



Engine Accessory Drive Driven Pulley

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 standard covers supplier requirements for engine accessory drive driven pulleys. These differ from idler pulleys in that they do not include a ball bearing.

1.2 Applicability. This standard covers all driven pulleys. Most common applications are water pump and power steering pump pulleys.

1.3 Remarks. This standard contains all information necessary to design, analyze, develop, validate, and manufacture accessory drive driven pulleys.

2 References

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

2.1 External Standards/Specifications.

ASME Y 14.5M	EN 10130	MPIF Standard 35 F-0005	QS 1109
DIN EN 10087	ISO 11469	MPIF Standard 35 FC-0200	SAE J1459
EN 10111	JIS G3131		

2.2 GM Standards/Specifications.

GMW2	GMW3059	GMW14671	GMW17081
GMW3038	GMW3116	GMW15702	

2.3 Additional References.

- Statement of Requirements (SOR)
- Tucker's Pottery, 15 West Pearce Street Unit Number 7, Richmond Hill, Ontario, Canada, www.tuckerspotttery.com

2.3.1 SAE International Steel Grades.

- 12L13, 12L14 or 12L15
- 1213, 1214 or 1215

3 Requirements

The grooved pulley profile must meet the requirements of Appendix A, Figures A1 thru A3, of this standard.

3.1 System/Subsystem/Component/Part Definition.

3.1.1 Appearance. Not applicable.

3.1.2 Content.

3.1.2.1 Physical Content.

3.1.2.1.1 Construction. There are several possible constructions for drive/driven pulleys:

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- One piece steel with no hub or integral hub
- Two piece steel with welded or brazed hub attachment
- Two piece steel with doubler for reinforcement
- Aluminum or magnesium one piece with/without steel hub
- Thermoplastic or thermoset injection molded resin with steel hub

Note: Thermoplastic backside pulleys suppliers, because of manufacturing variation and critical tool design, must be preapproved by the Global Technical Specialist. Thermoset plastic compression molded with steel hub parts are not permitted. Acceptable quality thermoset parts shall be injection molded only, and suppliers must be preapproved by the Global Technical Specialist.

3.1.2.1.2 Web Configuration. The design of the pulley is the responsibility of the supplier supported by finite element analysis (FEA), using quadratic elements, and based on loading provided by the Powertrain release engineer. Holes to provide accessibility to fasteners behind the pulley may be required on some applications. Nominal pulley outer diameter (OD), offset and pilot/hub/mounting hole and packaging information are supplied by the release engineer as required.

3.1.2.2 Functional Content. These pulleys are either pressed on or bolted on. Function is addressed in the requirements of the tests in this specification, Section 4.

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 Appendix A, Figures A1 thru A3.

3.1.5 Usage Definition. General purpose.

3.2 Product Characteristics.

3.2.1 Performance Requirements.

3.2.1.1 Hub Press Interference. Hubs, whether integral or separate parts, must have sufficient press on the mating shaft to withstand 68.0 N·m of rotational torque at minimum interference. This is based on a maximum power steering required torque of 22.7 N·m, and a factor of safety of 3.0. The factor of safety addresses the uncertainty of torsional vibration, as well as manufacturing variation. Press load must not exceed 33.4 kN at maximum interference. This is based on the installation tool capability in the assembly plant. Note that these are general design values, and that actual application values, which are sensitive to hub inner diameter (ID) surface finish, should be used to set production specifications. The supplier must evaluate the interference between the pulley hub bore and the mating shaft to ascertain the required pulley ID and tolerance to satisfy these requirements. This is accomplished by testing the assembly axial load at the press extremes, and the torque to turn, in the case of the minimum press condition. A minimum sample size of three is required to make this determination. A larger sample size may be required if variation is deemed excessive. The resulting pulley ID must then be placed on the detail drawing by the supplier, and submitted to the release engineer.

3.2.1.2 Balance. Balance is a function of pulley diameter and offset from a manufacturing perspective, and application sensitivity from a performance perspective. Pulleys which are mounted on accessories with internal construction involving high inertia components and high speeds (i.e., generators), or mating components sensitive to clearances (i.e., air conditioning (A/C) compressors), will require a greater control of balance to avoid exacerbation of noise. Balance is inherently tied to runout, which can add a further degradation of Noise and Vibration (N&V) performance, depending on vector direction.

3.2.1.2.1 Small Pulleys. Since small pulleys (< 70 mm diameter over balls (DOB)) are usually installed on generators (which operate up to 21 000 rpm), they have more stringent balance requirements: 2 g·cm or 3 g·cm force. Generator decoupler pulleys may require a balance operation to achieve this level, so a cost/benefit business case may be necessary to decide if this level of balance is necessary for each generator design. The variable usually affected is generator brush life. Accessory drive idler pulleys in this size range shall have an imbalance level of 10 g·cm maximum.

