



Engine Accessory Drive Belt

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This specification contains all information necessary to design, analyze, develop, validate and manufacture accessory drive belts. This Component Technical Specification (CTS) covers general requirements for general purpose accessory drive belts for car and truck applications. It has as its purpose to control the performance of the belt and thereby, the construction, base polymer and compounding from each approved supplier.

1.2 Applicability. This specification covers only general purpose belts. There are two other accessory drive belt specifications, GMW16328 and GMW16329 that cover low modulus cord and high load/torque belts.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ACEA A3/B3	ASTM D4485	ISO 22241	SAE J1459
ASTM D471	DIN 70070	SAE J300	SAE J2236
ASTM D3395	ISO 1431-1	SAE J369	SAE J2432

2.2 GM Standards/Specifications.

GMW3059	GMW3232	GMW16328	GMW16329
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2.3 Additional References.

- API SJ/ILSAC GF-2 SAE 5W-30, Engine Oil
- Statement of Requirements (SOR)

3 Requirements

3.1 System/Subsystem/Component/Part Definition.

3.1.1 Appearance. Backing must be smooth, and free of texture.

3.1.2 Content.

3.1.2.1 Physical Content. Belt consists of three basic layers: rib, cord and backing, with an adhesion layer at the cord line or an additional rib surface layer on some constructions. Construction details are at the discretion of the supplier but must result in meeting the requirements of this specification.

3.1.2.1.1 S and Z Twist Cords. In order to decrease sensitivity of the belt to tracking in the direction of the cord twist, it is required that the belt be constructed with alternating cords with S and Z twist. There is no intent to exclude other approaches to eliminating belt tracking error (no net cord twist via opposing twist bundles or zero twist), but any deviation requires approval of the Technical Specialist.

3.1.2.1.1.1 Cord Materials. Cords vary in denier (filament diameter), bundles of filaments and number of bundles as well as twist. Common cord materials are polyester and aramid (aromatic polyamide). Other cord materials exist, but are rarely used. All cords relax after a break-in period and lose a significant amount of modulus of elasticity and Ultimate Tensile Strength (UTS), which continues over time, depending upon application loading

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dynamics. These characteristics must be measured and reported to the GPS Technical Specialist. Toward that end, suppliers are to measure Modulus of Elasticity and Ultimate Tensile Strength (UTS) on test belts after each durability test in Section 4. Testing for reduction in UTS requires adding dynamics to test load. This is best accomplished on an engine dynamometer. Suppliers are to develop a test to achieve the maximum degradation of cord UTS. This test or testing requires Technical Specialist approval.

3.1.2.1.2 Backside Material. At this juncture, only rubber backed belts are recommended with fiber reinforcement to stabilize the cord layer and to improve backside abrasion. The visual appearance of the backside must be smooth and free of proud imperfections, blemishes, etc., as seen in reflected overhead light. Exceptions to this requirement require GM Technical Specialist approval. For the purpose of establishing a visual standard, these imperfections, in some cases, may not exceed 0.05 mm proud or depressed from the backside surface. On sensitive or molded belt applications, fiber reinforced rubber backing and/or a butt splice on all layers outside of the cord layer may be a requirement. Note that understanding of this requirement will be generated from samples of belts from each supplier which represent unacceptable quality. New blemish conditions will arise as a function of time, and GM Powertrain will determine acceptability of same through the Technical Specialist, Supplier Quality and application Release Engineer.

3.1.2.1.3 Pattern. Use of a pattern on the belt backside will require approval of the Technical Specialist and the application release engineer. It is not to be used as a normal design feature. Rubber backed belts serve as the method to achieve any backside surface which may address specific application issues.

3.1.2.1.4 Backside Labels. On some applications, it is required to control the step in the backside surface to less than 0.05 mm maximum by either printing the label or pre- or post-curing from a transfer film, or by making the label from a rubber material that need not be removed after cure.

3.1.2.2 Functional Content. Function is addressed in the requirements of the tests in this specification. See Section 4, Validation.

3.1.3 Ambient Environment. Varies by application, but assumed to be -40 °C to 121 °C. Exposure to contaminants covered in Section 4.

