



SURFACE VEHICLE RECOMMENDED PRACTICE

J2432™

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Superseding J2432 MAR2015

Performance Testing of PK Section V-Ribbed Belts

RATIONALE

This latest revision of SAE J2432 accomplishes the following:

- Re-added five pulley flex testing from previous specification versions.
- Updated belt rubber compound materials test name, temperature, duration, compression test methodology, and fiber loading.
- Updated misalignment test to include belt jump in the failure criteria.
- Updated list of ASTM references to match content and latest versions.

1. SCOPE

The following information covers accessory drive belt testing methods and includes test configurations, pulley diameters, power loads, and guidance for interpreting test data. Belt construction definitions are also documented. This information has been prepared from existing literature, including standards and data supplied by producers and users of V-ribbed belts.

1.1 Purpose

This SAE Recommended Practice is intended to provide methods to evaluate the performance of V-ribbed belt constructions.

1.2 Test Sample Size

The number of test samples should be agreed between each producer and user.

1.3 Test Conditions

Any variation or change in the test conditions outlined in this specification must be agreed between the producer and user.

1.4 Belt Test Lengths

The test belt length is 1200 mm $\pm$ 10 mm. Test data from belts of this length will be considered valid for all belt lengths of the same construction and specification.

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Documents

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1.5 Definition of Construction Specification

The belt producer's test data on belts of a certain construction shall be considered valid for evaluation of all belts, with respect to the producer's cross section dimensions, material specifications, and method of manufacture.

1.6 Pulley Construction

Unless otherwise specified, all pulleys used on test fixtures should be machined steel pulleys.

1.7 Pulley Tolerances

Pulleys should be manufactured to SAE measurement pulley tolerances as shown in SAE J1459, except diameter over balls (DOB) tolerance must be held to ± 0.1 mm and the groove angles must be held to ± 0.5 degree. (Five pulley flex test in Section 6 only requires ± 0.25 degree.)

1.8 Definitions

1.8.1 Profiled (Cut/Ground) Belts

- a. Rib layer: Outer layer of belt typically in contact with pulley grooves. The rib layer consists of rubber mixed with fiber. Ribs may be on one side or both sides of the belt. The rib layer provides the friction to carry the load between the accessory and the belt.
- b. Adhesion layer(s): Interior layer(s) of material between the cord and adjacent layers. Its purpose is to provide a bond between individual cords, the cord layer, and adjacent layers. It can be on one side of the cord, both sides of the cord, or not present at all.
- c. Cord layer: Interior layer consisting of individual strands of yarn that carry the tensile load on the belt. The cord layer defines the tensile modulus of the belt.
- d. Back layer: Outer layer of belt material opposite of the rib layer. The back layer has no rib profile. The purpose of the back layer is to provide a running surface for routing pulleys and may also provide friction to carry the load between flat pulleys and the belt. The back layer also provides support for the cord layer.
- e. Fabric layer: Optional internal or external to the back layer of the belt. Typically used to provide support for the cord layer.

1.8.2 Molded Belts

Otherwise same as profiled belts, with the exception of:

- a. Rib layer: Outer layer of belt material typically in contact with the pulley grooves. For molded belts, the rib layer consists of a fiber free rubber rib cross section with a surface layer for noise abatement. The surface layer can be a fabric sheet, glued on flock, a polymer sheet, a cellulose sheet, rubber, or potentially other treatments.

