Section 0

General Information

General Information

Introduction

Conversion - English/Metric

English	Multiply/ Divide by	Metric
In order to calculate English measurement, divide by the number in the center column. In order to calculate metric measurement, multiply by the number in the center column.		
Length		
in	25.4	mm
ft	0.3048	m
yd	0.9144	
mi	1.609	km
Area		
sq in	645.2	sq mm
	6.45	sq cm
sq ft	0.0929	sq m
sq yd	0.8361	
Volume		
cu in	16,387.0	cu mm
	16.387	cu cm
	0.0164	L
qt	0.9464	
gal	3.7854	
cu yd	0.764	cu m
Mass		
lb	0.4536	kg
ton	907.18	
	0.907	tonne (t)
Force		
kg F	9.807	newtons (N)
oz F	0.2780	
lb F	4.448	
Acceleration		
ft/s^2	0.3048	m/s^2
in/s^2	0.0254	
Torque		
lb in	0.11298	N·m
lb ft	1.3558	
Power		
hp	0.745	kW
Pressure (Stress)		
inches of H2O	0.2488	kPa
lb/sq in	6.895	
Energy (Work)		
Btu	1055.0	J (J= one Ws)
lb ft	1.3558	
kW hour	3,600,000.0	

Conversion - English/Metric (cont'd)

English	Multiply/ Divide by	Metric
Light		
Foot Candle	10.764	lm/m^2
Velocity		
mph	1.6093	km/h
Temperature		
(°F – 32) 5/9	=	°C
°F	=	(9/5 °C + 32)
Fuel Performance		
235.215/mpg	=	100 km/L

Equivalents - Decimal and Metric

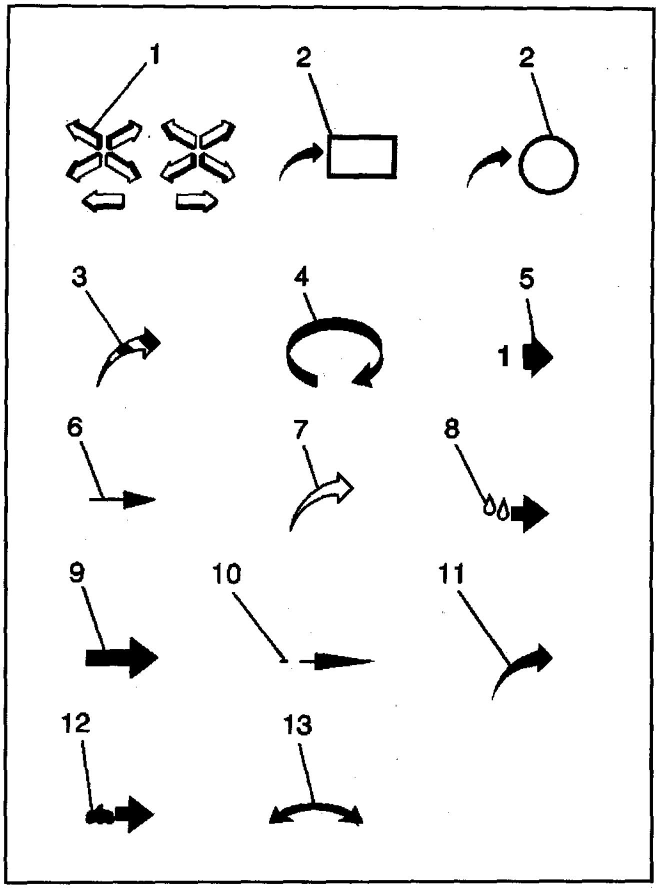
Fraction (in)	Decimal (in)	Metric (mm)
1/64	0.015625	0.39688
1/32	0.03125	0.79375
3/64	0.046875	1.19062
1/16	0.0625	1.5875
5/64	0.078125	1.98437
3/32	0.09375	2.38125
7/64	0.109375	2.77812
1/8	0.125	3.175
9/64	0.140625	3.57187
5/32	0.15625	3.96875
11/64	0.171875	4.36562
3/16	0.1875	4.7625
13/64	0.203125	5.15937
7/32	0.21875	5.55625
15/64	0.234375	5.95312
1/4	0.25	6.35
17/64	0.265625	6.74687
9/32	0.28125	7.14375
19/64	0.296875	7.54062
5/16	0.3125	7.9375
21/64	0.328125	8.33437
11/32	0.34375	8.73125
23/64	0.359375	9.12812
3/8	0.375	9.525
25/64	0.390625	9.92187
13/32	0.40625	10.31875
27/64	0.421875	10.71562
7/16	0.4375	11.1125
29/64	0.453125	11.50937
15/32	0.46875	11.90625
31/64	0.484375	12.30312

Equivalents - Decimal and Metric (cont'd)

Fraction (in)	Decimal (in)	Metric (mm)
1/2	0.5	12.7
33/64	0.515625	13.09687
17/32	0.53125	13.49375
35/64	0.546875	13.89062
9/16	0.5625	14.2875
37/64	0.578125	14.68437
19/32	0.59375	15.08125
39/64	0.609375	15.47812
5/8	0.625	15.875
41/64	0.640625	16.27187
21/32	0.65625	16.66875
43/64	0.671875	17.06562
11/16	0.6875	17.4625
45/64	0.703125	17.85937
23/32	0.71875	18.25625
47/64	0.734375	18.65312
3/4	0.75	19.05
49/64	0.765625	19.44687
25/32	0.78125	19.84375
51/64	0.796875	20.24062
13/16	0.8125	20.6375
53/64	0.828125	21.03437
27/32	0.84375	21.43125
55/64	0.859375	21.82812
7/8	0.875	22.225
57/64	0.890625	22.62187
29/32	0.90625	23.01875
59/64	0.921875	23.41562
15/16	0.9375	23.8125
61/64	0.953125	24.20937
31/32	0.96875	24.60625
63/64	0.984375	25.00312
1	1.0	25.4

Arrows and Symbols

This service manual uses various symbols in order to describe different service operations.



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Legend

(1) Front of Vehicle
(2) View Detail
(3) Ambient Air Mixed With Another Gas or Indicate Temperature Change
(4) Motion or Direction
(5) View Angle
(6) Dimension (1:2)
(7) Ambient/Clean Air Flow or Cool Air Flow
(8) Lubrication Point — Oil or Fluid
(9) Task Related
(10) Sectioning (1:3)
(11) Gas Other Than Ambient Air or Hot Air Flow
(12) Lubrication Point — Grease or Jelly
(13) Multidirectional Arrow

Special Tools Ordering Information

The special service tools shown in this service manual that have product numbers beginning with J, SA or BT are available for worldwide distribution from:

OE Tool and Equipment Group
Kent-Moore
28635 Mound Road
Warren, MI, U.S.A 48092-3499

Phone: 1-800-345-2233 or 586-574-2332

Monday through Friday

8:00 am–7:00 pm Eastern Standard Time
Fax: 1-800-578-7375 or 586-578-7321

The TECH 2 scan tool and accessories can be purchased through:

Dealer Equipment and Services
5775 Enterprise Dr.
Warren, MI, U.S.A 48092-3463

Phone: 1-800-GM-TOOLS or 586-574-2332

Monday through Friday

8:00 am–6:00 pm EST
Fax: 1-586-578-7205

Diagnostic Work Sheets

The GM Diagnostic Worksheet has been designed to improve communications between the service customer and the technician. The diagnostic worksheet can provide the technician with more information than the conventional repair order, since it is filled out by the service customer. Dealers in the US may contact Dealer Support Materials at 1–800–235–8521 and request Form Number DWS-01 to obtain these worksheets at no cost. Dealers may also access the DWD Store in Dealerworld and search for form DWS-01 or select Service Forms under Other Links and then select Diagnostic Worksheet (under Bulletin Information on use of Diagnostic Worksheet). Please limit your requests to a reasonable quantity.

Training

Dealers

All U.S. Dealers participating in the GM Common Training Program can enroll through the GM Common Training System Website at https://www.gmcommontraining.com. Within the website, there are individual training paths that are designed to assist in planning the training needs for each individual. Technicians should advise their Service Manager of their training needs including course names and course numbers. Dealers who have questions about GM Common Training should contact the GM Common Training help desk at 1-888-748-2686. The help desk is available Monday through Friday, 8:00 am–8:00pm Eastern Standard Time, excluding holidays. For GM Access support, contact the GM Access Help Desk at 1-888-337-1010.

Fleets

GM Fleet customers with GM Warranty In-Shop agreements are able to participate in service technical training through GM Common Training/GM Service Technical College (STC).

Assistance for all GM fleet customers using GM STC products and services is provided on the Internet via www.gmcommontraining.com using the “Contact Us” button on the site and/or the GM Common Training Help Desk at 1-888-748-2687. To order GM STC Training Materials, please contact the GM Training Materials Headquarters at 1-800-393-4831.

Most GM STC course materials have associated charges.

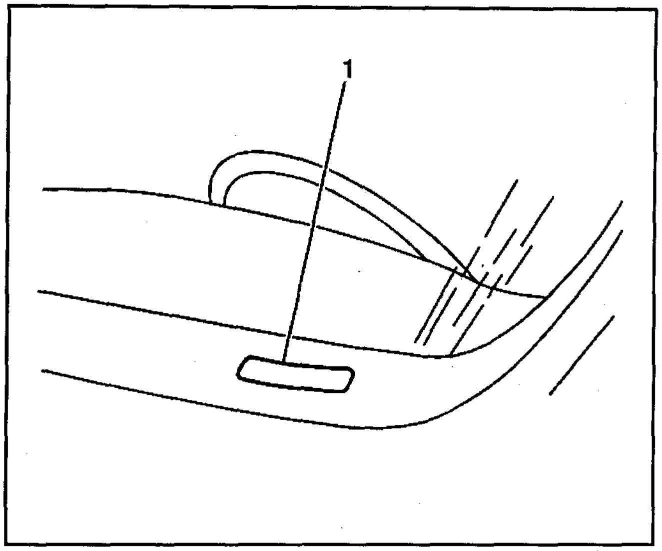
To purchase authentic GM STC Training Materials, contact the GM Training Materials Headquarters at 1-800-393-4831.

Non-GM Dealer Technicians

Technicians training for non-GM dealers is available through ACDelco. This training is for ACDelco customers employed in the automotive or truck service industry.

ACDelco courses are available at all approved GM Training Centers. Availability and schedules can be obtained by calling 1-800-825-5886 or contact us via the web at www.acdelcotechconnect.com and select the training button. Clinics are also offered through ACDelco Warehouse Distributors. Contract your dealer directly for more information.

Vehicle, Engine and Transmission ID and VIN Location, Derivative and Usage



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The vehicle identification number (VIN) plate (1) is the legal identifier of the vehicle. The VIN plate is located on the upper LH corner of the Instrument Panel and can be seen through the windshield from the outside of the vehicle:

Vehicle Identification Number (VIN) System

Position	Definition	Character	Description
1	Country of Origin	1	U.S. Built
2	Manufacturer	G	General Motors
3	Make	C	Chevrolet Truck
4	GVWR/Brake System	E	6,001-7,000 HYD Brakes
5	Truck Line/Chassis Type	S	Sm Conventional Cab—4x2
6	Series	1	½ Ton
7	Body Type	4	Two Door Cab
8	Engine Type	H	6.0L V8 RPO LS2
9	Check Digit	—	Check Digit
10	Model Year	6	2006
11	Plant Location	B	Lansing, MI
12–17	Plant Sequence Number	—	Plant Sequence Number

All engines and transmissions are stamped or laser etched with a partial VIN, which was derived from the complete VIN. A VIN derivative contains the following 9 positions:

Position	Definition	Character	Description
1	GM Division Identifier	C	Chevrolet Truck
2	Model Year	6	2006
3	Assembly Plant	B	Lansing, MI
4–9	Plant Sequence Number	—	Plant Sequence Number

VIN Derivative Position	Equivalent VIN Position
1	3
2	10
3	11
4–9	12–17

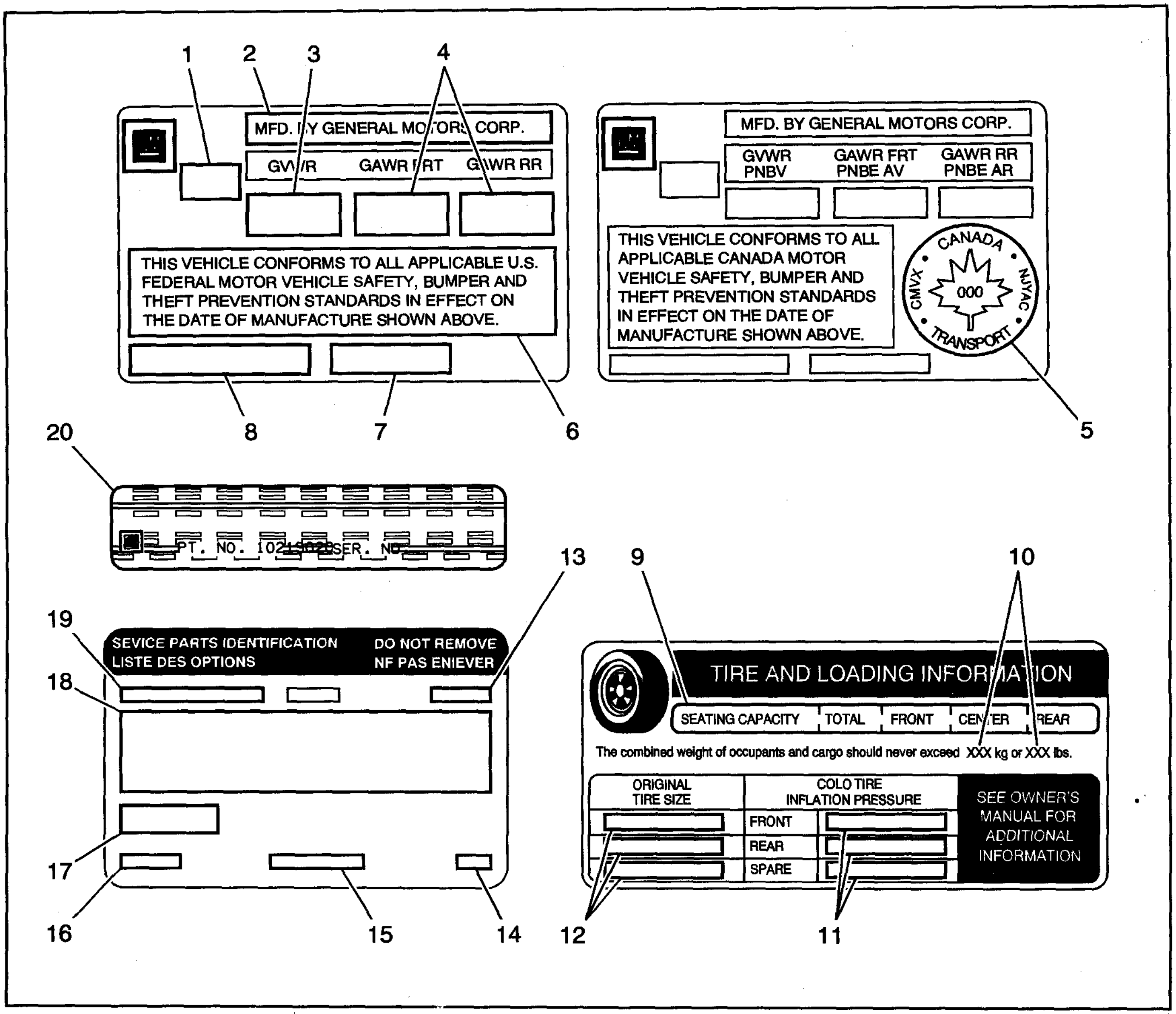
6.0L LS2 Engine ID and VIN Derivative Location

Refer to *Engine Identification on page 6-25* for the 6.0L engine.

4L60-E/4T65-E (M30) Transmission ID and VIN Derivative Location

Refer to *Transmission Identification Information on page 7-307* for the 4T60-E/4T65-E transaxle.

Label - Vehicle Certification, Tire Place Card, Anti-Theft and Service Parts ID



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Label - Vehicle Certification, Tire Place Card, Anti-Theft and Service Parts ID

Callout	Description
Vehicle Certifcation Label	
The vehicle certification label is located on the driver door and displays the following assessments: • Gross Vehicle Weight Rating (GVWR) • Gross Axle Weight Rating (GAWR), front and rear • The gross vehicle weight (GVW) is the weight of the vehicle and everything it carries. The gross vehicle weight must not exceed the GVWR. Include the following items when figuring the GVW: – The base vehicle weight (factory weight) – The weight of all vehicles accessories – The weight of the driver and the passengers – The weight of the cargo	
1	Name of Manufacturer
2	Gross Vehicle Weight Rating
3	Gross Axle Weight Rating (Front, Rear)
4	Canadian Safety Mark (w/RPO Z49)

Label - Vehicle Certification, Tire Place Card, Anti-Theft and Service Parts ID (cont'd)

Callout	Description
5	Certification Statement
6	Vehicle Class Type (Pass Car, etc.)
7	Vehicle Identification Number
8	Date of Manufacture (Mo/Yr)
Tire Placard The tire placard label is located on the driver door and displays the following assessments:	
9	Specified Occupant Seating Positions
10	Maximum Vehicle Capacity Weight
11	Original Equipment Tire Size
12	Tire Pressure, Front, Rear, and Spare (Cold)
Service Parts ID Label The vehicle service parts identification label is located on the instrument panel (I/P) compartment door. The label is use to help identify the vehicle original parts and options.	
13	Vehicle Identification Number
14	Engineering Model Number (Vehicle Division, Line and Body Style)
15	Interior Trim Level and Decor
16	Exterior (Paint Color) WA Number
17	Paint Technology
18	Special Order Paint Colors and Numbers
19	Vehicle Option Content
Anti-Theft Label	
20	The Federal law requires that General Motors label certain body parts on this vehicle with the VIN. The purpose of the law is to reduce the number of motor vehicle thefts by helping in the tracing and recovery of parts from stolen vehicles. Labels are permanently affixed to an interior surface of the part. The label on the replacement part contains the letter R, the manufacture's logo, and the DOT symbol. The anti-theft label must be covered before any painting, and rustproofing procedures, and uncovered after the procedures. Failure to follow the precautionary steps may result in liability for violation of the Federal Vehicle Theft Prevention Standard and possible suspicion to the owner that the part was stolen.

RPO Code List

RPO	Description
AAB	Memory – Driver Convenience Package
APV	Equipment – Camping Package, Table and Chairs
AJ1	Window Tinted – Deep, All Except W/S and DRS
AJ7	Restraint System – Seat, Inflatable, Driver and Pass, FRT and Side
AU0	Lock Control, Entry – Remote Entry
A31	Window – Power Operated, All Doors
A95	Seat – FRT BKT, High Back, Driver and Pass Recl
BCP	Cover – Engine, Appearance
BHP	Cover – Engine, Appearance, Body Color
BKF	Covering FRT – Floor Mats, AUX, Custom
BNK	Cover – Engine Compartment, Appearance
BVE	Steps, Running Board – Side
BVF	Steps, Running Board – Side, Color Keyed
B30	Covering FRT – Floor Mats, AUX
B32	Covering FRT – Floor Mats, AUX

RPO Code List (cont'd)

RPO	Description
CTD	Equipment – Cargo Tie Down (Moveable)
CJ3	HVAC System – Air Conditioner FRT, MAN Temp Cont, AUX Temp Cont
C44	Deflector – Air, Interior
C49	Defogger – RR Window, Electric
DJ2	Mirror I/S R/V – LT Sensitive, Reading, Home Convenience
DR2	Mirror O/S – LH and RH, Remote Control, Electric, Heated, LT Sensitive, Manual Folding, Color
DT3	Box – RR Compt, Stowage
ERJ	Equipment – Cargo, Trim Compartment Pkg, Aluminum
ERL	Equipment – Cargo, Trim Compartment Pkg, Body Color
ERK	Equipment – Cargo, Trim Compartment Pkg, Wood
EB6	GVW Rating – 6,050 lbs
EN3	Cover – Cargo, Storage System
E8A	Cover, RR Compt – Tonneau, RR Compt – Delete

RPO Code List (cont'd)

RPO	Description
E55	Body Equipment – End Gate
GT4	Axle Rear – 3.73 Ratio
GT5	Axle Rear – 4.10 Ratio
G80	Axle Positraction – Limited Slip
JF8	Brake – VAC Power, 4 WHL Disc
KA1	Heater – Seat, FRT
KG3	Generator – 145 amp
K34	Cruise Control – Automatic, Electronic
LM4	Engine – Gas, 8 CYL, 5.3L, SFI, ALUM, GM
LS2	Engine – Gas, 8 CYL, 6.0L, SFI, ALUM, GM
M10	Transmission – MAN 6 SPD, TREMEC, 85mm, 3.01 1st , 0.84 5th , 0.57 6th , O/D
M30	Transmission – Auto 4 SPD, HMD, 4L60-E, Electronic
M32	Transmission – Auto 4 SPD, HMD, 4L60-E, Electronic, HD
NC1	Emission System – California, LEV (Note: Not to be Used After 2007 MDL YR for Domestic NAO Pass Car and LT Duty Trucks)
NF4	Emission System – Clean Fuel Fleet
NT7	Emission System – Federal, Tier 2
NT8	Emission System – Federal, Tier 2 A
NT9	Emission System – Federal, Tier 2 Phase-Out
NU1	Emission System – California, LEV2
NU4	Emission System – California LEV2 Plus
NW7	Traction Control – Powertrain Management Only
N40	Steering – Power, Non-Variable Ratio
PZ7	Wheel – 19X8 (FRT) and 20X10 (RR) Painted Alum
QMX	Tire All – Mixed Sizes (Front and Rear)
RAE	Equipment – Cargo Management System
R1W	Noise Control – Air Cleaner Resonator Duck
STW	Steering Wheel – Leather Wrapped with Redundant Controls
T61	Lamp System – Daytime Running
T96	Lamp – Fog, FRT
UQA	Speaker System – Premium Performance Enhanced Audio
UQB	Speaker – RR, Dual, AU, Cargo Area
UA6	Theft Deterrent System
UB0	Radio – AM/FM Stereo, Seek/Scan, CD, Auto Tone, Data System, Clock, ETR
UC6	Radio – AM/FM Stereo, Seek/Scan, RDS, Multiple Compact Disc, Auto Tone Control, Clock, ETR
UE1	Communication System – Vehicle, G.P.S. 1
US8	Radio – AM/FM Stereo, Seek/Scan, CD, Auto Tone, Clock, ETR, MP3, RDS

RPO Code List (cont'd)

RPO	Description
U2K	Digital Audio – System – S-Band
U19	Speedometer – INST, Kilo and Miles, Kilo Odometer
U68	Display – Driver Info Center
U73	Antenna – Fixed, Radio
VCL	Certification – Emission, Clean Fuel Vehicle, Fleet
VXK	Equipment – Accent Pkg, PUBX Bed Strips, Eng CVR Insert, Aux Gage Housing, Body Color
VXM	Equipment – Accent Pkg, PUBX Bed Strips, Eng CVR Insert, AUX Gage Housing, Running Boards, Body Color
VXN	Equipment – Accent Pkg, Chrome, Exterior
VYH	Cover – Hinge, RR Compt, Tonneau Cover, (Cargo) Protective
VC4	Label – Price/Fuel Econ, Puerto Rico and Virgin Islands
VG8	Vehicle – Label, Notice to Buyer
VK3	License Plate Front – FRT Mounting Pkg
VR4	Trailer Hitch – Weight Distributing Platform
V73	Vehicle Statement – USA/Canada
Y4K	Protector – Vehicle, Cover
Z82	Trailer Provision S – Special Equipment, H.D.
14P	Wheel Color – Chrome
73P	Wheel Color – Sterling Silver (03)
96P	Wheel Color – Ultra Silver (04)

Fasteners

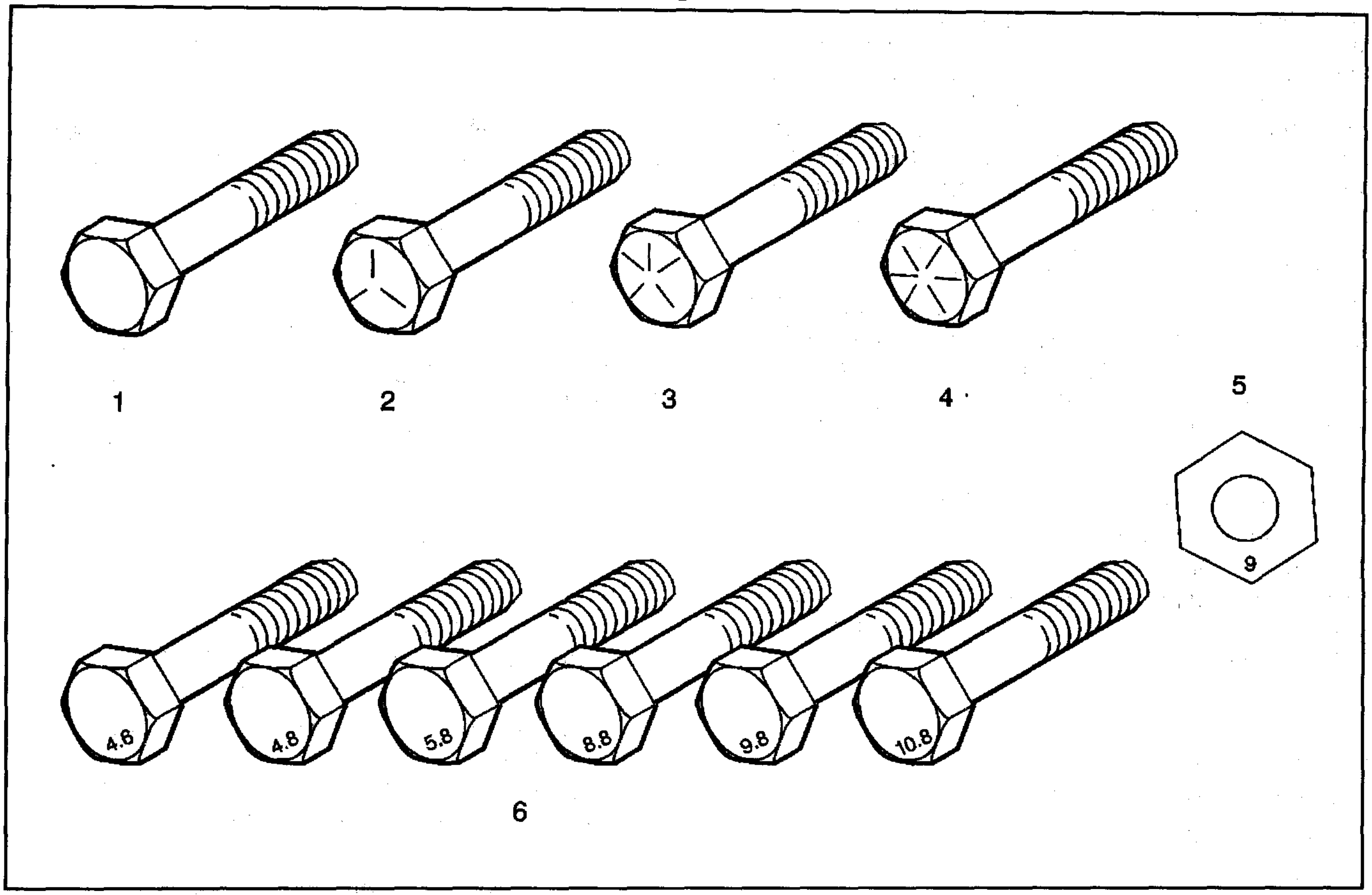
Metric Fasteners

This vehicle provides fastener dimensions using the metric system. Most metric fasteners are approximate in diameter to equivalent English fasteners. Make replacements using fasteners of the same nominal diameter, thread pitch, and strength.

A number marking identifies the OE metric fasteners except cross-recess head screws. The number also indicates the strength of the fastener material. A Posidrive® or Type 1A cross-recess identifies a metric cross-recess screw. For best results, use a Type 1A cross-recess screwdriver, or equivalent, in Posidrive® recess head screws.

GM Engineering Standards and North American Industries have adopted a portion of the ISO-defined standard metric fastener sizes. The purpose was to reduce the number of fastener sizes used while retaining the best thread qualities in each thread size. For example, the metric M6.0 X 1 screw, with nearly the same diameter and 25.4 threads per inch replaced the English 1/4–20 and 1/4–28 screws. The thread pitch is midway between the English coarse and fine thread pitches.

Fastener Strength Identification



Legend

(1) English Bolt, Grade 2 (Strength Class)
(2) English Bolt, Grade 5 (Strength Class)
(3) English Bolt, Grade 7 (Strength Class)
(4) English Bolt, Grade 8 (Strength Class)
(5) Metric Nut, Strength Class 9
(6) Metric Bolts, Strength Class Increases as Numbers Increase

The most commonly used metric fastener strength property classes are 9.8 and 10.9. The class identification is embossed on the head of each bolt. The English, inch strength classes range from grade 2 to grade 8. Radial lines are embossed on the head of each bolt in order to identify the strength class. The number of lines on the head of the bolt is 2 lines less than the actual grade. For example, a grade 8 bolt will have 6 radial lines on the bolt head. Some metric nuts are marked with a single digit strength identification number on the nut face.

The correct fasteners are available through GM SPO. Many metric fasteners available in the aftermarket parts channels are designed to metric standards of countries other than the United States, and may exhibit the following:

- Lower strength
- No numbered head marking system
- Wrong thread pitch

The metric fasteners on GM products are designed to new, international standards. The following are the common sizes and pitches, except for special applications:

- M6.0 X 1
- M8 X 1.25
- M10 X 1.5
- M12 X 1.75
- M14 X 2.00
- M16 X 2.00

Prevailing Torque Fasteners

Prevailing torque fasteners create a thread interface between the fastener and the fastener counterpart in order to prevent the fastener from loosening.

All Metal Prevailing Torque Fasteners

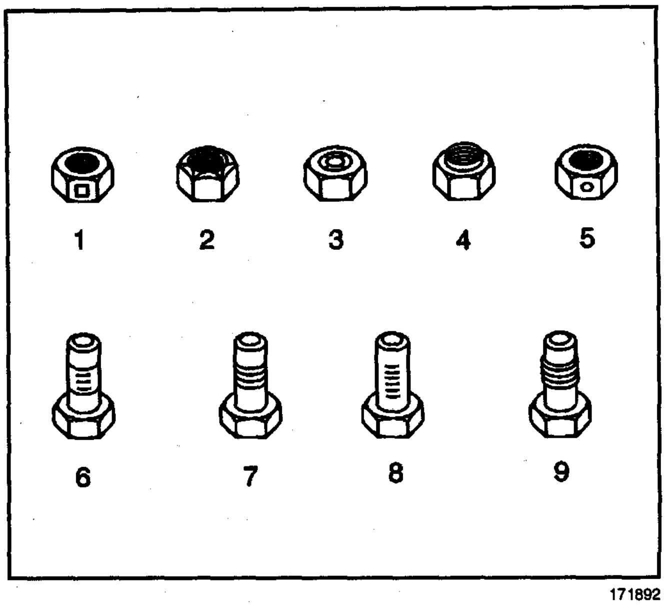
These fasteners accomplish the thread interface by a designed distortion or deformation in the fastener.