3.1.4 Interfaces. The belt/pulley interface is covered by SAE J1459, only as contained in Appendix A, Figure A1.

3.1.5 Usage Definition. General purpose.

3.2 Product Characteristics.

3.2.1 Performance Requirements. Durability and noise performance addressed in Section 4.

3.2.2 Physical Characteristics.

3.2.2.1 Dimensions and Capacity. Dimensional requirements are shown in the template in Appendix A, Figure A1. All belts are to be dimensioned to this template.

Note: This template is the same as SAE J1459, only as contained in Appendix A, Figure A1.

3.2.2.1.1 Drawing Dimension Determination. Belt dimensions are to be measured with the belt flat, either with a profilometer or with digital vision or laser systems. Measurements can also be made from a relatively thin cut belt section in profile with a vision system. The appropriate technique will be constrained by the amount of fiber on the surface of the ribs.

3.2.2.2 Mass Properties. No requirements.

3.2.3 Reliability.

3.2.3.1 Reliability Evaluation Point. Evaluated by performance to validation test series and manufacturing process approval.

3.2.3.2 Reliability Requirements. Supplier must meet requirements of Section 4, and have production manufacturing process approved by global Technical Specialist.

3.2.4 Serviceability. A system issue (not covered in this specification).

3.2.5 User System/Subsystem/Component/Part Interface. Not applicable. The interface is not the responsibility of the supplier.

3.3 Design and Construction.

3.3.1 Materials, Processes and Parts Selection Guidelines. Belt rubber compound and cord at the discretion of the supplier to meet the requirements of his specification.

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3.3.1.1 Material Guidelines. In general, only ethylene propylene diene monomer (EPDM) rubber shall form the basis for the rubber compound. Exceptions require Technical Specialist approval.

3.3.1.2 Processes Guidelines. See 7.3.2.

3.3.1.3 Parts Guidelines.

3.3.2 Design Guidelines and Constraints.

3.3.3 Identification and Marking. Label requirements shown on engineering chart/drawing.

3.3.4 Workmanship. Not applicable.

3.3.5 Interchangeability. Not applicable.

3.4 Documentation. See individual paragraph requirements.

3.5 Support of System/Subsystem/Component/Part After Sale. Supplier must provide root cause analysis and corrective action to issues identified in development service/warranty by Supplier Quality and/or Product Engineering.

3.6 System/Subsystem/Component/Part Operator Training. Not applicable.

3.7 System/Subsystem/Component/Part Characteristics. Not applicable.

3.7.1 System/Subsystem/Component/Part Definition. Not applicable.

4 Validation

4.1 General.

4.1.1 Basic Durability Goals. At the vehicle level, the requirement is for 240 000 km (150 000 mi) and fifteen (15) year life for cars and light duty truck applications at worst case conditions, such as taxi cabs in the desert Southwest, and 330 000 km (200 000 mi) and fifteen (15) year life for heavy duty trucks. The responsibility for meeting these goals is the purview of the cognizant release engineer. It is recognized that the 240 000 km (150 000 mi) requirement assumes a conservatively (meeting the GM internal Bill of Design) designed drive and that the actual performance will degrade if significant variables which affect rubber fatigue exist (higher ambient temperatures and loads, small pulleys on tight side, short spans, etc.) Requirements of the belt supplier as they relate to the vehicle requirements are limited to the bench tests and other requirements in this specification. This test series is to be performed only once for each belt construction as a prerequisite for approval by the Global Technical Specialist. It precedes all engineering and sourcing activity and the approval is required for a supplier to be considered for future GM business. Successful completion covers all future applications. It is not to be performed on individual applications, and has no bearing upon the Production Part Approval Process (PPAP) or production environment, which deal with individual applications/part numbers.

4.1.2 Reference Duty Cycle. For the purpose of accomplishing a correlation between the tests in this specification and actual vehicle operation, the following generic duty cycle is to be used (Table 1), based on measurement of many actual customer vehicles both in the USA and in Europe.

