



SURFACE VEHICLE STANDARD

J1459™

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Superseding J1459 DEC2009

V-Ribbed Belts and Pulleys

RATIONALE

This latest revision of SAE J1459 accomplishes the following:

- Fixed errors in Table 1.
- Added definitions and diagrams for different types of diameters used.
- Added optional belt dimensioning template.
- Provided correct calculations for pulley ratio calculation via pitch diameter ratio.
- Provided correct calculations for converting center distance to effective length.
- Updated to generic center distance tolerances to align with industry.

1. SCOPE

This SAE Standard covers the dimensioning technique, tolerances, and methods of measurement of V-ribbed belts and mating pulleys for use on automotive accessory drives.

2. REFERENCES

There are no referenced publications specified herein.

3. V-RIBBED BELTS

Although several V-ribbed cross sections are available, this document shall be confined to "PK" (K) section belts which are used in automotive applications, including trucks at least up to Class 3. Belts shall conform to Figure 1.

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4. PULLEYS MATING WITH V-RIBBED BELTS

It is the intention of this document to relate the belt profile to the pulley profile using the variables associated with the 2.50 mm ball used in measuring pulley diameters. Pulleys shall conform to Figures 2, 3, and 4. Figure 2 shows a split pulley section, Figure 3 a folded pulley section—both preferred constructions. Figure 4 shows an optional folded pulley section.

4.1 Pulley Diameter Definitions

The diameter over balls (DOB, or D_b) is the only diameter measured on a pulley in the groove/flange area. There are other diameters used that are calculated from this value. The ball diameter is defined as 2.500 mm \pm 0.010 mm. See Tables 1A and 1B.

**Table 1A - Pulley diameter - 40 degrees groove
(for calculation purposes only - 40 degrees groove)**

| Diameter | Definition |
|------------|--|
| Effective | $D_b - 0.990$ (Belt Reference Value)* |
| Groove Tip | $D_b - 1.875$ (Groove Diameter with 0.48R Tip) |
| Apex | $D_b - 0.028$ (Flank Intersect) |
| Pitch | $D_b + 2PB\Delta g$ (To Cord Line) |

* Effective diameter is always $D_b - 0.99$, as its only reference value used for the belt length callout.

**Table 1B - Pulley diameter - 37 degrees groove
(for calculation purposes only - 37 degrees groove)**

| Diameter | Definition |
|------------|--|
| Effective | $D_b - 0.990$ (Belt Reference Value)* |
| Groove Tip | $D_b - 1.805$ (Groove Diameter with 0.48R Tip) |
| Apex | $D_b + 0.261$ (Flank Intersect) |
| Pitch | $D_b + 2PB\Delta g$ (To Cord Line) |

* Effective diameter is always $D_b - 0.99$, as its only reference value used for the belt length callout.

Effective diameter is based on the tip diameter for a 40 degree pulley with 0.25R tip radius, while this standard utilizes a 0.48R tip radius for the pulley. This can be seen in Figure 1:

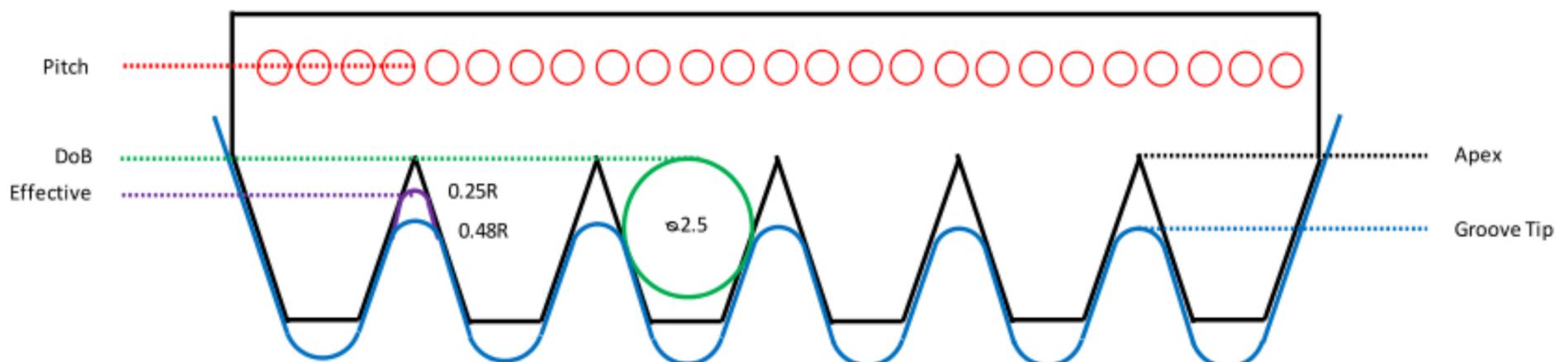


Figure 1 - Belt cutaway

4.2 Pulley Ratio Calculation

A pulley ratio is calculated using the ratio of the pitch diameters of the driver pulley and driven pulley using Equation 1:

$$\text{Ratio} = \frac{D_{\text{pitch,driver}}}{D_{\text{pitch,driven}}} \quad (\text{Eq. 1})$$

4.3 Dimensioning Templates

This section has a belt template drawing, as well as three different pulley template drawings that are to be used.