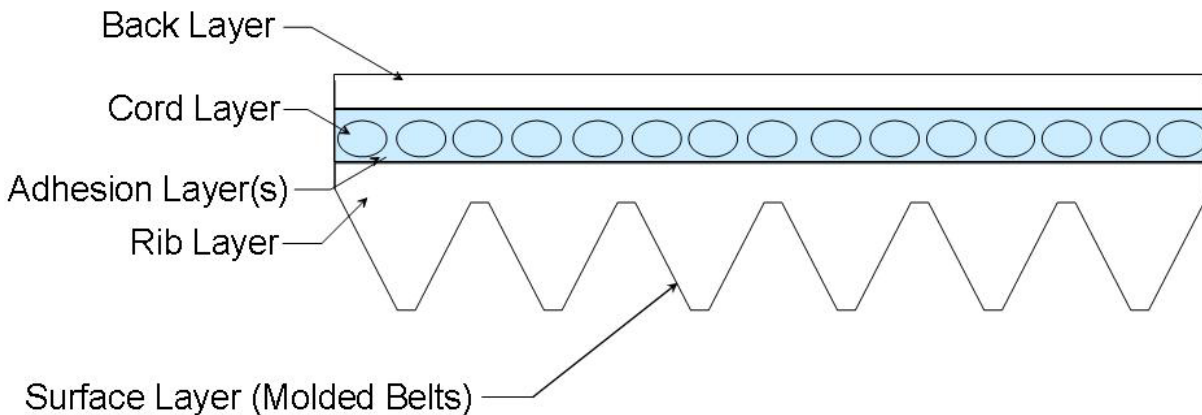


Figure 1 - Belt cross-section

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1459 V-Ribbed Belts and Pulleys

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A564 Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes

ASTM D395 Standard Test Methods for Rubber Property - Compression Set

ASTM D412 Test Methods for Rubber Properties in Tension

ASTM D573 Test Method for Rubber - Deterioration in an Air Oven

ASTM D624 Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

ASTM D1149 Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber (Flat Specimens)

ASTM D2240 Standard Test Method for Rubber Property - Durometer Hardness

3. HIGH TEMPERATURE, CONSTANT TENSION TEST

3.1 Purpose

To test the belt's durability under high temperature, high load conditions. This test was developed to reflect the increased use of automatic tensioners on automotive accessory drives. These systems have constant tension and therefore do not exhibit slip conditions resulting from loss of tension due to belt stretch.

Increased belt length will increase belt life on the test stand. Therefore, belt length has been limited to reduce test variability and provide comparable data from each manufacturer to the users.

NOTE: This test can be run in conjunction with Section 9. Interruptions for inspections or noise testing are allowed.

3.2 Test Configuration

See Figure 2.

3.2.1 Test Parameters

Driven torque = $20 \text{ Nm} \pm 1 \text{ Nm}$

Belt effective length = $1200 \text{ mm} \pm 10 \text{ mm}$

Steady state driver speed = 4900 rpm, within $\pm 100 \text{ rpm}$

Number of belt ribs = Six

Operating belt tension (around pulley 2) = $629 \text{ N} \pm 31 \text{ N}$

Belt load setup, as per Figure 2:

Option 1: Belt loaded at W_1 (reference) = $923 \text{ N} \pm 5\%$, as needed to obtain proper operating belt tension

Option 2: Belt loaded at W_2 (reference) = $713 \text{ N} \pm 5\%$, as needed to obtain proper operating belt tension

3.2.2 Test Chamber Temperature

$121^\circ\text{C} \pm 5^\circ\text{C}$

3.3 Test Stand

The four pulley hot test stand is shown in Figure 2.

Pulley	DIA(mm)	X	Y	Notes:
1	121.6 DOB	0.0	0.0	Driver Pulley
2	[W ₁]	200.0 (~215.5)	150.5	Idler Pulley (x-coordinate ~215.5 if tension at [W ₁])
3	[W ₂]	0.0	301.0 (~315.0)	Driven Pulley (y-coordinate ~315.0 if tension at [W ₂])
4	60.0	0.0	150.5	Back side Idler