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Table 1: Percentage Time ^{Note 1}

USA	Europe	Speed (rpm)
20	20	600/idle
20	20	1000
20	15	1500
20	20	2000
18.4	10	2500
1.0	4.9	3000
0.5	10	4000
0.1	0.1	6000/maximum

Note 1: Accessory Loads for durability testing in the absence of SimDrive data : Generator = Constant 7 N·m; Air Conditioning Compressor = 13 N·m; Power Steering Pump = 2 N·m; Water Pump is a cubic function with speed passing through 7 kW at 6000 rpm.

4.1.3 Fifteen (15) Year Life. This requirement results in an application of base polymers or polymer blends other than chloroprene or polybutadiene. The intent of the specification is to require use of base polymers which have as their inherent characteristics excellent heat, cold and ozone/oxidation resistance (without additives) so that they do not harden or glaze over time. One hundred (100)% EPDM base polymer belt compounds have been identified by all suppliers as a cost effective solution to these requirements, and only these are approved at this time as potential to meet the requirements of this specification. Should an alternative polymer later be demonstrated as compliant to the test matrix, it can be considered after Technical Specialist approval.

4.1.4 Durability/Performance Tests. This section covers the durability and performance tests which must be passed prior to consideration of a vendor for the production sourcing process. Approval of a source shall be performed by the Technical Specialist. Approval for sourcing a supplier to a future program will be based on a good balance of performance across all tests. A sample size of six (6) on each test is dictated to relieve the suppliers from an impractical statistical requirement. For release on a given application, all tests must be completed and passed. The particular sensitivities of that application will be considered, and the supplier list may be narrowed based on superior performance to a subset of the tests that address a particular sensitivity. For all tests, the failure criterion is one crack to the cord line, although, depending on the frequency of inspection, more than one may be present at the first discovery. A crack is defined as **Type B**, which is approximately half the depth of the ribs, or **Type C** which is to the cord line per SAE J2432. After the first crack, the tests must be continued to reveal the rate of crack growth with increased running time. Exact number of cracks, hours or cycles must be reported on each test belt, and statistics applied to predict the population via Weibull analysis. Confidence limits will vary with sample size. The minimum sample size is six on all tests except the contamination series, which requires three. Since only high temperature polymers are approved, all tests will be at a temperature of 121 °C.

4.1.5 SAE Standard References. References will be made to SAE standards to save space in describing test procedures. There will be differences between the SAE standard and this specification, and in those cases, this specification will prevail. Some of the SAE tests will not be required if not mentioned specifically.

4.2 Validation Cross Reference Index. Not applicable.

4.3 Supporting Paragraphs. Test Series. Note that each durability test belt must be broken to measure UTS and Modulus of Elasticity at end of test. The Modulus must be measured at start of test to provide a level of degradation.

4.3.1 Hot/Cold Cycle Test. This test repeats two tests, one at elevated temperature followed by one at low temperature. One cycle is defined as a hot test followed by a cold test. A half cycle is counted as no cycle. Cycles must be completed. The full test description is in SAE J 2432, Hot and Cold Cycling Test.

4.3.1.1 Hot Test Portion. This four (4) pulley hot test shall constitute the hot portion of the hot/cold cycle test and can serve as a break-in test. A 6PK1200 belt shall run with a driven torque of 20 N·m with 629 N constant belt strand dynamic tension with the four (4) pulley SAE J2432 configuration. Speed shall be 4900 rpm and hot

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box temperature 121 °C. For additional details, see High Temperature, Constant Tension Test and Hot and Cold Cycling Test in SAE J2432. Run for 20 h. Cool to room temperature. Note that the two idler pulleys have been reduced to 50 mm diameter.

4.3.1.2 Cold Test Portion. This test is the cold part of the Hot/Cold cycle test. Following 4.3.1.1 hot box tests, same belt is to be installed in cold box at -40 °C to -43 °C and soaked until belt achieves box temperature, and then one additional hour at that temperature. Belt is to be driven with same SAE drive configuration as in 4.3.1.1 at 1500 rpm for 10 s at the driver pulley after acceleration from rest in 1 s and re-cooled. Cycle is to be repeated for a total of ten (10) cycles. Belt is to be removed and soaked to room temperature prior to next cycle of hot box test. For additional details, see SAE J2432, Hot and Cold Cycling Test procedure.