NOTE: Flange geometry is important to enable a mis-seated belt to center itself once the pulley starts to rotate.

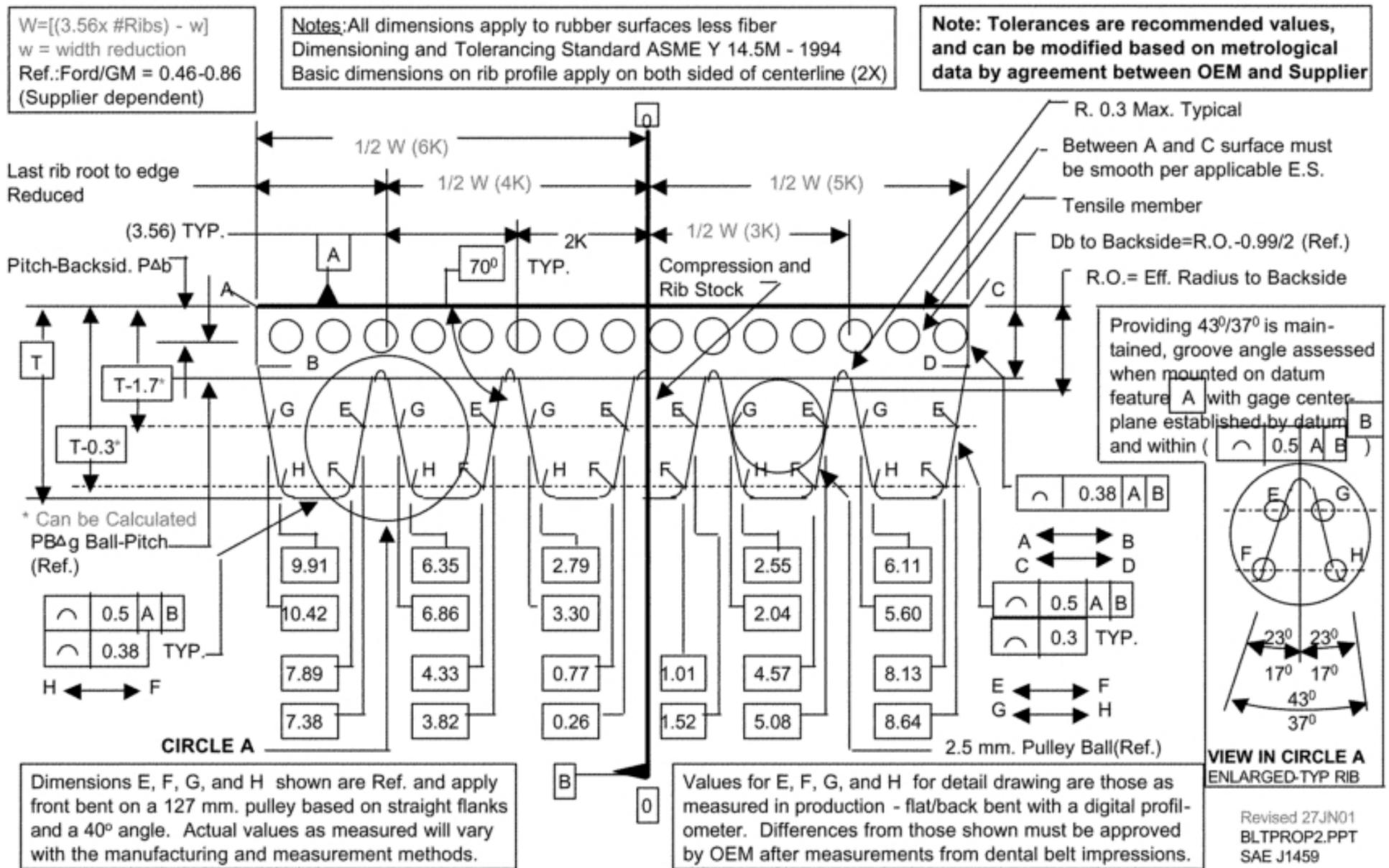


Figure 2 - Belt dimensioning template

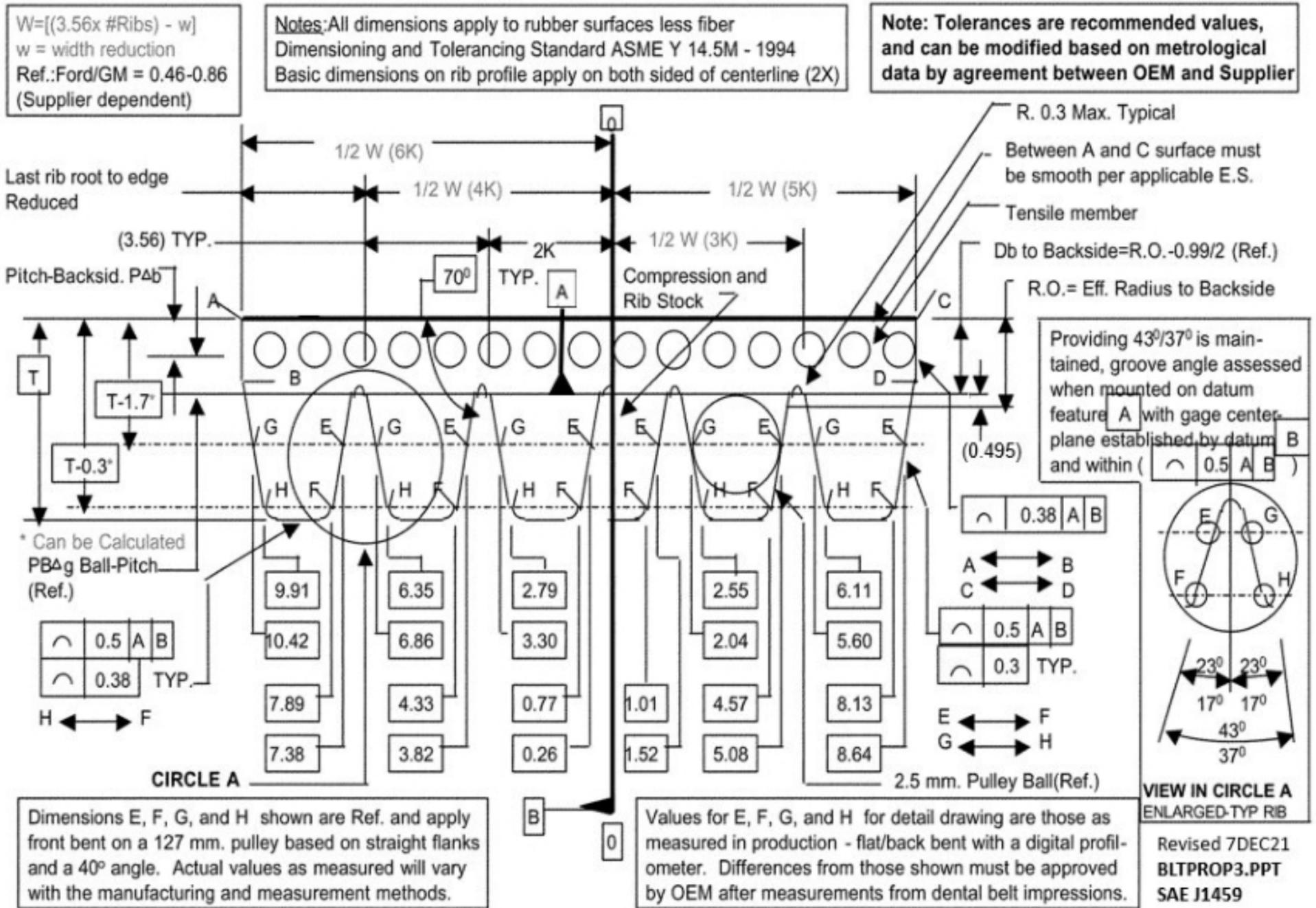


Figure 3 - Optional belt dimensioning template

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Notes:

1. This template applies to pulleys with DoB >70mm except where shown
2. All dimensions apply unpainted
