves designated by the same letter. For multi-belt drives, however, manufacturers don't recommend mixing belts from different manufacturers on the same drive because of possible differences in the cross-sectional shape, included angle between sidewalls, or length, Figure 1.

Replacing metric belts

The same recommendation applies to interchanging V-belts manufactured to different international standards, even though interchange guides are available. Such standards express belt dimensions in different units of measure: U.S. standards use English units (inches), whereas metric standards use millimeters.

Machinery designed in Europe according to standards of the International Organization for Standardization (ISO) or DIN (Germany) is widely used by many U.S. industries (e.g., textile looms, packaging equipment, and machine tools).

On much of this machinery, it may be tempting to try to save money by replacing imported OEM V-belt drive components with U.S. (RMA) standard components that are available off-the-shelf from industrial distributors as well as V-belt and sheave manufacturers.

Interchange catalogs, or crossover guides are supposed to help you match V-belts made to U.S. standards (RMA) with industrial belts made to metric standards (ISO/DIN). These guides use a soft conversion formula (not exact) to identify the manufacturer's belts and *nearly* equivalent metric belts covered by ISO and DIN standards.

By using a cross-section interchange chart, you can match the first two numbers of metric classical belts, or the letters on narrow metric belts, to the corresponding U.S. standard designation, see chart.

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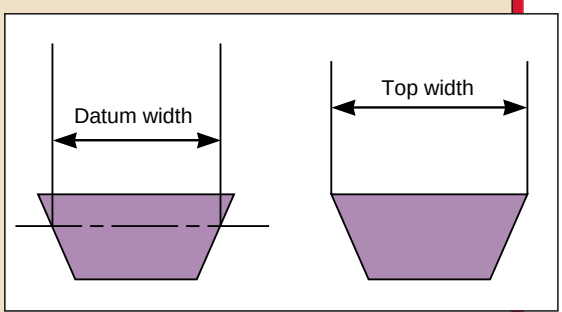
What do the numbers mean?

Standard V-belts are identified by numbers that indicate cross-sectional dimensions and length, and these numbers are marked on each belt. However, the numbering system differs between U.S. and metric standards, and within the metric system, between ISO and DIN standards.

Nominal dimensions of U.S. classical and narrow V-belts are expressed in inches. For classical V-belts, the part number consists of a letter identifying the cross section and a numeric designation identifying approximate inside length. Narrow V-belt sizes are identified by a number — 3, 5, or 8 — indicating the nominal belt top width in 1/8th-inch increments, followed by the letter "V." Remaining digits in the size designation indicate the effective belt length in tenths of inches.



Datum width and top width of the belt cross section are used to identify classical V-belts made to metric ISO and DIN standards respectively.

In the metric system, classical belts manufactured to ISO standards are identified by an ISO number indicating datum width (see figure) and datum length in millimeters. Datum length is a theoretical length based on datum diameters of the sheaves. For classical belts made to DIN standards, the numbers indicate nominal top width (see figure) and inside circumference in millimeters.

All narrow belts in the metric system are marked with letters indicating the cross-section: SPZ, SPA, SPB, SPC, plus numbers indicating the datum length in millimeters (e.g., SPZ 1500). A general designation of "SP" identifies metric narrow belts, and "XP" indicates molded notch metric narrow belts.

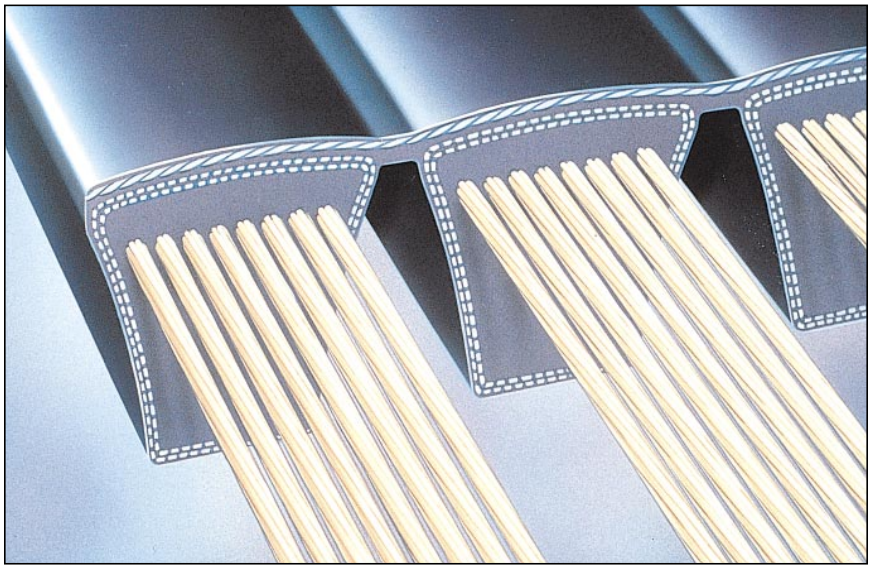


Figure 1 — Multi-belt drives, especially those with joined V-belts, may operate poorly or experience shortened belt life when equipped with belts and sheaves manufactured to different standards.

After determining the belt type and datum width or top width, you can identify the manufacturer's equivalent (closest matching) U.S. belt on separate charts in the interchange or crossover guide. These charts also contain length information.

Words of caution

Before substituting a U.S. belt for its metric equivalent based on an interchange chart, check for dimensional differences in cross sections, length, and belt ride-out (distance a belt extends beyond the sheave OD). For multi-belt drives with joined belts, check for compatibility between belt centers and sheave groove spacing.