Nylon Interface Prevailing Torque Fasteners

These fasteners accomplish the thread interface by the presence of a nylon material on the fastener threads.

Adhesive Coated Fasteners

These fasteners accomplish the thread interface by the presence of a thread-locking compound on the fastener threads. Refer to the appropriate repair procedure in order to determine if the fastener may be reused and the applicable thread-locking compound to apply to the fastener.



Legend

(1) Prevailing Torque Nut, Center Lock Type
(2) Prevailing Torque Nut, Top Lock Type
(3) Prevailing Torque Nut, Nylon Patch Type
(4) Prevailing Torque Nut, Nylon Washer Insert Type
(5) Prevailing Torque Nut, Nylon Insert Type
(6) Prevailing Torque Bolt, Dry Adhesive Coating Type
(7) Prevailing Torque Bolt, Thread Profile Deformed Type
(8) Prevailing Torque Bolt, Nylon Strip Type
(9) Prevailing Torque Bolt, Out-of-Round Thread Area Type

A prevailing torque fastener may be reused ONLY if:

- The fastener and the fastener counterpart are clean and not damaged
- There is no rust on the fastener
- The fastener develops the specified minimum torque against its counterpart prior to the fastener seating

Metric Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
6 mm	0.4 N·m	4 lb in
8 mm	0.8 N·m	7 lb in
10 mm	1.4 N·m	12 lb in
12 mm	2.1 N·m	19 lb in
14 mm	3 N·m	27 lb in
16 mm	4.2 N·m	37 lb in
20 mm	7 N·m	62 lb in
24 mm	10.5 N·m	93 lb in
Nylon Interface Prevailing Torque Fasteners		
6 mm	0.3 N·m	3 lb in
8 mm	0.6 N·m	5 lb in
10 mm	1.1 N·m	10 lb in
12 mm	1.5 N·m	13 lb in
14 mm	2.3 N·m	20 lb in
16 mm	3.4 N·m	30 lb in
20 mm	5.5 N·m	49 lb in
24 mm	8.5 N·m	75 lb in

English Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
1/4 in	0.5 N·m	4.5 lb in
5/16 in	0.8 N·m	7.5 lb in
3/8 in	1.3 N·m	11.5 lb in
7/16 in	1.8 N·m	16 lb in
1/2 in	2.3 N·m	20 lb in
9/16 in	3.2 N·m	28 lb in
5/8 in	4 N·m	36 lb in
3/4 in	7 N·m	54 lb in
Nylon Interface Prevailing Torque Fasteners		
1/4 in	0.3 N·m	3 lb in
5/16 in	0.6 N·m	5 lb in
3/8 in	1 N·m	9 lb in
7/16 in	1.3 N·m	12 lb in
1/2 in	1.8 N·m	16 lb in
9/16 in	2.5 N·m	22 lb in
5/8 in	3.4 N·m	30 lb in
3/4 in	5 N·m	45 lb in

Thread Inserts

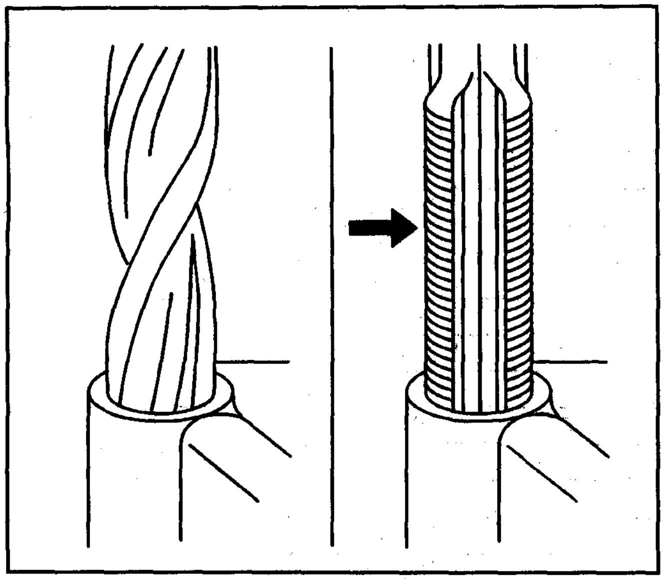
General purpose thread repair kits. These kits are available commercially.

Repair Procedure

Caution: Refer to Safety Glasses Caution on page P-6 in Cautions and Notices.

Important: Refer to the thread repair kit manufacturer's instructions regarding the size of the drill and tap to use.

Avoid any buildup of chips. Back out the tap every few turns and remove the chips.



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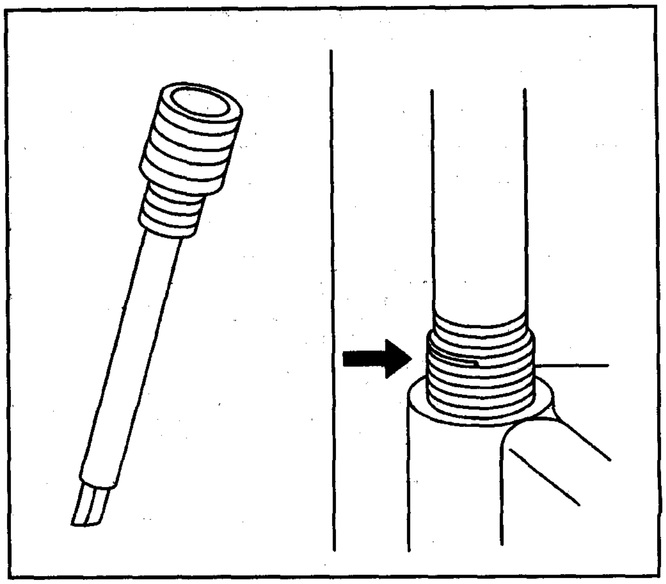
1. Determine the size, the pitch, and the depth of the damaged thread. If necessary, adjust the stop collars on the cutting tool and tap to the required depth.
2. Drill out the damaged threads. Clean out any chips.
3. Lubricate the tap with light engine oil. Tap the hole. Clean the threads.



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4. Thread the thread insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.

Important: The insert should be flush to one turn below the surface.

5. Lubricate the insert with light engine oil, except when installing in aluminum and install the insert.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift.

Abbreviations and Meanings

Abbreviation	Meaning
A	
A	Ampere(s)
ABS	Antilock Brake System
A/C	Air Conditioning
AC	Alternating Current
ACC	Accessory, Automatic Climate Control
ACL	Air Cleaner
ACR4	Air Conditioning Refrigerant, Recovery, Recycling, Recharging
AD	Automatic Disconnect
A/D	Analog to Digital
ADL	Automatic Door Lock
A/F	Air/Fuel Ratio
AH	Active Handling
AIR	Secondary Air Injection
ALC	Automatic Level Control, Automatic Lamp Control
AM/FM	Amplitude Modulation/Frequency Modulation
Ant	Antenna
AP	Accelerator Pedal
APCM	Accessory Power Control Module

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
API	American Petroleum Institute
APP	Accelerator Pedal Position
APT	Adjustable Part Throttle
ASM	Assembly, Accelerator and Servo Control Module
ASR	Acceleration Slip Regulation
A/T	Automatic Transmission/Transaxle
ATC	Automatic Transfer Case, Automatic Temperature Control
ATDC	After Top Dead Center
ATSLC	Automatic Transmission Shift Lock Control
Auto	Automatic
avg	Average
A4WD	Automatic Four-Wheel Drive
AWG	American Wire Gage
B	
B+	Battery Positive Voltage
BARO	Barometric Pressure
BATT	Battery
BBV	Brake Booster Vacuum
BCA	Bias Control Assembly
BCM	Body Control Module
BHP	Brake Horsepower
BLK	Black
BLU	Blue
BP	Back Pressure
BPCM	Battery Pack Control Module
BPMV	Brake Pressure Modulator Valve
BPP	Brake Pedal Position
BRN	Brown
BTDC	Before Top Dead Center
BTM	Battery Thermal Module
BTSI	Brake Transmission Shift Interlock
Btu	British Thermal Units
C	
°C	Degrees Celsius
CAC	Charge Air Cooler
CAFE	Corporate Average Fuel Economy
Cal	Calibration
Cam	Camshaft
CARB	California Air Resources Board
CC	Coast Clutch
cm^3	Cubic Centimeters
CCM	Convenience Charge Module, Chassis Control Module
CCOT	Cycling Clutch Orifice Tube
CCP	Climate Control Panel
CD	Compact Disc

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
CE	Commutator End
CEAB	Cold Engine Air Bleed
CEMF	Counter Electromotive Force
CEX	Cabin Exchanger
cfm	Cubic Feet per Minute
cg	Center of Gravity
CID	Cubic Inch Displacement
CKP	Crankshaft Position
CKT	Circuit
C/Ltr	Cigar Lighter
CL	Closed Loop
CLS	Coolant Level Switch
CMC	Compressor Motor Controller
CMP	Camshaft Position
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO2	Carbon Dioxide
Coax	Coaxial
COMM	Communication
Conn	Connector
CPA	Connector Position Assurance
CPP	Clutch Pedal Position
CPS	Central Power Supply
CPU	Central Processing Unit
CRT	Cathode Ray Tube
CRTC	Cathode Ray Tube Controller
CS	Charging System
CSFI	Central Sequential Fuel Injection
CTP	Closed Throttle Position
cu ft	Cubic Foot/Feet
cu in	Cubic Inch/Inches
CV	Constant Velocity Joint
CVRSS	Continuously Variable Road Sensing Suspension
Cyl	Cylinder(s)
D	
DAB	Delayed Accessory Bus
dB	Decibels
dBA	Decibels on A-weighted Scale
DC	Direct Current, Duty Cycle
DCM	Door Control Module
DE	Drive End
DEC	Digital Electronic Controller
DERM	Diagnostic Energy Reserve Module
DI	Distributor Ignition
dia	Diameter
DIC	Driver Information Center
Diff	Differential

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
DIM	Dash Integration Module
DK	Dark
DLC	Data Link Connector
DMCM	Drive Motor Control Module
DMM	Digital Multimeter
DMSDS	Drive Motor Speed and Direction Sensor
DMU	Drive Motor Unit
DOHC	Dual Overhead Camshafts
DPM	Driver Position Module
DR, Drvr	Driver
DRL	Daytime Running Lamps
DTC	Diagnostic Trouble Code
E	
EBCM	Electronic Brake Control Module
EBTCM	Electronic Brake and Traction Control Module
EC	Electrical Center, Engine Control
ECC	Electronic Climate Control
ECI	Extended Compressor at Idle
ECL	Engine Coolant Level
ECM	Engine Control Module, Electronic Control Module
ECS	Emission Control System
ECT	Engine Coolant Temperature
EEPROM	Electrically Erasable Programmable Read Only Memory
EEVIR	Evaporator Equalized Values in Receiver
EFE	Early Fuel Evaporation
EGR	Exhaust Gas Recirculation
EGR TVV	Exhaust Gas Recirculation Thermal Vacuum Valve
EHPS	Electro-Hydraulic Power Steering
EI	Electronic Ignition
ELAP	Elapsed
ELC	Electronic Level Control
E/M	English/Metric
EMF	Electromotive Force
EMI	Electromagnetic Interference
Eng	Engine
EOP	Engine Oil Pressure
EOT	Engine Oil Temperature
EPA	Environmental Protection Agency
EPR	Exhaust Pressure Regulator
EPROM	Erasable Programmable Read Only Memory
ESB	Expansion Spring Brake
ESC	Electronic Suspension Control
ESD	Electrostatic Discharge

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
ESN	Electronic Serial Number
ETC	Electronic Throttle Control, Electronic Temperature Control, Electronic Timing Control
ETCC	Electronic Touch Climate Control
ETR	Electronically Tuned Receiver
ETS	Enhanced Traction System
EVAP	Evaporative Emission
EVO	Electronic Variable Orifice
Exh	Exhaust
F	
°F	Degrees Fahrenheit
FC	Fan Control
FDC	Fuel Data Center
FED	Federal All United States except California
FEDS	Fuel Enable Data Stream
FEX	Front Exchanger
FF	Flexible Fuel
FFH	Fuel-Fired Heater
FI	Fuel Injection
FMVSS	Federal U.S. Motor Vehicle Safety Standards
FP	Fuel Pump
ft	Foot/Feet
FT	Fuel Trim
F4WD	Full Time Four-Wheel Drive
4WAL	Four-Wheel Antilock
4WD	Four-Wheel Drive
FW	Flat Wire
FWD	Front Wheel Drive, Forward
G	
g	Grams, Gravitational Acceleration
GA	Gage, Gauge
gal	Gallon
gas	Gasoline
GCW	Gross Combination Weight
Gen	Generator
GL	Gear Lubricant
GM	General Motors
GM SPO	General Motors Service Parts Operations
gnd	Ground
gpm	Gallons per Minute
GRN	Green
GRY	Gray
GVWR	Gross Vehicle Weight Rating
H	
H	Hydrogen

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
H2O	Water
Harn	Harness
HC	Hydrocarbons
H/CMPR	High Compression
HD	Heavy Duty
HDC	Heavy Duty Cooling
hex	Hexagon, Hexadecimal
Hg	Mercury
Hi Alt	High Altitude
HO2S	Heated Oxygen Sensor
hp	Horsepower
HPL	High Pressure Liquid
HPS	High Performance System
HPV	High Pressure Vapor
HPVS	Heat Pump Ventilation System
Htd	Heated
HTR	Heater
HUD	Head-up Display
HVAC	Heater-Ventilation-Air Conditioning
HVACM	Heater-Vent-Air Conditioning Module
HVIL	High Voltage Interlock Loop
HVM	Heater Vent Module
Hz	Hertz
I	
IAC	Idle Air Control
IAT	Intake Air Temperature
IC	Integrated Circuit, Ignition Control
ICCS	Integrated Chassis Control System
ICM	Ignition Control Module
ID	Identification, Inside Diameter
IDI	Integrated Direct Ignition
IGBT	Insulated Gate Bi-Polar Transistor
ign	Ignition
ILC	Idle Load Compensator
in	Inch/Inches
INJ	Injection
inst	Instantaneous, Instant
IP	Instrument Panel
IPC	Instrument Panel Cluster
IPM	Instrument Panel Module
I/PEC	Instrument Panel Electrical Center
ISC	Idle Speed Control
ISO	International Standards Organization
ISS	Input Speed Shaft, Input Shaft Speed
K	
KAM	Keep Alive Memory
KDD	Keyboard Display Driver
kg	Kilogram

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
kHz	Kilohertz
km	Kilometer
km/h	Kilometers per Hour
km/l	Kilometers per Liter
kPa	Kilopascals
KS	Knock Sensor
kV	Kilovolts
L	
L	Liter
L4	Four Cylinder Engine, In-Line
L6	Six-Cylinder Engine, In-Line
lb	Pound
lb ft	Pound Feet Torque
lb in	Pound Inch Torque
LCD	Liquid Crystal Display
LDCL	Left Door Closed Locking
LDCM	Left Door Control Module
LDM	Lamp Driver Module
LED	Light Emitting Diode
LEV	Low Emissions Vehicle
LF	Left Front
lm	Lumens
LR	Left Rear
LT	Left
LT	Light
LT	Long Term
LTPI	Low Tire Pressure Indicator
LTPWS	Low Tire Pressure Warning System
M	
MAF	Mass Air Flow
Man	Manual
MAP	Manifold Absolute Pressure
MAT	Manifold Absolute Temperature
max	Maximum
M/C	Mixture Control
MDP	Manifold Differential Pressure
MFI	Multiport Fuel Injection
mi	Miles
MIL	Malfunction Indicator Lamp
min	Minimum
MIN	Mobile Identification Number
mL	Milliliter
mm	Millimeter
mpg	Miles per Gallon
mph	Miles per Hour
ms	Millisecond
MST	Manifold Surface Temperature

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
MSVA	Magnetic Steering Variable Assist, Magnasteer®
M/T	Manual Transmission/Transaxle
MV	Megavolt
mV	Millivolt
N	
NAES	North American Export Sales
NC	Normally Closed
NEG	Negative
Neu	Neutral
NI	Neutral Idle
NiMH	Nickel Metal Hydride
NLGI	National Lubricating Grease Institute
N·m	Newton-meter Torque
NO	Normally Open
NOx	Oxides of Nitrogen
NPTC	National Pipe Thread Coarse
NPTF	National Pipe Thread Fine
NOVRAM	Non-Volatile Random Access Memory
O	
O2	Oxygen
O2S	Oxygen Sensor
OBD	On-Board Diagnostics
OBD II	On-Board Diagnostics Second Generation
OC	Oxidation Converter Catalytic
OCS	Opportunity Charge Station
OD	Outside Diameter
ODM	Output Drive Module
ODO	Odometer
OE	Original Equipment
OEM	Original Equipment Manufacturer
OHC	Overhead Camshaft
Ω	Ohm
OL	Open Loop, Out of Limits
ORC	Oxidation Reduction Converter Catalytic
ORN	Orange
ORVR	On-Board Refueling Vapor Recovery
OSS	Output Shaft Speed
oz	Ounce(s)
P	
PAG	Polyalkylene Glycol
PAIR	Pulsed Secondary Air Injection
PASS, PSGR	Passenger
PASS-Key®	Personalized Automotive Security System
P/B	Power Brakes
PC	Pressure Control

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
PCB	Printed Circuit Board
PCM	Powertrain Control Module
PCS	Pressure Control Solenoid
PCV	Positive Crankcase Ventilation
PEB	Power Electronics Bay
PID	Parameter Identification
PIM	Power Inverter Module
PM	Permanent Magnet Generator
P/N	Part Number
PNK	Pink
PNP	Park/Neutral Position
PRNDL	Park, Reverse, Neutral, Drive, Low
POA	Pilot Operated Absolute Valve
POS	Positive, Position
POT	Potentiometer Variable Resistor
PPL	Purple
ppm	Parts per Million
PROM	Programmable Read Only Memory
P/S, PS	Power Steering
PSCM	Power Steering Control Module, Passenger Seat Control Module
PSD	Power Sliding Door
PSP	Power Steering Pressure
psi	Pounds per Square Inch
psia	Pounds per Square Inch Absolute
psig	Pounds per Square Inch Gauge
pt	Pint
PTC	Positive Temperature Coefficient
PWM	Pulse Width Modulated
Q	
QDM	Quad Driver Module
qt	Quart(s)
R	
R-12	Refrigerant-12
R-134a	Refrigerant-134a
RAM	Random Access Memory, Non-permanent memory device, memory contents are lost when power is removed.
RAP	Retained Accessory Power
RAV	Remote Activation Verification
RCDLR	Remote Control Door Lock Receiver
RDCM	Right Door Control Module
Ref	Reference
Rev	Reverse
REX	Rear Exchanger
RIM	Rear Integration Module
RF	Right Front, Radio Frequency
RFA	Remote Function Actuation

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
RFI	Radio Frequency Interference
RH	Right Hand
RKE	Remote Keyless Entry
Rly	Relay
ROM	Read Only Memory, Permanent memory device, memory contents are retained when power is removed.
RPM	Revolutions per Minute Engine Speed
RPO	Regular Production Option
RR	Right Rear
RSS	Road Sensing Suspension
RTD	Real Time Damping
RT	Right
RTV	Room Temperature Vulcanizing Sealer
RWAL	Rear Wheel Antilock
RWD	Rear Wheel Drive
S	
s	Second(s)
SAE	Society of Automotive Engineers
SC	Supercharger
SCB	Supercharger Bypass
SCM	Seat Control Module
SDM	Sensing and Diagnostic Module
SEO	Special Equipment Option
SFI	Sequential Multiport Fuel Injection
SI	System International Modern Version of Metric System
SIAB	Side Impact Air Bag
SIR	Supplemental Inflatable Restraint
SLA	Short/Long Arm Suspension
sol	Solenoid
SO2	Sulfur Dioxide
SP	Splice Pack
S/P	Series/Parallel
SPO	Service Parts Operations
SPS	Service Programming System, Speed Signal
sq ft, ft^2	Square Foot/Feet
sq in, in^2	Square Inch/Inches
SRC	Service Ride Control
SRI	Service Reminder Indicator
SRS	Supplemental Restraint System
SS	Shift Solenoid
ST	Scan Tool
STID	Station Identification Station ID
S4WD	Selectable Four-Wheel Drive
Sw	Switch
SWPS	Steering Wheel Position Sensor
syn	Synchronizer

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
T	
TAC	Throttle Actuator Control
Tach	Tachometer
TAP	Transmission Adaptive Pressure, Throttle Adaptive Pressure
TBI	Throttle Body Fuel Injection
TC	Turbocharger, Transmission Control
TCC	Torque Converter Clutch
TCS	Traction Control System
TDC	Top Dead Center
TEMP	Temperature
Term	Terminal
TFP	Transmission Fluid Pressure
TFT	Transmission Fluid Temperature
THM	Turbo Hydro-Matic
TIM	Tire Inflation Monitoring, Tire Inflation Module
TOC	Transmission Oil Cooler
TP	Throttle Position
TPA	Terminal Positive Assurance
TPM	Tire Pressure Monitoring, Tire Pressure Monitor
TR	Transmission Range
TRANS	Transmission/Transaxle
TT	Tell Tail Warning Lamp
TV	Throttle Valve
TVRS	Television and Radio Suppression
TVV	Thermal Vacuum Valve
TWC	Three Way Converter Catalytic
TWC+OC	Three Way + Oxidation Converter Catalytic
TXV	Thermal Expansion Valve
U	
UART	Universal Asynchronous Receiver Transmitter
U/H	Underhood
U/HEC	Underhood Electrical Center
U-joint	Universal Joint
UTD	Universal Theft Deterrent
UV	Ultraviolet
V	
V	Volt(s), Voltage
V6	Six-Cylinder Engine, V-Type
V8	Eight-Cylinder Engine, V-Type
Vac	Vacuum
VAC	Vehicle Access Code
VATS	Vehicle Anti-Theft System
VCIM	Vehicle Communication Interface Mode
VCM	Vehicle Control Module

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
V dif	Voltage Difference
VDOT	Variable Displacement Orifice Tube
VDV	Vacuum Delay Valve
vel	Velocity
VES	Variable Effort Steering
VF	Vacuum Fluorescent
VIO	Violet
VIN	Vehicle Identification Number
VLR	Voltage Loop Reserve
VMV	Vacuum Modulator Valve
VR	Voltage Regulator
V ref	Voltage Reference
VSES	Vehicle Stability Enhancement System
VSS	Vehicle Speed Sensor
W	
w/	With
W/B	Wheel Base
WHL	Wheel
WHT	White
w/o	Without
WOT	Wide Open Throttle
W/P	Water Pump
W/S	Windshield
WSS	Wheel Speed Sensor
WU-OC	Warm Up Oxidation Converter Catalytic
WU-TWC	Warm Up Three-Way Converter Catalytic
X	
X-valve	Expansion Valve
Y	
yd	Yard(s)
YEL	Yellow

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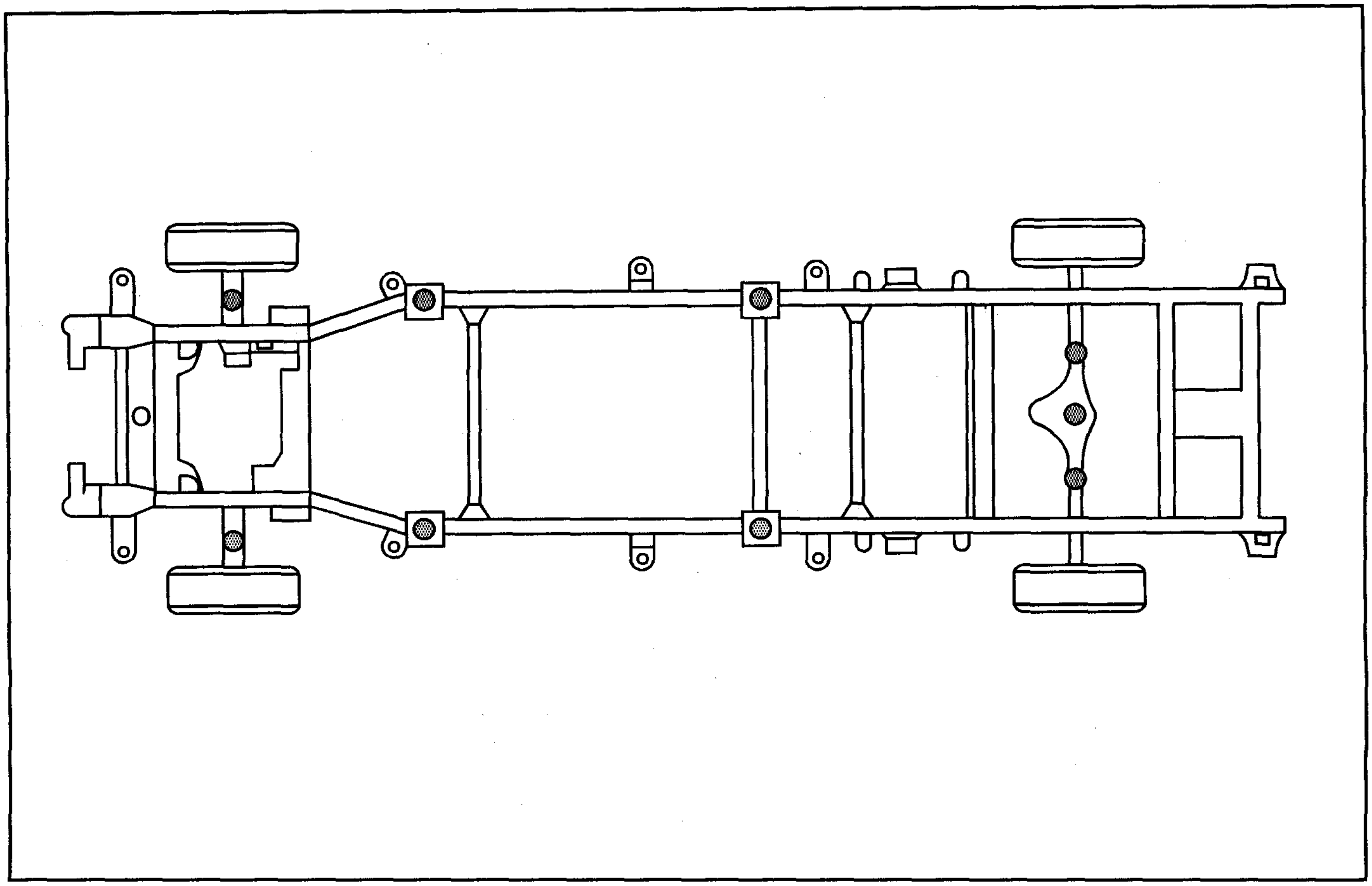
Key and Lock Cylinder Coding

Use Instruction Sheet Supplied

For the key cutting and lock cylinder coding procedure, refer to the instruction sheet supplied in the key and lock cylinder kit.

Lifting and Jacking the Vehicle



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Caution: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed.

Caution: To avoid any vehicle damage, serious personal injury or death, always use the jackstands to support the vehicle when lifting the vehicle with a jack.

Notice: Perform the following steps before beginning any vehicle lifting or jacking procedure:

- Remove or secure all of the vehicle's contents in order to avoid any shifting or any movement that may occur during the vehicle lifting or jacking procedure.
- The lifting equipment or the jacking equipment weight rating must meet or exceed the weight of the vehicle and any vehicle contents.
- The lifting equipment or the jacking equipment must meet the operational standards of the lifting equipment or jacking equipment's manufacturer.
- Perform the vehicle lifting or jacking procedure on a clean, hard, dry, level surface.
- Perform the vehicle lifting or jacking procedure only at the identified lift points. DO NOT allow the lifting equipment or jacking equipment to contact any other vehicle components.

Failure to perform the previous steps could result in damage to the lifting equipment or the jacking equipment, the vehicle, and/or the vehicle's contents.

Vehicle Lifting

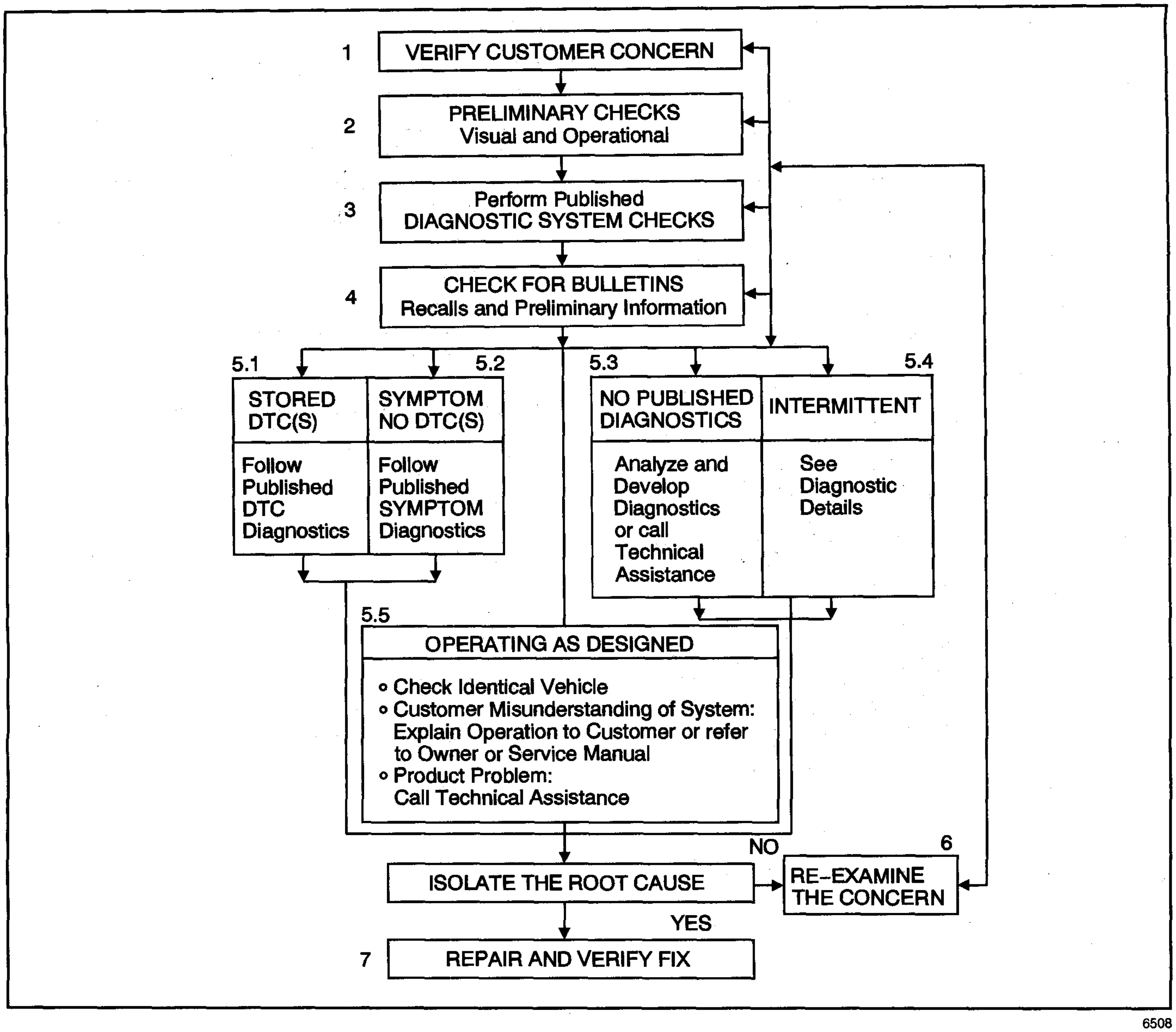
- Ensure that the lifting equipment meets weight requirements and is in good working order. Always follow the lift manufacturer's instructions.
- You may lift and support the front of the vehicle at the front suspension near the wheel assemblies. Ensure that the arms of the front cradle are extended as close to the steering knuckle as possible.
- Ensure that the vehicle is centered on the hoist before attempting to lift.
- When using a suspension-contact hoist, ensure that the rear cradle has adequate clearance for the rear stabilizer bar.
- When lifting or jacking a vehicle, be certain that the lift pads do not contact the exhaust system, brake pipes, cables, HVAC lines, wiring harnesses, fuel lines, or underbody. Such contact may result in damage or unsatisfactory vehicle performance.
- When using a frame-contact hoist, only place the pads on flat surfaces. Do not place pads within 50 mm (2 in) of any radius.
- Before lifting the vehicle, verify that the vehicle loads are secure and equally distributed.
- When major components are removed from the vehicle when supported on a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and secure the vehicle frame to the hoist pads nearest the component to be removed.

