



Engine Crankshaft Torsional Isolator

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 crankshaft torsional isolators.

1.2 Applicability. This standard covers the torsional isolator either as a standalone component or as a portion of the crankshaft combined torsional damper and isolator assembly.

1.3 Remarks. This standard contains all information necessary to design, analyze, develop, validate, and manufacture engine crankshaft torsional isolators.

2 References

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

2.1 External Standards/Specifications.

ACEA A3/B3	ISO 9001	SAE D4512	SAE J2236
ISO 1431-1	ISO 11469	SAE J431	

2.2 GM Standards/Specifications.

GMW2	GMW10	GMW3286	GMW15282
GMW4	GMW3059	GMW4700	GMW16290
GMW5	GMW3116	GMW14671	GMW17081

2.3 Additional References.

- CONTECS Engineering Service GmbH, Berlin, Germany (www.contecs-engineering.de)
- Global Propulsion Systems (GPS) Global Engine Durability (GED) Test
- Statement of Requirements (SOR)
- Tucker's Pottery Supplies Incorporated, Ontario, Canada (www.tuckerspotttery.com)

3 Requirements

3.1 System/Subsystem/Component/Part Definition.

3.1.1 Appearance. Not applicable.

3.1.2 Content.

3.1.2.1 Physical Content. There are two (2) potential functional applications, one (1) for normal accessory drives, and a second for Belt Alternator Starter (BAS) applications.

3.1.2.2 Functional Content. This standard covers crankshaft torsional isolators and not Torsional Vibration Dampers (TVD). The term isolator is used to describe a device which is tuned to frequencies below the engine firing frequency at idle speed. This device can be standalone or can be part of a combined device which serves both isolator and damper functions. The torsional vibration damper is a device which is tuned to the first mode torsional natural frequency of the crankshaft (in the 200 Hz to 300 Hz range) in order to reduce stress on the crankshaft at resonance. It splits the resonance peak into two frequency peaks, one at about 4000 engine rpm and the other above the maximum firing frequency of the engine at red line. The weight on the outside of the

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damper is 180 degrees out of phase with the motion of the crankshaft at its tuning frequency and, therefore, will reduce its amplitude. A BAS isolator has internal stops which allow transmission of torque in both directions to accommodate the engine being driven by the Motor Generator Unit (MGU) during engine starts and the boost function or the crankshaft. Both the TVD and the accessory drive crankshaft torsional isolator are spring/mass tuning devices, and only differ by tuning frequency and mechanical design.

The isolator has two purposes:

- Correcting engine accessory drive issues.
- Addressing vehicle steering shudder on V6 engine applications with hydraulic power steering pumps driven by the accessory drive. These are almost completely eliminated with electrically driven power steering pumps (eBoost).

3.1.2.2.1 Accessory Drive. The isolator decouples the rigid body torsional motion of the crankshaft from the accessory drive above the drive natural frequency. This, in turn, reduces the torsional amplitude of the accessory drive at its higher torsional first mode natural frequency, and especially at idle speed, where accessory loads are the highest. On diesel engines, the rigid body motion of the crank is much greater than that of a gas engine, so the isolator may be required even if the accessory drive first mode torsional frequency is not at/near idle speed. The manifestation of the problem is the inability of the auto tensioner on the accessory drive to control belt span vibration or its own amplitude. On gas engines, an idle accessory drive system resonance can also excite a belt tensioner beyond its absorption authority. System dynamics determine the need for these devices.

3.1.2.2.2 Steering System Shudder. When the rigid body motion of the crankshaft is sufficient to transmit torsional motion to the power steering pump pulley that exacerbates a resonant phenomenon, or sensitivity, in the steering system beyond an acceptable level, the isolator may be considered. It should be noted, however, that a generator isolator should be tried first, since it is a more cost effective solution.

3.1.2.2.3 Functional Requirements. The function of the device is to decouple the torsional vibration of the crankshaft from the accessory drive at idle speed. This is accomplished by adding a spring to the crankshaft nose to interact with the accessory drive torsional masses/inertias, and tuning its first torsional resonant mode below engine firing frequency at idle.

3.1.2.2.3.1 Frequency Control. The device must be able to be tuned to 5 Hz below engine firing frequency at idle or far enough below that frequency such that its resonant amplitude is controlled to an acceptable level at idle. A running engine test, with the accessory drive installed, shall confirm the SIMDRIVE analysis (CONTECS Engineering Service GmbH).

3.1.2.2.3.2 Temperature Stability. It is also required that this function and noise not be degraded at the extremes of the ambient temperature operating envelope of -40 °C to +110 °C. Although some frequency shift may be inherent, it must not result in a functional vibration issue on the application in question.

