SECTION 0C

VIBRATION DIAGNOSIS

NOTICE: Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. General Motors will call out those fasteners that require a replacement after removal. General Motors will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and joint clamping force, and may damage the fastener. When you install fasteners, use the correct sequence and tightening specifications. Following these instructions can help you avoid damage to parts and systems.

CONTENTS

GENERAL DESCRIPTION

VIBRATION

Among the problems encountered in the development and servicing of a vehicle, vibration conditions are perhaps the most difficult to identify and correct. This difficulty arises since the vibration the driver feels or hears is generally not the source of the problem, but rather a component responding to some external excitation, e.g., the steering wheel may vibrate due to the unbalance of a wheel, the engine, etc. Also, the source of the excitation may be built into the operation of the vehicle, and therefore cannot be eliminated (vehicle is normal) as in the case of the power pulses from the engine.

Vibration is a back and forth oscillation that can be seen, heard or felt. A vibration results from a system (group of parts) responding to an alternating excitation, the resulting motion being transmitted either visually (can be seen), audibly (can be heard) or physically (can be felt) to the occupants. A vehicle imbalance or misalignment is usually the cause of a vibration.

There are three ways to correct a vibration:

1. Eliminate the source of the vibration.
2. Interrupt the transfer path.
3. Stop the responder from responding.

DIAGNOSIS

REED TACHOMETER

Figures 1 and 2

To aid in the diagnosis of vibrations, a reed tachometer can be used to identify the frequency of a rotational component with a repetitive vibration (Figure 1).

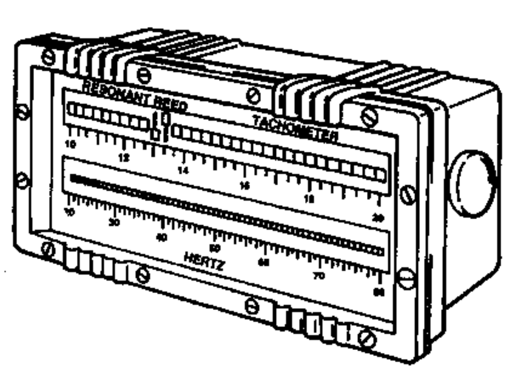


Figure 1—Reed Tachometer

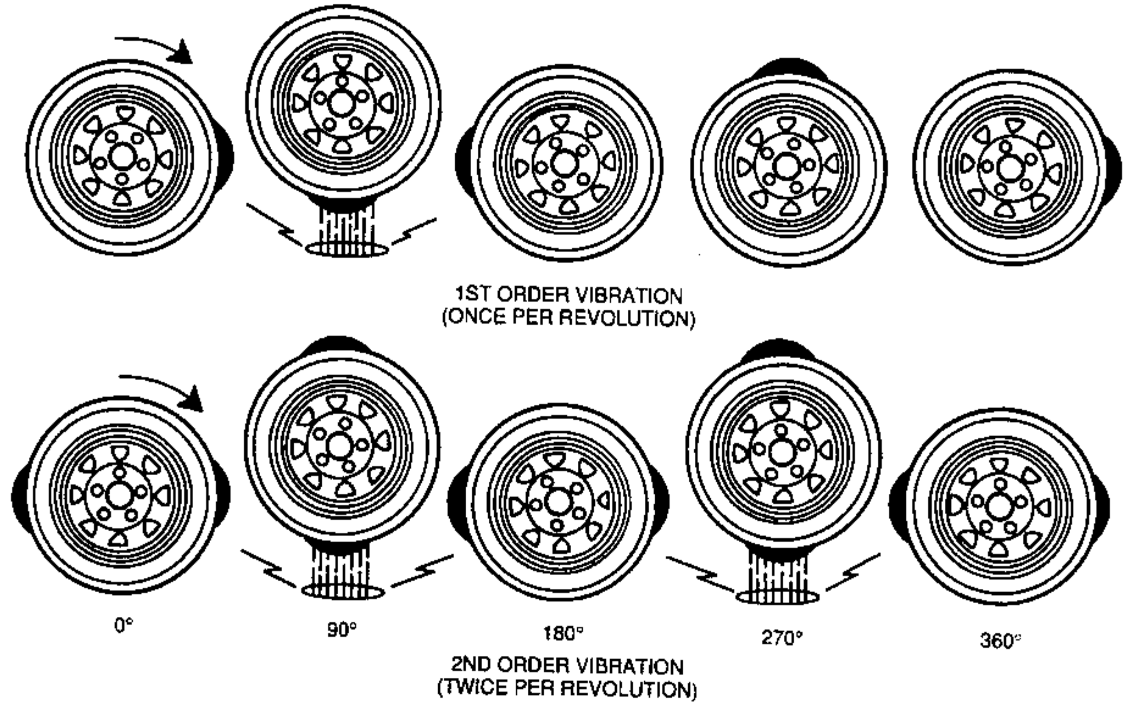


Figure 2—Order of Vibration

The Biddle Frahm Reed Tachometer, or equivalent, measures vibration in cycles per minute (CPM). It consists of two rows of reeds. Each row is designed to vibrate at a particular frequency.