Vehicle Jacking

- Park the vehicle on a clean, hard, level surface before jacking the vehicle.
- Any time you lift the vehicle on one end, chock the wheels at the opposite end.
- Use jack stands in order to provide support.
- When supporting the vehicle using jack stands, place the jack stands under the side rails or the axle.
- When lifting under the rear differential, do not allow the jack pad to contact the rear stabilizer bar or mounting hardware.

Strategy Based Diagnosis

The goal of Strategy Based Diagnostics is to provide guidance when you create a plan of action for each specific diagnostic situation. Following a similar plan for each diagnostic situation, you will achieve maximum efficiency when you diagnose and repair vehicles. Although each of the Strategy Based Diagnostics boxes is numbered, you are not required to complete every box in order to successfully diagnose a customer concern. The first step of your diagnostic process should always be, verify the Customer Concern box. The final step of your diagnostic process should be Repair and verify the Fix box 7. Refer to the following chart for the correct Strategy Based Diagnostics.



Legend

(1) Verify the Customer Concern: The first part of this step is to obtain as much information as possible from the customer. Are there aftermarket accessories on the vehicle? When does the condition occur? Where does the condition occur? How long does the condition last? How often does the condition occur? In order to verify the concern, the technician should be familiar with the normal operation of the system and refer to the owner or service manual for any information needed.

(2) Preliminary Checks: Conduct a thorough visual inspection. Review the service history. Detect unusual sounds or odors. Gather diagnostic trouble code (DTC) information in order to achieve an effective repair.

(3) Perform Published Diagnostic System Checks: One or more DTCs may not support a system. System checks verify the proper operation of the system. This will lead the technician in an organized approach to diagnostics.

(4) Check Bulletins, Recalls and Preliminary Information (PI)s.

(5.1) Stored DTCs: Follow the designated DTC table exactly in order to make an effective repair.

(5.2) Symptom No DTC: Select the symptom from the symptom tables. Follow the diagnostic steps or suggestions in order to complete the repair, or refer to the applicable component/system check.

(5.3) No Published Diagnostics: Analyze the Concern. Develop a plan for the diagnostics. The service manual schematics will help you to see system power, ground, input and output circuits. You can also identify splices and other areas where multiple circuits are tied together. Look at component locations to see if components, connectors or harnesses may be exposed to extreme temperature, moisture, road salt or other corrosives battery acid, oil or other fluids. Utilize the wiring diagrams, system description and operation, and system circuit description.

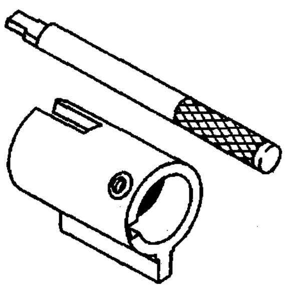
(5.4) Intermittents: An intermittent condition is one that does not occur continuously and will occur when certain conditions are met. Generally, intermittents are caused by faulty electrical connections and wiring, malfunctioning components, electromagnetic/radio frequency interference, and aftermarket equipment. Combine technician knowledge with efficient use of the available service information. Evaluate the symptoms and conditions described by the customer. Use a check sheet or other method in order to identify the component. Follow the suggestions for intermittent diagnosis found in the service manual. The Tech 1 and Tech 2 scan tools, and the J 39200 (Fluke 87) have data capturing capabilities that can assist in detection of intermittents.

(5.5) Vehicle Operates as Designed: This condition exists when the vehicle is found to operate normally. The condition described by the customer may be normal. Verify against another like vehicle that is operating normally under the same conditions described by the customer. Explain your findings and the operation of that system to the customer.

(6) Re-examine the Concern: If a technician cannot successfully find or isolate the concern, a re-evaluation is necessary. Re-verify the concern. The concern could be an intermittent or normal.

(7) Repair and Verify Fix: After isolating the cause, make the repairs and validate for proper operation. Verify that the symptom has been corrected, which may involve road testing the vehicle.

Special Tools and Equipment

Illustration	Tool Number/ Description
 65540	J 41340 Ignition Lock Cylinder Staking and Holding Fixture

Maintenance and Lubrication

Specifications

Capacities - Approximate Fluid

The following approximate capacities are given in English and metric conversions. Refer to *Fluid and Lubricant Recommendations on page 0-25* for more information.

All capacities are approximate. When adding fluids, be sure to fill to the appropriate level, as recommended in this manual. Recheck the fluid level after filling.

Application	Specifications	
	Metric	English
Cooling System	13.0 liters	13.7 quarts
Engine Oil with Filter		
6.0L (LS2)	5.7 liters	6.0 quarts
Fuel Tank	94.6 liters	25.0 gallons
Rear Axle		
8.6 (Automatic)	2.0 liters	2.1 quarts
9.5 (Manual)	2.6 liters	2.7 quarts
Transmission		
Automatic – Pan Release	4.7 liters	5.0 quarts
Automatic – Overhaul	10.6 liters	11.0 quarts
Manual	3.5 liters	3.71 quarts

Fluid and Lubricant Recommendations

The Recommended Fluids and Lubricants information will only be found in the Owner's Manual. Refer to the Maintenance Schedule subsection of the Owner's Manual.

You may be able to use the Search information function using the words Fluids or Lubricants.

Maintenance Items

The Normal Maintenance Replacement Parts information will only be found in the Owner's Manual. Refer to the Maintenance Schedule subsection of the Owner's Manual.

You may be able to use the Search information function using the words Replacement Parts.

Maintenance

Maintenance Schedule (North American Emissions)

The Maintenance Schedule information will only be found in the Owner's Manual.

Refer to the Maintenance Schedule subsection of the Owner's Manual, or you may be able to use the Search information function using the words Scheduled Maintenance.

GM Oil Life System - Resetting

This information is no longer published in the service manual. This information will be found within Engine Oil Life System in the Owner's Manual. Refer to Category Service and Appearance Care, then Checking Things Under the Hood, and then subsection Description and Operation.

You may be able to use the Search information function using the words Oil Life.

Vibration Diagnosis and Correction

Specifications

Tire and Wheel Runout Specifications

Application	Specification	
	Metric	English
Tire and Wheel Assembly – Lateral and Radial		
Off-Vehicle	1.27 mm	0.050 in
On-Vehicle	1.52 mm	0.060 in
Wheel, Aluminum		
Lateral	0.762 mm	0.030 in
Radial	0.762 mm	0.030 in
Wheel, Steel		
Lateral	1.143 mm	0.045 in
Radial	1.015 mm	0.040 in
Wheel Hub/Axle Flange – Guideline	0.132 mm	0.0052 in
Wheel Stud – Guideline	0.25 mm	0.010 in

Propeller Shaft Runout Specifications

Application	Front Runout		Center Runout		Rear Runout	
	Metric	English	Metric	English	Metric	English
One-Piece Propeller Shaft	1.17 mm	0.046 in	1.27 mm	0.050 in	1.40 mm	0.055 in
One-Piece Aluminum Graphite Propeller Shaft	1.17 mm	0.046 in	—	—	1.40 mm	0.055 in

Diagnostic Information and Procedures

Diagnostic Starting Point - Vibration Diagnosis and Correction

Important: The following steps must be completed before using the analysis tables or the symptom tables.

1. Perform the *Vibration Analysis - Road Testing on page 0-27* table before using the other Vibration Analysis tables or the Symptom tables in order to effectively diagnose the customer's concern.

   The use of Vibration Analysis - Road Testing will first provide duplication of virtually any vibration concern and then identify the correct procedure for diagnosing the area of concern which has been duplicated.
2. Review the following Vibration Diagnostic Process.
3. Review the general descriptions to familiarize yourself with vibration theory and terminology, the *J 38792-A*, Electronic Vibration Analyzer (EVA) 2 and the *J 38792-VS*, Vibrate Software. Reviewing this information will help you determine whether the condition described by the customer is a potential operating characteristic or not.

   Refer to the following:
   - *Vibration Theory and Terminology on page 0-78*
   - *Electronic Vibration Analyzer (EVA) Description and Operation on page 0-86*
   - *Vibrate Software Description and Operation on page 0-88*
   - *Reed Tachometer Description on page 0-88*

Vibration Diagnostic Process

Important: Using the following steps of the vibration diagnostic process will help you to effectively narrow-down and pin-point the search for the specific source of a vibration concern and to arrive at an accurate repair.

1. Gather specific information on the customer's vibration concern.
2. Perform the road testing steps in sequence as identified in Vibration Analysis - Road Testing in order to duplicate the customer's concern and evaluate the symptoms of the concern under changing conditions. Observe what the vibration feels like and what it sounds like. Observe when the symptoms first appear, when they change, and when they cease.
3. Determine if the customer's vibration concern is truly an abnormal condition or something that is potentially an operating characteristic of the vehicle.
4. Systematically eliminate or "rule-out" possible vehicle systems.
5. Focus diagnostic efforts on the remaining vehicle system and systematically eliminate or "rule-out" possible components of that system.
6. Make a repair on the remaining component, or components, which have not been eliminated systematically, and must therefore be the cause of the vibration.
7. Verify that the customer's concern has been eliminated or at least brought to an acceptable level.
8. Again perform the road testing steps in sequence as identified in Vibration Analysis - Road Testing in order to verify that the vehicle did not have more than one vibration occurring.

Preliminary Visual/Physical Inspection

- Inspect for aftermarket equipment and modifications which could affect the operation of the vehicle rotating component systems.
- Inspect the easily accessible or visible components of the vehicle rotating component systems for obvious damage or conditions which could cause the symptom.
- Inspect the tire inflation pressures for the proper pressure.

Diagnostic Aids

Improper component routing or isolation, or components which are worn or faulty may be the cause of intermittent conditions that are difficult to duplicate. If the vibration concern could not be duplicated by following the steps of the Vibration Diagnostic Process, refer to *Vibration Diagnostic Aids on page 0-51*.

Vibration Analysis - Road Testing

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. Obtaining rotational speed for the components rotating at both tire/wheel speed and propeller shaft speed is critical to systematically eliminating specific vehicle component groups. These component rotational speeds can be generated by using the *J 38792-VS* Vibrate Software or through calculating them manually.

Important: Be certain to OBSERVE for disturbances that match the customer description FIRST, then look at the *J 38792-A* Electronic Vibration Analyzer 2 frequency which corresponds with that disturbance.

8. Proper location of the *J 38792-A* sensor onto the component which is most excited by the vibration disturbance is critical to obtaining an accurate frequency reading.

   This test will duplicate virtually any disturbance which occurs while the vehicle is in motion.

11. Accelerate to a speed high enough above the speed of the disturbance to allow for the time needed to shift into NEUTRAL and for the engine to decrease in RPM to idle speed before coasting down through the disturbance range.
12. This test will either eliminate or confirm the engine as a contributing cause of the customer concern.

Vibration Analysis - Road Testing

Step	Action	Yes	No
Caution: Refer to Road Test Caution on page P-6 in Cautions and Notices.			
1	Did you review the Diagnostic Starting Point – Vibration Diagnosis?	Go to *Step 2*	Go to *Diagnostic Starting Point - Vibration Diagnosis and Correction on page 0-26*
2	Visually inspect the tire and wheel assemblies, steering components, and suspension components for any possible faults. Are the tire and wheel assemblies, steering components, and suspension components in good working condition?	Go to *Step 4*	Go to *Step 3*
3	Correct the faults before proceeding. Did you correct the faults?	Go to *Step 4*	Do NOT operate the vehicle Go to *Step 2*
4	1. Obtain the drive axles, final drive, ratios. 2. If the *J 38792-VS* Vibrate Software IS available, obtain the transmission gear ratios. 3. If the *J 38792-VS* is NOT available, take note of the tire size on each axle, then calculate the tire rotational speed for each size tire used and calculate the propeller shafts rotational speeds. Refer to *Component Rotational Speed Calculation on page 0-30.* Did you obtain the powertrain ratios for use with the *J 38792-VS* or calculate the component rotational speeds, if *J 38792-VS* is NOT available?	Go to *Step 5*	—
5	1. Install a scan tool. 2. With the scan tool, bring up the Powertrain Control Module data list and select Engine Speed. Is the scan tool operating properly?	Go to *Step 6*	Go to *Scan Tool Does Not Communicate with Class 2 Device on page 10-62* in Computer/Integrating Systems
6	Install the *J 38792-A* Electronic Vibration Analyzer (EVA) 2. Is the *J 38792-A* operating properly?	Go to *Step 7*	Go to *Electronic Vibration Analyzer (EVA) Description and Operation on page 0-86*
7	Did the customer concern indicate that the vibration occurs ONLY while the vehicle is standing still?	Go to *Vibration Analysis - Engine on page 0-39*	Go to *Step 8*
8	1. Install the *J 38792-A* sensor to the component identified by the customer as most respondent to the vibration. If no component was identified, install the *J 38792-A* sensor to the steering column. You may have to move the sensor to other locations later. 2. Select a smooth, level road and slowly accelerate the vehicle up to highway speed. 3. Observe the vehicle for disturbances that match the customer description and note the following conditions: • The vehicle speed (km/h, mph) • The engine speed (RPM) • The transmission gear range and the specific gear • The vibration frequency reading, if detected by the *J 38792-A* • The feel and/or sound of the disturbance 4. If the vibration seems to excite a particular component of the vehicle more than the steering column, then move the *J 38792-A* sensor onto that component and repeat steps 2 and 3. Were you able to duplicate the customer concern?	Go to *Step 11*	Go to *Step 9*
9	Is the vehicle equipped with four-wheel drive or all-wheel drive?	Go to *Step 10*	Go to *Vibration Diagnostic Aids on page 0-51*

Vibration Analysis - Road Testing (cont'd)

Step	Action	Yes	No
10	1. With the *J 38792-A* sensor still installed in the same position, activate/engage all-wheel drive. 2. Select a smooth, level road and slowly accelerate the vehicle up to highway speed. 3. Observe the vehicle for disturbances that match the customer description and note the following conditions: • The vehicle speed (km/h, mph) • The engine speed (RPM) • The transmission gear range and the specific gear • The vibration frequency reading, if detected by the *J 38792-A* • The feel and/or sound of the disturbance 4. If the vibration seems to excite a particular component of the vehicle more than the steering column, then move the *J 38792-A* sensor onto that component and repeat steps 2 and 3. Were you able to duplicate the customer concern?	Go to *Step 11*	Go to *Vibration Diagnostic Aids on page 0-51*
11	1. Accelerate the vehicle to a speed higher than the speed at which the disturbance occurs. 2. Shift the vehicle into NEUTRAL and allow the vehicle to coast down through the disturbance range. Does the disturbance still occur while coasting-down in NEUTRAL?	Go to *Step 13*	Go to *Step 12*
12	1. Select a smooth, level road and slowly accelerate the vehicle up to the speed at which the disturbance occurs. 2. Decelerate and safely downshift by one gear range. 3. Operate the vehicle at the same VEHICLE SPEED at which the disturbance occurs. Does the disturbance still occur while going the same vehicle speed in a lower gear range?	Go to *Vibration Analysis - Driveline on page 0-34*	Go to *Vibration Analysis - Engine on page 0-39*
13	Did the *J 38792-A* detect a dominant frequency?	Go to *Step 14*	Go to *Symptoms - Vibration Diagnosis and Correction on page 0-53*
14	1. If the *J 38792-VS* IS available, use the drive axles, final drive, ratios, the specific transmission gear ratio, and the engine speed to make a comparison to the dominant frequency reading recorded. 2. If the *J 38792-VS* is NOT available, compare the dominant frequency reading recorded to the component rotational data which you calculated previously. Does the frequency data clearly fall within the tire/wheel parameters ONLY?	Go to *Vibration Analysis - Tire and Wheel on page 0-32*	Go to *Step 15*
15	Does the frequency data clearly fall within the propeller shaft parameters ONLY?	Go to *Vibration Analysis - Driveline on page 0-34*	Go to *Symptoms - Vibration Diagnosis and Correction on page 0-53*

Component Rotational Speed Calculation

Tire and Wheel Rotational Speed Calculation

A size P235/75R15 tire rotates ONE complete revolution per second (RPS), or 1 Hz, at a vehicle speed of 8 km/h (5 mph). This means that at 16 km/h (10 mph), the same tire will make TWO complete revolutions in one second, 2 Hz, and so on.

Tire Rotational Speed (at 8 km/h [5 mph])

Tire Size	Tread	Revs/Sec (Hertz) at 8 km/h (5 mph)
P245/70R16	ALS	0.98
P245/65R17	ALS	0.97
	OOR	0.96
P255/60R17	AL2	0.99
Tread Codes		
ALS		All Season
AL2		All Season Touring
OOR		On-Off Road

1. Determine the rotational speed of the tires in revolutions per second (RPS), or Hertz (Hz), at 8 km/h (5 mph), based on the size of the tires. Refer to the preceding Tire Rotational Speed table.

   For example: According to the Tire Rotational Speed table, a P245/70R16 tire makes 0.98 revolutions per second (Hz) at a vehicle speed of 8 km/h (5 mph). This means that for every increment of 8 km/h (5 mph) in vehicle speed, the tire's rotation increases by 0.98 revolutions per second (Hz).
2. Determine the number of increments of 8 km/h (5 mph) that are present, based on the vehicle speed (km/h, mph) at which the disturbance occurs.

   For example: Assume that a disturbance occurs at a vehicle speed of 96 km/h (60 mph). A speed of 96 km/h (60 mph) has 12 INCREMENTS of 8 km/h (5 mph):

   96 km/h (60 mph) divided by 8 km/h (5 mph) = 12 increments
3. Determine the rotational speed of the tires in revolutions per second (Hz), at the specific vehicle speed (km/h, mph) at which the disturbance occurs.

   For example: To determine the tire rotational speed at 96 km/h (60 mph), multiply the number of increments of 8 km/h (5 mph) by the revolutions per second (Hz) for one increment:

   12 (increments) X 0.98 Hz = 11.76 Hz (rounded to 12 Hz)
4. Compare the rotational speed of the tires at the specific vehicle speed at which the disturbance occurs, to the dominant frequency recorded on the *J 38792-A* during testing. If the frequencies match, then a first-order disturbance related to the rotation of the tire/wheel assemblies is present.

   If the frequencies do not match, then the disturbance may be related to a higher order of tire/wheel assembly rotation.
5. To compute higher order tire/wheel assembly rotation related disturbances, multiply the rotational speed of the tires at the specific vehicle speed at which the disturbance occurs, by the order number:

   12 Hz X 2 (for second order) = 24 Hz second-order tire/wheel assembly rotation related

   12 Hz X 3 (for third order) = 36 Hz third-order tire/wheel assembly rotation related

   If any of these computations match the frequency of the disturbance, a disturbance of that particular order, relating to the rotation of the tire/wheel assemblies is present.

Propeller Shaft Rotational Speed Calculation

1. Determine the first order rotational speed of the propeller shaft(s) in revolutions per second (Hz), based on the first-order rotational speed of the tire/wheel assemblies and the drive axle(s) (final drive) ratio(s).

   12 Hz X 3.42 drive axle (final drive) ratio = 41.04 Hz (rounded to 41 Hz) first-order propeller shaft rotation related
2. Compare the rotational speed of the propeller shaft(s) at the specific vehicle speed at which the disturbance occurs, to the dominant frequency recorded on the *J 38792-A* during testing. If the frequencies match, then a first-order disturbance related to the rotation of the propeller shaft is present.

   If the frequencies do not match, then the disturbance may be related to the second-order of propeller shaft rotation.
3. To compute a second order propeller shaft rotation related disturbance, multiply the first order rotational speed of the propeller shaft at the specific vehicle speed at which the disturbance occurs, by the order number of 2:

   41 Hz X 2 (for second order) = 82 Hz second-order propeller shaft rotation related

   If the computation matches the frequency of the disturbance, a disturbance relating to the second-order rotation of the propeller shaft is present.

Component Rotational Speed Worksheet

Utilize the following worksheet as an aid in calculating the first, second and third order of tire/wheel assembly rotational speed and the first and second order of propeller shaft rotational speed related disturbances that may be present in the vehicle.

If after completing the Tire/Wheel Rotation Worksheet, the frequencies calculated do NOT match the dominant frequency of the disturbance recorded during testing, either recheck the data, or attempt to rematch the figures allowing for 1½–8 km/h (1–5 mph) of speedometer error.

If the possible tire/wheel assembly and/or propeller shaft rotational speed related frequencies still do not match the dominant frequency of the disturbance, the disturbance is most likely torque/load sensitive.

If after completing the Tire/Wheel Rotation Worksheet, one of the frequencies calculated DOES match the dominant frequency of the disturbance, the disturbance is related to the rotation of that component group, (tire/wheel assembly or propeller shaft).

TIRE/WHEEL AND PROPSHAFT ROTATION

Vehicle Information

Complaint Speed:	______ km/h (mph)	Year: ______	Model: ______
Symptom:	______	VIN: ______	
Frequency:	______	Engine: ______	Trans: ______
Engine Speed:	______ rpm	Tire Size: ______	Axle Ratio: ______
Gear:	______	TPC Spec: ______	

Tire/Wheel Speed

Vibration Occurs at:	☐	km/h ÷ 8(km/h) mph ÷ 5(mph)		=	☐	Increments of 8 km/h (5mph)
8 km/h (5mph) increments	☐	x	☐ tire RPS* at 8 km/h (5mph) (from chart)	=	☐	Tire/Wheel Speed, RPS (Hz) 1st order
1st order	☐	x 2		=	☐	2nd order
1st order	☐	x 3		=	☐	3rd order

Propeller Shaft Speed

						Propeller Shaft Speed
1st order tire	☐	x	☐ (axle ratio)	=	☐	1st order
1st order propshaft	☐	x 2		=	☐	2nd order

*RPS=revolutions per second; equates to cycles per second (Hz).

6509

Vibration Analysis - Tire and Wheel

Test Description

The numbers below refer to the step numbers in the diagnostic table:

4. A buildup of foreign material on a tire and wheel assembly and/or a damaged, abnormally or excessively worn tire and wheel assembly could cause a vibration disturbance.
6. Tire and wheel assemblies that exhibit excessive runout when measured while mounted on the vehicle, may or may not be contributing to, or causing a vibration disturbance. On-vehicle runout, if present, could contribute to, or cause a vibration disturbance, but the cause of the on-vehicle runout may not be the tire and wheel assemblies.
7. Tire and wheel assemblies that exhibit excessive runout when measured off of the vehicle could cause a vibration disturbance.
8. Tire and wheel assemblies that exhibit marginal runout (within acceptable limits, but close to the maximum) when measured off of the vehicle could still be contributing to a vibration disturbance, if its mating hub/axle flange also exhibits marginal runout. When the tire and wheel assembly and the hub axle flange are mounted to each other, the combined stack-up of their marginal amounts of runout could combine to produce an excessive amount of runout, which could cause a vibration disturbance.
13. Brake rotors that exhibit excessive imbalance could contribute to, or possibly cause a vibration disturbance.
14. A hub/axle flange and/or wheel studs that exhibit excessive runout could cause a vibration disturbance.
15. When the tire and wheel assembly and the hub axle flange are mounted to each other, the combined stack-up of their marginal amounts of runout could combine to produce an excessive amount of runout, which could cause a vibration disturbance. Match-mounting or vectoring the tire and wheel assembly to the hub/axle flange will modify the amount of combined runout.
19. Force variation may be present in a tire and wheel assembly that exhibited acceptable balance and runout. Force variation, if present, could contribute to, or cause a vibration disturbance.
21. Vibration disturbances could be affected by, or possibly caused by, components that are susceptible to steering input and/or torque-load input.
23. On-vehicle balancing, or finish-balancing can be used to reduce small amounts of imbalance which may be present as a result of the combined stack-up of the tire and wheel assembly with other components which may exhibit marginal balance.

Vibration Analysis - Tire and Wheel

Step	Action	Yes	No
1	Has the Vibration Analysis - Road Testing table been completed?	Go to *Step 2*	Go to *Vibration Analysis - Road Testing on page 0-27*
2	Based on the Vibration Analysis - Road Testing table, is the concern first-order tire and wheel assembly related?	Go to *Step 4*	Go to *Step 3*
3	Based on the Vibration Analysis - Road Testing table, is the concern second-order, or higher-order tire and wheel assembly related?	Go to *Step 19*	Go to *Vibration Analysis - Road Testing on page 0-27*
4	Visually inspect the tire and wheel assemblies for the following: • Debris buildup, such as packed mud, undercoating, ice/snow buildup, road tar, etc. • Damage, abnormal or excessive wear Refer to *Tire and Wheel Inspection on page 0-55.* Do any of the tire and wheel assemblies exhibit any of the conditions listed?	Go to *Step 5*	Go to *Step 6*
5	1. Remove the debris from the tire and wheel assemblies. 2. Replace the damaged, abnormally or excessively worn wheels or tires as necessary. Refer to *Tire Mounting and Dismounting on page 3-74* in Tires and Wheels. Did you complete the repair or replacement?	Go to *Step 24*	—
6	Measure the on–vehicle runout of the tire and wheel assemblies. Refer to *Tire and Wheel Assembly Runout Measurement - On-Vehicle on page 0-56.* Does the runout measurement indicate a runout concern?	Go to *Step 7*	Go to *Step 11*

Vibration Analysis - Tire and Wheel (cont'd)

Step	Action	Yes	No
7	Measure the off–vehicle runout of the tire and wheel assemblies. Refer to *Tire and Wheel Assembly Runout Measurement - Off-Vehicle on page 0-56.* Does the runout measurement indicate a runout concern?	Go to *Step 20*	Go to *Step 8*
8	Are any of the tire and wheel assembly runout measurements marginal (within acceptable limits, but close to the maximum)?	Go to *Step 9*	Go to *Step 14*
9	1. Match-mount (vector) the tire-to-wheel for each tire and wheel assembly with marginal runout. Refer to *Tire-to-Wheel Match-Mounting (Vectoring) on page 0-73.* 2. Remeasure the runout of each match-mounted tire and wheel assembly. Refer to *Tire and Wheel Assembly Runout Measurement - Off-Vehicle on page 0-56.* Were you able to significantly reduce the amount of tire and wheel assembly runout?	Go to *Step 10*	Go to *Step 20*
10	Remeasure the on–vehicle runout of the tire and wheel assemblies. Refer to *Tire and Wheel Assembly Runout Measurement - On-Vehicle on page 0-56.* Does the remeasurement indicate a runout concern?	Go to *Step 14*	Go to *Step 24*
11	Inspect the balance of the tire and wheel assemblies. Refer to *Tire and Wheel Assembly Balancing - Off-Vehicle on page 0-69.* Are any or the tire and wheel assemblies out of balance?	Go to *Step 12*	Go to *Step 13*
12	Balance the tire and wheel assemblies as necessary. Refer to *Tire and Wheel Assembly Balancing - Off-Vehicle on page 0-69.* Were you able to achieve balance?	Go to *Step 24*	Go to *Vibration Diagnostic Aids on page 0-51*
13	1. Inspect the brake rotors for damage. 2. Inspect the balance of the brake rotors. Refer to *Brake Rotor/Drum Balance Inspection on page 0-60.* Are any of the brake rotors damaged and/or out of balance?	Go to *Step 17*	Go to *Step 18*
14	Measure the runout of the hub/axle flanges and the wheel studs. Refer to *Hub/Axle Flange and Wheel Stud Runout Inspection on page 0-60.* Does the runout measurement indicate a runout concern?	Go to *Step 16*	Go to *Step 15*
15	1. Match-mount (vector) the tire and wheel assemblies-to-hub/axle flanges. Refer to *Tire and Wheel Assembly-to-Hub/Axle Flange Match-Mounting on page 0-74.* 2. Remeasure the on-vehicle runout of tire and wheel assemblies. Refer to *Tire and Wheel Assembly Runout Measurement - On-Vehicle on page 0-56.* Were you able to significantly reduce the amount of on-vehicle tire and wheel assembly runout?	Go to *Step 24*	Go to *Step 2*
16	Replace components as required. Refer to the following procedures as necessary: • *Wheel Stud Replacement on page 3-39* in Front Suspension • *Wheel Stud Replacement on page 3-65* in Rear Suspension • *Wheel Hub, Bearing, and Seal Replacement on page 3-39* in Front Suspension • *Rear Axle Shaft Replacement on page 4-29* in Rear Drive Axle Did you complete the replacement?	Go to *Step 24*	—
17	Replace the brake rotors as necessary. Refer to the appropriate procedure in Disc Brakes: • *Brake Rotor Replacement - Front on page 5-104* • *Brake Rotor Replacement - Rear on page 5-108* Did you complete the replacement?	Go to *Step 24*	—

Vibration Analysis - Tire and Wheel (cont'd)

Step	Action	Yes	No
18	Inspect for radial and lateral force variation. Refer to *Tire and Wheel Assembly Isolation Test on page 0-62.* Were you able to isolate one or more of the tire and wheel assemblies as the cause of the disturbance?	Go to *Step 20*	Go to *Step 21*
19	Inspect for radial and lateral force variation. Refer to *Tire and Wheel Assembly Isolation Test on page 0-62.* Were you able to isolate one or more of the tire and wheel assemblies as the cause of the disturbance?	Go to *Step 20*	Go to *Step 22*
20	Replace the tire(s) and/or wheel(s) as necessary. Refer to *Tire Mounting and Dismounting on page 3-74* in Tires and Wheels. Did you complete the replacement?	Go to *Step 24*	—
21	Perform the Vibration Analysis - Hub/Axle Input table. Refer to *Vibration Analysis - Hub and/or Axle Input on page 0-37.* Did you find and correct a condition?	Go to *Step 24*	Go to *Step 23*
22	Perform the Vibration Analysis - Hub/Axle Input table. Refer to *Vibration Analysis - Hub and/or Axle Input on page 0-37.* Did you find and correct a condition?	Go to *Step 24*	Go to *Vibration Diagnostic Aids on page 0-51*
23	Finish-balance the tire and wheel assemblies ON-vehicle. Refer to *Tire and Wheel Assembly Balancing - On-Vehicle on page 0-73.* Did you complete the on-vehicle finish balancing?	Go to *Step 24*	—
24	1. Install or connect any components that were removed or disconnected during diagnosis. 2. Perform the Vibration Analysis - Road Testing table. Refer to *Vibration Analysis - Road Testing on page 0-27.* Is the vibration still present?	Go to *Step 2*	System OK

Vibration Analysis - Driveline

Test Description

The numbers below refer to the step numbers in the diagnostic table.