3.1.3 Ambient Environment. The component parts for the isolator must meet the application ambient conditions:

- **Temperature:** -40 °C to +110 °C.
- **Humidity:** 0% to 100%.
- **Contamination:** Underhood fluid splash (not immersion). All elastomers and thermoplastics must have resistance to typical underhood fluids, based on the potential for their exposure to these products in the application. Evidence of resistance to these contaminants must be submitted to the GM Technical Specialist for approval. Plastic and elastomeric parts must maintain their function and durability after exposure to the contaminants listed in Table 1.

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Table 1: Contaminants

North America	Europe (Exceptions)
Coolant - dexcool® (orange)	
Windshield washer solvent - GM Optikleen® (based on ethanol)	
Engine oil – Starburst Symbol	Must meet ACEA A3/B3
Dexron® VI Automatic Transmission Fluid	
Brake fluid – Department of Transportation (DOT) 3	
Road Salt, Water, Mud, Sand	

3.1.4 Interfaces. Interface is the engine crankshaft nose, and the crankshaft TVD. Also inherent is maintaining clearance to vehicle components in front of the isolator. This is done together with the supplier and the Global Propulsion Systems (GPS) release engineer contributing.

3.1.5 Usage Definition. Isolators are used to shift the torsional first mode natural frequency/resonance of the accessory drive system to a frequency significantly below the engine idle speed firing frequency.

3.2 Product Characteristics.

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

3.2.2 Physical Characteristics.

3.2.2.1 Dimensions and Capacity. Not applicable.

3.2.2.2 Mass Properties. Mass is a function of the space available to package and the materials used in the construction of the isolator. There are no specific 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 the Global Technical Specialist.

3.2.4 Serviceability. Preferred to be removable without removing the engine assembly from the vehicle.

3.2.5 User System/Subsystem/Component/Part Interface. The crankshaft and/or damper interface requirements will be described in the Statement of Requirements (SOR) for each application.

3.3 Design and Construction.

3.3.1 Materials, Processes and Parts Selection Guidelines. All materials must be specified and approved by the Accessory Drive Technical Specialist.

3.3.1.1 Material Guidelines. Material specifications shall be North American controlled GM, GMW, SAE International (SAE), ASTM International (ASTM), and/or Metal Powder Industries Federation (MPIF).

National standards, from other regions may be acceptable, and supplier internal standards may be acceptable, but must first be approved by the GPS Materials Engineer and the Technical Specialist. See 3.3.1.1.2 for exceptions.

3.3.1.1.1 Part Cleanliness. Every detail drawing must call out: "Parts as delivered to assembly plant shall be clean and free of debris, residual abrasive material and corrosion products adversely affecting function or appearance."

3.3.1.1.2 Coatings/Platings/Finishes. All finishes must be called out on the detail drawing to a GMW standard where possible. Exceptions, including other region manufacture, may use selected local standards approved by the GM Materials Engineer and Technical Specialist. If an Electrodeposition Primer (ELPO) or powder epoxy finish is used, the options are:

- Clean, zinc phosphate and paint black by cathodic Electrodeposition paint per conforming to GMW14671 type A-U/H, except scribed 168 h salt spray is the only testing required. Salt spray and corrosion creepback limit per GMW3286 and GMW15282 respectively.

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- Clean, zinc phosphate and paint black with powder epoxy conforming to GMW14671 type A-U/H except scribed 168 h of salt spray is the only testing required.

3.3.1.1.3 Metals. Callouts are required on the detail drawing as follows:

- **Die Cast Aluminum:** Shall employ GMW5 specification. A380 is equivalent to GMW5M-Al-C-Si8Cu3Fe, and 383 is equivalent to GMW5M-Al-C-Si10C2Fe1. Alloys ADC10 and ADC12 are approved substitutes in Europe and Asia, where they are commonly used.

Note: The GMW5 callouts follow ISO 9001, based on chemical symbols applicable to all the light metals and their alloys. International symbols are used in GMW5 to cover the major alloying elements and significant residual elements. Alloying elements, defined as those with an upper and lower limit (other than zero) in the chemical composition are listed left to right in order of decreasing content, or in alphabetical order in the case of equal percentages. Each chemical symbol is followed by whole numbers denoting the nominal percent present in the alloy.

- **Steel Parts:** Shall be called out as either cold or hot rolled steel per GMW2.
- **Powdered Metal Parts:** Particular alloys must be described in terms of MPIF standards. The particular powder used must have GM Technical Specialist approval. Density must be specified. The manufacturer must have GM Technical Specialist approval, based on a personal visit to the supplier manufacturing facility, unless approvals and experience is available from other GM business with the supplier.

3.3.1.1.4 Thermoplastic Parts. All of these materials must have the approval of the Technical Specialist. Callouts are required on the detail drawings using applicable GMW, ASTM, or SAE specifications where available. Include information on the group, class, grade, and glass/filler content, as applicable. Note the increase in the life requirement from 10 years to 15 years. Callouts must be approved by the GPS Materials Engineer.

3.3.1.1.4.1 Recycling. Some plastic parts are subject to recycling consideration. Generally internal component 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". See GMW3116 Recycling Design Guide for more information.