If you can match the rotational speed of a particular component with the frequency reading of the reed tachometer, you will know in which area to concentrate your efforts for repairs. Each component on a vehicle will vibrate at a natural frequency. This frequency acts like a fingerprint and will identify a component. For a particular component, this frequency will vary with vehicle speed and/or engine speed. These frequency relationships exist for all vibrations that occur in a vehicle, and understanding these relationships can often solve difficult vibration problems.

The reed tachometer should be placed on the top of the instrument panel for ease of viewing and for effective pickup of a vibration.

Some components may induce more than one vibration at a given speed. These multiple vibrations are referred to as the order of vibration. The order of vibration refers to the number of disturbances created by one rotation of a component. For example, a tire with one heavy spot will produce one disturbance each rotation, a first order vibration (Figure 2). An oval-shaped tire will produce two disturbances each rotation, a second order vibration. (Figure 2).

In general, the suspect component should be isolated to verify the cause of a vibration before parts are replaced. For a first order tire vibration, the responsible component can be anything which rotates at wheel and tire speed (i.e., wheels, tires, brake rotors, brake drums). These can be serviced or replaced with known good parts to identify the component causing the vibration. Once verified, the component can be balanced or replaced as necessary.

Using a reed tachometer in a vehicle will take some practice. One of the more important things to be aware of when using the reed tachometer for the first time is that the reeds are very sensitive and will pick up many low amplitude vibrations. These will appear as slight movements of many reeds, and do not correspond to any particular component. Reed movement that corresponds to a vibrating component will be greater in amplitude, traveling the full range of the viewing area. Reed vibration will also change as engine speed or vehicle speed changes.

ELECTRONIC VIBRATION ANALYZER (EVA)

Figure 3

The Electronic Vibration Analyzer (EVA) J 38792 speeds up the diagnosis of vibrations (Figure 3). The EVA displays three predominant frequencies and their amplitudes in order from the strongest to the weakest.

The EVA is equipped with a vibration sensor that can be plugged into either input A or input B on the front of the EVA. The vibration sensor can be mounted almost anywhere on the vehicle using a magnet or adhesive putty. There is a trigger wire on the front of the EVA that a strobe light can be attached to for driveshaft balancing.

Figure 3—Electronic Vibration Analyzer (EVA)

Important

- The vibration sensor is marked with the word "UP" on one side. Mount the sensor in the horizontal position with the "UP" identification facing up. Mount the sensor as close as possible to the source of the vibration. Refer to the EVA instruction manual for information about sensor calibration.

CLASSIFYING A VIBRATION COMPLAINT

There are several excitation sources and many responding systems which may cause an annoying vibration. The first step is to identify the individual vibration complaints by systematically classifying them, during a road test, into one or more of the following categories:

1. Vehicle speed sensitive.
2. Engine speed sensitive.
3. Torque sensitive.
4. Jounce (load) sensitive.

In the process of classifying vibration problems in terms of these four sensitivity categories, you will find that many problems fit more than one of the categories. These four sensitivity categories can be combined into a list of five possible combinations into which a majority of vibration problems will fall:

A. Engine speed sensitive only.
B. Vehicle speed sensitive only.
C. Torque sensitive and vehicle speed sensitive.
D. Torque sensitive and engine speed sensitive.
E. Torque sensitive, vehicle speed sensitive and jounce sensitive.

Since each of the categories has specific vibrations associated with it, determining which category(ies) the vibration falls into will give direction to the proper area for analysis of the problem. This will eliminate many components that cannot be the cause, and will focus attention on only those items that can contribute to the specific condition encountered.