3. Dimensioning and tolerancing to ASME Y 14.5M-1994
4. Digital profilometer/vision system required for production metrology
5. Points B & C must be on a line at a greater diameter than the tangent point of the root radii
6. Points D & E must be on a line at a greater diameter less than the tip radii

Y and Z are functions of material thickness and supplier processes; to be defined numerically on the drawing.

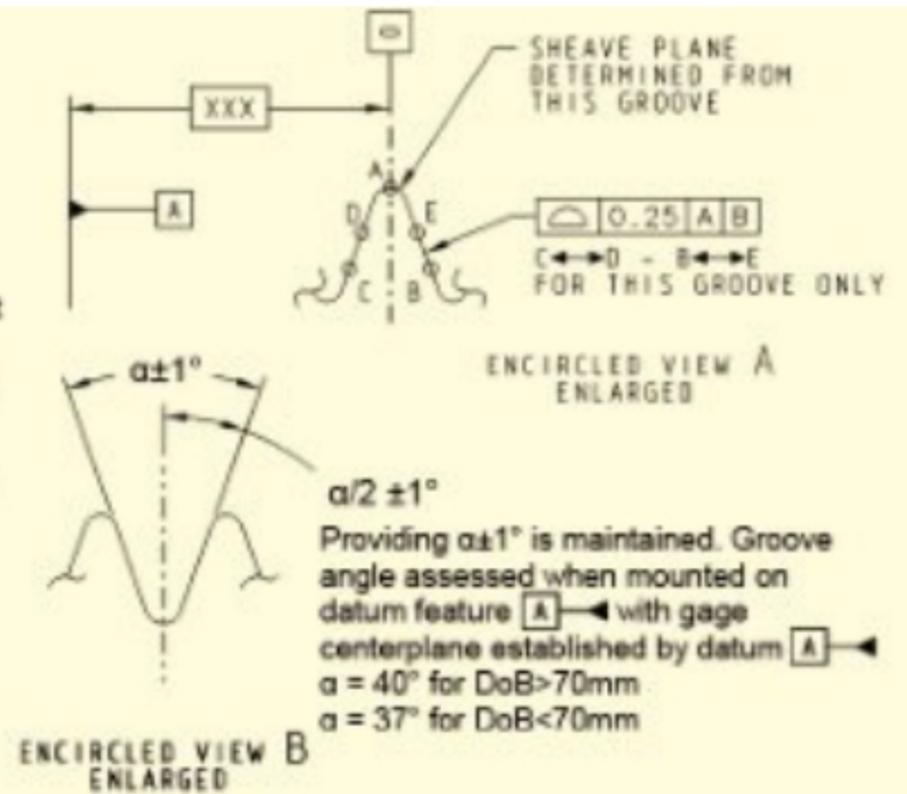
Coating must be smooth and even within AREA A