3.2.1.2.2 Larger Pulleys. Larger pulleys have a generic balance specification of 20 g·cm force, however, with larger pulleys (> 150 mm DOB), and those with significant offset, this may require a balance operation not necessary (lower speeds) with smaller, lower offset pulleys. In these cases, sensitivity testing for belt span vibration, accessory noise, steering shudder, etc., may have to be performed to assess the need for such an added cost.

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3.2.2 Physical Characteristics.

3.2.2.1 Dimensions and Capacity. Dimensional requirements are in Appendix A, Figures A1 thru A3.

3.2.2.1.1 Runout. Maximum radial and lateral runout shall not exceed 0.25 mm, unless otherwise specified. There may be exceptions for very large diameter/high offset applications, if approved by the Global Technical Specialist.

3.2.2.1.2 Flanges. Flanges are not permitted on backside pulleys, but are required on both sides of grooved pulleys as an assembly aide to center the belt in the pulley. These must meet the requirements contained in Appendix A, Figures A1 thru A3.

3.2.2.1.3 Self-Correcting. A flange must also be self-centering/correcting, meaning that, if the belt is installed one rib off center, it will move over to the centered position upon rotation. In order to achieve this characteristic, the flanges are required on both sides of the pulley. Depending on the manufacturing process used for the pulley, the thickness of the flange and its configuration must be such that there will be no damage to the belt if it is mis-installed one rib off center, before it self-corrects. The options in Appendix A (Figures A1 thru A3) should permit compliance to this requirement.

3.2.2.1.4 Alternative Design. Should the above be impossible to package, an alternate design must be developed which will self-correct. This usually involves a wider flange (3.0 mm) with a surface tapered toward the grooves. However, regardless of the configuration, it must be demonstrated to be effective. The ideal design has both the diameter and the width, so that even a two rib mis-installation will self-correct.

3.2.2.2 Mass Properties. Not applicable.

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. Power steering pulleys have a puller groove in the hub for removal, as described in the Appendix, and holes in the web section to access bolts on the pump. Water pump pulleys have several attachment designs, but all must be serviceable with the engine in the vehicle.

3.2.5 User System/Subsystem/Component/Part Interface. Interfaces include the pump shaft, or a water pump hub. These are addressed in the SOR.

3.3 Design and Construction.

3.3.1 Materials, Processes and Parts Selection Guidelines.

3.3.1.1 Material Guidelines. Pulleys are typically made of steel or plastic. Either thermoset or thermoplastic materials are used.

3.3.1.1.1 Steel. Steel shall meet the requirements of GMW2M-ST-S-HR1/CR2. Steel in Europe must meet EN 10111 Hot Rolled – Grade DD-13 or EN 10130 Cold Rolled – Grade DC03.

Steel in Asia is usually JIS G3131 – Grade SPHE, cold rolled or hot rolled. The elemental content requires approval of the Global Technical Specialist and Materials Engineers. All steel should be fully annealed to avoid "earring" of the pulley skirts. The surface should be temper rolled by a 5% rolling operation at the steel mill.

3.3.1.1.2 Polymers. Polymer materials are either glass filled 6/6 polyamide, or glass and mineral filled phenol based thermosets. The percent fill and fill material is at the discretion of the supplier but must be preapproved before any contract award.

3.3.1.1.2.1 Callouts. Callouts are required on the detail drawings using applicable GMW, ASTM International or SAE International specifications where available. Include information on the group, class, grade, and glass content, as applicable.

3.3.1.1.2.2 Recycling. Some plastic parts are subject to recycling consideration. Generally internal tensioner parts are not in this classification, but a pulley may be. At the direction of the release or materials engineer, it may be necessary to mold in a symbol to identify the material for potential use in collecting and handling of parts for recycling. In such cases, the drawing note shall read, "Mark parts per ISO 11469. Marking size and location per GMW17081".

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3.3.1.1.2.3 Reground Plastic. Thermoset plastic parts shall be made of 100% virgin polymer, and must be called out as such. Thermoplastic parts must have a note on the detail drawing designating the permissible level of regrind (even if zero, which is normally the case). The note shall read, "Regrind content: Re XXHS maximum per GMW17081". Levels will vary depending on the nature of the composite reinforcement and the length of fiberglass fibers when used. No callout presence shall default to 100% virgin material. No postindustrial or postconsumer material shall be used, but rather home scrap (runners/sprues and not flash), from the same process, when allowed. See GMW3116 Recycling Design Guide for more information.

3.3.1.1.2.4 Thermoplastic. For polyamide 6/6, must be described on the engineering drawing to meet GMW17081 and GMW3038 Polyamide 66 with Glass Reinforcement levels as validated. The supplier is to use these specifications to describe the particular material they are using. Specification approval by the GM Materials Engineer is required.