ROAD TEST

The road test is a very beneficial way to help the technician locate the vibration. If possible, the owner of the vehicle should be present for the road test to help point out the vibration complaint. The importance of riding in the vehicle with the owner cannot be overemphasized. If the condition is normal, and no corrective action is needed, the owner should be told so immediately. A normal condition can be demonstrated with other vehicles, pointing out that similar vehicles have the same condition. To help diagnose and isolate the source of a vibration, it is important to road test the vehicle and use a systematic approach in narrowing down the possible causes of a vibration.

Important

- Before road testing the vehicle, check the following:
  A. Tires for correct inflation pressure. Refer to the tire placard affixed to the driver's door jamb for tire inflation specifications.
  B. Vehicle for correct load conditions. Refer to the tire placard affixed to the driver's door jamb for vehicle load specifications.
  C. Wheel nuts for proper torque. Refer to SECTION 3E.
  D. Engine mounts for proper torque. Refer to SECTION 6A1.
  E. All universal joint fasteners for tightness and correct torque. Refer to SECTION 4A.

- When did the vibration start?
- Did the vibration start after a repair?
  —Exhaust system
  —Undercoating
  —Tire repair or replacement
  —Wheel alignment
  —Engine repair
  —Other

The following questions should be used as a basic outline during the road test. These questions will enable you to eliminate many components and focus attention on only those items that can be responsible for the vibration complaint.

- Is it a noise? Can it be heard as well as felt?
- What type of noise is it?
  —Buzz
  —Moan
  —Rattle
  —Squeak
  —Shudder
- Where can the vibration be felt?
  —Seat
  —Floor
  —Steering Wheel
- Does the vibration occur on smooth or rough roads?
- When does the vibration occur?

Four major component groups are usually the cause of, or are related to the vibration:

1. Engine and mounts
2. Clutch and transmission
3. Tires, wheels, brake drums and rotors
4. Propeller shaft and universal joints

The following list contains items that may cause vibration:

Inspect

1. Wheel alignment. Refer to SECTION 3A for wheel alignment specifications.
2. Tire treads for blisters or separations.
3. Tire or wheel for proper balance. Refer to SECTION 3E for specifications.
4. Wheel studs for excessive runout. Refer to SECTION 3 for specifications.
5. Brake drum or rotor for damage or deformation.
6. Tie rod ends for wear.
7. Trim height. Refer to SECTION 3 for trim height specifications.
8. Lower ball joints for wear or damage.
9. Wheel for excessive runout. Refer to SECTION 3E for wheel runout specifications.
10. Tire and wheel assembly for excessive loaded radial runout. Refer to SECTION 3 for radial runout specifications.
11. Universal joints for looseness or damage.

Coast Test

Drive the vehicle past the vibration speed, shift into neutral and coast back through the vibration speed. In this test two kinds of vibrations normally occur: a shaking or a buzzing. A shaking vibration is usually caused by tires or a wheel and brake drum/disc assembly problem. A buzzing vibration is usually caused by a driveline problem.

VEHICLE SPEED SENSITIVE

Tool Required:
TK-0-A TECH 1 Tester

Most vibration complaints are vehicle speed sensitive. The frequency of the excitation depends on the speed of the vehicle. To determine if a given problem is vehicle speed sensitive:

1. Connect a TECH 1 to the Data Link Connector (DLC) and display engine rpm. Refer to the TECH 1 operator's guide.
2. Drive the vehicle in high gear and record the vehicle speed and the engine speed at which the problem occurs.
3. Shift the vehicle into the next lowest gear and again record the vehicle speed and engine speed at which the problem occurs.
4. If the problem occurs at the same vehicle speed as when the vehicle was in high gear, the vibration is vehicle speed sensitive.

ENGINE SPEED SENSITIVE

Tool Required:
TK-0-A TECH 1 Tester

Another group of vibration complaints are engine speed sensitive. The frequency of the excitation depends only on the speed of the engine, independent of the vehicle speed. To determine if a given problem is engine speed sensitive:

1. Connect a TECH 1 to the Data Link Connector (DLC) and display engine rpm. Refer to the TECH 1 operator's guide.
2. Drive the vehicle in high gear and record the vehicle speed and the engine speed at which the problem occurs.
3. Shift the vehicle into the next lowest gear and again record the vehicle speed and engine speed at which the problem occurs.
4. If the problem occurs at the same engine speed as when the vehicle was in high gear, the vibration is engine speed sensitive.