Effective Belt Length = 1200mm. All pulleys groove side except pulley 4

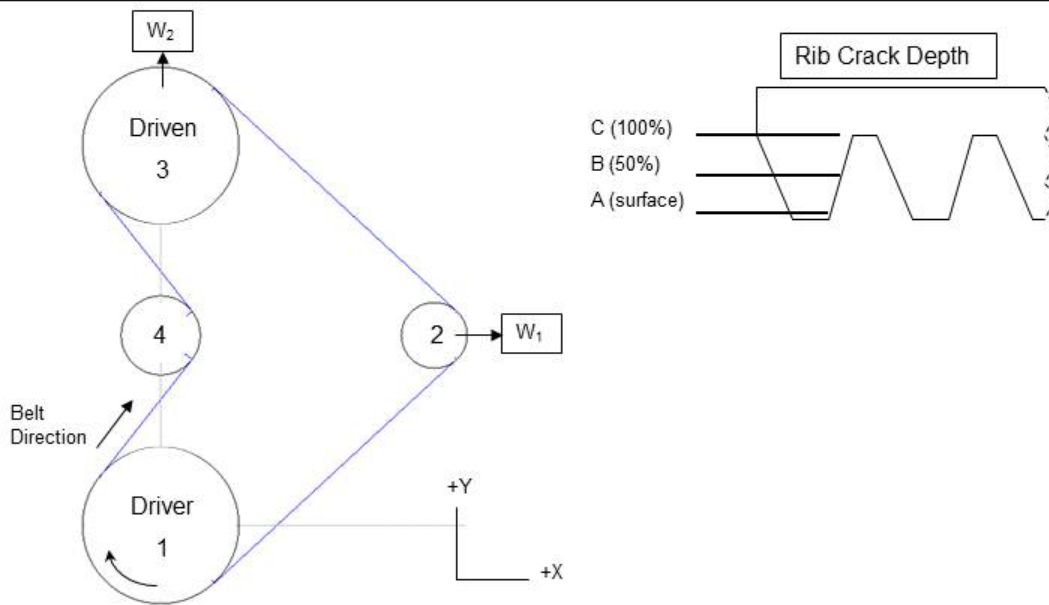


Figure 2 - High temperature, constant tension test layout

3.3.1 Tension

Constant tension will be maintained with a dead weight device or equivalent. The operating belt tension (steady state, loaded, dynamic) should be obtained at either span around pulley 2, having applied the 20 Nm of torque at pulley 3 and the recommended load at either W₁ or W₂. The static tension may be measured on the belt, with the stand at rest, noting however that it will be a different value depending on the chosen loading option (W₁ versus W₂).

3.3.2 Motor

The test stand is driven by a motor sized to handle a minimum of the sustained torque applied to the driven pulley plus system losses at the rpm indicated in 3.2.1.

3.3.3 Power Absorber

The driven pulley is to be attached to a power absorption unit capable of handling the torque indicated in 3.2.1.

3.3.4 Temperature Control

The test stand temperature should be mapped with a running belt, over a 2 hour period, and proven to be capable of no more than $\pm 5^\circ\text{C}$ variation throughout the test area. The test stand must have at least five thermocouples: one near each of the four pulleys, and one in the center of the drive layout. It is recommended that stands be recertified when modified or annually if no modifications are performed.

3.3.5 Miscellaneous

A control capable of shutting down the test under specified conditions is required. The test stand belt alignment error angle should be less than 0.5 degree at each grooved pulley.

3.4 Test Description

- 3.4.1 Prior to start of test, remove any grease, rubber, or other foreign material from the pulley grooves.
- 3.4.2 Weigh the belt and install the belt on the test fixture. Apply the required belt tension. The belt tension must be constant throughout the test.
- 3.4.3 Start the machine. Adjust the torque to the proper setting. Temperatures should be properly monitored to maintain constant temperature. Set the test stand control to stop the machine if the temperature goes outside of the specified tolerance. Use the thermocouple in the center of the drive layout for temperature monitoring.
- 3.4.4 Set the test stand control to stop the machine if the driven pulley speed has dropped 4% from the target driver pulley speed.
- 3.4.5 Inspect belts daily (minimum), recording test hours, chamber temperature, and belt temperature. Note any evidence of edge cord pop out, pilling, and belt cracks. When belt is found to be failed (see 3.5.1), weigh the belt and revert to the last inspection for time to failure. Belts should be weighed upon completion of all testing. Belt weights should be taken when the belt reaches ambient temperature.