3.3.1.1.4.2 Plastic Regrind. Thermoset plastic parts shall be made of 100% virgin polymer, and must be called out as such. No postindustrial or postconsumer material shall be used, but rather home scrap (runners/sprues, and not flash) from the same process, when allowed. 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 REXXHS 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.

3.3.1.1.5 Elastomers. Callouts must be expressed in terms of standards per 3.3.1.1. Supplier and grade must be submitted for approval by the Technical Specialist and the callouts must be approved by the GPS Materials Engineer.

3.3.1.1.6 Greases. Must be expressed in terms of the supplier name, basic oil, and stiffener and grade, and require the approval of the Technical Specialist for performance and the Materials Engineer as far as the callout is concerned.

3.3.1.2 Processes Guidelines. Not applicable.

3.3.1.3 Parts Guidelines. Not applicable.

3.3.2 Design Guidelines and Constraints.

3.3.2.1 Physical Description. The isolator is mechanized as a large rubber (rare) or steel spring (usual) element between the crankshaft and the accessory drive pulley for tuning to a frequency below engine firing frequency at idle. In order to maintain the accessory drive pulley on the crank in its correct plane with the soft rubber spring, a ball bearing or composite bushing Inner Diameter (ID) is placed on the crank hub and its Outer Diameter (OD) is mated to the pulley. The bearing dithers with the cyclic oscillation of the isolator spring. Other concepts are mechanized with steel springs, but in either case, all these devices must incorporate a One-Way Clutch (OWC) feature or a "dwell zone" to provide a similar functionality, to eliminate startup and/or shutdown belt chirp when the isolator passes through its natural frequency.

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3.3.2.2 Hub. When the isolator is directly attached to the crankshaft, it has a hub. Some designs are bolted to a damper hub. If applicable, the hub, which is pressed lightly on the crankshaft and clamped with a bolt, can be made of steel, aluminum or nodular cast iron. The combination of press and clamp load at a given surface finish at the interface must resist the torque of the accessory drive, stalls and backfire conditions which vary by application. The responsibility for the retention design lies with GPS. Only the maintenance of the hub ID size within the specified tolerance and its surface finish and hardness are the responsibility of the isolator supplier, once the geometry and material are chosen. Specific applications may differ in requirements, and require GPS Technical Specialist and Release Engineer approval.

In the event that the hub bolts to the damper hub, there must be a pilot feature which engages the damper hub either on the ID or OD of a feature, which must be held within 0.10 mm concentricity.

3.3.2.2.1 Keyway. A keyway is not required for the function of the part, but it may be needed for a secondary function, such as ignition timing, crank position sensing, or external crank balance (balancer). If this is the case, the requirements will be communicated by the Release Engineer.

3.3.2.2.2 Crank Seal Surface. The other function which may be required of the hub is to provide a crankshaft seal surface in an identified zone. The following are requirements:

- Material: Seals do not function well on steel interfaces, so the seal interface on the isolator must be cast iron, and approved by the Cranktrain Technical Specialist.
- Surface finish: 0.2 μm to 0.6 μm Surface Roughness (Ra).
- Runout (radial): 0.05 mm (crank nose is typically 0.025 mm).
- Lead condition: No lead (defined on process specification).
- Defined as a Key Product Characteristic (KPC), therefore the Key Control Characteristic (KCC) sets the process.
- Typical processes.
- Plunge grind and polish in direction of engine rotation.
- Turn and burnish.

3.3.2.2.3 Seal Installation Features. To prevent seal lip damage.

- Combination of radii, chamfers and stepped diameters.
- Varies with application.

3.3.2.2.4 Removal Features. Where applicable, features are required to remove the isolator without damage with a standard puller, and after normal corrosion of the crank to hub interface have taken place.

Optional:

- Threaded holes in hub.
- Pull tabs cast onto spokes (requires open design).

3.3.2.2.5 Installation Provision. Depending on the design configuration, an installation provision is required. It may consist of four (4) equally spaced tapped holes which may double as puller provisions. Pull tabs cast onto the spokes can be used when an open face is possible. Use of a standard puller for this operation is desired. In any case, the design must have GPS Release Engineer and Technical Specialist approval.

3.3.2.2.6 Slinger Provision. In some applications, protection for the front crank oil seal from contamination is required in the form of a stamped steel ring on the engine side of the hub. The exact configuration must be defined by the Release Engineer based on the application specifics.

3.3.2.2.7 Hub Material, Nodular Iron. Normally, nodular iron is the material of choice for the weight, and perhaps the hub. Use GMW10M Grade 4010 (see GMW10) or equivalent SAE D4512.

3.3.2.2.8 Hub Material. Aluminum used as a lightweight feature with associated added cost: A390 or equivalent. Seal mating surface must be hard anodized from 30 Rc to 35 Rc (Rockwell C scale) and a minimum depth of 0.25 mm. Use of aluminum must be directed by GPS in the SOR.

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