TORQUE SENSITIVE

Tool Required:
TK-0-A TECH 1 Tester

A torque sensitive problem is one which increases in intensity as the torque (power) output of the engine increases. The intensity of the vibration increases as the throttle opening is increased. To determine if a given problem is torque sensitive:

1. Connect a TECH 1 to the Data Link Connector (DLC) and display engine rpm. Refer to the TECH 1 operator's guide.
2. Drive the vehicle in high gear and record the vehicle speed and the engine speed at which the problem occurs.
3. Observe the disturbance while varying the throttle position. That is, drive the vehicle with steady throttle, slowly increasing to heavy throttle by going uphill or applying the brakes while increasing the throttle opening and then slowly decreasing to minimum throttle by coasting through the disturbance.
4. If the disturbance becomes more severe as the throttle opening is increased, the vibration is torque sensitive.

JOUNCE OR LOAD SENSITIVE

A jounce or load sensitive problem is one which varies in intensity as the height of the vehicle changes with respect to the surface of the road. The intensity varies as the front struts are extended or compressed. To determine if a given problem is jounce or load sensitive:

1. Drive the vehicle a number of times, changing the load each time and observing the disturbance.
2. Drive the vehicle over a road that dips in such a way that it causes the front of the vehicle to move up and down in relation to the surface of the road. Keeping a constant throttle, observe the disturbance.

3. If the condition varies depending on the passenger load (or varies as the front of the vehicle moves up and down), the problem is jounce or load sensitive.

Jounce sensitive vibrations may also be torque or engine speed sensitive.

ON-VEHICLE SERVICE

ENGINE SPEED SENSITIVE ONLY

Problems in this category may be duplicated with the vehicle stopped and the transmission in neutral by running the engine at the speed which the disturbance was felt during the road test. All additional appraisals can thus be made under this "free engine" condition.

Engine speed sensitive problems can be due to the belt or engine-driven accessories (generator, A/C compressor, coolant pump, power steering pump). To isolate the offending component, first check the torque on all accessory bracket fasteners. Also, check the condition and tension of the drive belts. If any abnormal conditions are found, correct and retest for the vibration problem.

For generator fastener torque specifications and drive belt tension information, refer to SECTION 6D3. For A/C compressor fastener torque specifications and drive belt tension information, refer to SECTION 1B. For coolant pump fastener torque specifications and drive belt tension information, refer to SECTION 6B. For power steering pump fastener torque specifications and drive belt tension information, refer to SECTION 3B1.

If the vibration occurs after all accessory drive belts and fasteners have been properly adjusted and tightened, the accessory may have an internal problem such as bad bearings, bent shafts or imbalance. Repair or replace unsatisfactory parts until all accessories run smoothly.

If all accessories run smoothly and the vibration problem still exists, check for basic engine imbalance due to a faulty or loose flywheel. For flywheel torque specifications, refer to SECTION 6A1. Also, on automatic transmission equipped vehicles, check for a faulty or loose torque converter. For torque converter specifications, refer to SECTION 7A. If the vibration occurred after a major engine overhaul, the cause may be internal. For engine mechanical diagnosis, refer to SECTION 6.

A/C compressor problems can be diagnosed by turning the compressor off and on while the vibration condition is being experienced. Refer to SECTION 1B for air conditioning service procedures and proper drive belt tension specifications.

VEHICLE SPEED SENSITIVE ONLY

Figure 4

Vehicle speed sensitive vibration problems are usually related to tire and wheel imbalance or runout. Low speed vibrations, those occurring at less than 64 km/h (40 mph), are usually runout related. Highway speed vibrations, those speeds above 64 km/h (40 mph), can be caused by either imbalance or runout. For wheel and tire balancing procedures, refer