8. First-order driveline related vibrations are usually caused by components that exhibit excessive runout or imbalance. Reproducing a vibration concern in the service stall can aid in pin-pointing the component which may be at fault. A vibration concern may appear to be either less severe or more severe when duplicated in a service stall, than when duplicated on the road.
9. First-order driveline related vibrations that could not be duplicated during the non-torque sensitive service stall test, could be caused by internal axle components. This test is designed to duplicated first-order driveline related vibrations that are sensitive to torque/load. A vibration concern may appear to be either less severe or more severe when duplicated in a service stall, than when duplicated on the road.
11. First-order driveline vibrations can be caused by excessive runout of a propeller shaft.
15. First-order driveline vibrations can be caused by excessive runout of the pinion flange. If a propeller shaft exhibits excessive runout at a pinion flange end only, the runout may actually be caused by the pinion flange.
17. Re-indexing a propeller shaft to a pinion flange can reduce the amount of total combined runout which the components produce, which may in-turn reduce a vibration.

Vibration Analysis - Driveline

Step	Action	Yes	No
1	Has the Vibration Analysis - Road Testing table been completed?	Go to *Step 2*	Go to *Vibration Analysis - Road Testing on page 0-27*
2	Did you record frequency data from the *J 38792-A* during the Vibration Analysis - Road Testing procedure?	Go to *Step 3*	Go to *Step 5*
3	Based on the Vibration Analysis - Road Testing table, is the concern first order driveline related?	Go to *Step 6*	Go to *Step 4*
4	Based on the Vibration Analysis - Road Testing table, is the concern second order driveline related?	Go to *Step 19*	Go to *Step 5*

Vibration Analysis - Driveline (cont'd)

Step	Action	Yes	No
5	Based on the Vibration Analysis - Road Testing table, is the concern a noise that is not felt?	Go to *Vibration Diagnostic Aids on page 0-51*	Go to *Vibration Analysis - Road Testing on page 0-27*
6	Inspect the following components for wear or damage: • Inspect the propeller shafts for dents, damage, missing weights, and undercoating. • Inspect the U-joints for damage and missing components. Are any of the components listed worn or damaged?	Go to *Step 7*	Go to *Step 8*
7	Replace the damaged or missing components. Refer to one of the following procedures in Propeller Shaft: • *Propeller Shaft Replacement on page 4-6* • *Universal Joint Replacement - Nylon Injected Ring on page 4-7* • *Universal Joint Replacement - External Snap Ring on page 4-10* Did you complete the replacement?	Go to *Step 26*	—
8	Attempt to duplicate the vibration in the stall. Refer to *Vibration in Service-Stall Test (Non-Torque Sensitive) on page 0-63.* Were you able to duplicate the vibration?	Go to *Step 10*	Go to *Step 9*
9	Perform the *Vibration in Service-Stall Test (Torque Sensitive) on page 0-63.* Were you able to duplicate the vibration?	Go to *Diagnostic Starting Point - Rear Drive Axle on page 4-16* in Rear Drive Axle	Go to *Vibration Diagnostic Aids on page 0-51*
10	Was the vibration most evident under the transmission mount?	Go to *Step 11*	Go to *Step 13*
11	Measure the runout at the rear of the front axle propeller shaft, if equipped and measure the runout at the front of the rear axle propeller shaft. Refer to *Propeller Shaft Runout Measurement (One-Piece) on page 0-64.* Does the runout measurement require that the propeller shafts be replaced?	Go to *Step 13*	Go to *Step 12*
12	1. Replace the transmission mount. Refer to *Transmission Mount Replacement on page 7-297* in Automatic Transmission – 4L60-E. 2. Perform the *Vibration in Service-Stall Test (Non-Torque Sensitive) on page 0-63.* Is the vibration still present?	Go to *Step 13*	Go to *Step 26*
13	Measure the runout of the complete propeller shafts. Refer to *Propeller Shaft Runout Measurement (One-Piece) on page 0-64.* Does the runout measurement require that the propeller shafts be replaced?	Go to *Step 14*	Go to *Step 15*
14	1. Replace the propeller shaft. Refer to *Propeller Shaft Replacement on page 4-6* in Propeller Shaft: 2. Perform the *Vibration in Service-Stall Test (Non-Torque Sensitive) on page 0-63.* Was the vibration reduced or eliminated?	Go to *Step 26*	Go to *Step 17*
15	Determine the runout of the front axle pinion flange, if equipped, and determine the runout of the rear axle pinion flange. Refer to the *Pinion Flange Runout Measurement (System Balanced Flange) on page 0-66.* Does the runout measurement require that the front and/or rear pinion flange be replaced?	Go to *Step 16*	Go to *Step 17*
16	Replace the pinion flange. Refer to *Drive Pinion Flange/Yoke and/or Oil Seal Replacement on page 4-33* in Rear Drive Axle. Did you complete the replacement?	Go to *Step 26*	—

Vibration Analysis - Driveline (cont'd)

Step	Action	Yes	No
17	Re-index the propeller shaft. Perform the following steps: 1. Raise the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information. 2. Mark the position of the shaft on the pinion flange. 3. Remove the propeller shaft from the pinion flange. 4. Rotate the propeller shaft 180 degrees in the pinion flange. 5. Reinstall the propeller shaft. 6. Attempt to duplicate the vibration in the stall. Refer to the *Vibration in Service-Stall Test (Non-Torque Sensitive) on page 0-63.* Was the vibration reduced or eliminated?	Go to *Step 26*	Go to *Step 18*
18	Return the propeller shaft to it's original position and balance the propeller shaft. Refer to *Driveline System Balance Adjustment (Using EVA) on page 0-75.* Were you able to balance the driveline system?	Go to *Step 26*	Go to *Vibration Diagnostic Aids on page 0-51*
19	Inspect the following components for wear or damage: • Inspect the propeller shafts for dents, damage, missing weights, and undercoating. • Inspect the U-joints for damage and missing components. Are any of the components listed worn or damaged?	Go to *Step 20*	Go to *Step 21*
20	Replace the damaged or missing components. Refer to one of the following procedures in Propeller Shaft: • *Propeller Shaft Replacement on page 4-6* • *Universal Joint Replacement - Nylon Injected Ring on page 4-7* • *Universal Joint Replacement - External Snap Ring on page 4-10* Did you complete the replacement?	Go to *Step 26*	—
21	1. Measure the vehicle trim height. 2. Adjust the vehicle trim height, if necessary. Refer to *Trim Height Inspection Procedure on page 3-11* in Suspension General Diagnosis. Did you find and correct a condition?	Go to *Step 26*	Go to *Step 22*
22	Measure the propeller shaft angles. Refer to *Driveline Working Angles Measurement on page 0-67.* Do the propeller shaft angles require adjustment?	Go to *Step 23*	Go to *Step 24*
23	Adjust the propeller shaft angles. Refer to *Driveline Working Angles Adjustment on page 0-77.* Did you complete the repair?	Go to *Step 26*	—
24	Inspect the propeller shafts for proper phasing. Refer to *Propeller Shaft Phasing Inspection on page 0-68.* Does the propeller shaft phasing require correction?	Go to *Step 25*	Go to *Vibration Diagnostic Aids on page 0-51*
25	Correct the propeller shaft phasing. Refer to *Propeller Shaft Phasing Correction on page 0-78.* Did you complete the repair?	Go to *Step 26*	—
26	1. Install or connect any components that were removed or disconnected during diagnosis. 2. Perform the Vibration Analysis - Road Testing table. Refer to *Vibration Analysis - Road Testing on page 0-27.* Is the vibration still present?	Go to *Step 3*	System OK

Vibration Analysis - Hub and/or Axle Input

Test Description

The numbers below refer to the step numbers on the diagnostic table:

2. This test will determine the effect of turning input on the vibration.
6. This test will determine the effect of an initial heavy torque load on the vibration.
7. Damaged or worn wheel drive shafts may cause a noise or vibration that may be transferred into the passenger compartment.
9. Damaged or worn wheel bearings may cause a noise or vibration that may be transferred into the passenger compartment.
10. Damaged or worn suspension components may cause a noise or vibration that may be transferred into the passenger compartment.
11. Damaged or worn engine, transmission, and/or exhaust mounts may cause a noise or vibration that may be transferred into the passenger compartment.
12. Incorrect trim height may cause binding and/or interference between components that may produce a vibration.

Vibration Analysis - Hub and/or Axle Input

Step	Action	Yes	No
Caution: Refer to Work Stall Test Caution on page P-7 in Cautions and Notices.			
1	Has the Vibration Analysis – Road Testing table been performed?	Go to *Step 2*	Go to *Vibration Analysis - Road Testing on page 0-27*
2	1. Operate the vehicle at the speed of the vibration concern. 2. While maintaining the concern speed, drive the vehicle through slow, sweeping turns. First in one direction, then in the other direction. 3. Observe the vehicle for changes in the vibration disturbance. 4. Select a smooth, level surface, such as an empty parking lot or a remote road. 5. While maintaining the vehicle at the concern speed, if possible, drive the vehicle through sharp turns, 360 degrees, first in one direction, then in the other direction. 6. Observe the vehicle for changes in the vibration disturbance. Did the characteristics of the vibration change significantly, become worse or go away, during these steps?	Go to *Step 3*	Go to *Step 6*
3	Did you hear a clicking noise and/or feel a shudder during these steps?	Go to *Step 6*	Go to *Step 4*
4	Did you hear a growling noise during these steps?	Go to *Step 7*	Go to *Step 5*
5	Did you hear a popping noise during these steps?	Go to *Step 8*	Go to *Step 11*
6	1. With the vehicle at a stand-still, apply the regular brake and place the transmission in the lowest forward gear. **Important:** Do not accelerate to the point of causing the drive wheels to squeal, slip or hop. This would obscure the results of the test. 2. Release the regular brakes and accelerate aggressively to 32 km/h (20 mph). 3. Observe the vehicle for changes in the vibration disturbance. Did you feel a shudder or shaking during these steps?	Go to *Step 7*	Go to *Vibration Diagnostic Aids on page 0-51*
7	1. Inspect the wheel bearings for wear and/or damage. Refer to *Wheel Bearings Diagnosis on page 3-11* in Suspension General Diagnosis. 2. Replace any of the wheel bearings found to be worn and/or damaged. Refer to *Wheel Hub, Bearing, and Seal Replacement on page 3-39* in Front Suspension or to *Rear Axle Shaft Seal and/or Bearing Replacement on page 4-32* in Rear Drive Axle. Did you find and correct a condition?	Go to *Step 11*	Go to *Vibration Diagnostic Aids on page 0-51*

Vibration Analysis - Hub and/or Axle Input (cont'd)

Step	Action	Yes	No
8	1. Inspect the following suspension components for wear, damage, looseness and/or possible contact with other vehicle components: • Shock absorbers • Springs • Bushings • Insulators 2. Replace any of the suspension components found to be worn, damaged, loose and/or contacting other vehicle components. Did you find and correct a condition?	Go to *Step 11*	Go to *Step 9*
9	1. Inspect the powertrain mounts for the following: • Loose and/or missing fasteners • Improper alignment • Cracked, dry-rotted, and/or oil-soaked insulators • Twisted, broken, torn, and/or collapsed insulators • Bent, twisted, and/or deformed brackets 2. Replace powertrain mounts as necessary. Refer to the following procedures: • For the transmission mount, refer to *Transmission Mount Replacement on page 7-297* in Automatic Transmission – 4L60-E. • For the left engine mount, refer to *Engine Mount Replacement - Left on page 6-52* in Engine Mechanical – 6.0L. • For the right engine mount, refer to *Engine Mount Replacement - Right on page 6-56* in Engine Mechanical – 6.0L. 3. Inspect the exhaust system components for the following: • Loose and/or missing fasteners – Heat shields – Joints and/or couplings (nuts, bolts, studs, clamps, straps) – Bracket and/or insulator mounting • Inadequate clearance to body and/or chassis components (with the exhaust system both COLD and HOT; in NEUTRAL, FORWARD and REVERSE gears) • Improper alignment • Disconnected and/or missing insulators • Cracked, dry-rotted, and/or oil-soaked insulators • Stretched, twisted, broken, torn, and/or collapsed insulators • Bent, twisted, cracked, and/or deformed brackets 4. Repair, replace, and/or realign exhaust system components as necessary. Did you find and correct a condition?	Go to *Step 11*	Go to *Step 10*
10	Inspect the vehicle trim height and adjust as necessary. Refer to *Trim Height Inspection Procedure on page 3-11* in Suspension General Diagnosis. Did you find and correct a condition?	Go to *Step 11*	Go to *Vibration Diagnostic Aids on page 0-51*
11	1. Install or connect any components that were removed or disconnected during diagnosis. 2. Perform the Vibration Analysis – Road Testing table. Refer to *Vibration Analysis - Road Testing on page 0-27.* Is the vibration still present?	Go to *Step 2*	System OK

Vibration Analysis - Engine

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. If powertrain related DTCs are present, there may be a powertrain performance condition present which could be a contributing cause to the customer's concern.
3. This step is designed to identify engine-speed related disturbances that are NOT torque or load sensitive.
4. This step is designed to identify engine-speed related disturbances that ARE torque or load sensitive.
6. Making comparisons of the customer's vehicle with an equally equipped, same model year and type, KNOWN GOOD vehicle will help determine if certain disturbances may be characteristic of a vehicle design.

Vibration Analysis - Engine

Step	Action	Yes	No
Caution: Refer to Work Stall Test Caution on page P-7 in Cautions and Notices.			
1	Has the Vibration Analysis – Road Testing table been completed?	Go to *Step 2*	Go to *Vibration Analysis - Road Testing on page 0-27*
2	Using a scan tool, determine if any DTCs are set. Were any DTCs set?	Go to *Diagnostic Starting Point - Engine Controls on page 6-411* in Engine Controls – 6.0L	Go to *Step 3*
3	1. Block the front wheels. 2. Apply BOTH the service brakes and the park brake. 3. With the scan tool and the *J 38792-A* Electronic Vibration Analyzer (EVA) 2 still installed, start the engine. 4. Place the transmission in NEUTRAL or PARK. 5. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 6. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the *J 38792-A*. Were you able to duplicate the customer's concern?	Go to *Step 5*	Go to *Step 4*
4	1. Block the front wheels. 2. Apply BOTH the service brakes and the park brake. 3. With the scan tool and the *J 38792-A* still installed, start the engine. 4. Place the transmission in DRIVE. 5. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 6. Record the engine RPM obtained on the scan tool, and the most dominant frequency reading, if obtained on the *J 38792-A*. 7. If no frequency data was obtained, attempt to obtain the frequency by placing the transmission into REVERSE, then repeat steps 5 and 6. Were you able to duplicate the customer's concern?	Go to *Step 5*	Go to *Vibration Diagnostic Aids on page 0-51*
5	Did the *J 38792-A* detect a dominant frequency?	Go to *Step 6*	Go to *Symptoms - Vibration Diagnosis and Correction on page 0-53*

Vibration Analysis - Engine (cont'd)

Step	Action	Yes	No
6	Compare the test results of the customer's vehicle to the results of the same tests run, at the same engine RPM, on an equally-equipped, same model year and type, KNOWN GOOD vehicle. Refer to *Vehicle-to-Vehicle Diagnostic Comparison on page 0-54.* 1. Install a scan tool into the known good vehicle. 2. Install the *J 38792-A* into the known good vehicle; place the sensor in exactly the same location as it was placed in the customer's vehicle. 3. Block the front wheels. 4. Apply BOTH the service brakes and the park brake. 5. Start the engine. 6. Place the transmission in NEUTRAL or PARK. 7. Slowly increase the engine RPM to the level at which the disturbance was most noticeable in the customer's vehicle. 8. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the *J 38792-A*. 9. Place the transmission in DRIVE. 10. Slowly increase the engine RPM to the level at which the disturbance was most noticeable in the customer's vehicle. 11. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the *J 38792-A*. 12. If no frequency data was obtained, attempt to obtain the frequency by placing the transmission into REVERSE, then repeat steps 10 and 11. Did both of the vehicles exhibit the same characteristics?	Go to *Vibration Diagnostic Aids on page 0-51*	Go to *Vibration Analysis - Engine/Accessory Isolation on page 0-42*

Engine Order Classification

Engine First Order Classification

1. Convert the engine speed in revolutions per minute (RPM), recorded during duplication of the disturbance into Hertz, revolutions per second (RPS), by dividing the RPM by 60 seconds. Refer to the following example:

   1,200 RPM divided by 60 = 20 Hz (or RPS)
2. Compare the dominant frequency in Hz, recorded during duplication of the disturbance with the engine speed just converted into Hz, to determine if they are related.
3. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine speed, converted into Hz, ARE related, then an engine FIRST ORDER related disturbance is present. Engine first order disturbances are usually related to an imbalanced component. Refer to the Engine Order Related Disturbances table.
4. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine speed, converted into Hz, are NOT related, then determine if the disturbance is related to the engine's firing frequency. Proceed to Engine Firing Frequency Classification.

Engine Firing Frequency Classification

Engine firing frequency is a term used to describe the number of firing pulses (one firing pulse = one cylinder firing) that occur during ONE complete revolution of the crankshaft, multiplied by the number of crankshaft revolutions per second, Hz.

1. Calculate the engine firing frequency.
   - To determine the firing frequency of a 4-stroke engine during ONE complete revolution of the crankshaft, multiply the engine speed, converted into Hz, by HALF of the total number of cylinders in the engine.
   - For example: The engine speed, converted into Hz, was 20 Hz; if the vehicle was equipped with a V8 engine, 4 of the 8 cylinders would actually fire during ONE complete revolution of the crankshaft.
     - Multiply the converted engine speed (20 Hz) by 4 cylinders firing.

       20 Hz X 4 = 80 Hz
     - The engine firing frequency for a V8 engine at the original engine speed of 1,200 RPM, recorded during duplication of the disturbance, would be 80 Hz.
     - In like manner, a 6-cylinder engine would have a firing frequency of 60 Hz at the same engine speed of 1,200 RPM.

       20 Hz X 3 = 60 Hz

2. Compare the dominant frequency in Hz, recorded during duplication of the disturbance with the engine firing frequency in Hz, just calculated, to determine if they are related.
3. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine firing frequency in Hz, just calculated ARE related, then an engine FIRING FREQUENCY related disturbance is present. Engine firing frequency disturbances are usually related to improper isolation of a component. Refer to the Engine Order Related Disturbances table.
4. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine firing frequency in Hz, just calculated are NOT related, then determine if the disturbance is related to another engine order classification. Proceed to Other Engine Order Classification.

Other Engine Order Classification

1. Multiply the engine speed, converted into Hz, recorded during duplication of the disturbance by different possible order-numbers, other than 1 (first order) or the number used to determine the firing frequency of the engine.
2. Compare the dominant frequency in Hz, recorded during duplication of the disturbance with the other possible engine orders just calculated, to determine if they are related.
3. If the dominant frequency in Hz, recorded during duplication of the disturbance and one of the other engine order frequencies in Hz, just calculated ARE related, then an engine related disturbance of that order is present. If an engine related disturbance is present that is NOT related to first order or firing frequency, then it could be related to an engine driven accessory system. Proceed to Engine Driven Accessories Related to Engine Order.

Engine Driven Accessories Related to Engine Order

Engine driven accessory systems can be related to specific engine orders depending upon the relationship of the accessory pulley diameter to the crankshaft pulley diameter. For example:

- If the crankshaft pulley measured 20 cm (8 in) in diameter and one of the engine driven accessory pulleys measured 10 cm (4 in) in diameter, then that accessory pulley would rotate 2 times for every one rotation of the crankshaft pulley. If that accessory system was not isolated properly, or was not operating properly, it would be identifiable as a 2nd order engine related disturbance.
- In like manner, if an engine driven accessory pulley measured 5 cm (2 in) in diameter, then that accessory pulley would rotate 4 times for every one rotation of the crankshaft pulley. If that accessory system was not isolated properly, or was not operating properly, it would be identifiable as a 4th order engine related disturbance.

Engine driven accessories that contribute to, are excited by, or are the sole cause of a disturbance are usually doing so because of improper isolation that causes a transfer path into the passenger compartment or to another major component of the vehicle body.

Using the *J 38792-VS*, Vibrate Software, accurately measuring the diameters of the accessory pulleys and the crankshaft pulley, and performing the appropriate diagnostic procedures completely will lead to the specific accessory system which is either contributing to, or causing the customer's concern.

Engine Order Related Disturbances

<table>
<tr><th rowspan="2">Engine Order</th><th colspan="6">Engine Arrangement</th><th rowspan="2">90 Degree V8</th></tr>
<tr><th>L4 W/O Balance Shaft</th><th>L4 With Balance Shaft</th><th>L5</th><th>L6</th><th>60 Degree V6</th><th>90 Degree V6 With Balance Shaft</th></tr>
<tr><td>½ Order Torque Sensitive</td><td>Abnormal - Likely Single Cylinder Misfire</td><td>Abnormal - Likely Single Cylinder Misfire</td><td>Abnormal - Likely Single Cylinder Misfire</td><td>Abnormal - Likely Single Cylinder Misfire</td><td>Abnormal - Likely Single Cylinder Misfire and/or EGR/Fuel Variance</td><td>Abnormal - Likely Single Cylinder Misfire and/or EGR/Fuel Variance</td><td>Abnormal - Likely Single Cylinder Misfire</td></tr>
<tr><td>1st Order</td><td>Abnormal - Likely Component Imbalance</td><td>Abnormal - Likely Component Imbalance</td><td>Abnormal - Likely Component Imbalance</td><td>Abnormal - Likely Component Imbalance</td><td>Abnormal - Likely Component Imbalance</td><td>Abnormal - Likely Component Imbalance</td><td>Abnormal - Likely Component Imbalance</td></tr>
<tr><td rowspan="2">1½ Order Torque Sensitive</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td>Abnormal - Likely Bank to Bank EGR/Fuel Variance</td><td>Abnormal - Likely Bank to Bank EGR/Fuel Variance</td><td rowspan="2">Possible Engine Driven Accessory Related</td></tr>
<tr><td>Possible Engine Driven Accessory Related</td><td>Possible Engine Driven Accessory Related</td></tr>
</table>

Engine Order Related Disturbances (cont'd)

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<tr><th>L4 W/O Balance Shaft</th><th>L4 With Balance Shaft</th><th>L5</th><th>L6</th><th>60 Degree V6</th><th>90 Degree V6 With Balance Shaft</th></tr>
<tr><td>2nd Order Non Torque Sensitive</td><td>Characteristic of Engine Arrangement - Possible Powertrain Isolation Related</td><td>Possible Engine Driven Accessory Related</td><td>Possible Engine Driven Accessory Related</td><td>Possible Engine Driven Accessory Related</td><td>Characteristic of Engine Arrangement - Possible Powertrain Isolation Related</td><td>Characteristic of Engine Arrangement - Possible Powertrain Isolation Related</td><td>Possible Engine Driven Accessory Related</td></tr>
<tr><td rowspan="2">2nd Order Torque Sensitive</td><td>Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related</td><td>Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td>Abnormal - Likely Bank to Bank EGR/Fuel Variance</td></tr>
<tr><td>Possible Engine Driven Accessory Related</td><td>Possible Engine Driven Accessory Related</td><td>Possible Engine Driven Accessory Related</td></tr>
<tr><td rowspan="2">3rd Order Torque Sensitive</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td>Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related</td><td>Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related</td><td>Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related</td><td>Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td></tr>
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<tr><td rowspan="2">4th Order Torque Sensitive</td><td>Characteristic - Minimal Amount - of Engine Arrangement - Possible Powertrain Isolation Related</td><td>Characteristic - Minimal Amount - of Engine Arrangement - Possible Powertrain Isolation Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td rowspan="2">Possible Engine Driven Accessory Related</td><td>Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related</td></tr>
<tr><td>Possible Engine Driven Accessory Related</td><td>Possible Engine Driven Accessory Related</td><td>Possible Engine Driven Accessory Related</td></tr>
</table>

Vibration Analysis - Engine/Accessory Isolation

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4. A loose, damaged, misaligned, or defective powertrain insulator and/or bracket may create a transfer path into the passenger compartment.
6. A loose, damaged, misaligned, or defective exhaust system insulator and/or bracket may create a transfer path into the passenger compartment.
8. Incorrectly seated and/or aligned powertrain components and/or exhaust system components may create a transfer path into the passenger compartment.

   When loosening powertrain mounts in order to re-bed the powertrain observe the following:

   Do not loosen the mount bracket-to-engine bolts/nuts, do not loosen the mount bracket-to-vehicle frame bolts/nuts if mount brackets are used.

Loosen the mount-to-mount bracket bolts/nuts if mount brackets are used, or loosen the mount-to-slotted holes in vehicle frame bolts/nuts if a direct-mount design is used.

9. Non-rotating engine driven accessory component systems can no longer produce a unique disturbance.
10. Non-rotating engine driven accessory components can no longer produce a unique disturbance. If a disturbance is still present, but the characteristics have been altered, it is possible that these component systems are acting as a transfer path for engine firing frequency or a first order engine disturbance.

    If a disturbance is still present, but the characteristics have NOT been altered, it is NOT likely that these component systems are acting as a transfer path for engine firing frequency or a first order engine disturbance.
11. If the mark placed on the face of an engine driven accessory seems to stand still while running this test, then that accessory system is either responding to an existing frequency (such as engine firing pulses), or creating a disturbance.
12. A loose, damaged, misaligned, or defective engine driven accessory system insulator and/or bracket may create a transfer path into the passenger compartment.
13. Removing the engine driven accessory and bracket(s) from the engine allows a thorough inspection to determine if any conditions are present that may create a transfer path into the passenger compartment.

Vibration Analysis - Engine/Accessory Isolation

Step	Action	Yes	No
Caution: Refer to Work Stall Test Caution on page P-7 in Cautions and Notices.			
1	Were you sent here from the Vibration Analysis – Engine table?	Go to *Step 2*	Go to *Vibration Analysis - Engine on page 0-39*
2	1. Using the engine RPM and frequency data recorded for the customer's vehicle, determine the order of engine rotation to which the disturbance is related. 2. Determine the possible causes of the disturbance as it relates to a specific order of engine rotation. Refer to *Engine Order Classification on page 0-40.* Does the Engine Order Classification table indicate that the disturbance is of the same order as the engine firing frequency?	Go to *Step 4*	Go to *Step 3*
3	Does the Engine Order Classification table indicate that the disturbance is likely related to engine driven accessories?	Go to *Step 9*	Go to *Step 4*
4	Inspect the powertrain mounts for the following: • Loose and/or missing fasteners • Improper alignment • Cracked, dry-rotted, and/or oil-soaked insulators • Twisted, broken, torn, and/or collapsed insulators • Bent, twisted, and/or deformed brackets Did any of the powertrain mounts exhibit any of the conditions listed?	Go to *Step 5*	Go to *Step 6*
5	Replace powertrain mounts as necessary. Refer to the following procedures: • *Engine Mount Replacement - Left on page 6-52* in Engine Mechanical – 6.0L • *Engine Mount Replacement - Right on page 6-56* in Engine Mechanical – 6.0L • *Transmission Mount Replacement on page 7-297* in Automatic Transmission – 4L60-E Did you complete the replacement?	Go to *Step 15*	—

Vibration Analysis - Engine/Accessory Isolation (cont'd)

Step	Action	Yes	No
6	Inspect the exhaust system components for the following: • Loose and/or missing fasteners – Heat shields – Joints and/or couplings — nuts, bolts, studs, clamps, straps – Bracket and/or insulator mounting • Inadequate clearance to body and/or chassis components (with the exhaust system both COLD and HOT; in NEUTRAL, FORWARD and REVERSE gears) • Improper alignment • Disconnected and/or missing insulators • Cracked, dry-rotted, and/or oil-soaked insulators • Stretched, twisted, broken, torn, and/or collapsed insulators • Bent, twisted, cracked, and/or deformed brackets Did any of the exhaust systems components exhibit any of the conditions listed?	Go to *Step 7*	Go to *Step 8*
7	Repair, replace, and/or realign exhaust system components as necessary. Did you complete the repair, replacement, and/or realignment?	Go to *Step 15*	—
8	Re-bed the powertrain: 1. Loosen, but do not remove, all powertrain mounts and exhaust system hangers. 2. Ensure that the exhaust flexible coupling, if equipped, moves freely. 3. Start the engine. 4. Settle the powertrain by shifting the transmission from DRIVE to REVERSE. 5. Place the transmission into NEUTRAL. 6. Turn OFF the ignition. 7. Tighten all of the loosened fasteners with the powertrain in a relaxed position. Refer to the following procedures: • *Engine Mount Replacement - Left on page 6-52* in Engine Mechanical – 6.0L • *Engine Mount Replacement - Right on page 6-56* in Engine Mechanical – 6.0L • *Transmission Mount Replacement on page 7-297* in Automatic Transmission – 4L60-E Did you complete the operation?	Go to *Step 15*	—
9	***Notice:*** Do not run the engine for longer than 60 seconds with the accessory drive belt, or belts removed, or overheating and/or damage may result. 1. Remove the engine accessory drive belt(s). 2. Block the front wheels. 3. Apply BOTH the service brakes and the park brake. 4. With the scan tool still installed, start the engine. 5. Place the transmission in NEUTRAL or PARK. 6. Increase the engine speed (RPM) to the level recorded during duplication of the disturbance. 7. Allow the engine to idle, then place the transmission in DRIVE. 8. Increase the engine speed (RPM) to the level recorded during duplication of the disturbance. 9. Turn OFF the ignition. 10. Install the engine accessory drive belts. Was the disturbance significantly reduced or eliminated?	Go to *Step 11*	Go to *Step 10*
10	Were the characteristics of the disturbance altered but still present?	Go to *Step 12*	Go to *Step 17*

Vibration Analysis - Engine/Accessory Isolation (cont'd)

Step	Action	Yes	No
11	1. Mark the face of the suspected accessory pulleys, including idler pulleys if necessary, near the outer edge with a paint mark. 2. Install the *J 38792-25* Electronic Vibration Analyzer (EVA) timing (strobe) light to the *J 38792-A* Electronic Vibration Analyzer 2. For information on the use of the EVA features, refer to *Electronic Vibration Analyzer (EVA) Description and Operation on page 0-86.* 3. Block the front wheels. 4. Apply BOTH the service brakes and the park brake. 5. With the scan tool and the *J 38792-A*, still installed, start the engine. 6. Select the Smart Strobe feature on the *J 38792-A*. 7. Enter the recorded frequency of the disturbance as the initial frequency for strobe operation. 8. Have an assistant place the transmission in NEUTRAL or PARK. 9. Slowly increase the engine speed (RPM) to the level recorded during duplication of the disturbance, then maintain that speed. 10. Using the *J 38792-25*, inspect each of the suspected accessory pulleys to determine if any of them is related to the frequency of the disturbance. Inspect each of the accessory systems, both engaged and under maximum load and disengaged or under minimum load. 11. Allow the engine to idle, then place the transmission in DRIVE. 12. Slowly increase the engine speed (RPM) to the level recorded during duplication of the disturbance, then maintain that speed closely. 13. Using the *J 38792-25*, inspect each of the suspected accessory pulleys to determine if any of them is related to the frequency of the disturbance. Inspect each of the accessory systems, both engaged and under maximum load and disengaged or under minimum load. 14. Turn OFF the ignition. Did you identify an engine driven accessory system as being related to the frequency of the disturbance?	Go to *Step 12*	Go to *Vibration Diagnostic Aids on page 0-51*
12	Inspect the components of the engine driven accessory system for the following: • Loose and/or missing fasteners – Heat shields, if equipped – Joints and/or couplings — nuts, bolts, studs, clamps, straps – Bracket and/or insulator mounting • Inadequate clearance to body and/or chassis components, with the accessory system both under a LOAD and NOT loaded • Improper alignment • Bent or damaged pulleys • Disconnected and/or missing insulators • Cracked, dry-rotted, and/or oil-soaked component insulators • Stretched, twisted, broken, torn, and/or collapsed component insulators • Bent, twisted, cracked and/or deformed component brackets Did any of the components of the engine driven accessory system exhibit any of the conditions listed?	Go to *Step 14*	Go to *Step 13*

Vibration Analysis - Engine/Accessory Isolation (cont'd)

Step	Action	Yes	No
13	1. Remove the engine driven accessory and brackets from the engine. 2. Thoroughly inspect the accessory brackets, bolts/nuts/studs, and the accessory itself for signs of bent, twisted, cracked and/or deformed conditions. 3. Replace any of the components found to exhibit any of these conditions. 4. Reinstall the components to the engine. Did you find and correct a condition?	Go to *Step 15*	Go to *Step 18*
14	Repair, replace, and/or realign the engine driven accessory system components as necessary. Did you complete the repair, replacement, and/or realignment?	Go to *Step 15*	—
15	Inspect the vehicle to determine if the disturbance is now significantly reduced or eliminated. Perform the following steps: 1. Install a scan tool into the vehicle. 2. Install the *J 38792-A* into the vehicle. Place the sensor in exactly the same location as it was originally placed in the vehicle. 3. Block the front wheels. 4. Apply BOTH the service brakes and the park brake. 5. Start the engine. 6. Place the transmission in NEUTRAL or PARK. 7. Slowly increase the engine speed (RPM) to the level at which the disturbance was most noticeable. 8. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the *J 38792-A*. 9. Place the transmission in DRIVE. 10. Slowly increase the engine speed (RPM) to the level at which the disturbance was most noticeable. 11. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the *J 38792-A*. 12. If the disturbance has been significantly reduced or eliminated, confirm the results by placing the transmission into REVERSE, then repeat steps 10 and 11. Has the disturbance been significantly reduced or eliminated?	Go to *Step 19*	Go to *Step 16*
16	Have you investigated powertrain isolation as a possible cause of the disturbance?	Go to *Step 17*	Go to *Step 4*
17	Have engine driven accessories been investigated as a possible cause of the disturbance?	Go to *Vibration Analysis - Engine Balance on page 0-47*	Go to *Step 9*
18	Replace the engine driven accessory component causing the disturbance. Did you complete the replacement?	Go to *Step 19*	—
19	1. Install or connect any components that were removed or disconnected during diagnosis. 2. Perform the Vibration Analysis – Road Testing table. Refer to *Vibration Analysis - Road Testing on page 0-27.* Is the disturbance still present?	Go to *Step 2*	System OK

Vibration Analysis - Engine Balance

Test Description

The numbers below refer to the step numbers on the diagnostic table.