3.5 High Temperature, Constant Tension Test Performance Guidelines

3.5.1 Failure Criteria

A belt shall be considered failed when one or more of the following conditions occur:

- a. Belt breakage (fracture of cord).
- b. Belt chunking, loss of rib stock.
- c. Delamination of belt layers.
- d. Belt fraying or tensile cord separation (edge cord pop out: in two places, 25 mm long).
- e. Maximum number of B or C level cracks = 8 (see Figure 2).
- f. Loss of belt traction capacity (4% slip).
- g. In-line crack across the belt rib cross section.
- h. Weight loss more than 10% of original weight at end of test.
- i. Pilling rating "high" (see 8.6 for definition).

3.5.2 Acceptance Criteria

- a. The belt manufacturer and user will agree on acceptance/rejection criteria and may agree on other failure criteria.

4. HOT AND COLD CYCLING TEST

4.1 Purpose

To test a belt's durability under high temperature, high load; and low temperature, no load conditions.

4.2 Test Specification Summary

NOTE: The hot and cold segments of this test use the same geometric configuration as shown in Figure 2.

4.2.1 Test Parameters (Hot Segment)

Driven torque = 20 Nm $\pm$ 1 Nm

Temperature = 121 °C $\pm$ 5 °C

Belt effective length = 1200 mm $\pm$ 10 mm

Steady state driver speed = 4900 rpm, within $\pm$ 100 rpm

Number of belt ribs = Six

Operating belt tension (around pulley 2) = 629 N $\pm$ 31 N

Belt load setup, as per Figure 2:

Option 1: Belt loaded at W_1 (reference) = 923 N $\pm$ 5%, as needed to obtain proper operating belt tension

Option 2: Belt loaded at W_2 (reference) = 713 N $\pm$ 5%, as needed to obtain proper operating belt tension

4.2.2 Test Parameters (Cold Segment)

Driven torque = No torque reaction load is to be applied

Temperature = -40°C +0°C/-5°C

Belt effective length = 1200 mm $\pm$ 10 mm

Driver speed = 1500 rpm, within $\pm$ 30 rpm

Number of belt ribs = Six

Belt tension = 267 N $\pm$ 13 N

Belt hubload setup, per Figure 2:

Option 1: Belt loaded at W_1 (reference) = 392 N $\pm$ 5%, as needed to obtain proper operating belt tension

Option 2: Belt loaded at W_2 (reference) = 417 N $\pm$ 5%, as needed to obtain proper operating belt tension

4.3 Test Fixture Setup

4.3.1 Hot Fixture Setup

The four pulley stand is shown in Figure 2.

4.3.1.1 Tension

Constant tension will be maintained with a dead weight device or equivalent. For the hot segment, the operating belt tension (steady state, loaded, dynamic) should be obtained at either span around pulley 2, having applied the 20 Nm of torque at pulley 3 and the recommended load at either W_1 or W_2 . The static tension may be measured on the belt, with the stand at rest, noting however that it will be a different value depending on the chosen loading option (W_1 versus W_2).

4.3.1.2 Motor

The test stand is driven by a motor sized to handle a minimum of the sustained torque applied to the driven pulley plus system losses at the rpm indicated in 4.2.1.

4.3.1.3 Power Absorber

The driven pulley is to be attached to a power absorption unit capable of handling the torque indicated in 4.2.1.

4.3.1.4 Temperature Control

The test stand temperature should be mapped with a running belt, over a 2 hour period, and proven to be capable of no more than $\pm$ 5 °C variation throughout the test area. The test stand must have at least five thermocouples: one near each of the four pulleys, and one in the center of the drive layout. Use a thermocouple in the center of the drive layout for temperature monitoring. It is recommended that stands be recertified when modified or annually if no modifications are performed.

4.3.1.5 Miscellaneous

A control capable of shutting down the test under specified conditions is required. Test stand belt alignment entry angle should be less than 0.5 degree at each grooved pulley.

4.3.2 Cold Fixture Setup

The four pulley stand is shown in Figure 2.

4.3.2.1 Tension

The tension will be maintained with a dead weight device or equivalent. For the cold segment, since no torque is applied at any pulley during the test, a static tension measurement is acceptable.

4.3.2.2 Motor

The test stand is driven by a motor capable of meeting rpm requirements indicated in 4.2.2.