Tolerances are recommended values, and may be modified based on metrological data by agreement between OEM and supplier

Unless otherwise specified:

Max imbalance = 44/R g-cm (R = highest pulley ratio for this pulley)

Stamped surfaces 0.15 A B



- A is surface feature parallel to the sheave plane
- B is axis of rotation or feature perpendicular to A
- A or B may be primary depending upon application (e.g. push-on versus bolt-on)

Pulleys with DoB <70mm

| | |
|------|------|
| - 2x | 9.92 |
| = 2x | 7.88 |
| - 2x | 6.36 |
| - 2x | 4.32 |
| - 2x | 2.79 |
| - 2x | 0.76 |
| - | 0.00 |

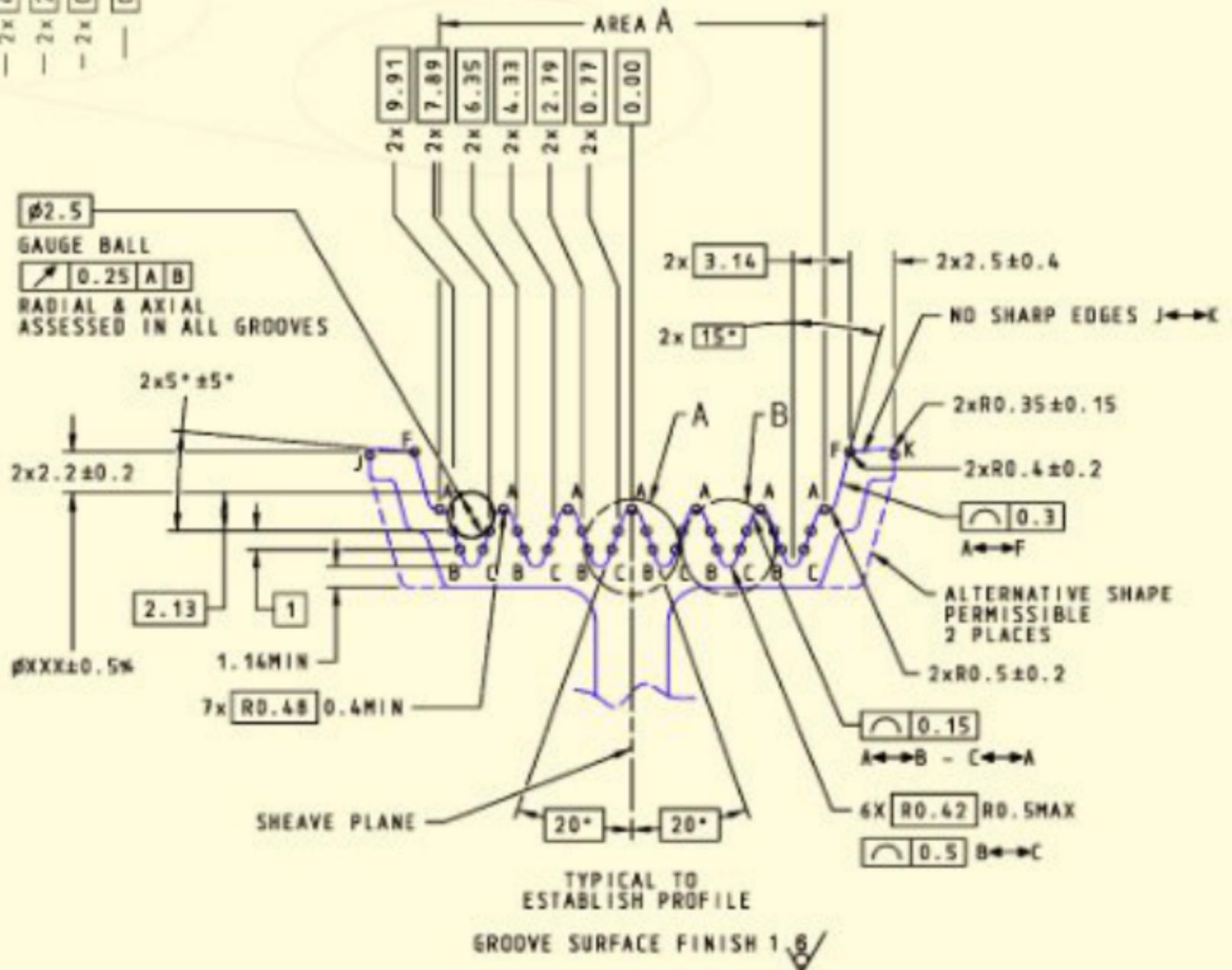


Figure 4 - "Split" pulley dimensioning template (6) groove shown (typical)

Notes:

1. This template applies to pulleys with DoB >70mm except where shown
2. All dimensions apply unpainted
3. Dimensioning and tolerancing to ASME Y 14.5M-1994
4. Digital profilometer/vision system required for production metrology
5. Points B & C must be on a line at a greater diameter than the tangent point of the root radii
6. Points D & E must be on a line at a greater diameter less than the tip radii

Y and Z are functions of material thickness and supplier processes; to be defined numerically on the drawing.