A U.S. belt may have a different cross section or length than a comparable metric belt, even though their specification numbers indicate interchangeability. Further, it's common to find metric belts in nonstandard cross sections and lengths that can't be easily interchanged with U.S. belts.

Some interchange catalogs list differences in length between equivalent U.S. and metric belts, with these differences typically ranging up to 1 in. for the longest belts. The difference in length that can be tolerated depends on the application and the amount of take-up. It is usually up to the equipment operator or maintenance engineer to decide if the difference in length is acceptable for a particular application.

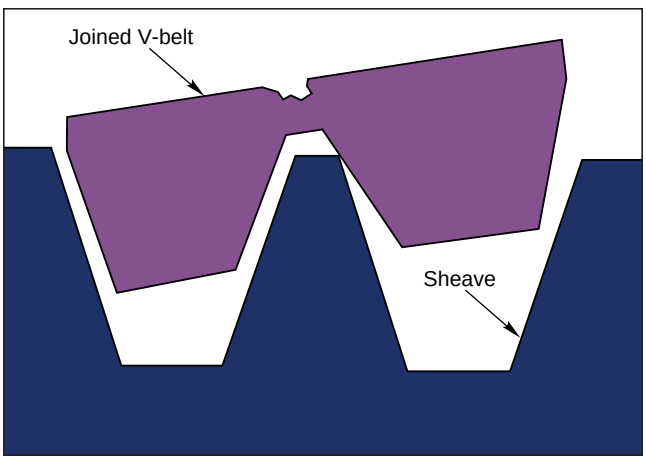


Figure 2 — When U.S. and metric belt drive components are intermixed, the mismatch in spacing between sheave grooves and joined belt centers may reduce belt and sheave life.

Differences in belt ride-out and included angle of the cross section between equivalent U.S. and metric belts can adversely affect the speed ratio of the drive, as well as power capacity.

Because of differences in groove spacing between U.S. and metric sheaves, Figure 2, interchanging joined U.S. belts with joined metric belts causes the belts to seat improperly in the sheaves. This leads to early belt failure and rapid sheave wear.

If you're unsure about the effect of any dimensional differences on your application, consult the belt manufacturer. Fail-

Typical V-belt cross-section interchange chart

Metric standards		RMA standard	
ISO datum width, mm	**DIN top width, mm**	**Cross section**	**Nominal top width, in.**
	Classical		
11	13	A	½
14	17	B	21/32
19	22	C	⅞
27	32	D	1¼
32	40	E	1½
	Narrow		
SPZ/XPZ	SPZ	3V/3VX	⅜
SPB/XPB	SPB	5V/5VX	⅝
*SPA/XPA	SPA	A	½
*SPC/XPC	SPC	C	⅞

Though cross sections A and C are dimensional interchanges for SPA and SPC, dependent on the specific drive, reduced belt performance may result.

ure to use compatible replacement belts can lead to reduced belt service life and lost production due to equipment downtime, especially on speed-sensitive machinery typically used in the textile, packaging, and machine tool industries.

Case history

Users often waste time and money because they don't realize that joined U.S. and metric belts are different. Many exasperated maintenance personnel (along with local distributors as observers) have experienced early belt failure without understanding the cause.

At one U.S. textile plant, for example, maintenance supervisors bought from their local distributor what appeared to be equivalent U.S. joined belts to replace metric joined belts for their European-manufactured machinery. Using an interchange table for single belts, they found that their original metric (SPB) belt was dimensionally the same as a U.S. 5V belt.

The supervisors quickly discovered that although the basic "V" portion of both belts was essentially the same, there are differences in spacing when two or more V-belts are joined at the top. The result: improper seating between belts and sheaves, leading to early belt failure.

Switching from joined replacement belts to single belts proved equally disappointing when the single belts turned over and came off their sheaves due to equipment vibration caused by shock loads — thus the need for joined belts. The supervisors finally resolved the problem with a made-to-order (MTO) joined metric belt designed for the specific machine.

Typically, MTO belts require production lead time of several weeks, minimum production quantities, and higher cost than off-the-shelf belts. This option also increases downtime cost if replacement inventory is not maintained. And of course, there's an associated inventory cost.

Another option is to switch from metric to U.S. sheaves. Engineers prescribed such a solution for a Brazilian production facility where operators had reliable, economical access to U.S. belts from a local source.

Any decision to incur the expense of replacing sheaves, or to custom order joined MTO metric belts, needs to be weighed against the availability and added cost of importing metric belts from OEMs. ■

Keep them trouble-free

After you've properly interchanged V-belt drive components, ensure their efficient operation and long service life by following these maintenance tips:

- Never mix old and new belts on multiple belt drives. Older belts don't have the same tensile capabilities as newer belts, so the drive load is carried only by the newer belts.
- When a belt fails to ride properly in the sheave groove, excessive wear of the sheaves may be the cause. This may require sheave replacement. Use a sheave groove gage to inspect for wear. Also inspect sheaves and bushings for chipping, cracking, and other damage.
- If belt drives operate under conditions of high speeds, heavy loads, frequent starts and stops, and temperature extremes, or on critical machinery, check them for noise, vibration, or visual deterioration every 1 to 2 weeks.

A more complete inspection of belts and sheaves may be required every 3 to 6 months. With the power off, check the belt for wear, cracks, frayed spots, or cuts. Check belt temperature by touch, infrared heat detector, or needle pyrometer. Make sure the belt is properly tensioned. Too little tension may cause slip; too much tension can reduce belt and bearing life.

- Check sheaves for proper alignment with a straight edge.
- Check guards for wear or damage and clean them to prevent clogging and ventilation loss.
- Check bearings for proper alignment and lubrication, motor mounts for tightness, and take-up rails for dirt, rust, and obstructions.