4.3.2.3 Miscellaneous

A control capable of shutting down the test under specified conditions is required. The test stand belt entry angle should be less than 0.5 degree at each grooved pulley.

4.4 Test Procedure

4.4.1 Hot Test Procedure

4.4.1.1 Prior to start of test, remove any grease, rubber, or other foreign material from the pulley grooves.

4.4.1.2 Weigh the belt and install the belt on the test fixture. Apply the required belt tension. The belt tension must be constant throughout the life of the test.

4.4.1.3 Set the driver pulley to the specified speed.

4.4.1.4 Adjust the torque to the proper setting. Temperature should be properly monitored to maintain constant temperature and reduce test variability. Set the test stand control to stop the machine if the temperature goes outside of the specified tolerance. Use the thermocouple in the center of the drive layout for temperature monitoring.

4.4.1.5 Set the test stand control to stop the machine if the driven pulley speed has dropped 4% from the target driver pulley speed.

4.4.1.6 Run for 20 hours at the specified temperature and load condition. Inspect belts, recording test hours, chamber temperature, and belt temperature. Note any evidence of edge cord pop out, pilling, and belt cracks.

4.4.1.7 Allow the belt to cool on the stand until it reaches ambient room temperature. Weigh the belt. When the belt is found to be failed (see 4.5.1), identify the cycle during which the failure occurred.

4.4.2 Cold Test Procedure

4.4.2.1 Install the same belt on the cold chamber equipment.

4.4.2.2 Cool the belt and stand until the specified temperature is reached at the belt and pulley interface. After the belt and pulley interfaces reach the specified temperature, soak the belt a minimum of 1 additional hour.

4.4.2.3 Run the driver pulley at 1500 rpm for 10 seconds. 1500 rpm must be achieved in 1 second. Stop driver pulley.

4.4.2.4 Resoak the belt until belt temperature stabilizes.

4.4.2.5 Rerun 4.4.2.3 through 4.4.2.4 nine times with the same belt and pulley at the specified temperature each time.

4.4.2.6 Note any evidence of edge cord pop out, pilling, and belt cracks. End test if failed (see 4.5.1).

4.4.3 Remove belt and rerun 4.4.1 and 4.4.2 until belt failure (see 4.5.1).

NOTE: One cycle is equal to one hot test procedure and one cold test procedure

4.5 Hot and Cold Cycling Test Performance Guidelines

4.5.1 Failure Criteria

A belt shall be considered failed when one or more of the following conditions occur:

- a. Belt breakage (fracture of cord).
- b. Belt chunking, loss of rib stock.
- c. Delamination of belt layers.
- d. Belt fraying or tensile cord separation (edge cord pop out: in two places, 25 mm long).
- e. Maximum number of B or C level cracks = 8 (see Figure 2).
- f. Loss of belt traction capacity (4% slip).
- g. In-line crack across the belt rib cross section.
- h. Weight loss in excess of 10% of original weight at end of test.
- i. Pilling rating "high" (see 8.6 for definition).

4.5.2 Acceptance Criteria

- a. The belt manufacturer and user will agree on acceptance/rejection criteria and may agree on other failure criteria.

5. CONTAMINATION TEST

5.1 Purpose

To determine the effect of underhood fluids on the accessory drive belt.

5.2 Test Specification Summary

Use the identical test equipment specified in Figure 2. Use the identical test parameters as shown in 3.2.1

5.3 Fluid Requirements

Fluids that should be considered for this test should be those that may be spilled on the belt in the underhood environment. These include but are not limited to the following:

Antifreeze/glycol
Motor oil*
P/S fluid
Brake fluid
Transmission fluid
Washer fluid

The belt manufacturer and the user should specify which fluids to use, based on the application.

* For motor oil, it is recommended to use ASTM Service Oil 105. This oil has been established as an aggressive oil toward rubber components by the SAE Committee on Automotive Rubber Specifications (CARS). It is also recommended to use an OEM specified full synthetic motor oil, such as Mobil 1® SAE 5W-30.