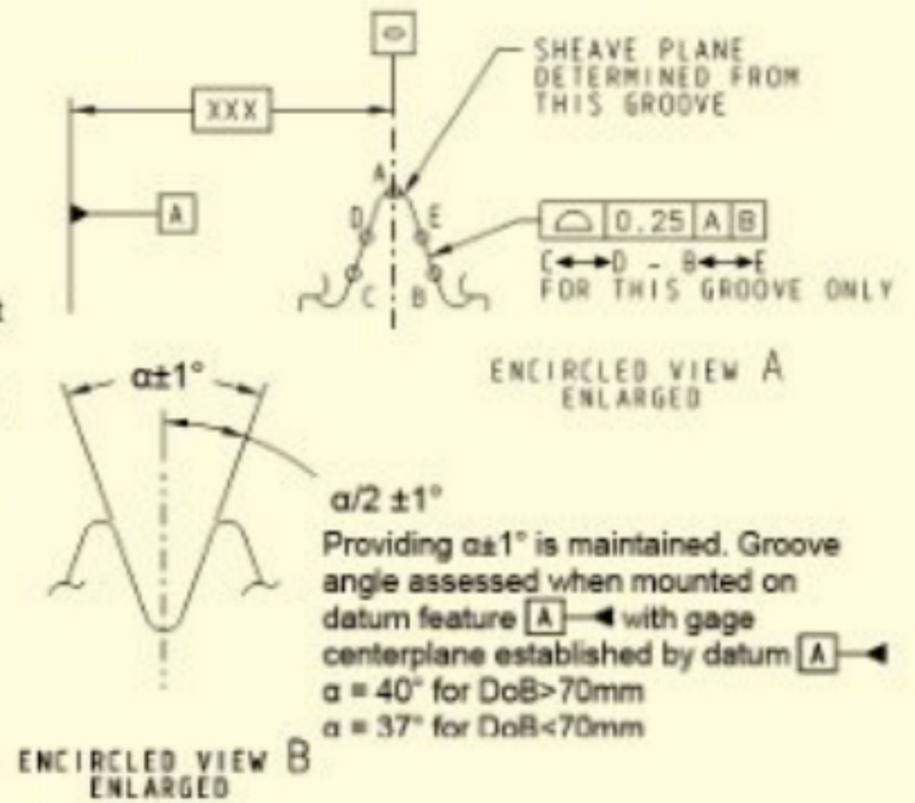
Coating must be smooth and even within AREA A

Tolerances are recommended values, and may be modified based on metrological data by agreement between OEM and supplier

Unless otherwise specified:

Max imbalance = 44/R g-cm (R = highest pulley ratio for this pulley)

Stamped surfaces $\sqrt{1.6 \text{ A B}}$



$\text{A} \leftarrow$ is surface feature parallel to the sheave plane
 $\text{B} \leftarrow$ is axis of rotation or feature perpendicular to $\text{A} \leftarrow$
 $\text{A} \leftarrow$ or $\text{B} \leftarrow$ may be primary depending upon application (e.g. push-on versus bolt-on)

Pulleys with DoB < 70mm

| | | | | | | |
|---------|---------|---------|---------|---------|---------|------|
| 2x 9.92 | 2x 7.88 | 2x 6.36 | 2x 4.32 | 2x 2.79 | 2x 0.76 | 0.00 |
|---------|---------|---------|---------|---------|---------|------|