3. If sufficient clearance exists to separate the transmission torque converter from the engine flywheel/flexplate, then further tests can be used to isolate the transmission from the engine.
4. An engine flywheel/flexplate that has excessive lateral runout, when combined with the mass of the transmission torque converter, can produce a disturbance.
5. An engine flywheel/flexplate that is loose at the engine crankshaft or that is cracked, or damaged, when combined with the mass of the transmission torque converter, can produce a disturbance.
6. This step is designed to isolate the transmission from the engine to determine if the disturbance is related to the engine ONLY.
8. Re-indexing the transmission torque converter to the engine flywheel/flexplate alters the balance relationship between the torque converter and the rear of the engine.
10. Placing the J 38792-A Electronic Vibration Analyzer (EVA) 2 sensor onto the underside of the engine oil pan, along the FRONT and the REAR edge, allows for a determination to be made, which will help to narrow down the cause of the disturbance.
12. An engine flywheel that has excessive lateral runout, when combined with the extra mass of the clutch pressure plate, and clutch driven plate, can produce a disturbance.
13. The clutch pressure plate, and the engine flywheel, are marked for proper indexing of the heavy-spot of one, to the light-spot of the other. Improper indexing of the pressure plate to the flywheel, can produce a disturbance.
14. An engine flywheel that is loose at the engine crankshaft, or that is cracked, damaged, and/or missing balance weights, and/or a clutch pressure plate, and clutch driven plate that has loose springs, cracks, warpage, damage, and/or missing balance weights, can produce a disturbance when their mass is combined.
15. An engine flywheel that is loose at the engine crankshaft, or that is cracked, damaged, and/or missing balance weights, and/or a clutch pressure plate, and clutch driven plate that has loose springs, cracks, warpage, damage, and/or missing balance weights, can produce a disturbance when their mass is combined.
16. Re-indexing the pressure plate to the engine flywheel alters the balance relationship between the pressure plate/flywheel assembly and the rear of the engine.
17. An engine flywheel/flexplate that is damaged, misaligned, and/or imbalanced, can produce a disturbance.
19. An engine crankshaft balancer that is damaged, misaligned, and/or imbalanced, can produce a disturbance.

Vibration Analysis - Engine Balance

Step	Action	Yes	No
Caution: Refer to Work Stall Test Caution on page P-7 in Cautions and Notices.			
1	Were you sent here from the Vibration Analysis – Engine/Accessory Isolation table?	Go to *Step 2*	Go to *Vibration Analysis - Engine/Accessory Isolation on page 0-42*
2	Is the vehicle equipped with a manual transmission?	Go to *Step 10*	Go to *Step 3*
3	1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information. 2. Remove the flywheel/flexplate-to-torque converter bolts access cover, if equipped. 3. Determine if sufficient clearance exists to separate the transmission torque converter away from the engine flywheel/flexplate, and safely secure the torque converter from accidentally engaging with the flywheel/flexplate. Is there sufficient clearance to separate and safely secure the transmission torque converter away from the engine flywheel/flexplate?	Go to *Step 4*	Go to *Step 10*

Vibration Analysis - Engine Balance (cont'd)

Step	Action	Yes	No
4	1. With the flywheel/flexplate-to-torque converter access cover still removed, and with the vehicle still raised, mark the position of the transmission torque converter in relation to the engine flywheel/flexplate. 2. Disconnect the torque converter and move it away from the flywheel/flexplate. 3. Secure the transmission torque converter away from the engine flywheel/flexplate. 4. Lower the vehicle, start the engine, and allow the engine to idle. 5. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information. 6. Visually inspect the flywheel/flexplate for excessive lateral runout. 7. Lower the vehicle. 8. Turn OFF the ignition. Did the flywheel/flexplate exhibit excessive lateral runout?	Go to *Step 7*	Go to *Step 5*
5	1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information. 2. Inspect the flywheel/flexplate for the following: • Looseness at the engine crankshaft • Cracks and/or damage • Missing balance weights Did the flywheel/flexplate exhibit any of the conditions listed?	Go to *Step 7*	Go to *Step 6*
6	1. With the vehicle still raised and supported, tie the transmission torque converter away from the engine flywheel/flexplate to avoid accidental engagement with the flywheel/flexplate. 2. Lower the vehicle. 3. Block the front wheels. 4. Apply BOTH the service brakes and the park brake. 5. With the scan tool and the *J 38792-A* Electronic Vibration Analyzer (EVA) 2 still installed, start the engine. 6. Place the transmission in NEUTRAL or PARK. 7. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 8. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the *J 38792-A*. 9. Turn OFF the ignition. Has the disturbance been significantly reduced or eliminated?	Go to *Step 8*	Go to *Step 10*
7	• If the flywheel/flexplate is loose at the engine crankshaft, tighten the flywheel/flexplate mounting bolts in sequence and to specification. • If the flywheel/flexplate is cracked, damaged, and/or has missing balance weights, replace the damaged flywheel/flexplate. Refer to *Engine Flywheel Replacement on page 6-114* in Engine Mechanical – 6.0L. Did you complete the tightening or replacement?	Go to *Step 20*	—

Vibration Analysis - Engine Balance (cont'd)

Step	Action	Yes	No
8	1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information. 2. Re-index the transmission torque converter to the engine flywheel/flexplate, 120 degrees from its original position. 3. Reconnect the transmission torque converter to the engine flywheel/flexplate. 4. Lower the vehicle. 5. Block the front wheels. 6. Apply BOTH the service brakes and the park brake. 7. With the scan tool and the *J 38792-A* still installed, start the engine. 8. Place the transmission in NEUTRAL or PARK. 9. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 10. Record the engine RPM obtained on the scan tool and the most dominant frequency reading, if obtained on the *J 38792-A*. 11. If the disturbance is still noticeable, re-index the torque converter again to obtain the least amount of disturbance. Has the disturbance been significantly reduced or eliminated?	Go to *Step 20*	Go to *Step 9*
9	Replace the out-of-balance transmission torque converter. Did you complete the replacement?	Go to *Step 20*	—
10	1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information. 2. Position the *J 38792-A* sensor onto the underside of the engine oil pan, along the FRONT edge. 3. Lower the vehicle. 4. Block the front wheels. 5. Apply BOTH the service brakes and the park brake. 6. With the scan tool and the *J 38792-A* still installed, start the engine. 7. Place the transmission in NEUTRAL or PARK. 8. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 9. Record the engine RPM obtained on the scan tool, and the most dominant frequency reading if obtained on the *J 38792-A*, from the underside of the engine oil pan. 10. Repeat steps 1–9, placing the *J 38792-A* sensor onto the underside of the engine oil pan, along the REAR edge. Is the disturbance greater along the FRONT of the engine?	Go to *Step 19*	Go to *Step 11*
11	Is the vehicle equipped with an automatic transmission?	Go to *Step 17*	Go to *Step 12*
12	1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information. 2. Remove the flywheel inspection cover. 3. Start the engine. Allow the engine to idle. 4. Visually inspect the engine flywheel clutch surface for excessive lateral runout. Does the engine flywheel clutch surface exhibit excessive lateral runout?	Go to *Step 18*	Go to *Step 13*
13	Inspect the clutch pressure plate to engine flywheel mounting for proper factory indexing. Is the clutch pressure plate properly indexed to the engine flywheel?	Go to *Step 15*	Go to *Step 14*

Vibration Analysis - Engine Balance (cont'd)

Step	Action	Yes	No
14	1. Remove the clutch pressure plate and clutch driven plate from the engine flywheel. Refer to *Clutch Assembly Replacement (CTS-V) on page 7-330* in Clutch. 2. Inspect the engine flywheel for the following: • Looseness at the engine crankshaft • Cracks, warpage, and/or damage • Missing balance weights 3. Inspect the clutch pressure plate and clutch driven plate for the following: • Loose and/or damaged clutch driven plate damper springs • Loose and/or damaged clutch pressure plate diaphragm springs • Cracks, warpage, and/or damage • Missing balance weights Do any of the above conditions exist?	Go to *Step 18*	Go to *Step 16*
15	1. Remove the clutch pressure plate and clutch driven plate from the engine flywheel. Refer to *Clutch Assembly Replacement (CTS-V) on page 7-330* in Clutch. 2. Inspect the engine flywheel for the following: • Looseness at the engine crankshaft • Cracks, warpage, and/or damage • Missing balance weights 3. Inspect the clutch pressure plate and clutch driven plate for the following: • Loose and/or damaged clutch driven plate damper springs • Loose and/or damaged clutch pressure plate diaphragm springs • Cracks, warpage, and/or damage • Missing balance weights Do any of the above conditions exist?	Go to *Step 18*	Go to *Vibration Diagnostic Aids on page 0-51*
16	Re-index the pressure plate to the engine flywheel. Did you complete the re-indexing?	Go to *Step 20*	—
17	Replace the imbalanced engine flywheel/flexplate. Refer to *Engine Flywheel Replacement on page 6-114* in Engine Mechanical – 6.0L. Did you complete the replacement?	Go to *Step 20*	—
18	Replace the engine flywheel. Refer to *Engine Flywheel Replacement on page 6-114* in Engine Mechanical – 6.0L. Did you complete the replacement?	Go to *Step 20*	—
19	Replace the engine crankshaft balancer. Refer to *Crankshaft Balancer Replacement on page 6-88* in Engine Mechanical – 6.0L. Did you complete the replacement?	Go to *Step 20*	—
20	1. Install or connect any components that were removed or disconnected during diagnosis. 2. Perform the Vibration Analysis – Road Testing table. Refer to *Vibration Analysis - Road Testing on page 0-27.* Is the disturbance still present?	Go to *Vibration Diagnostic Aids on page 0-51*	System OK

Vibration Diagnostic Aids

Important: If you have not reviewed the Diagnostic Starting Point – Vibration Diagnosis and completed the Vibration Analysis tables as indicated, refer to *Diagnostic Starting Point - Vibration Diagnosis and Correction on page 0-26* BEFORE proceeding.

The diagnostic information contained in this Diagnostic Aids section will help you determine the correct course of action to take for the following 4 main conditions. Refer to the appropriate condition from this list:

- *Vibration Diagnostic Aids - Vibration Intermittent or Not Duplicated on page 0-51*
- *Vibration Diagnostic Aids - Vibration Duplicated, Component Not Identified on page 0-52*
- *Vibration Diagnostic Aids - Vibration Duplicated, Difficult to Isolate/Balance Component on page 0-52*
- *Vibration Diagnostic Aids - Vibration Duplicated, Appears to Be Potential Operating Characteristic on page 0-53*

Vibration Diagnostic Aids - Vibration Intermittent or Not Duplicated

Important: If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to *Vibration Diagnostic Aids on page 0-51* BEFORE proceeding.

If you have not been able to duplicate the vibration concern or have only been able to duplicate the concern intermittently, review the following information.

Most vibration concerns that cannot be duplicated are due to either specific conditions that are not present during the duplicating attempts, or due to not following the procedures designed to duplicate concerns properly and in the sequence indicated.

Specific Conditions Can Affect the Condition

Consider the following conditions which may not have been present while attempts were made to duplicate the vibration concern. Attempt to obtain more specific information from the customer as to the EXACT conditions that are present when they experience the vibration which they are concerned about. Attempt to duplicate the vibration concern again while recreating the EXACT conditions necessary, except those which pose a safety concern or are outside the boundaries of normal operating conditions, such as loading the vehicle beyond its designed weight ratings, etc.

Most attempts to duplicate a vibration concern are made after the vehicle has been driven to the dealership and perhaps even sat inside the building for a time; the vehicle may be too warm to detect the concern during duplication efforts. The opposite could also occur; perhaps the vehicle has sat out in the cold for a time and fails to reach full operating temperatures during attempts to duplicate the concern.

Temperature, Ground-Out, Accessory Load

Flat Spots on Tires

Tires which have sat and been cool for a time can develop flat spots.

Irregular Wear on Tire Treads

Tires which have sat and been cool for a time will be stiffer and any irregular wear conditions will be more noticeable than they will be once the tires have warmed and softened.

Exhaust System Growth

Exhaust systems may exhibit a ground-out condition when cool which goes away once the system hot. The opposite may be true that the exhaust system is fine when cool but a ground-out condition occurs once the system reaches operating temperatures. Exhaust systems can grow by 2½–5 cm (1–2 in) when hot.

Engine-Driven Accessory Noises

- Belt Whipping

  An engine accessory drive belt, or belts could exhibit a whipping condition if a belt is deteriorating and deposits are building up on the underside of the belt.
- Loose Mounting Brackets or Component Ground-Out

  Engine-driven accessories such as a generator, a power steering pump, or an air conditioning compressor could exhibit noise conditions due to either loose mounting brackets or due to related components of the system in a ground-out condition during certain operation of that accessory system.
- Cold or Hot

  These accessories could exhibit noise conditions when cool which go away once they are fully warmed-up, or the opposite may be true.
- Load on an Accessory Component

  These accessories could exhibit a noise condition while under a heavy load – perhaps when combined with a cool or fully warmed-up condition.
- Bent or Misaligned Pulleys

  Bent or mis-aligned pulleys in one or more engine-driven accessory systems could contribute to a noise or vibration condition.

- Fluid Level in Accessory Systems

  These accessories could exhibit a noise condition due to an abnormal amount of fluid contained in the system of which the accessory is a part.
  - An improper power steering fluid level could produce noises in the power steering system.
  - An improper air conditioning refrigerant level or an excessive amount of refrigerant oil could produce noises or possibly vibrations in the air conditioning system.
- Incorrect Fluid Type in Accessory Systems

  These accessories could exhibit a noise condition due to the incorrect type of fluid contained in the system of which the accessory is a part.

Vehicle Payload

The vibration concern may only occur when the vehicle is carrying heavy payloads or towing a trailer; the vehicle may have been empty during duplication efforts.

Heavy Payload

The vehicle may have been empty during attempts to duplicate the vibration concern, but the customer may actually experience the vibration concern while the vehicle is carrying a large payload.

Trailer Towing

The customer may experience the vibration concern only while towing a trailer.

Roadway Selection

The selection of roadways used to perform the vibration duplication procedures is likely to be in the near vicinity of the dealership and may not provide a road surface that is close enough to the surface on which the customer usually drives the vehicle.

The customer may only experience the vibration on a particular roadway. Perhaps the roadway is overly crowned or is very bumpy or rough.

Vibration Diagnostic Aids - Vibration Duplicated, Component Not Identified

Important: If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to *Vibration Diagnostic Aids on page 0-51* BEFORE proceeding.

Aftermarket Add-On Accessories

Aftermarket accessories which have been added to the vehicle can actually transmit and magnify INHERENT component rotational frequencies, if the accessories were not installed correctly.

An accessory should be installed in such a way that it is isolated from becoming a possible transfer path into the rest of the vehicle. For example, if a set of running boards has been installed improperly and they are sensitive to a particular frequency of a rotating component, the running boards could begin to respond to the frequency and actually create a disturbance once the amplitude of the frequency reaches a high enough point, probably at a higher vehicle speed.

If the same set of running boards were installed properly – isolated properly – the transfer path would be removed and the disturbance would no longer be present.

Vibration Diagnostic Aids - Vibration Duplicated, Difficult to Isolate/Balance Component

Important: If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to *Vibration Diagnostic Aids on page 0-51* BEFORE proceeding.

If you have duplicated the vibration concern but have had difficulty in balancing a component or isolating a component, refer to the following information.

Most vibration concerns are corrected or eliminated through correcting excessive runout of a component, correcting balance of a component or isolating a component which has come into abnormal contact with another object/component.

Components which can generate a lot of energy and are experiencing excessive runout, imbalance or ground-out can produce a vibration with a strong enough amplitude that the vibration can transmit to components which are closely related. This type of a condition is usually related to and sensitive to torque-load. The most likely system that could exhibit this type of a condition is the driveline.

Driveline Torque-Load Conditions

An axle differential that has internal conditions such as excessive runout of components, misalignment of components, imbalance, etc., can produce vibration concerns which may be transmitted into the propeller shaft(s). This sort of a vibration occurrence can increase or decrease in severity based primarily upon torque-load, but can also be affected by cold or hot conditions.

The propeller shaft and other related components may or may not pass inspections for wear or damage, runout, alignment, etc., depending upon whether there is only one vibration source or more than one.

Difficult to System Balance the Driveline

If after following the Vibration Analysis – Driveline table you were instructed to system balance the driveline and you experienced difficulty in doing so while CAREFULLY following the procedures indicated (the EVA strobe readings seem to keep changing), then the axle differential to which the propeller shaft is attached should be suspected to have internal problems which are being transmitted to the propeller shaft. Refer to *Diagnostic Starting Point - Rear Drive Axle on page 4-16* in Rear Drive Axle, for internal axle diagnostics.

Vibration Diagnostic Aids - Vibration Duplicated, Appears to Be Potential Operating Characteristic

Important: If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to *Vibration Diagnostic Aids on page 0-51* BEFORE proceeding.

Check Service Bulletins

If BOTH of the following statements are TRUE, then check service bulletins for the condition identified. If the condition has already been identified and investigated prior to this vehicle, and has been determined to be something that is not truly an operating characteristic or that perhaps is not design-intent, there will likely be adjustments or corrections identified which will address the condition.

- You CAREFULLY followed the steps indicated through reviewing the Diagnostic Starting Point – Vibration Diagnosis and completing the Vibration Analysis tables identified and you have duplicated the vibration concern.
- You have come to the conclusion through comparison with a very equally-equipped, same model year and type, KNOWN GOOD vehicle that the customer's concern is a condition that appears to be a potential operating characteristic of the vehicle.

Symptoms - Vibration Diagnosis and Correction

Important: Perform the following steps in sequence BEFORE using these symptom tables.

1. Begin the diagnosis of a vibration concern by reviewing *Diagnostic Starting Point - Vibration Diagnosis and Correction on page 0-26* to become familiar with the diagnostic process used to properly diagnose vibration concerns.
2. Perform the *Vibration Analysis - Road Testing on page 0-27* table before using these symptom tables in order to duplicate and effectively diagnose the customer's concern.

Symptom Tables

Refer to a Vibration Analysis table as indicated in the following symptom tables, based on the most dominant characteristic(s) of the customer's vibration concern (felt or heard) that is evident during the appropriate condition of the occurrence.

Vibration Symptoms that are Felt

Category	Description	Typical Frequency Range	Condition of Occurrence	Area of Focus
Shake	Can sometimes be seen or felt in the steering wheel, seat or console. Related terminology—shimmy, wobble, waddle, shudder, hop	5–20 Hz	Vehicle Speed Sensitive Still occurs during coast down in NEUTRAL	Go to *Vibration Analysis - Tire and Wheel on page 0-32*
			Vehicle Speed Sensitive Affected by torque/load	Go to *Vibration Analysis - Driveline on page 0-34*
			Vehicle Speed Sensitive Affected by steering input	Go to *Vibration Analysis - Hub and/or Axle Input on page 0-37*
			Engine Speed Sensitive	Go to *Vibration Analysis - Engine on page 0-39*
Roughness	Similar to the feeling of holding a jigsaw.	20–50 Hz	Vehicle Speed Sensitive Still occurs during coast down in NEUTRAL	Go to *Vibration Analysis - Tire and Wheel on page 0-32*
			Vehicle Speed Sensitive Affected by torque/load	Go to *Vibration Analysis - Driveline on page 0-34*
			Vehicle Speed Sensitive Affected by steering input	Go to *Vibration Analysis - Hub and/or Axle Input on page 0-37*
			Engine Speed Sensitive	Go to *Vibration Analysis - Engine on page 0-39*

Vibration Symptoms that are Felt (cont'd)

Category	Description	Typical Frequency Range	Condition of Occurrence	Area of Focus
Buzz	Similar to the feeling of holding an electric razor. May be felt in the hands through the steering wheel, in the feet through the floor, or in the seat of the pants.	50–100 Hz	Vehicle Speed Sensitive Affected by torque/load	Go to *Vibration Analysis - Driveline on page 0-34*
			Vehicle Speed Sensitive Affected by steering input	Go to *Vibration Analysis - Hub and/or Axle Input on page 0-37*
			Engine Speed Sensitive	Go to *Vibration Analysis - Engine on page 0-39*
Tingling	May produce a "pins and needles" sensation or may put hands or feet "to sleep". Highest vibration frequency range that can still be felt.	Greater than 100 Hz	Vehicle Speed Sensitive Affected by torque/load	Go to *Vibration Analysis - Driveline on page 0-34*
			Vehicle Speed Sensitive Affected by steering input	Go to *Vibration Analysis - Hub and/or Axle Input on page 0-37*
			Engine Speed Sensitive	Go to *Vibration Analysis - Engine on page 0-39*

Vibration Symptoms that are Heard

Category	Description	Typical Frequency Range	Condition of Occurrence	Area of Focus
Boom	Usually heard as an interior noise similar to the noise of a bowling ball rolling down an alley, deep thunder, or a bass drum. • Related terminology—droning, growling, moaning, roaring, rumbling, humming • May not be accompanied by a perceptible vibration (roughness)	20–60 Hz	Vehicle Speed Sensitive Still occurs during coast down in NEUTRAL	Go to *Vibration Analysis - Tire and Wheel on page 0-32*
			Vehicle Speed Sensitive Affected by torque/load	Go to *Vibration Analysis - Driveline on page 0-34*
			Vehicle Speed Sensitive Affected by steering input	Go to *Vibration Analysis - Hub and/or Axle Input on page 0-37*
Moan or Droan	Similar to the sound of a bumblebee or blowing air across the top of a bottle. • Related terminology—humming, buzzing, resonance • May be accompanied by a perceptible vibration (buzz)	60–120 Hz	Vehicle Speed Sensitive Affected by torque/load	Go to *Vibration Analysis - Driveline on page 0-34*
			Vehicle Speed Sensitive Affected by steering input	Go to *Vibration Analysis - Hub and/or Axle Input on page 0-37*
			Engine Speed Sensitive	Go to *Vibration Analysis - Engine on page 0-39*
Howl	Similar to the sound of the wind howling	120–300 Hz	Vehicle Speed Sensitive Affected by torque/load	Go to *Vibration Analysis - Driveline on page 0-34*
			Vehicle Speed Sensitive Affected by steering input	Go to *Vibration Analysis - Hub and/or Axle Input on page 0-37*
			Engine Speed Sensitive	Go to *Vibration Analysis - Engine on page 0-39*

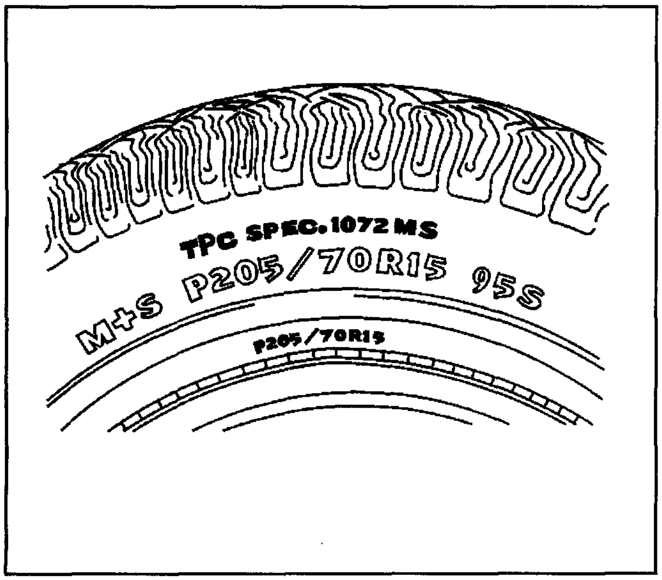
Vehicle-to-Vehicle Diagnostic Comparison

Comparing the customer's vehicle to a KNOWN GOOD vehicle that is essentially identical will help determine if the customer's concern may be characteristic of a vehicle design. To arrive at a valid conclusion, the comparison must be performed under the same conditions, using the same criteria, on a vehicle that has the same option content as the customer's vehicle.

The comparison vehicle must match the customer's vehicle in the following areas:

- Year
- Make
- Model
- Body style
- Powertrain configuration
- Driveline configuration
- Final drive ratio
- Tire/wheel size and type
- Suspension package
- Trailering package
- GVW rating
- Performance options
- Luxury options

Tire and Wheel Inspection



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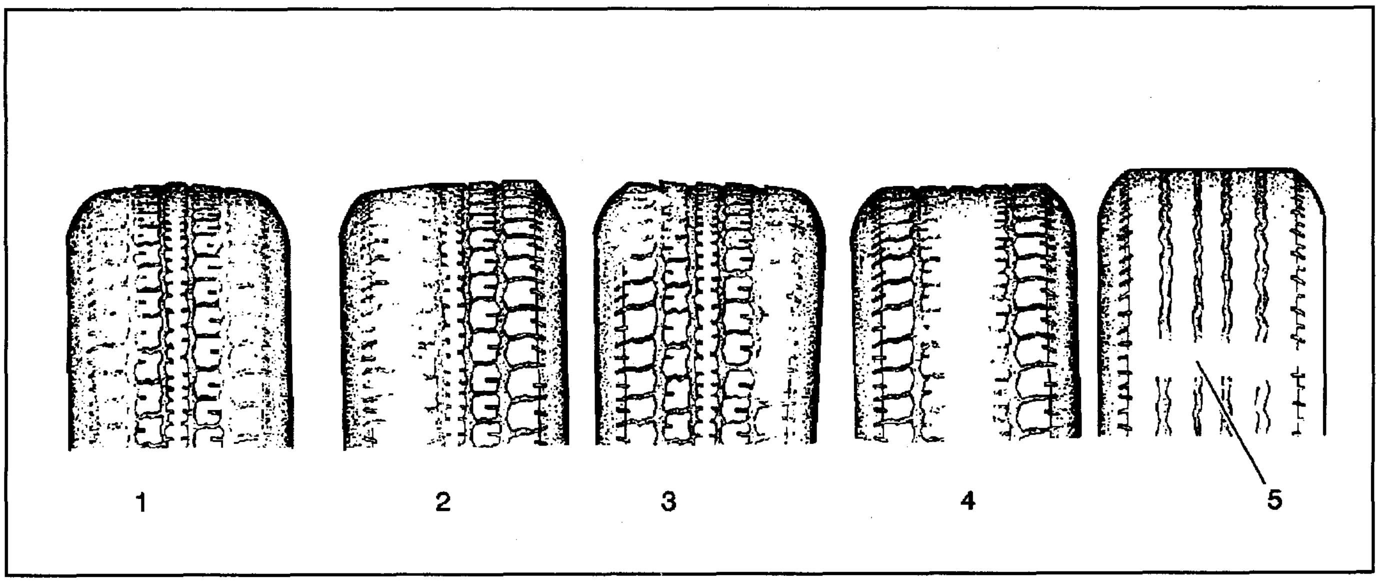
The tires on all new production models have a tire performance criteria (TPC) rating number molded on the sidewall. The TPC rating will appear as a 4-digit number preceded by the letters TPC SPEC on the tire wall near the tire size. A replacement tire should have the same TPC rating.