3.3.1.1.2.5 Thermoset. Must be described by base polymer, i.e., phenol/formaldehyde, on the engineering drawing to the GMW17081 or GMW15702 (e.g., -022751), with glass/mineral filler level as applicable and validated. The supplier is to use these specifications to describe the particular material they are using. Specification approval by the GM Materials Engineer is required.

3.3.1.1.3 Metal Matrix Composite (MMC). MMC pulleys are aluminum with a filler to improve wear. The aluminum alloy and the filler must be preapproved, as well as the manufacturing process to adequately distribute the composite filler at the wear surfaces in contact with the belt. These pulleys are not in current use.

3.3.1.2 Processes Guidelines. See 7.3.

3.3.1.3 Parts Guidelines. Not applicable.

3.3.2 Design Guidelines and Constraints.

3.3.2.1 Web Configuration. The design of the pulley is the responsibility of the supplier supported by FEA, using quadratic elements, and based on loading provided by the Powertrain release engineer. Holes to provide accessibility to fasteners behind the pulley may be required on some applications. Pulley OD, offset and pilot/hub/mounting hole and packaging information are supplied by the release engineer as required.

3.3.2.1.1 Sensitivity to Hub Walking. The design of the pulley for high offset (generally 50 mm or greater) or idler applications may be sensitive to the phenomenon of **walking** off of the shaft, even with a correct press fit. This is caused by elastic deformation of the hub in the presence of belt load. The design of the web section is the most influential in determining the adequacy of the design to resist walking. Deflection is inherent due to load, and an offset load will increase the deflection. The pulley will deflect where it has the lowest stiffness, and the hub press can be overcome due to distortion of the bore. The bore separates from the shaft locally, and will re-contact the shaft in a different location due to the offset load effects. As the pulley rotates, the entire circumference of the shaft in a given plane will advance on the shaft in a spiral fashion, and eventually walk itself off of the shaft.

The supplier shall analyze the deflection of the pulley under load (if required, assistance will be provided by GMPT) to assess what press level will be sufficient to resist the deflection present. It must be determined if that required level of press is within the torque to turn and press load requirements elsewhere in this specification. Walking tests must be run to verify the analysis. Approval of both the supplier analysis and testing must be obtained from the GM Release Engineer and Global Technical Specialist.

3.3.2.2 Groove Configuration. Must conform to Appendix A (Figures A1 thru A3) dimensioning templates, including flange configuration, supplied with this specification. Drawing of part, submitted by the supplier must use this dimensioning technique.

3.3.2.3 Backside Pulleys. Intent on backside pulleys is for the belt running surface to be flat. No concavity is permissible and any crown must not exceed a height of 0.10 mm across a six (6) groove area of 21.36 mm width, and proportionally more/less for other pulley widths.

3.3.2.4 Hub. Where applicable, the hub is to be made of steel, either screw machined or cold formed iron/copper powdered metal with machined ID. It requires puller groove on pressed-on-shaft applications with sufficient integrity to withstand 33.4 kN press load on shaft. Groove must be 4.5 mm wide minimum and puller lip must be a minimum of 3.8 mm thick. See Appendix B, Figure B1 for common hub configuration.

3.3.2.4.1 Hub Material. For screw machined hubs, SAE International grade 12L13, 12L14 or 12L15 or SAE International grade 1213, 1214 or 1215 lead-free steel may be used (not required). This is equivalent to European Specification QS 1109 or DIN EN 10087. Powdered metal hubs must conform to MPlF Standard 35

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F-0005 or MPIF Standard 35 FC-0200 as determined by performance requirements. Deviations require Global Technical Specialist approval.

3.3.2.4.2 Hub Weld Penetration. For welded hubs, the penetration of the weld must conform to configuration shown in Appendix C, Figure C1.

3.3.2.5 Grooved Pulley Angle. Note that grooved pulleys have two possible groove angles, shown in Appendix A, Figures A1 thru A3. For pulley DOB of 70 mm or greater, a 40 degree groove angle shall be used. For DOB less than 70 mm a groove angle of 37 degrees is required.

3.3.3 Identification and Marking. Part number and date code requirements shown on engineering 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 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. Not applicable.

4.2 Validation Cross Reference Index. Not applicable.

4.3 Supporting Paragraphs.

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

Table 1: Percentage Time ^{Note 1}

USA (% Time)	Europe (% Time)	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: 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.

4.3.2 Fatigue Resistance. Represents the fatigue resistance for actual number of cycles based on 525×10^6 crankshaft revolutions per 250 000 km (150 000 mi). Only steel pulleys, with a well-defined Stress-Cycles (S-N) curve can be tested to 3×10^7 cycles and assume infinite life. Requirement for 250 000 km (150 000 mi) must be multiplied by pulley drive ratio involved. Nonferrous pulley testing must be run at 100 °C in a chamber with circulated air. Nonferrous pulleys are best designed to very low stresses, so fatigue failure is impossible.

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