Repeat hot/cold tests until failure. Report portion of test where failure occurred and failure mode (cracks or chunk out). A minimum of four (4) cycles of this hot/cold test on every test belt is the requirement of this test.

4.3.2 Oven Aging. Belt rubber compounds shall be run for 1008 h (42 days) at 150 °C with the requirement of 50% retention of elongation and tensile strength per SAE J2236. This test is for the rubber compounds only; not with reinforcement from fiber or fabric or cord. A separate test for each layer compound used in the belt is required. This test is for rubber properties only as it relates to fifteen (15) year life. Durability may be unrelated. If samples cannot meet the retention of elongation and tensile strength at the end of test, comparison between materials will be used to judge acceptability. The passing criteria for this test shall be 50% retention of elongation at 21 days or 504 h, and 30% retention of elongation at 42 days or 1008 h. Details of this test are in SAE J2432, Stationary Oven Test.

4.3.3 Ozone Resistance. Belt must withstand 70 h at 100 pphm with "0" rating per ISO 1431-1. The test specimen is to be the default 25 mm ×150 mm (2 mm to 2.5 mm), cut from calendared stock without fiber of fabric. This test may be superseded by the dynamic test in 4.3.3.1. Note that EPDM will always pass this test, so it may be waived by the Technical Specialist.

4.3.3.1 Dynamic Ozone Test. This optional test can be run as described by SAE in J2432, Dynamic Ozone Test. No failures have yet been generated to serve as a basis for requirement setting, so only data collection and reporting is appropriate at this juncture. The procedure will be according to ASTM D3395 - Method B with belt test description per SAE J2432, Dynamic Ozone Test. Contact the Technical Specialist before running this test, since it is normally not required.

4.3.4 Hot Box Test. This test is identical to SAE J2432, High Temperature, Constant Tension Test. Correlation is established with the field test in Section 4.3.5. The test is to be run until the first crack(s) appears. The **passing criteria** for this test will be comparison between suppliers on the same test rigs. Benchmarking is encouraged by suppliers to cancel out variation between test rigs.

4.3.5 Field Testing. No belt compound/construction shall be considered for release without first demonstrating 240 000 km (150 000 mi) life. This is to be done on a robustly designed drive with no cracks on field test vehicles in low speed, high ambient temperature Desert Southwest U.S. conditions. Examples are Las Vegas taxi; Phoenix or Texas delivery/taxi fleets. Suppliers are required to arrange and conduct these tests. The make/model/powertrain of the test fleet is not as important as the severity of the application. Applications chosen should represent good design practice. The GM Powertrain Technical Specialist shall approve the data submitted for consideration in this area. This field test is not required on every application, but, rather on every belt material/construction. Just one belt application test is enough provided sample size is six or more. GM road testing on individual applications is eliminated as a validation requirement, but may be run to confirm other testing and to serve as verification test. The passing criterion for this test is 240 000 km (150 000 mi) to cracking on all test belts.

Belts are to be inspected periodically for cracks, and tested for dry and wet rib side and dry backside coefficient of friction. At this time misalignment noise near 160 000 km (100 000 mi) must be repeated periodically thereafter until 240 000 km (150 000 mi) is reached or belt failure (cracks), whichever is longer. Inspection/test frequency will depend upon vehicle use and agreement between the supplier and Technical Specialist. Every calendar quarter is the minimum frequency for inspections and noise measurements.

4.3.6 Five Pulley Flex Test. This test has been eliminated from this Specification.

4.3.7 Fluid Resistance. The details of this test procedure are described in SAE J2432, Contamination Test. Resistance to immersion of belts in fluids to measure volume swell is not a requirement for vehicle applications. Gross fluid leakage has all but been eliminated in current powertrain and vehicle designs. This test represents a realistic exposure of contaminants which the belt must be able to survive, albeit at reduced life. Procedure is

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