Tire Wear



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Legend

- (1) Hard Cornering/Underinflation
- (2) Incorrect Alignment/Lack of Rotation
- (3) Incorrect Alignment/Non-uniform Tire
- (4) Heavy Acceleration/Over inflation
- (5) Wear Indicator

Inspect the tire and wheel assemblies for the following conditions:

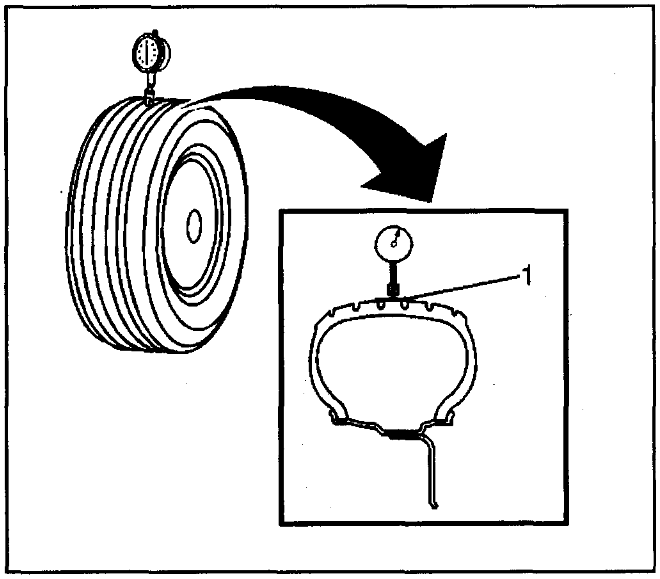
- Unusual wear such as cupping, flat spots, and/or heel-and-toe wear

  These conditions can cause tire growl, tire howl, slapping noises, and/or vibrations throughout the vehicle.
- Proper inflation to specifications for the vehicle
- Bulges in the sidewalls

  Do not confuse bulges, which are an abnormal condition, with normal ply splices which are commonly seen as indentations in the sidewall.
- Bent rim flanges

Tire and Wheel Assembly Runout Measurement - On-Vehicle

1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. Closely inspect each tire for proper and even bead seating.
3. If any of the tire beads were not properly or evenly seated, reseat the tire bead, then proceed to step 4. Refer to *Tire Mounting and Dismounting on page 3-74* in Tires and Wheels.



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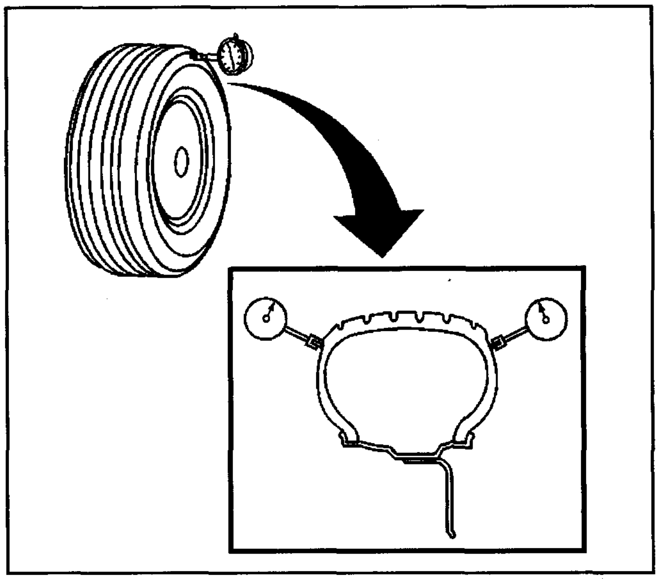
4. Wrap the circumference of each tire with tape (1) in the center tread area.

   Wrapping the tread with tape allows for a smooth and accurate reading of radial runout to be obtained.
5. Position the dial indicator on the taped portion of the tire tread such that the dial indicator is perpendicular to the tire tread surface.
6. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
7. Set the dial indicator to zero at the low spot.
8. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of radial runout.

   Specification

   Maximum tire and wheel assembly radial runout – measured on-vehicle: 1.52 mm (0.060 in)



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9. Position the dial indicator on a smooth portion of the tire sidewall, as close to the tread as possible, such that the dial indicator is perpendicular to the tire sidewall surface.
10. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot. Ignore any jumps or dips due to sidewall splices.
11. Set the dial indicator to zero at the low spot.
12. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of lateral runout. Ignore any jumps or dips due to sidewall splices and attain an average runout measurement.

    Specification

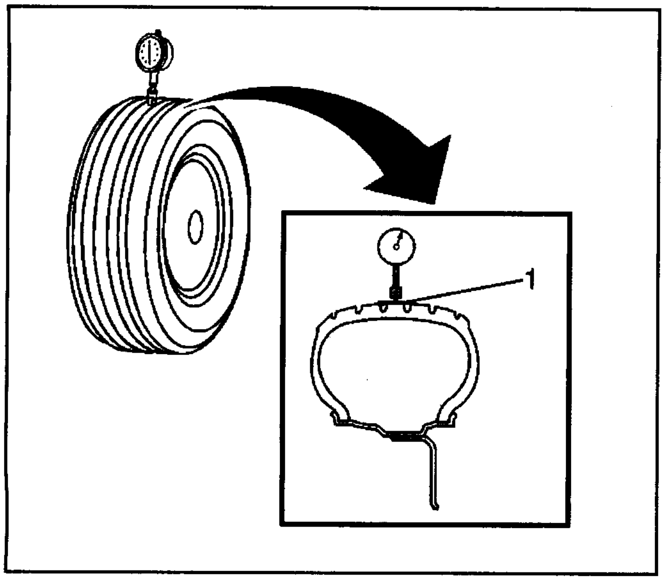
    Maximum tire and wheel assembly lateral runout – measured on-vehicle: 1.52 mm (0.060 in)
13. Repeat steps 4 through 12 until all of the tire and wheel assembly radial and lateral runout measurements have been taken.
14. Lower the vehicle.

Tire and Wheel Assembly Runout Measurement - Off-Vehicle

1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. Mark the location of the wheels to the wheel studs and mark the specific vehicle position on each tire and wheel – LF, LR, RF, RR.
3. Remove the tire and wheel assemblies from the vehicle. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
4. Closely inspect each tire for proper and even bead seating.

5. If any of the tire beads were not properly or evenly seated, reseat the tire bead, then proceed to step 6. Refer to *Tire Mounting and Dismounting on page 3-74* in Tires and Wheels.
6. Mount a tire and wheel assembly on a spin-type wheel balancer.

   Locate the tire and wheel assembly on the balancer with a cone through the back side of the center pilot hole.



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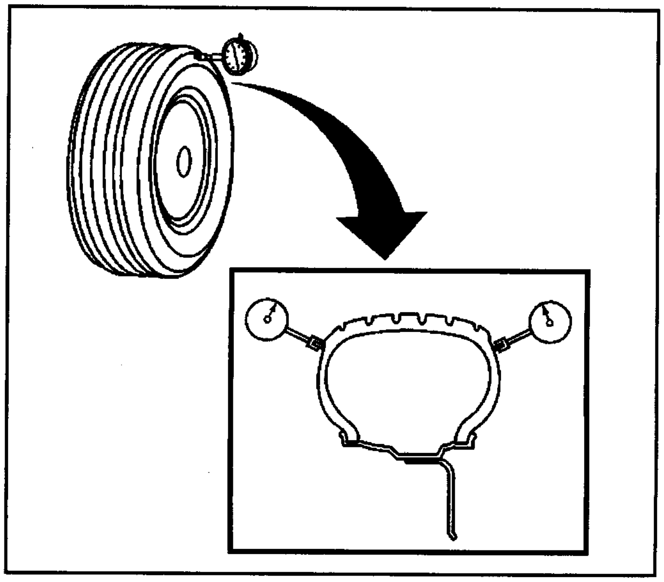
7. Wrap the outer circumference of each tire with tape (1) in the center tread area.

   Wrapping the tread with tape allows for a smooth and accurate reading of radial runout to be obtained.
8. Position the dial indicator on the taped portion of the tire tread such that the dial indicator is perpendicular to the tire tread surface.
9. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
10. Set the dial indicator to zero at the low spot.
11. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of radial runout.

    Specification

    Maximum tire and wheel assembly radial runout – measured off-vehicle: 1.27 mm (0.050 in)



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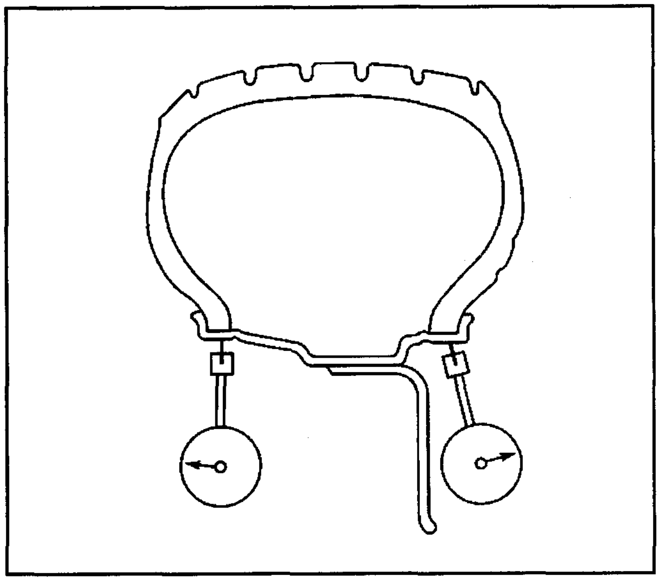
12. Position the dial indicator on a smooth portion of the tire sidewall, as close to the tread as possible, such that the dial indicator is perpendicular to the tire sidewall surface.
13. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot. Ignore any jumps or dips due to sidewall splices.
14. Set the dial indicator to zero at the low spot.
15. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of lateral runout. Ignore any jumps or dips due to sidewall splices and attain an average runout measurement.

    Specification

    Maximum tire and wheel assembly lateral runout – measured off-vehicle: 1.27 mm (0.050 in)
16. Repeat steps 6 through 15 until all of the tire and wheel assembly radial and lateral runout measurements have been taken.
17. If ANY of the tire and wheel assembly runout measurements were NOT within specifications, proceed to step 19.
18. If ALL of the tire and wheel assembly runout measurements WERE within specifications, then the off-vehicle tire and wheel assembly runout is considered acceptable.



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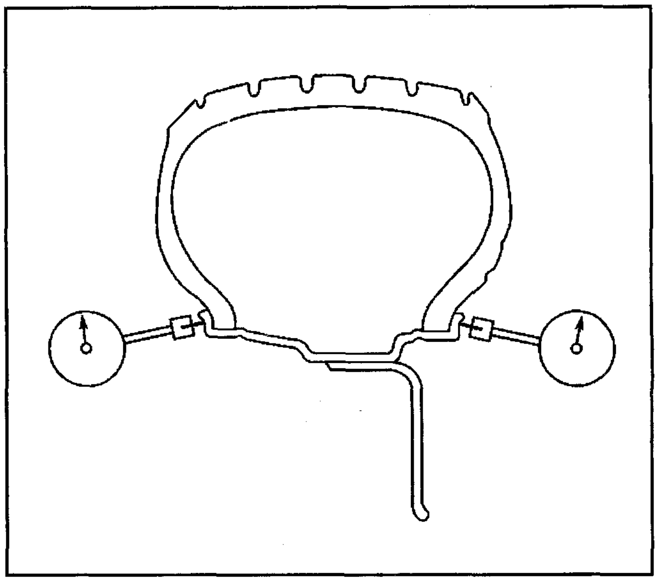
19. Position the dial indicator on the horizontal outer surface of the wheel rim flange – with the tire still mounted – such that the dial indicator is perpendicular to the rim flange surface.

    Wheel runout should be measured on both the inboard and outboard rim flanges, unless wheel design will not permit. Ignore any jumps or dips due to paint drips, chips, or welds.
20. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
21. Set the dial indicator to zero at the low spot.
22. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of wheel radial runout.

    Specification

    - Maximum aluminum wheel radial runout – measured off-vehicle, tire mounted: 0.762 mm (0.030 in)
    - Maximum steel wheel radial runout – measured off-vehicle, tire mounted: 1.015 mm (0.040 in)



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23. Position the dial indicator on the vertical outer surface of the wheel rim flange – with the tire still mounted – such that the dial indicator is perpendicular to the rim flange surface.

    Wheel runout should be measured on both the inboard and outboard rim flanges, unless wheel design will not permit. Ignore any jumps or dips due to paint drips, chips, or welds.
24. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
25. Set the dial indicator to zero at the low spot.
26. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of wheel lateral runout.

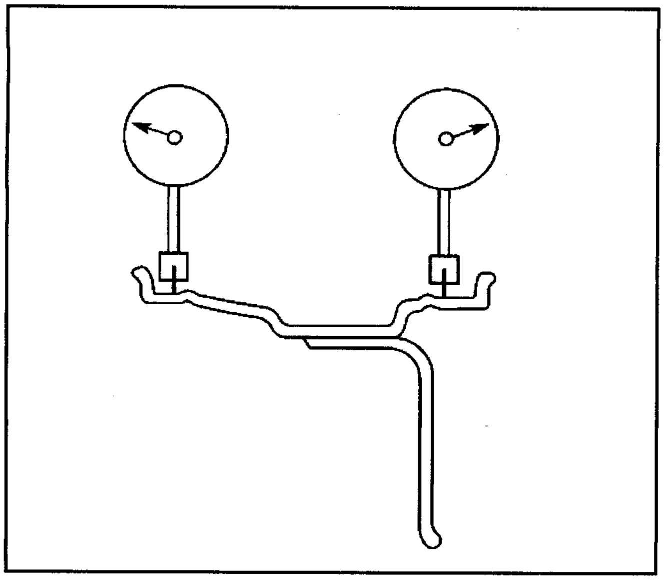
    Specification

    - Maximum aluminum wheel lateral runout – measured off-vehicle, tire mounted: 0.762 mm (0.030 in)
    - Maximum steel wheel lateral runout – measured off-vehicle, tire mounted: 1.143 mm (0.045 in)
27. Repeat steps 19 through 26 until all of the wheel radial and lateral runout measurements have been taken on each of the – tire and wheel – assemblies with assembly runout measurements which were NOT within specifications.
28. If any of the wheel runout measurements were NOT within specifications, proceed to Measuring Wheel Runout – Tire Dismounted.
29. For any of the wheel runout measurements which WERE within specifications, while the – tire and wheel – assembly runout measurements were NOT within specifications, replace the tire, then balance the assembly. Refer to *Tire and Wheel Assembly Balancing - Off-Vehicle on page 0-69*.
30. After replacement of any tires, always remeasure the runout of the affected tire and wheel assembly, or assemblies.

31. Using the matchmarks made prior to removal, install the tire and wheel assemblies to the vehicle. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
32. Lower the vehicle.

Wheel Runout Measurement – Tire Dismounted

1. On the tire and wheel assembly, or assemblies with wheel runout measurements – tire mounted – which were NOT within specifications, mark each tire and wheel in relation to each other.
2. Dismount the tire from the wheel. Refer to *Tire Mounting and Dismounting on page 3-74* in Tires and Wheels.
3. Mount the wheel on a spin-type wheel balancer.
4. Locate the wheel on the balancer with a cone through the back side of the center pilot hole.



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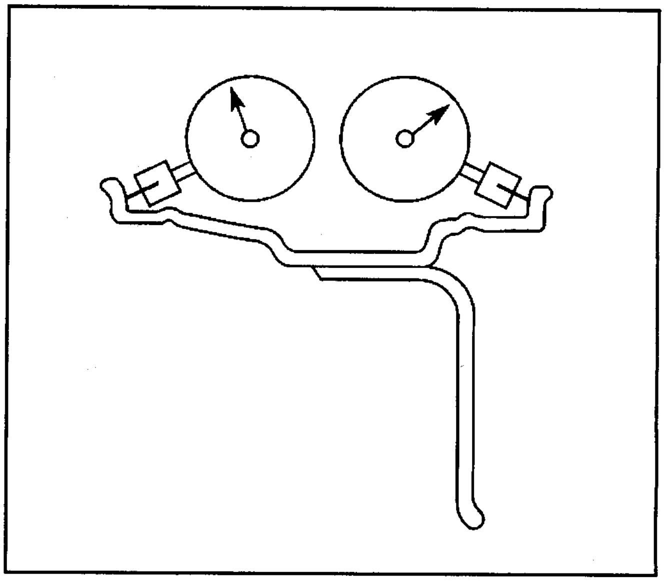
5. Position the dial indicator on the horizontal inner surface of the wheel rim flange – with the tire dismounted – such that the dial indicator is perpendicular to the rim flange surface.

   Wheel runout should be measured on both the inboard and outboard rim flanges. Ignore any jumps or dips due to paint drips, chips, or welds.
6. Slowly rotate the wheel one complete revolution in order to find the low spot.
7. Set the dial indicator to zero at the low spot.
8. Slowly rotate the wheel one more complete revolution and measure the total amount of wheel radial runout.

   Specification
   - Maximum aluminum wheel radial runout – measured off-vehicle, tire dismounted: 0.762 mm (0.030 in)
   - Maximum steel wheel radial runout – measured off-vehicle, tire dismounted: 1.015 mm (0.040 in)



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9. Position the dial indicator on the vertical inner surface of the wheel rim flange – with the tire dismounted – such that the dial indicator is perpendicular to the rim flange surface.

   Wheel runout should be measured on both the inboard and outboard rim flanges. Ignore any jumps or dips due to paint drips, chips, or welds.
10. Slowly rotate the wheel one complete revolution in order to find the low spot.
11. Set the dial indicator to zero at the low spot.
12. Slowly rotate the wheel one more complete revolution and measure the total amount of wheel lateral runout.

    Specification
    - Maximum aluminum wheel lateral runout – measured off-vehicle, tire dismounted: 0.762 mm (0.030 in)
    - Maximum steel wheel lateral runout – measured off-vehicle, tire dismounted: 1.143 mm (0.045 in)
13. Repeat steps 2 through 12 until all of the wheel radial and lateral runout measurements – tire dismounted – have been taken on each wheel with runout measurements – tire mounted – which were NOT within specifications.
14. If any of the wheel runout measurements – tire dismounted – were NOT within specifications, replace the wheel.

    Always measure the runout of any replacement wheels.
15. For any of the wheel runout measurements which WERE within specifications, while the – tire and wheel – assembly runout measurements were NOT within specifications, replace the tire, then balance the assembly. Refer to *Tire and Wheel Assembly Balancing - Off-Vehicle on page 0-69.*

16. Using the matchmarks made prior to dismounting the tire, or tires, mount the tire, or tires to the wheel, or wheels, then balance the assembly, or assemblies. Refer to *Tire and Wheel Assembly Balancing - Off-Vehicle on page 0-69.*

    Always measure the runout of any of the tire and wheel assemblies which have had the tires dismounted and mounted.
17. Using the matchmarks made prior to removal, install the tire and wheel assemblies to the vehicle. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
18. Lower the vehicle.

Brake Rotor/Drum Balance Inspection

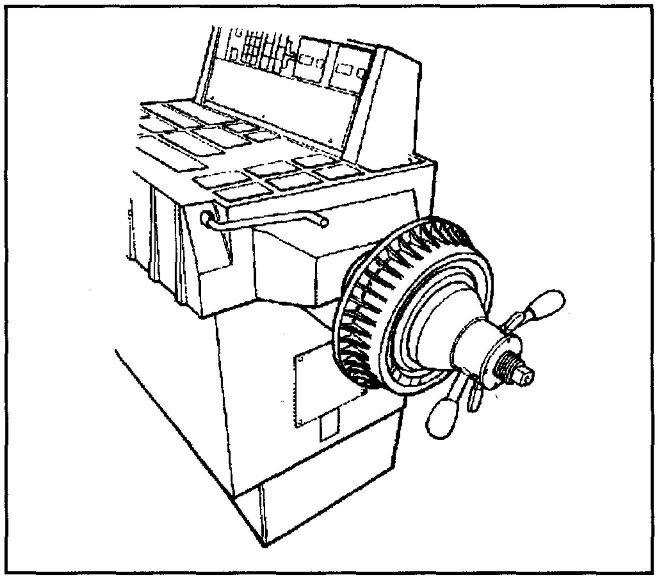
1. Support the vehicle drive axle(s) on a suitable hoist. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. Remove the tire and wheel assemblies from the drive axle(s). Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.

Caution: Refer to Work Stall Test Caution on page P-7 in Cautions and Notices.

3. Reinstall the wheel nuts in order to retain the brake rotors.
4. Run the vehicle at the concern speed while inspecting for the presence of the vibration.

Notice: Do not depress the brake pedal with the brake rotors and/or the brake drums removed, or with the brake calipers repositioned away from the brake rotors, or damage to the brake system may result.

5. If the vibration is still present, remove the brake rotors from the drive axle(s), then run the vehicle back to the concern speed. Refer to *Brake Rotor Replacement - Front on page 5-104* and *Brake Rotor Replacement - Rear on page 5-108* in Disc Brakes.
6. If the vibration is eliminated when the brake rotors are removed from the drive axle(s), repeat the test with one rotor installed at a time. Replace the rotor that is causing or contributing to the vibration concern. Refer to *Brake Rotor Replacement - Front on page 5-104* and *Brake Rotor Replacement - Rear on page 5-108* in Disc Brakes.



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7. If a brake rotor was replaced as a result of following the previous steps, or if necessary to confirm the results obtained during the previous steps, and/or to check the non-drive axle components, perform the following:
    7.1. Mount the brake rotor on a balancer in the same manner as a tire and wheel assembly.

Important: Check brake rotors for static imbalance only; ignore the dynamic imbalance readings.

7.2. Inspect the rotor for static imbalance.

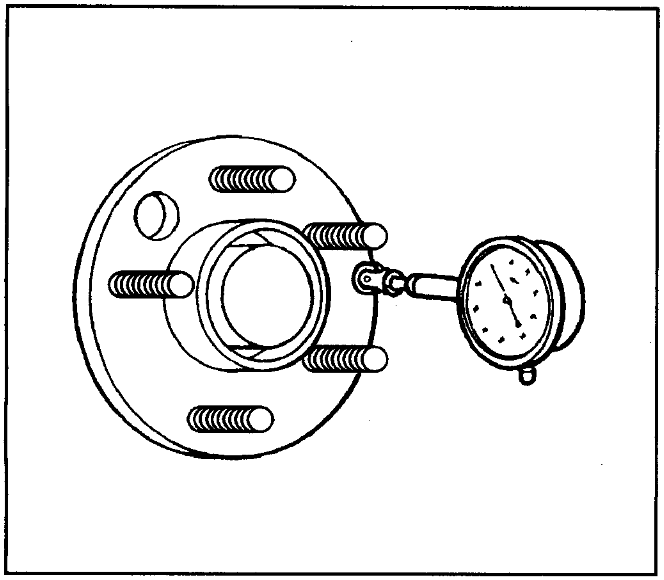
There is not a set tolerance for brake rotor static imbalance. (However, any brake rotor measured in this same manner which is over 21 g [3/4 oz] may have the potential to cause or contribute to a vibration.) Rotors suspected of causing or contributing to a vibration should be replaced. Any rotor that is replaced should be checked for imbalance in the same manner.

Hub/Axle Flange and Wheel Stud Runout Inspection

Tools Required

J 8001 Dial Indicator Set, or equivalent

1. Raise and suitably support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. Mark the location of the wheels to the wheel studs and mark the specific vehicle position on each tire and wheel (LF, LR, RF, RR).
3. Remove the tire and wheel assemblies from the vehicle. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
4. Remove the brake rotors from the vehicle, except for full floating type rear drive axles. Refer to *Brake Rotor Replacement - Front on page 5-104* and *Brake Rotor Replacement - Rear on page 5-108* in Disc Brakes.
5. Remove any loose debris or corrosion from the hub/axle flange surface.



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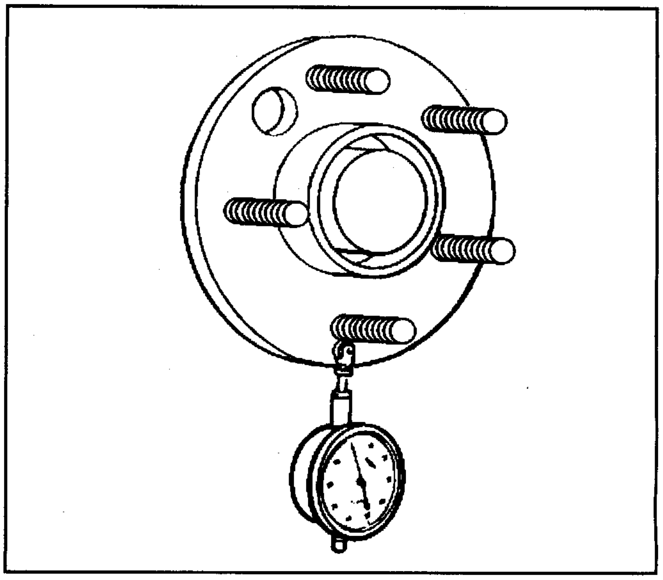
6. Position the *J 8001*, or equivalent, on the machined surface of the wheel hub/axle flange (or brake rotor on full-floating axles) outside of the wheel studs.
7. Rotate the hub one complete revolution in order to find the low spot.
8. Set the *J 8001*, or equivalent, to zero at the low spot.
9. Rotate the hub one more complete revolution and measure the total amount of wheel hub/axle flange runout.

   Specification (Guideline)

   Wheel hub/axle flange runout tolerance guideline: 0.132 mm (0.005 in)
10. If the runout of the wheel hub/axle flange IS within specification, proceed to step 13.
11. If the runout of the wheel hub/axle flange is marginal, the wheel hub may or may not be the source of the disturbance.
12. If the runout of the wheel hub/axle flange is excessive, replace the wheel hub/axle flange. Measure the runout of the new wheel hub/axle flange. Refer to the appropriate procedure:
    - *Wheel Hub, Bearing, and Seal Replacement on page 3-39* in Front Suspension
    - *Rear Axle Shaft Replacement on page 4-29* in Rear Drive Axle



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13. Position the *J 8001*, or equivalent, in order to contact the wheel mounting studs.

    Measure the stud runout as close to the flange as possible.
14. Turn the hub one complete revolution to register on each of the wheel studs.
15. Zero the *J 8001*, or equivalent, on the lowest stud.
16. Rotate the hub one more complete revolution and measure the total amount of wheel stud (stud circle) runout.

    Specification (Guideline)

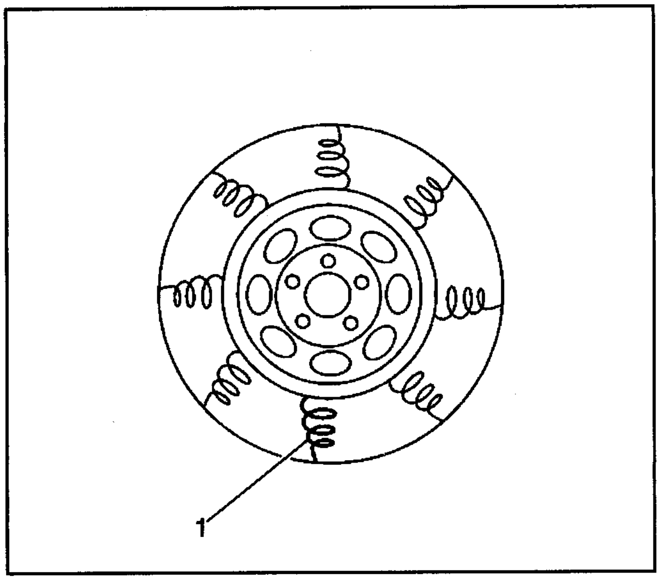
    Wheel stud runout tolerance guideline: 0.254 mm (0.010 in)
17. If the runout of the wheel studs (stud circle) is marginal, the wheel studs may or may not be contributing to the disturbance.
18. If the runout of the wheel studs (stud circle) is excessive, replace the wheel studs as necessary. Measure the runout of the new wheel studs. Refer to the appropriate procedure:
    - *Wheel Stud Replacement on page 3-39* in Front Suspension
    - *Wheel Stud Replacement on page 3-65* in Rear Suspension

Tire and Wheel Assembly Isolation Test

Force Variation

Force variation refers to a radial or lateral movement of the tire and wheel assembly which acts much like runout, however, force variation has to do with variations in the construction of the tire. These variations in tire construction may actually cause vibration in a vehicle, even though the tire and wheel assembly runout and balance may be within specifications.

Radial Force Variation



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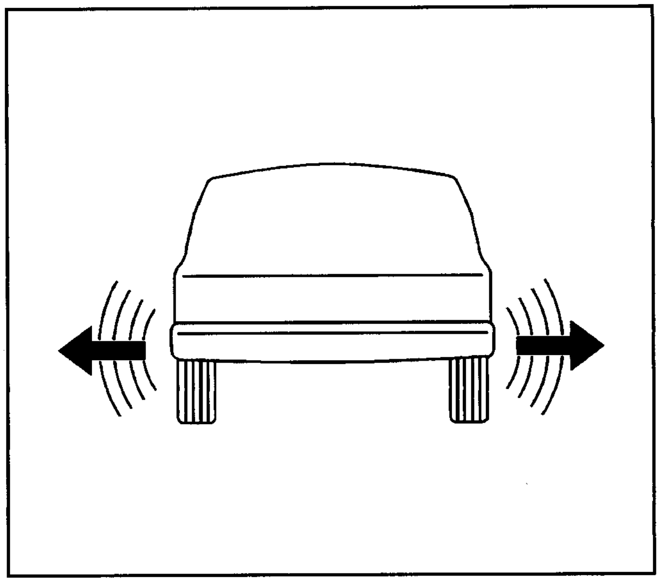
Radial force variation refers to the difference in the stiffness of a tire sidewall as the tire rotates and contacts the road. Tire sidewalls have some stiffness due to splices in the different plies of the tire, but these stiffness differences do not cause a problem unless the force variation is excessive. Stiff spots (1) in a tire sidewall can deflect a tire and wheel assembly upward as the assembly contacts the road.

Lateral Force Runout



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Lateral force variation refers to the difference in the stiffness or conformity of the belts within a tire as the tire rotates and contacts the road. Tire belts may have some stiffness or conformity differences, but these differences do not cause a problem unless the force variation is excessive. These variations in the belts of the tire can deflect the vehicle sideways or laterally. A shifted belt inside a tire may cause lateral force variation.

In most cases where excessive lateral force variation exists, the vehicle will display a wobble or waddle at low speeds – 8–40 km/h (5–25 mph) – on a smooth road surface.

Isolation Test Procedure

Perform the following test in order to determine if force variation is present in the vehicle.