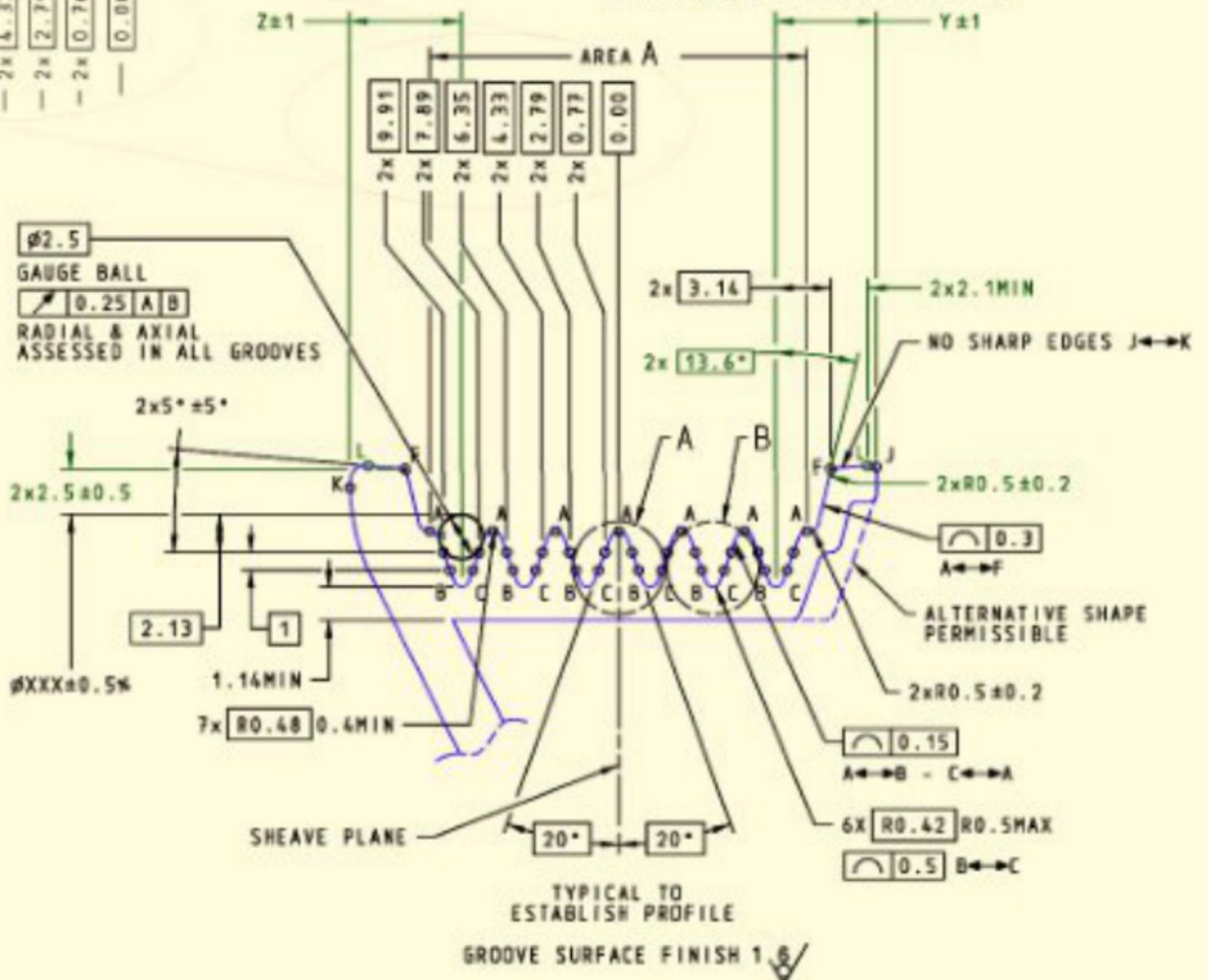


Figure 5 - "Folded" pulley dimensioning template (6) groove shown (typical)

Notes:

1. This template applies to pulleys with DoB >70mm except where shown
2. All dimensions apply unpainted
3. Dimensioning and tolerancing to ASME Y 14.5M-1994
4. Digital profilometer/vision system required for production metrology
5. Points B & C must be on a line at a greater diameter than the tangent point of the root radii
6. Points D & E must be on a line at a greater diameter less than the tip radii

Y and Z are functions of material thickness and supplier processes; to be defined numerically on the drawing.

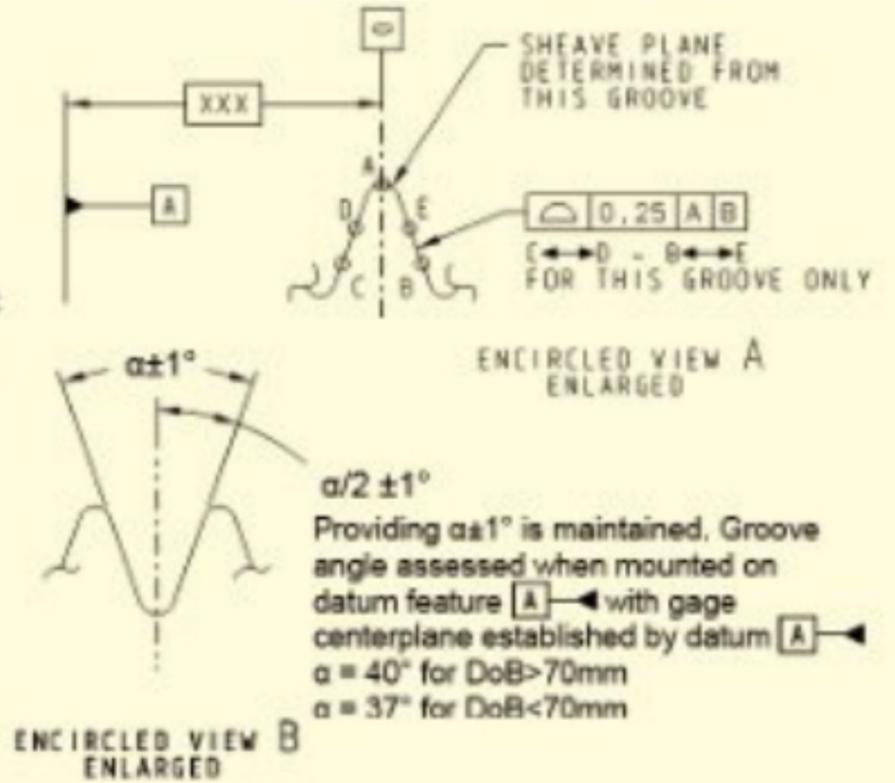
Coating must be smooth and even within AREA A

Tolerances are recommended values, and may be modified based on metrological data by agreement between OEM and supplier

Unless otherwise specified:

Max imbalance = 44/R g-cm (R = highest pulley ratio for this pulley)

Stamped surfaces $\sqrt{1.6} \text{ A B}$



$\text{A} \leftarrow$ is surface feature parallel to the sheave plane
 $\text{B} \leftarrow$ is axis of rotation or feature perpendicular to $\text{A} \leftarrow$
 $\text{A} \leftarrow$ or $\text{B} \leftarrow$ may be primary depending upon application (e.g. push-on versus bolt-on)

Pulleys with DoB <70mm

| | | | | | | |
|---------|---------|---------|---------|---------|---------|------|
| 2x 9.92 | 2x 7.88 | 2x 6.36 | 2x 4.32 | 2x 2.79 | 2x 0.76 | 0.00 |
|---------|---------|---------|---------|---------|---------|------|

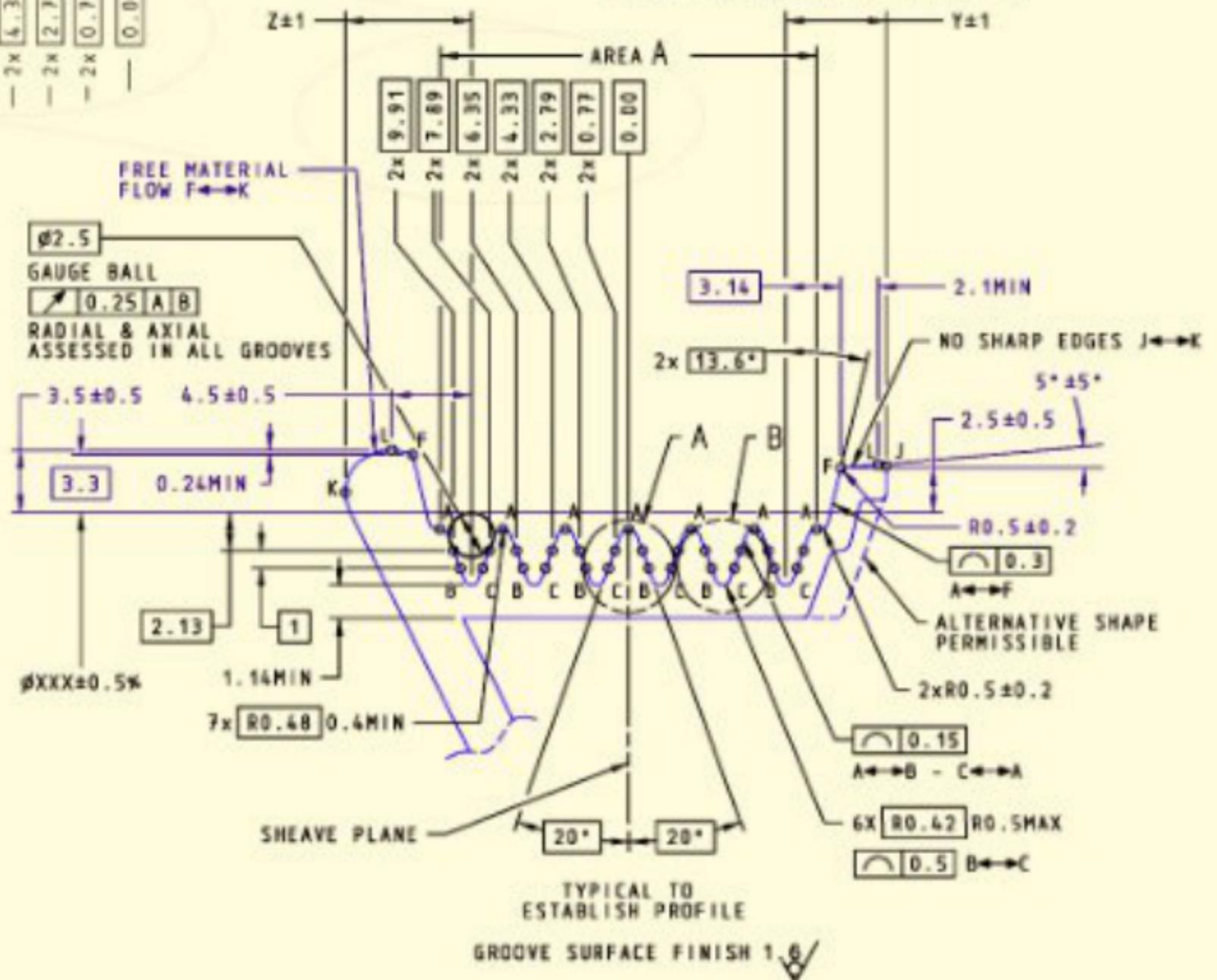


Figure 6 - "Folded" pulley dimensioning template (6) groove shown (alternate for thinner material)

5. MEASUREMENT METHOD

Since the templates in Figures 1 to 4 have profile of a line callouts, it is necessary to capture the entire profile digitally and compare it to the drawing dimensions. This requires a digital profilometer or digital vision system and eliminates the optical comparator as acceptable for metrology. Because of the inherent speed of these devices, the frequency of audit may have to be reduced, depending on the process used in production. If verification of ongoing quality requires more frequent measurement, the audit with the profilometer is still required, while the supplier can use traditional methods to measure additional belts or pulleys to satisfy an internal process control characteristic, if they feel the need.