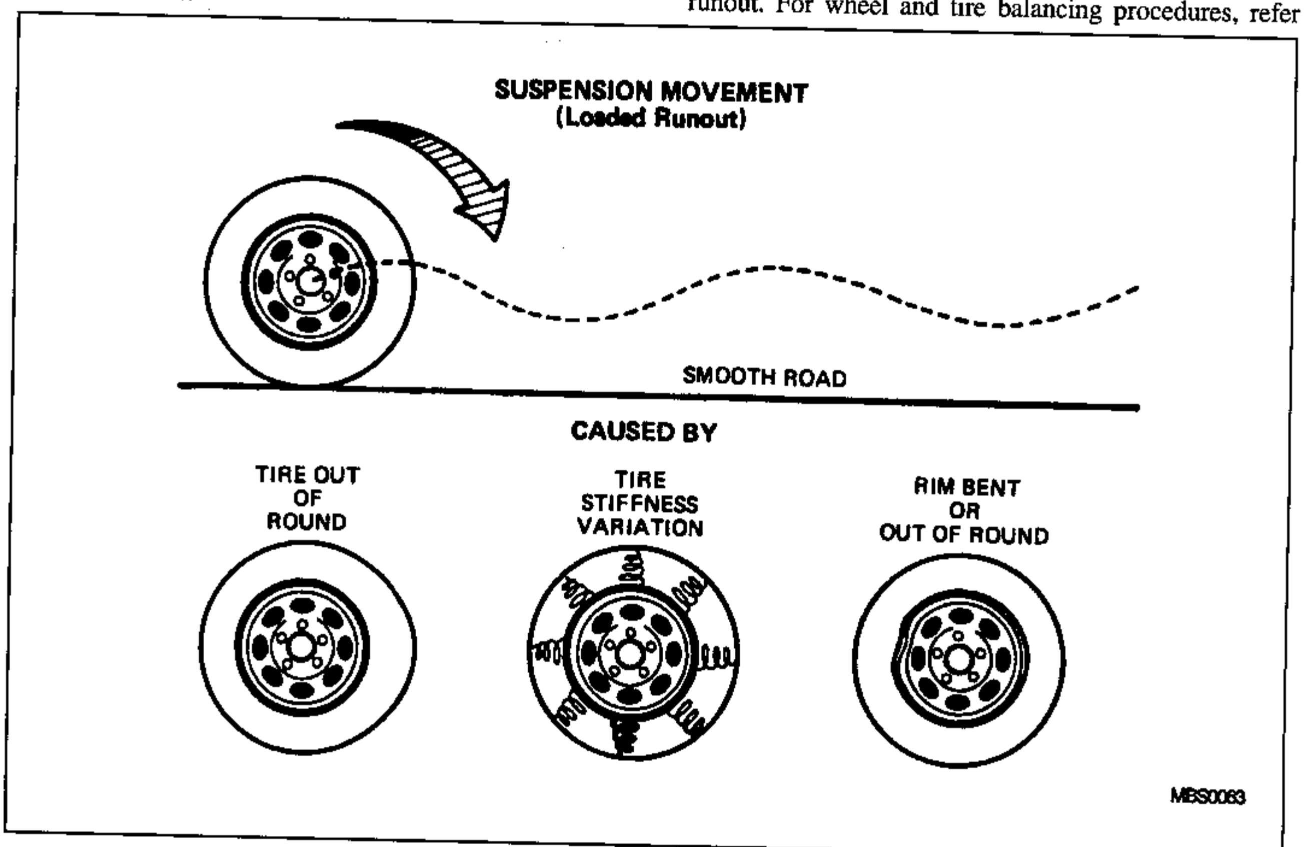


Figure 4—Causes of Vibrations

to SECTION 3E. To investigate the possibility of wheel or tire runout, refer to SECTION 3. If a vibration remains after dynamic balancing, it can be caused by three things (Figure 4):

1. Tire runout.
2. Wheel runout.
3. Tire stiffness variations.

For service procedures concerning these three problems, refer to SECTION 3.

Another condition that is vehicle speed sensitive is a problem called "radial tire waddle." This condition is caused by a steel belt not being straight within the tire, or by excessive lateral runout of the tire or wheel. The vehicle can be road tested to determine which end of the vehicle has the faulty tire. If the waddle tire is on the rear, the rear end of the vehicle will shake from side to side or "waddle." From the driver's seat it feels as though someone is pushing on the side of the vehicle. For "radial tire waddle" service procedures, refer to SECTION 3.

TORQUE AND VEHICLE SPEED SENSITIVE

The only excitations which are both vehicle speed sensitive and torque sensitive (and possibly jounce sensitive) are disturbances caused by improper driveline angles which are a result of incorrect trim height or faulty universal joints. Check for the following:

- Worn or damaged universal joints. The universal joints should pivot smoothly. If universal joint binds or appears tight, replace the universal joint as an assembly. Refer to SECTION 4A for universal joint service procedures.
- Correct trim height. Refer to SECTION 3.

TORQUE AND ENGINE SPEED SENSITIVE

Vibration problems likely to be encountered in this class are as follows:

A. Engine-driven accessories (generator, A/C compressor, coolant pump, power steering pump).
   - Engine-driven accessories generally do not present a problem if all fasteners are tightened to specifications and their respective drive belts are adjusted to proper tension. Also check physical condition of the drive belts. Visually inspect each accessory to ensure that the brackets installed are complete and properly assembled.
   - For generator fastener torque specifications and drive belt tension information, refer to SECTION 6D3. For A/C compressor fastener torque specifications and drive belt tension information, refer to SECTION 1B. For coolant pump fastener torque specifications and drive belt tension information, refer to SECTION 6B. For power steering pump torque specifications and drive belt tension information, refer to SECTION 3B1.