1. Substitute a set of KNOWN GOOD – pre-tested – tire and wheel assemblies of the same size and type for the suspected original assemblies. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
2. Road test the vehicle to determine if the vibration is still present. Refer to *Vibration Analysis - Road Testing on page 0-27.*
3. If the vibration is still present while using the known good set of tire and wheel assemblies, then force variation is not the cause of the vibration.
4. If the vibration is eliminated when using the known good set of tire and wheel assemblies, install one of the original tire and wheel assemblies using the matchmarks made prior to removal. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels. Road test the vehicle to determine if the vibration has returned. Refer to *Vibration Analysis - Road Testing on page 0-27.*

5. Continue the process of installing the original tire and wheel assemblies one at a time, then road testing the vehicle, until the tire and wheel assembly, or assemblies which is causing the vibration has been identified.
6. Replace the tire, or tires on the vibration-causing tire and wheel assembly, or assemblies, then balance the assembly, or assemblies. Refer to *Tire and Wheel Assembly Balancing - Off-Vehicle on page 0-69.*

Vibration in Service-Stall Test (Non-Torque Sensitive)

Notice: Do not fill the propeller shaft with foam, oil, or any other substance in order to correct a vibration. Filling the propeller shaft is only effective in reducing an unrelated condition called Torsional Rattle.
Filling the propeller shaft should only be done in strict adherence to the procedure outlined in corporate bulletins that address Torsional Rattle. Failure to follow the correct procedure will induce a vibration and/or affect the structural integrity of the propeller shaft. The propeller shaft will then have to be replaced.

1. Support the vehicle on a hoist or jackstands. Support the axle(s) at curb height. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. Turn the ignition ON.
3. Place the transmission in NEUTRAL.
4. Remove the rear tire/wheel assemblies. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
5. Remove the brake rotors. Refer to *Brake Rotor Replacement - Front on page 5-104* or *Brake Rotor Replacement - Rear on page 5-108* in Disc Brakes.
6. Inspect the propeller shaft. The propeller shaft should be free of undercoating before continuing.

Notice: Do not depress the brake pedal with the brake rotors and/or the brake drums removed, or with the brake calipers repositioned away from the brake rotors, or damage to the brake system may result.

7. Start the engine.
8. Place the transmission in the highest forward gear.
9. Have an assistant accelerate and decelerate the vehicle through the speed range at which the vibration was first noted during the Vibration Analysis-Road Testing procedure.
10. Record whether the vibration was present, and at what speed.
11. If the vibration is present, determine which end of the driveshaft is vibrating the most. Hold an *J 38792-A* vibration sensor up to the pinion nose and the transmission tailshaft housing.
12. If the vehicle is equipped with a multiple-piece propeller shaft, hold an *J 38792-A* vibration sensor up to the center support bearing(s) to inspect for vibration.
13. If the transmission tailshaft housing is vibrating, hold the *J 38792-A* vibration sensor up to the transmission crossmember under the transmission mount. If there is no vibration on the crossmember, then the transmission mount is working properly.
14. Record which end of the driveshaft is vibrating the most, and how severe the vibration is. The inspection will be a reference by which to judge future progress.

Vibration in Service-Stall Test (Torque Sensitive)

Notice: Do not fill the propeller shaft with foam, oil, or any other substance in order to correct a vibration. Filling the propeller shaft is only effective in reducing an unrelated condition called Torsional Rattle.
Filling the propeller shaft should only be done in strict adherence to the procedure outlined in corporate bulletins that address Torsional Rattle. Failure to follow the correct procedure will induce a vibration and/or affect the structural integrity of the propeller shaft. The propeller shaft will then have to be replaced.

1. Support the vehicle on a hoist or jackstands. Support the axle(s) at curb height. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. Turn the ignition ON.
3. Place the transmission in NEUTRAL.
4. Remove the rear tire/wheel assemblies. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
5. Remove the brake rotors. Refer to *Brake Rotor Replacement - Front on page 5-104* or *Brake Rotor Replacement - Rear on page 5-108* in Disc Brakes.
6. Hold the *J 38792-A* sensor against the pinion nose.

Notice: Do not depress the brake pedal with the brake rotors and/or the brake drums removed, or with the brake calipers repositioned away from the brake rotors, or damage to the brake system may result.

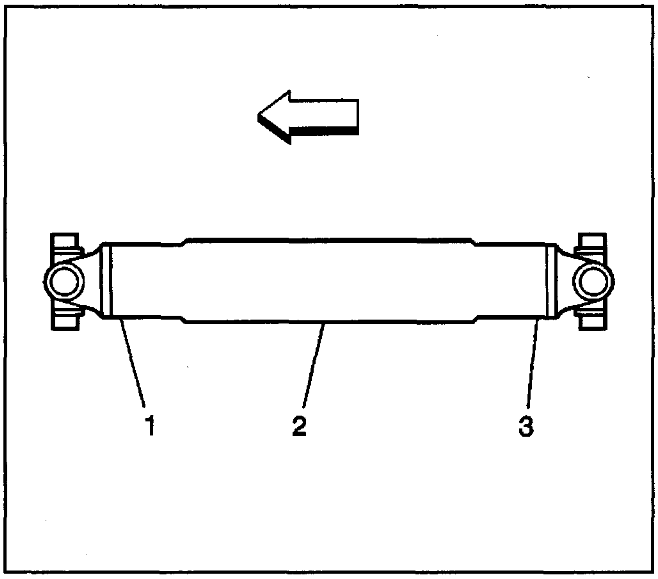
7. Start the vehicle.
8. Place the transmission in the highest forward gear.
9. Have an assistant accelerate and decelerate the vehicle through the speed range at which the vibration was first noted during the Vibration Analysis — Road Testing procedure.
10. If a vibration is present, note the *J 38792-A* reading during acceleration or deceleration.
11. Note as to whether or not the pinion nose vibrates under load during the acceleration or deceleration.
12. If the vibration is not reproduced, reinstall the brake rotors and the wheel/tire assemblies to put an additional load on the system. Check the components again while an assistant maintains the vehicle at the vibration concern speed.

13. If the vibration is still not reproduced, lightly apply the brakes to further load the system while maintaining the vibration concern speed.
14. If the pinion nose vibrates under acceleration or deceleration, and other driveline components have been eliminated as a cause, the vibration may be an internal axle problem.

Propeller Shaft Runout Measurement (One-Piece)

Tools Required

- *J 7872* Magnetic Base Dial Indicator Set, or equivalent
- *J 8001* Dial Indicator Set, or equivalent



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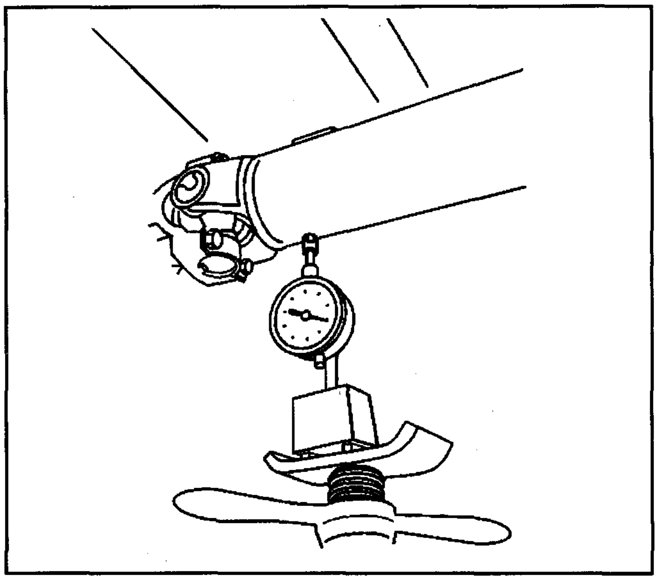
1. Raise and suitably support the vehicle. Ensure that the drive axle is supported at ride height (vehicle body supported by suspension components) with the wheels free to rotate. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. Place the transmission in NEUTRAL.
3. Clean the circumference of the propeller shaft of any debris and/or undercoating along the front (1), center (2), and rear (3) positions.
4. Inspect the propeller shaft for dents, damage, and/or missing weights. Any propeller shaft that is dented or damaged requires replacement.



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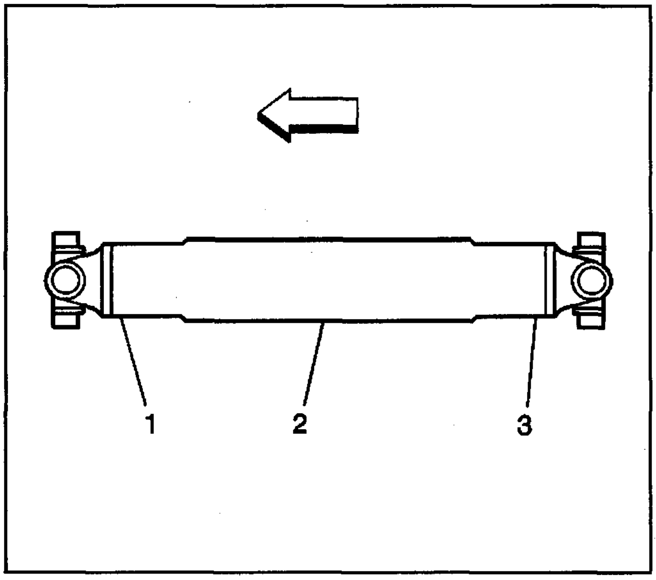
5. Mount the *J 7872*, or equivalent, or the *J 8001*, or equivalent, to the vehicle underbody, or to a service stand in order to measure the runout of the propeller shaft beginning at the rear-most position.



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6. Rotate the pinion flange or the transmission yoke by hand while taking runout measurements of the propeller shaft. The propeller shaft will rotate more easily in one direction than in the other. If necessary, the tire and wheel assemblies and even the rotors/drums can be removed from the drive axle to provide easier rotation of the propeller shaft.

Important: Do not include fluctuations on the dial indicator due to welds or surface irregularities.

7. Beginning at the rear-most position and working forward, record the runout measurement at the rear (3), the center (2), and the front (1) of the propeller shaft.

8. Compare the propeller shaft runout measurements recorded to the runout tolerance specifications.
9. If any of the propeller shaft runout measurements exceed the runout tolerances, perform the following:
   - 9.1. Mark the position of the propeller shaft to the pinion flange.
   - 9.2. Remove the propeller shaft from the pinion flange.
   - 9.3. Rotate the propeller shaft 180 degrees from it's original position.
   - 9.4. Reinstall the propeller shaft to the pinion flange.
   - 9.5. Remeasure and record the runout of the propeller shaft at the same 3 places measured previously.
   - 9.6. Compare the propeller shaft runout remeasurements recorded to the runout tolerance specifications.
   - 9.7. If any of the propeller shaft runout remeasurements still exceed the runout tolerances, perform the following:
     - 9.7.1. Inspect the pinion flange runout to determine if the pinion flange is affecting the runout of the propeller shaft. Refer to *Pinion Flange Runout Measurement (System Balanced Flange) on page 0-66.*
     - 9.7.2. If the pinion flange runout exceeds the runout tolerances, the pinion flange must be reindexed or replaced to bring the runout within tolerances before proceeding.
     - 9.7.3. If the pinion flange was reindexed or replaced, return the propeller shaft to it's original relationship when reinstalling the shaft to the flange.
     - 9.7.4. If the pinion flange runout is within tolerances, inspect the deflection of transmission output shaft for indications of a worn or damaged bushing which could be affecting the runout of the propeller shaft.

       A leaking transmission output shaft seal may be an indication of an output shaft bushing concern.
     - 9.7.5. If the transmission output shaft bushing is found to be worn or damaged, the bushing must be replaced before proceeding.

Important: Inspect the runout of any replacement propeller shaft.

     - 9.7.6. If the first measurement of pinion flange runout was within tolerances and the transmission output shaft bushing was not found to be worn or damaged, the propeller shaft requires replacement. Check the runout of the replacement propeller shaft.
     - 9.7.7. If either the pinion flange was reindexed or replaced, or if the transmission output shaft bushing was replaced; remeasure and record the runout of the propeller shaft at the same 3 places measured previously.
     - 9.7.8. Compare the propeller shaft runout remeasurements recorded to the runout tolerance specifications.
     - 9.7.9. If any of the propeller shaft runout remeasurements still exceed the runout tolerances, remove and rotate the propeller shaft 180 degrees from it's original position at the reindexed or replaced pinion flange.
     - 9.7.10. Reinstall the propeller shaft to the reindexed or replaced pinion flange then remeasure and record the runout of the propeller shaft at the same 3 places measured previously.
     - 9.7.11. Compare the propeller shaft runout remeasurements recorded to the runout tolerance specifications.

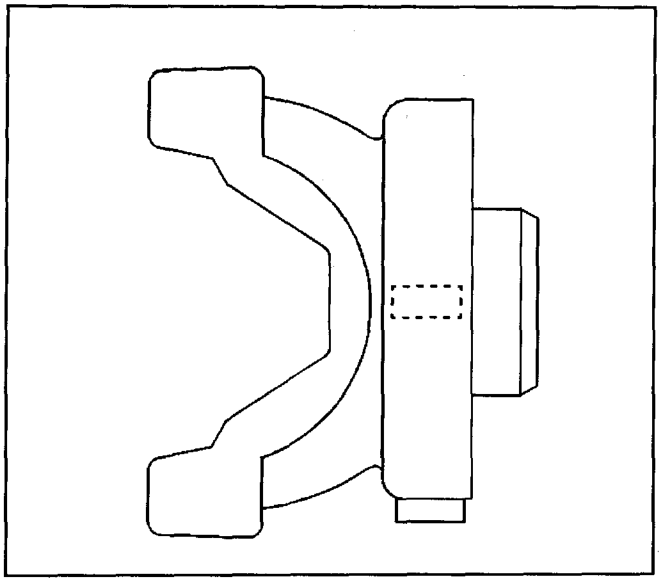
Important: Inspect the runout of any replacement propeller shaft.

     - 9.7.12. If any of the propeller shaft runout remeasurements still exceed the runout tolerances, the propeller shaft requires replacement. Check the runout of the replacement propeller shaft.

Pinion Flange Runout Measurement (System Balanced Flange)

Tools Required

- *J 8001* Dial Indicator Set, or equivalent
- *J 23409* Dial Indicator Extension, or equivalent
- *J 35819* Flange Runout Gage



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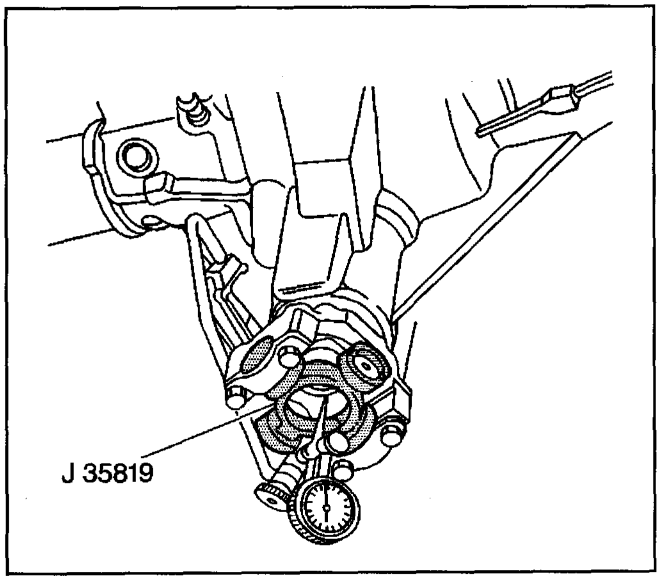
System balanced drive axles utilize a deflector design on the pinion flange, that is able to hold system balance weights on its outside diameter.

1. Raise and support the vehicle, with the wheels free to rotate. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General information.
2. Remove the propeller shaft from the pinion flange.



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3. Install the *J 35819* to the pinion flange.
4. Assemble and install the *J 8001* and the *J 23409* to the drive axle and to the *J 35819*.

Important: The dial indicator will display inverted readings. You are measuring the inside diameter of the flange, not the outside diameter. The highest reading on the dial indicator is the low spot; the lowest reading is the high spot.

5. Rotate the pinion flange 360 degrees and zero the dial indicator on the low spot.
6. Rotate the pinion flange again and record the total runout.

Important: All runout measurement tolerances provided are to be used as guidelines. The measurement tolerances provided and their effect on vibration correction may vary for each vehicle.

7. If the system balanced pinion flange runout measurement is between 0.00–0.38 mm (0.00–0.015 in), the pinion flange is considered within acceptable runout limits.
8. If the system balanced pinion flange runout measurement exceeds 0.00–0.38 mm (0.00–0.015 in), the pinion flange must be reindexed 180 degrees or replaced.

   If the drive axle utilizes a crush-type sleeve to achieve pinion bearing preload, the pinion flange can only be removed and installed 1 time before the crush-type sleeve must be replaced. Sleeve replacement requires removal and installation of the ring and pinion gear set. If there is evidence that the pinion has been removed and installed previously, replace the sleeve.
9. If the pinion flange has been reindexed, remeasure the pinion flange runout.
10. If the runout remeasurement of the reindexed pinion flange still exceeds the tolerance guidelines, the pinion flange requires replacement.

Important: Inspect the runout of any replacement pinion flange.

11. If the pinion flange was replaced, check the runout of the replacement pinion flange.

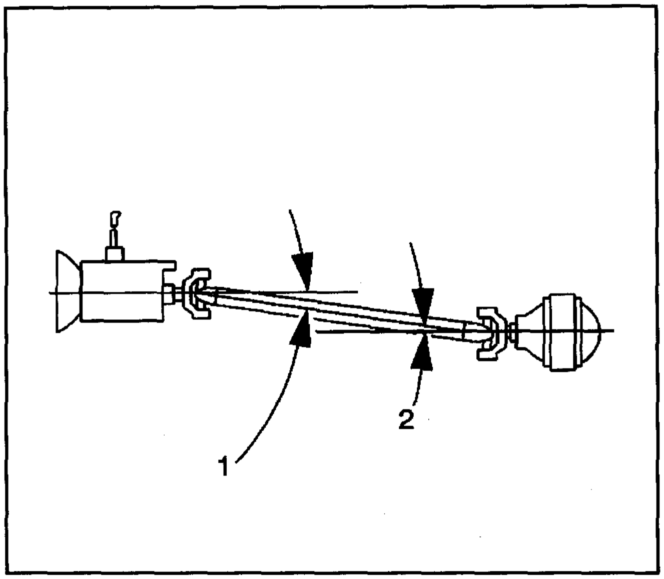
Important: If the pinion flange was reindexed or replaced, the driveline MUST be system balanced.

12. If the pinion flange was reindexed or replaced, system balance the driveline. Refer to *Driveline System Balance Adjustment (Using EVA) on page 0-75.*

Driveline Working Angles Measurement

Tools Required

- *J 23498-A* Driveshaft Inclinometer
- *J 23498-20* Driveshaft Inclinometer Adapter



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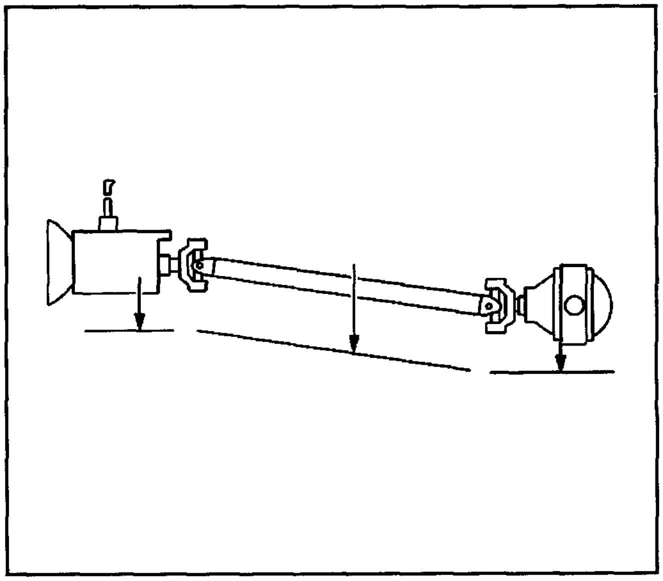
The working angle of a U-joint is formed by the difference between the angles of two shafts that intersect. One-piece propeller shaft systems have two working angles; front (1) and rear (2).

- The front working angle (1) is formed by the intersection of the transmission output shaft and the propeller shaft.
- The rear working angle (2) is formed by the intersection of the propeller shaft and the drive axle pinion.

When measuring and evaluating driveline working angles, observe the following:

- The two working, or cancelling angles should be equal to each other within 1/2 degree to provide effective cancellation of the U-joints.
- No working angle should exceed 4 degrees.
- No working angle should be equal to zero. An angle of 0 degrees will cause premature U-joint wear due to a lack of rotation of the needle bearings in the U-joint.
- Always orientate the *J 23498-A* so that it faces the same side of the vehicle for each measurement taken.



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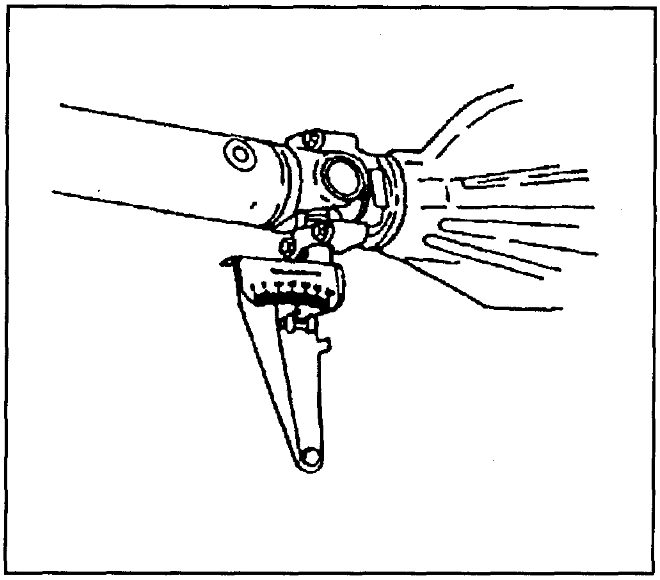
- Be sure to accurately record the measurements taken on a diagram, similar to the one shown.

Measurement Procedure

Important: If it is necessary to use the *J 23498-20* adapter, first verify the accuracy of the *J 23498-20* by inspecting the angle of an accessible joint using the *J 23498-A*, then inspecting the same joint angle using the *J 23498-20*.

1. Raise and support the vehicle. Ensure that the drive axle is supported at ride height – vehicle body supported by suspension components – with the wheels free to rotate. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. Place the transmission in NEUTRAL.
3. Ensure that the vehicle has a full tank of fuel or the equivalent amount of weight in the rear to simulate a full tank. The weight of 3.8 L (1 gal) of gasoline is approximately 2.8 kg (6.2 lb).
4. Clean any corrosion or foreign material from the U-joint bearing caps.
5. Remove any of the U-joint bearing cap snap rings that may interfere with the correct placement of the *J 23498-A*.



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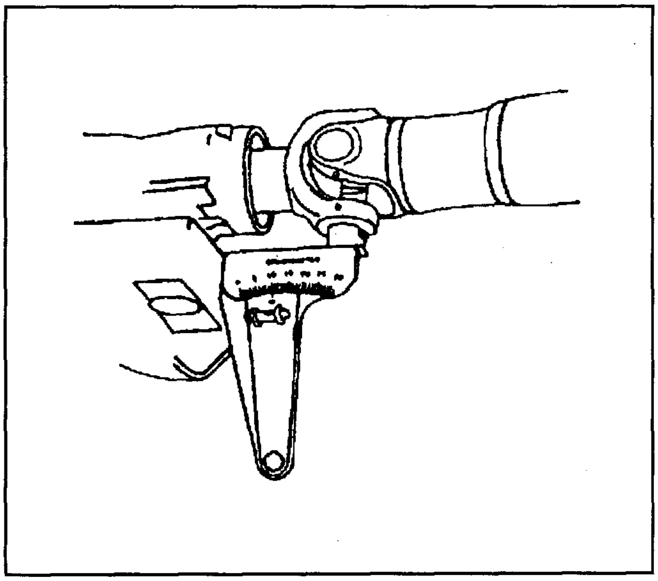
6. Measure the angle of the drive axle pinion.
   6.1. Rotate the drive axle pinion to align the pinion yoke flanges vertically.
   6.2. Install the *J 23498-A* to the lower U-joint bearing cap of the drive axle pinion.
   6.3. Using the *J 23498-A*, measure and record the angle of the drive axle pinion.



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7. Measure the angle of the transmission output shaft yoke.
   7.1. Do not rotate the propeller shaft. With the propeller shaft in the same position, the transmission output shaft yoke flange will be aligned vertically.
   7.2. Install the *J 23498-A* to the lower U-joint bearing cap of the transmission output shaft yoke.
   7.3. Using the *J 23498-A*, measure and record the angle of the transmission output shaft yoke.
8. Rotate the propeller shaft 1/4 turn.
9. Measure the angle of the propeller shaft.
   9.1. Do not rotate the propeller shaft. With the propeller shaft in this position, the U-joints of the propeller shaft will be aligned vertically.
   9.2. Install the *J 23498-A* to the lower U-joint bearing cap of either of the U-joints on the propeller shaft.
   9.3. Using the *J 23498-A*, measure and record the angle of the propeller shaft.
10. Remove the *J 23498-A*.
11. Install any U-joint bearing cap snap rings that were removed prior to installing the *J 23498-A*.
12. Calculate the working angles at each intersection of two shafts.

    Subtract the larger number from the smaller to obtain the working angle. For example: If the drive axle pinion has an angle of 16 degrees and the connecting propeller shaft has an angle of 13 degrees, then the working angle of that intersection is 3 degrees.
13. Compare the working angles of cancelling U-joints, beginning at the rear-most position.
14. If the working angles of two cancelling U-joints are not within 1/2 degree of each other, or if one or both of the angles exceed 4 degrees, then the angle requires adjustment.

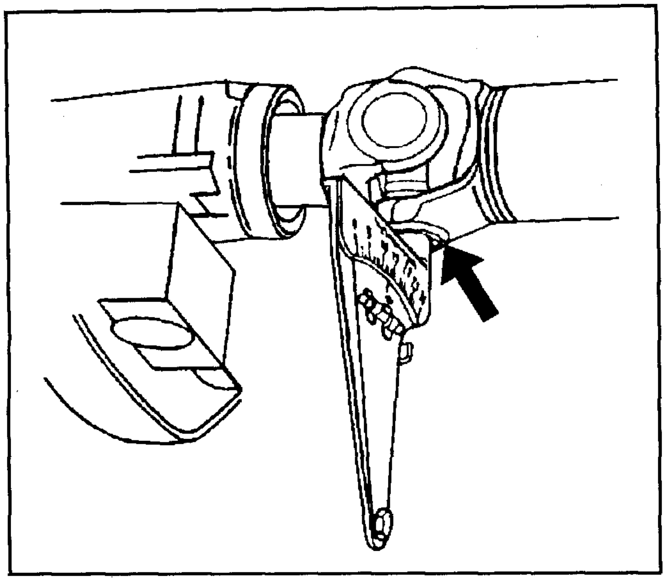
Propeller Shaft Phasing Inspection

Tools Required

J 23498-A Driveshaft Inclinometer

Inspect the propeller shaft for correct phasing. Correct phasing means that the front and the rear U-joint are directly in line or parallel with each other so that proper cancellation takes place.

1. Raise and support the vehicle. Ensure that the drive axle is supported at ride height – vehicle body supported by suspension components – with the wheels free to rotate. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. Place the transmission in NEUTRAL.
3. Clean any corrosion or foreign material from the U-joint bearing caps.
4. Remove any of the U-joint bearing cap snap rings that may interfere with the correct placement of the *J 23498-A*.



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5. Inspect the propeller shaft for proper phasing.
   5.1. Rotate the propeller shaft to align the rear shaft flanges vertically.
   5.2. Install the *J 23498-A* to the lower U-joint bearing cap of the rear U-joint of the propeller shaft. The *J 23498-A* should be aligned perpendicular to the propeller shaft.
   5.3. Set the indicator line on the *J 23498-A* to 15, the horizontal reference.
   5.4. Rotate the propeller shaft slightly to center the bubble to the indicator. The U-joint is now vertical.
   5.5. Without disturbing the setting on the *J 23498-A*, remove the *J 23498-A* from the rear U-joint bearing cap.
   5.6. Install the *J 23498-A* to the lower U-joint bearing cap of the front U-joint of the propeller shaft.
   5.7. Observe the reading of the front U-joint with the *J 23498-A* still set to 15, the horizontal reference.
6. If the difference between the front and rear U-joints of a welded-yoke propeller shaft is 3 degrees or less, the propeller shaft is properly phased.
7. If the difference between the front and rear U-joints of a welded-yoke propeller shaft is greater than 3 degrees, the propeller shaft is either constructed improperly, or damaged from twisting and it requires replacement to restore proper cancellation of the U-joints.

Repair Instructions

Tire and Wheel Assembly Balancing - Off-Vehicle

Caution: Failure to adhere to the following precautions before tire balancing can result in personal injury or damage to components:

- ***Clean away any dirt or deposits from the inside of the wheels.***
- ***Remove any stones from the tread.***
- ***Wear eye protection.***
- ***Use coated weights on aluminum wheels.***

Tire and Wheel Assembly Balancer Calibration

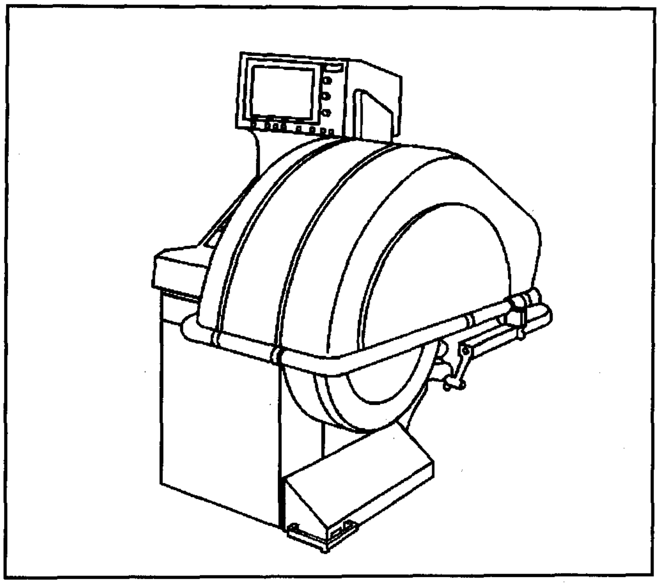
Tire and wheel balancers can drift out of calibration over time, or can become inaccurate as a result of heavy use. There will likely not be any visual evidence that a calibration problem exists. If a balancer is not calibrated within specifications, and a tire and wheel assembly is balanced on that machine, the assembly may actually be imbalanced.

Tire and wheel assembly balancer calibration should be checked approximately every 2 weeks, if the machine is used frequently, and/or whenever the balance readings are questionable.

Tire and Wheel Assembly Balancer Calibration Test

Important: If the balancer fails any of the steps in this calibration test, the balancer should be calibrated according to the manufacturer's instructions. If the balancer cannot be calibrated, contact the manufacturer for assistance.

Check the calibration of the tire and wheel assembly balancer according to the manufacturer's recommendations, or perform the following test.



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1. Spin the balancer without a wheel or any of the adapters on the shaft.
2. Inspect the balancer readings.