6. BELT DIMENSION DETERMINATION

The shape of the belt profile changes with bending, either as profiled back bent, if it is not molded, or between manufacture and measurement. The intent of the document is to achieve a precise mating of the belt as bent around a grooved pulley. The 37 degree pulley standard deals with the distortion of the belt around small diameter pulleys. For larger pulleys, the 40 degree belt rib angle is to be defined on a 127 mm pulley as measured in an arch with a dental compound casting, or equivalent. The detail drawing is to show the rib dimensions as measured in production with the digital profilometer (usually flat). These dimensions may be different from those measured in the arch. Once the relationship between the arch and the production measurements due to the rubber distortion is established, the arch dimensions shall not be measured on an ongoing basis, but rather the detail drawing dimensions representing the flat profilometer method.

7. METROLOGICAL ISSUES

In order to facilitate the execution of the programs for digital profilometers to measure both belts and pulleys, it is permissible to calculate the points defined on the flanks of the belt ribs or pulley grooves. This can be done from the line defined by points along the rib/groove flank line between the tangent points of the tip and root radii. Gage R&R improves with increasing distance between the points selected. Precise methodology can be mutually agreed upon between supplier and OEM.

8. V-RIBBED BELT SIZE

Belt size is designated by a standard series of alphanumeric characters. Belts measured on a metric length system are designated by the number of ribs followed by the belt cross-sectional size ("PK" or "PL") and the effective length in millimeters. For example, 6PK1370 signifies a six-rib "PK" section belt, with an effective length of 1370 mm.

9. MEASUREMENT OF V-RIBBED BELTS

9.1 Length and Center Distance

The length of a V-ribbed belt is determined by use of a measuring fixture comprised of two pulleys of equal diameter, a method of applying force, and a means of measuring the center distance between the two pulleys. One of the two pulleys is fixed in position while the other is movable along a graduated scale. Both pulleys are allowed to rotate. The fixture is shown schematically in Figure 5. Grooves of master inspection pulleys shall be machined to dimension tolerances shown in Table 2, treated to resist wear, and checked periodically for wear and damage.

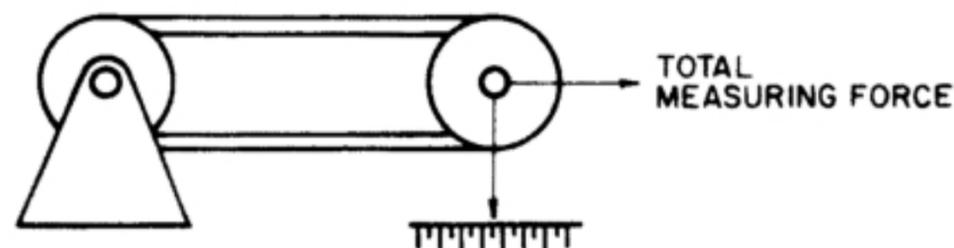


Figure 7 - Diagram of a fixture for measuring V-ribbed belts

Table 2 - Measuring conditions - millimeters

| Cross Section Size | Effective Diameter (reference) | Effective Circumference (reference) | d_B Ball or Rod Diameter ± 0.010 | Diameter Over Ball or Rods ± 0.10 | Total Measuring Force per Rib (N) |
|--------------------|--------------------------------|-------------------------------------|--|--|-----------------------------------|
| PK | 95.49 | 300 | 2.500 | 96.48 | 100 |

To measure the length, the belt is placed on the measuring fixture at the total measuring force shown in Table 2, and rotated around the pulleys at least two revolutions to seat the belt properly in the pulley grooves and to divide the total force equally between the two strands of the belt. The midpoint of the center distance travel of the movable pulley defines the center distance and will be measured through a minimum of one revolution of the belt after the two seating revolutions. The belt effective length is equal to two times the center distance plus the pulley effective circumference, shown in Equations 2 and 3:

$$CD = \frac{EL-300}{2} \quad (\text{Eq. 2})$$

$$EL = 2 * CD + 300 \quad (\text{Eq. 3})$$

Standard belt center distance tolerances are shown in Table 3. For center distance tolerances less than standard, the belt manufacturer should be consulted.

Table 3 - Standard belt center distance tolerances⁽¹⁾ - millimeters

| Belt Length | Tolerance on Center Distance |
|-------------------|------------------------------|
| 0 to 1200 | ±2.0 |
| Over 1200 to 2000 | ±2.5 |
| Over 2000 to 2500 | ±3.0 |
| Over 2500 to 3000 | ±3.5 |

⁽¹⁾ These tolerances are for reference only, and depend on manufacturing process as well as cost. Supplier and OEM agreement must be reached on each application.

10. OTHER DIMENSIONAL NOTES

NOTE 1: Radial and axial run-out is not to exceed 0.25 mm full indicator movement (FIM). Run-out in the two directions is measured separately with a ball mounted under spring pressure to follow the groove as the pulley is rotated.

NOTE 2: For any groove set in a pulley, the DoB must not vary by more than 0.25 mm over six consecutive grooves.

NOTE 3: Centerline of groove is to be 90.0 degrees ± 0.5 degree with pulley axis.

11. NOTES

11.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

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