B. Engine/transmission contacting the engine cradle or body.
   - Inspect the vehicle to be certain that neither the engine or transmission is contacting the engine cradle or body. If any irregularities are revealed during inspection, correct and retest on the road.

C. Exhaust system components.
   - Visually inspect the exhaust manifold, intermediate pipe/muffler, forward pipe/catalytic converter and tailpipe for sufficient clearance of all points, at least 13 mm (0.51 inch) in all directions. Be particularly certain that sufficient clearance exists in all directions during engine torque load.
   - A majority of exhaust system problems are due to "bound up" conditions. Loosen all joints in the entire system and rest the pipes on floor stands while each clamp and bolt is tightened to specifications. Refer to SECTION 6F for proper exhaust system torque specifications.
   - Be certain that the end of the tailpipe is below the surface of the rear bumper fascia.
   - After inspecting the exhaust system and making any corrections, retest on the road.

PROPELLER SHAFT

Driveline vibrations will generally be a high speed vibration associated with a "buzz" or a "shudder" occurring in the 72 to 88 km/h (45 to 55 mph) range. A majority of the vibration is experienced on either acceleration or deceleration. Driveline vibrations emanate from four general areas:

1. Propeller shaft balance.
2. Propeller shaft runout.
3. Driveline angles.
4. Joint phasing.

Most driveline vibrations that are associated with a "buzz" or a "shudder" type vibration will also have a high frequency reading on the reed tachometer or Electronic Vibration Analyzer (EVA). Refer to "Reed Tachometer" or " Electronic Vibration Analyzer (EVA)" earlier in this section.

Propeller Shaft Runout

If a noise vibration is present in the vehicle driveline, the propeller shaft may be bent or out of round due to damage. Inspect the propeller shaft for dents or other damage. The propeller shaft and its components must be "true" or turning with an absolute minimum amount of lateral movement. Refer to SECTION 4A for propeller shaft runout specifications.

Propeller Shaft Balance

If balance weights are loose or missing, the propeller shaft must be balanced or replaced. Refer to SECTION 4A for propeller shaft balance check procedures. Excessive looseness or wear at the propeller shaft sliding yoke splines may also cause a propeller shaft to be unbalanced. For propeller shaft inspections procedures, refer to SECTION 4A. Inspect propeller shaft and universal joints for mud buildup, undercoating buildup or loose fasteners.

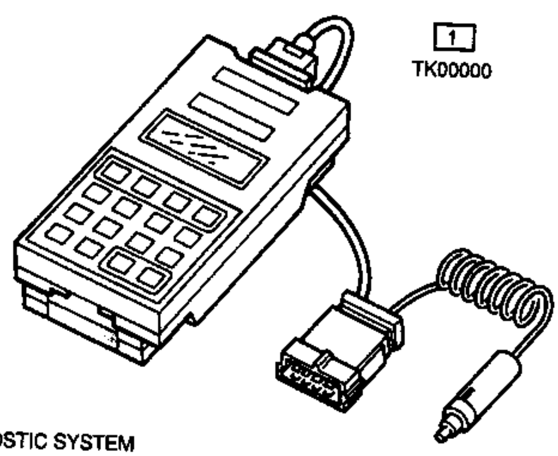
UNIVERSAL JOINTS

Faulty universal joints can be another cause for driveline vibrations. If a universal joint is suspected of producing a rattling or knocking noise, the universal joint may be worn or loose. Make a preliminary inspection by grasping the propeller shaft toward the end near the suspected universal joint and rotate it back and forth, then, move the propeller shaft in an up and down direction while feeling for any looseness. If the propeller shaft shows excessive movement, the universal joint should be removed and inspected for wear or damage. Refer to SEC.TION 4A for universal joint diagnosis and service procedures.

DRIVELINE ANGLES

Vibrations due to improper driveline angles are caused by either incorrect trim height or faulty universal joints. Incorrect trim height can lead to excessive universal joint angles. Refer to SECTION 3 for trim height specifications. Faulty universal joints can lead to incorrect driveline angles. Refer to SECTION 4A for universal joint angle measurement procedures.

SPECIAL TOOLS



1 TECH 1 MODULAR DIAGNOSTIC SYSTEM

MBS0040C