   Specification

   Zero within 7 g (¼ oz)
3. If the balancer is within the specification range, balance a tire and wheel assembly – that is within radial and lateral runout tolerances – to ZERO, using the same balancer.
4. After the tire and wheel assembly has been balanced, add an 85 g (3 oz) test weight to the wheel at any location.
5. Spin the tire and wheel assembly again. Note the readings.
   - In the static and dynamic modes, the balancer should call for 85 g (3 oz) of weight, 180 degrees opposite the test weight.
   - In the dynamic mode, the weight should be called for on the flange of the wheel opposite the test weight.
6. With the assembly imbalanced to 85 g (3 oz), cycle the balancer 5 times.
7. Inspect the balancer readings:

   Specification

   Maximum variation: 7 g (¼ oz)
8. Index the tire and wheel assembly on the balancer shaft, 90 degrees from the previous location.
9. Cycle the balancer with the assembly at the new location.
10. Inspect the balancer readings:

    Specification

    Maximum variation: 7 g (¼ oz)
11. Repeat steps 8 through 10 until the tire and wheel assembly has been cycled and checked at each of the 4 locations on the balancer shaft.

Tire and Wheel Assembly Balancing Guidelines

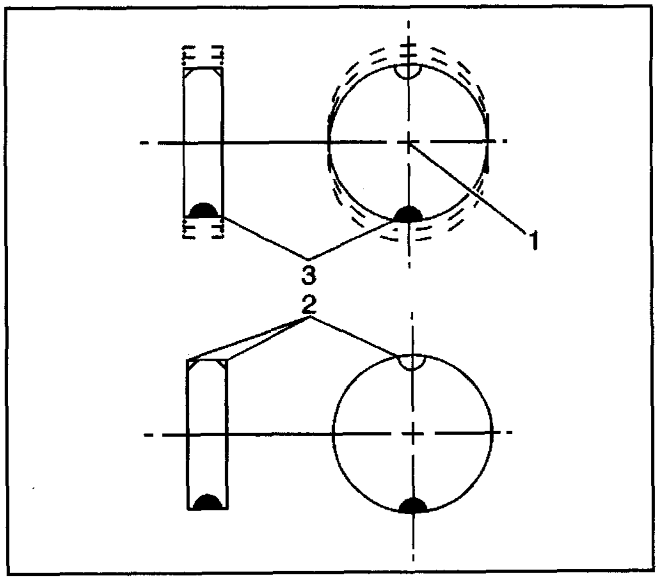
Important: Tire and wheel assemblies which exhibit excessive runout can produce vibrations even if the assemblies are balanced.

It is strongly recommended that the tire and wheel assembly runout be measured and corrected if necessary BEFORE the assemblies are balanced.

If the runout of the tire and wheel assemblies has not yet been measured, refer to *Tire and Wheel Assembly Runout Measurement - Off-Vehicle on page 0-56* before proceeding.

There are 2 types of tire and wheel balance:

Static Balance



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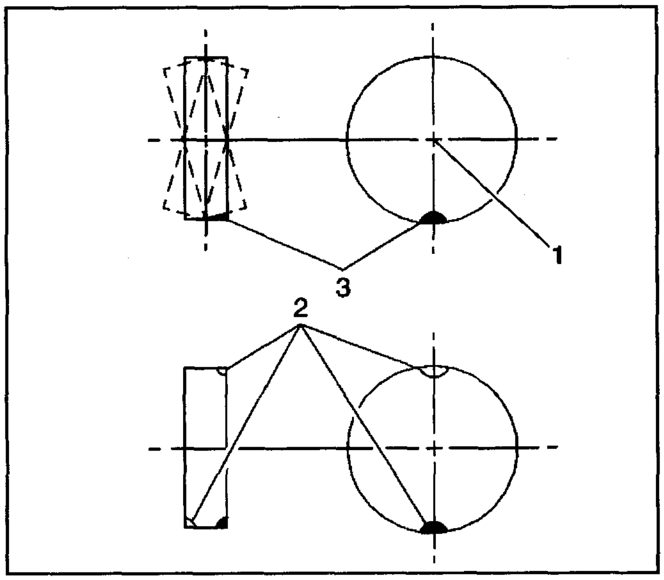
Static balance is the equal distribution of weight around the wheel circumference. The wheel balance weights (2) are positioned on the wheel in order to offset the effects of a heavy spot (3). Wheels that have static imbalance can produce a bouncing action called tramp.

Dynamic Balance



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Dynamic balance is the equal distribution of weight on each side of the tire and wheel assembly centerline. The wheel balance weights (2) are positioned on the wheel in order to offset the effects of a heavy spot (3). Wheels that have dynamic imbalance have a tendency to move from side to side and can cause an action called shimmy.

Most off-vehicle balancers are capable of checking both types of balance simultaneously.

As a general rule, most vehicles are more sensitive to static imbalance than to dynamic imbalance; however, vehicles equipped with low profile, wide tread path, high performance tires and wheels are susceptible to small amounts of dynamic imbalance. As little as 14–21 g (½–¾ oz) imbalance is capable of inducing a vibration in some vehicle models.

Balancing Procedure

Important: When balancing tire and wheel assemblies, use a known good, recently calibrated, off-vehicle, two-plane dynamic balancer set to the finest balance mode available.

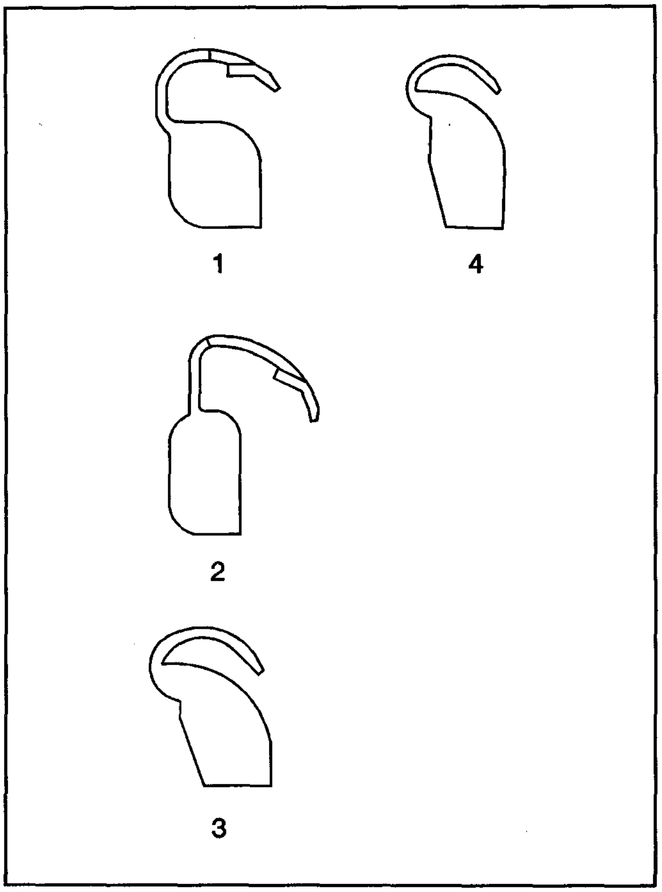
1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. Mark the location of the wheels to the wheel studs and mark the specific vehicle position on each tire and wheel – LF, LR, RF, RR.
3. Remove the tire and wheel assemblies one at a time and mount on a spin-type wheel balancer. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
4. Carefully follow the wheel balancer manufacturer's instructions for proper mounting techniques to be used on different types of wheels.

   Regard aftermarket wheels, especially those incorporating universal lug patterns, as potential sources of runout and mounting concerns.
5. Be sure to use the correct type of wheel balance weights for the type of wheel rim being balanced. Be sure to use the correct type of coated wheel balance weights on aluminum wheels. Refer to Wheel Weight Usage.
6. Balance all four tire and wheel assemblies as close to zero as possible.
7. Using the matchmarks made prior to removal, install the tire and wheel assemblies to the vehicle. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
8. Lower the vehicle.

Wheel Weight Usage

Tire and wheel assemblies can be balanced using either the static or dynamic method.

Clip-on Weights



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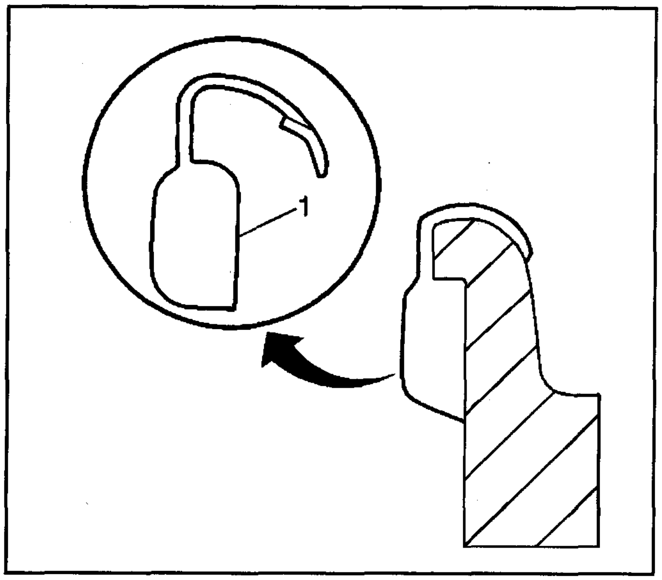
Important: When balancing factory aluminum wheels with clip-on wheel balance weights, be sure to use special polyester-coated weights. These coated weights reduce the potential for corrosion and damage to aluminum wheels.

These coated weights reduce the potential for corrosion and damage to aluminum wheels.

- MC (1) and AW (2) series weights are approved for use on aluminum wheels.
- P (3) series weights are approved for use on steel wheels only.
- T (4) series coated weights are approved for use on both steel and aluminum wheels.



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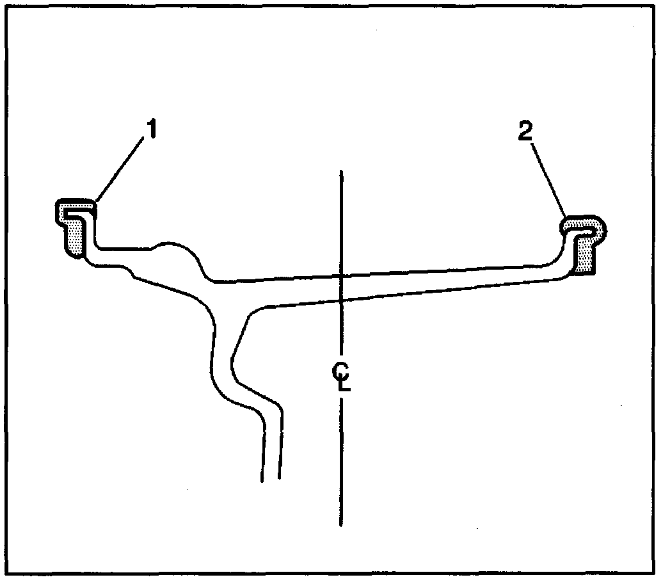
Important: Use a nylon or plastic-tipped hammer when installing coated clip-on wheel balance weights to minimize the possibility of damage to the polyester coating.

The contour and style of the wheel rim flange will determine which type of clip-on wheel weight (1) should be used. The weight should follow the contour of the rim flange. The weight clip should firmly grip the rim flange.

Wheel Weight Placement – Clip-on Weights



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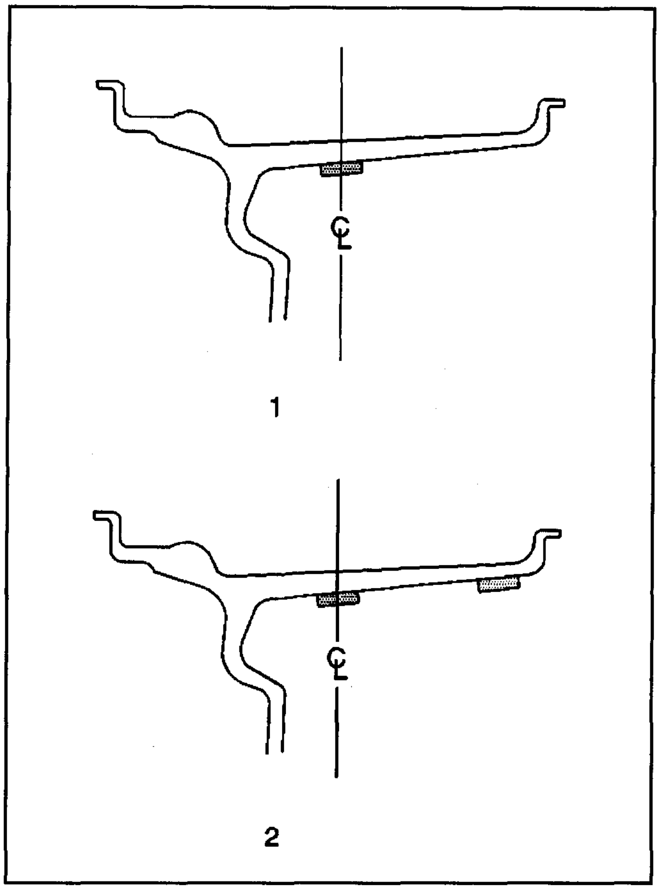
When static balancing, locate the wheel balance weights on the inboard flange (2) if only 28 g (1 oz) or less is called for. If more than 28 g (1 oz) is called for, split the weights as equally as possible between the inboard (2) and outboard (1) flanges.

When dynamic balancing, locate the wheel balance weights on the inboard (2) and outboard (1) rim flanges at the positions specified by the wheel balancer.

Adhesive Weights



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Important: When installing adhesive balance weights on flangeless wheels, do NOT install the weight on the outboard surface of the rim.

Adhesive wheel balance weights may be used on factory aluminum wheels. Perform the following procedure to install adhesive wheel balance weights.

1. Determine the correct areas for placement of the wheel weights on the wheel.
   - When static balancing, locate the wheel balance weights along the wheel centerline (1) on the inner wheel surface if only 28 g (1 oz) or less is called for. If more than 28 g (1 oz) is called for, split the weights as equally as possible between the wheel centerline and the inboard edge of the inner wheel surface (2).
   - When dynamic balancing, locate the wheel balance weights along the wheel centerline and the inboard edge of the inner wheel surface (2) at the positions specified by the wheel balancer.
2. Ensure that there is sufficient clearance between the wheel weights and brake system components.

Important: Do not use abrasives to clean any surface of the wheel.

3. Using a clean cloth or paper towel with a general purpose cleaner, thoroughly clean the designated balance weight attachment areas of any corrosion, overspray, dirt or any other foreign material.
4. To ensure there is no remaining residue, wipe the balance weight attachment areas again, using a clean cloth or paper towel with a mixture of half isopropyl alcohol and half water.
5. Dry the attachment areas with hot air until the wheel surface is warm to the touch.
6. Warm the adhesive backing on the wheel balance weights to room temperature.
7. Remove the protective covering from the adhesive backing on the back of the balance weights. DO NOT touch the adhesive surface.
8. Apply the wheel balance weights to the wheel, press into place with hand pressure.
9. Secure the wheel balance weights to the wheel with a 90 N (21 lb) force applied with a roller.

Tire and Wheel Assembly Balancing - On-Vehicle

Tools Required

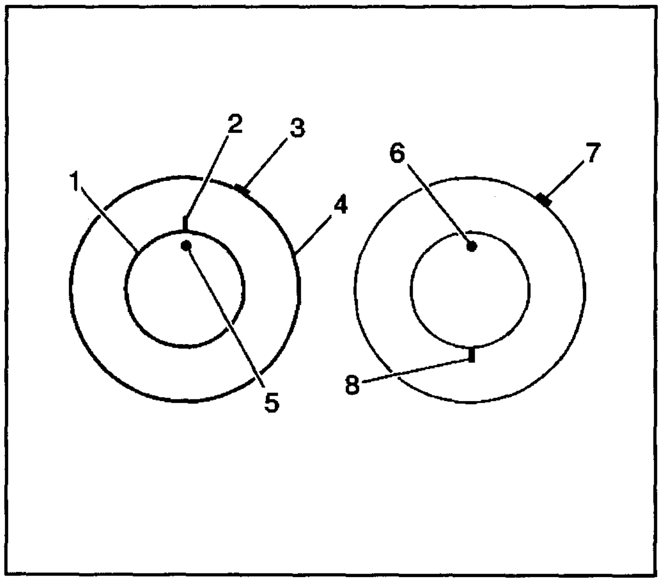
J 38792-A Electronic Vibration Analyzer (EVA) 2

If after following the tire and wheel vibration diagnostic process, some amount of tire and wheel vibration is still evident, an on-vehicle high-speed spin balancer may be used to perform an on-vehicle balance in an attempt to finish balance the tire and wheel assemblies, wheel hubs, brake rotors, brake drums, if equipped, and wheel trim, if equipped, simultaneously. On-vehicle balancing can also compensate for minor amounts of residual runout encountered as a result of mounting the tire and wheel assembly on the vehicle, as opposed to the balance which was achieved on the off-vehicle balancer.

In order to perform an on-vehicle balancing procedure, carefully follow the on-vehicle balancer manufacturer's specific operating instructions and carefully consider the following information before proceeding:

- Vehicles equipped with low profile, wide tread path, high performance tires and wheels are susceptible to small amounts of dynamic imbalance.
- When performing an on-vehicle balance, great care must be taken when placing the wheel balance weights on the wheels. If the wheel balance weights are not placed accurately, they can actually induce dynamic imbalance and thus increase the severity of the vibration.
- Inspect the vehicle wheel bearings to ensure that they are in good condition.
- Thoroughly inspect all on-vehicle balancing equipment and ensure that it is fully within the manufacturer's recommended specifications.
- Do not remove the off-vehicle balance weights. The purpose of on-vehicle balance is to fine tune the assembly balance already achieved off-vehicle, not to start over.
- Leave all wheel trim installed whenever possible.
- If the on-vehicle balancer calls for more than 56 g (2 oz) of additional weight, split the weight between the inboard and outboard flanges of the wheel, so as not to upset the dynamic balance of the assembly achieved in the off-vehicle balance. For wheel balance weight information, refer to *Tire and Wheel Assembly Balancing - Off-Vehicle on page 0-69*.
- If available, tape-off an area on top of the fenders and the quarter panels, then place the vibration sensor of the *J 38792-A* on the fender or quarter panel above the specific tire and wheel assembly while it is being on-vehicle balanced. The *J 38792-A* will provide a visual indication of the amplitude of the vibration, and the effect that the on-vehicle balance has on it.

Tire-to-Wheel Match-Mounting (Vectoring)



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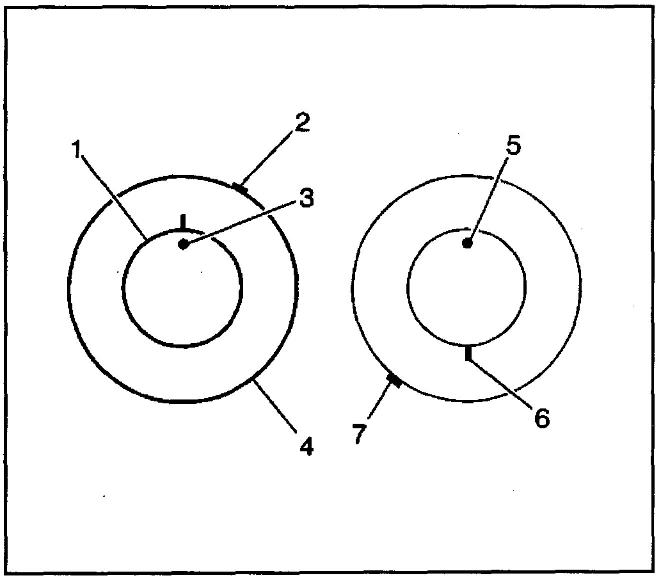
Important: After remounting a tire to a wheel or after replacing a tire and/or a wheel, remeasure the tire and wheel assembly runout in order to verify that the amount of runout has been reduced and brought to within tolerances. Ensure that the tire and wheel assembly is properly balanced before reinstalling to the vehicle.

1. Mark the location of the high spot (3) on the tire as determined during the off-vehicle tire and wheel assembly runout measurement.
2. Place a reference mark (2) on the tire sidewall at the location of the valve stem (5).
   - Always refer to the valve stem as the 12 o'clock position.
   - Refer to the location of the high spot (3) by its clock position on the wheel, relative to the valve stem.

3. Mount the tire and wheel assembly on a tire machine and break down the bead. Do not dismount the tire from the wheel at this time.
4. Rotate the tire 180 degrees on the rim so that the valve stem reference mark (8) is now at the 6 o'clock position in relation to the valve stem (6). You may need to lubricate the bead in order to easily rotate the tire on the wheel.
5. Reinflate the tire and seat the bead properly.
6. Mount the assembly on the tire balancer and remeasure the runout. Mark the new location of the assembly runout high spot on the tire.
7. If the assembly runout has been reduced and is within tolerance, no further steps are necessary. Balance the tire and wheel assembly, then install the assembly to the vehicle. Refer to the following:
   - *Tire and Wheel Assembly Balancing - Off-Vehicle on page 0-69*
   - *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels
8. If the clock location of the high spot remained at or near the original clock location of the high spot (7) and the assembly runout has NOT been reduced, the wheel is the major contributor to the assembly runout concern.



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9. If the clock location of the high spot has moved, however the assembly runout has NOT been reduced, perform the following steps:
   9.1. If the clock location of the high spot (7) is now at or near a position 180 degrees from the original clock location of the high spot, the tire is the major contributor to the assembly runout concern.
   9.2. If the clock location of the high spot is now in-between the 2 extremes, then both the tire and the wheel are both contributing to the assembly runout concern. Rotate the tire an additional 90 degrees in both the clockwise and the counterclockwise directions to obtain the lowest amount of assembly runout.

Tire and Wheel Assembly-to-Hub/Axle Flange Match-Mounting

Important: After remounting a tire and wheel assembly to a hub/axle flange, remeasure the tire and wheel assembly on-vehicle runout in order to verify that the amount of runout has been reduced and brought to within tolerances.

1. Mark the location of the high spot on the tire and wheel assembly as determined during the on-vehicle tire and wheel assembly runout measurement.
2. Place a reference mark on the wheel stud that is located closest to the wheel valve stem.
   - Always refer to the reference mark on the wheel stud as the 12 o'clock position.
   - Refer to the location of the high spot by its clock position on the tire and wheel assembly, relative to the marked wheel stud.
3. Remove the tire and wheel assembly from the hub/axle flange. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
4. Rotate the tire and wheel assembly as close to 180 degrees as possible on the hub/axle flange, so that the wheel valve stem is now approximately at the 6 o'clock position in relation to the marked wheel stud.
5. Reinstall the wheel lug nuts to secure the tire and wheel assembly in the new position. Refer to *Tire and Wheel Removal and Installation on page 3-72* in Tires and Wheels.
6. Remeasure the tire and wheel assembly on-vehicle runout. Mark the new location of the assembly on-vehicle runout high spot on the tire. Refer to *Tire and Wheel Assembly Runout Measurement - On-Vehicle on page 0-56.*
7. If the assembly on-vehicle runout has been reduced and is within tolerance, no further steps are necessary.
8. If the assembly runout has NOT been reduced, perform the following steps:
   8.1. If the clock location of the high spot remained at or near the original clock location of the high spot, the hub/axle flange and/or the brake rotor/drum mounting flange is the major contributor to the assembly on-vehicle runout concern.

8.2. If the clock location of the high spot is now at or near a position 180 degrees from the original clock location of the high spot, the tire and wheel assembly is the major contributor to the assembly on-vehicle runout concern.

8.3. If the clock location of the high spot is now in-between the two extremes, then both the tire and wheel assembly and the hub/axle flange are contributing to the assembly on-vehicle runout concern. Rotate the tire and wheel assembly as close to an additional 90 degrees as possible in both the clockwise and the counterclockwise directions to obtain the lowest amount of assembly on-vehicle runout.

Driveline System Balance Adjustment (Using EVA)

This procedure is designed to fine-tune the balance of a propeller shaft while it is mounted in the vehicle. Small amounts of residual imbalance which could be present in other related driveline system components could be compensated for as a result of performing this procedure. The end result of properly fine-tuning a propeller shaft balance may be either a significant reduction or an elimination of a vibration disturbance that is related to the first-order rotation of a propeller shaft.

Fine-tuning the balance of a propeller shaft can aid in achieving a more balanced total driveline system.

Important: The runout of the propeller shaft to be balanced and the runout of the components that the propeller shaft mates to must be within tolerances before an attempt should be made to perform this procedure.

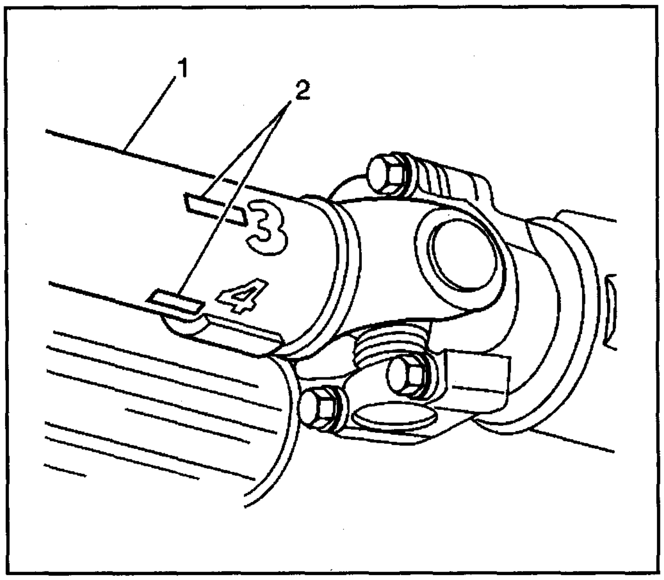
Tools Required

- *J 38792-A* Electronic Vibration Analyzer 2
- *J 38792-20* 20–Foot Timing Light Power Cord Extension
- *J 38792-25* Inductive Pickup Timing Light, or equivalent
- *J 38792-27* 6–Foot EVA Power Cord Extension

Adjustment Procedure

Notice: Do not depress the brake pedal with the brake rotors and/or the brake drums removed, or with the brake calipers repositioned away from the brake rotors, or damage to the brake system may result.

1. Raise and support the vehicle; ensure that the drive axle(s) are supported at ride height – vehicle body supported by suspension components. Refer to *Lifting and Jacking the Vehicle on page 0-21* in General Information.
2. With the tire and wheel assemblies, and the brake rotors and/or brake drums removed from the drive axle, or axles, start the engine and turn OFF all engine accessories.
3. Place the transmission in forward gear.
4. Run the vehicle at the speed which causes the most vibration in the propeller shaft; observe which end of the propeller shaft exhibits the greatest amount of vibration disturbance.
5. Turn the engine OFF to slow and stop the rotation of the propeller shaft.



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6. Mark the circumference of the propeller shaft (1) to be balanced at four points 90 degrees apart (2), nearest the end that exhibited the greatest amount of vibration. Number the marks 1 through 4.
7. Install the *J 38792-A*, the *J 38792-27*, the *J 38792-25*, or equivalent, and the *J 38792-20* to the vehicle.
8. Connect the clip of the *J 38792-25*, or equivalent, onto the trigger wire of the *J 38792-A*.
9. Mount the *J 38792-A* vibration sensor to the bottom of the driveline component nearest to the end of the propeller shaft that exhibited the greatest amount of vibration.

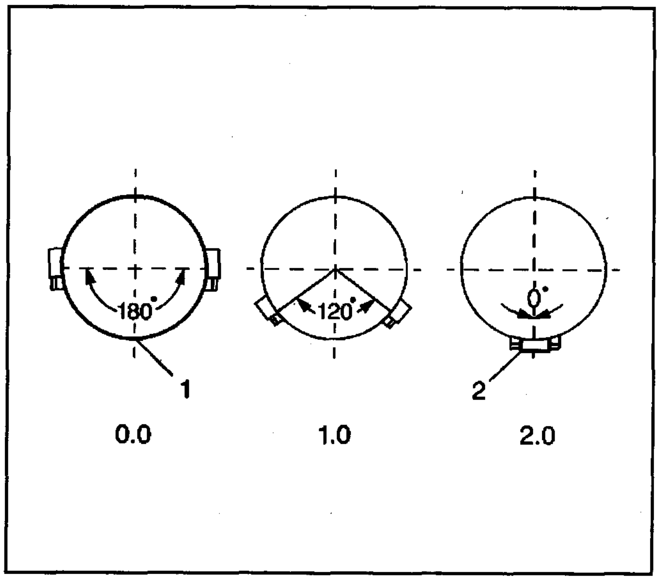
   Ensure that the side of the sensor marked UP faces upward and that the sensor is positioned as close to horizontal as possible.
10. Plug the vibration sensor cord into Input A of the *J 38792-A*. Input B is not used with the strobe function.
11. Run the vehicle at the speed which causes the most vibration in the propeller shaft; observe the frequency readings displayed on the *J 38792-A*.

Important: Do NOT continue with fine-tuning the balance of a propeller shaft if the dominant frequency displayed is not related to the first-order rotational speed of the propeller shaft.

12. Verify that the dominant frequency displayed on the *J 38792-A* matches the recorded frequency of the vibration concern.
13. Record the amplitude reading of the dominant frequency displayed.

14. Using the strobe function of the *J 38792-A*, select the correct filter range to use for the balance adjustment, so that the dominant frequency would be near the middle of the filter range. Use the full range filter only as a last resort if one of the specific range filters will not cover the frequency adequately.
15. The *J 38792-A* display will show the dominant frequency, the amplitude and the selected filter range.
16. Aim the *J 38792-25*, or equivalent, at the marks placed on the propeller shaft. When activated, the strobe effect will appear to freeze the marks placed on the rotating propeller shaft. Record which of the numbered marks appears to be at the bottom of the propeller shaft, or the 6 o'clock position. This position identifies the light spot of the propeller shaft.
17. Turn the engine OFF to slow and stop the rotation of the propeller shaft.
18. Install a band-type hose clamp as a weight, with the head of the clamp directly on the light spot.
19. Run the vehicle at the speed which causes the most vibration in the propeller shaft.
20. Using the *J 38792-25*, or equivalent, observe the positioning of the marks placed on the propeller shaft.
21. If the marks on the propeller shaft now appear to move erratically, compare the current amplitude of the vibration frequency to the original amplitude recorded previously.

    If the amplitude has decreased from the amplitude recorded, the balance achieved may be sufficient and the vehicle should be road tested to determine the effect on the vibration concern.
22. If the clamp head over the original light spot, is now near the top of the propeller shaft, within 180 degrees – near or below the 12 o'clock position – of the original position at the bottom of the propeller shaft – 6 o'clock position – the position of the weight needs adjusting. Perform the following steps:
    - 22.1. Move the position of the clamp head toward the 6 o'clock position.
    - 22.2. Using the *J 38792-25*, or equivalent, recheck the positioning of the propeller shaft marks.
    - 22.3. If necessary, continue to move the position of the clamp head toward the 6 o'clock position and recheck progress until an improvement in balance is achieved.



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23. If the clamp head over the original light spot, is still positioned at the bottom of the propeller shaft – 6 o'clock position – additional weight is required. Perform the following steps:
    - 23.1. Add a second clamp to the propeller shaft, next to the first clamp and with the clamp heads aligned.
    - 23.2. Using the *J 38792-25*, or equivalent, recheck the positioning of the propeller shaft marks.
    - 23.3. If the clamp heads over the original light spot, are now 90 to 180 degrees – at or above the 9 o'clock or the 3 o'clock positions – from the original position at the bottom of the propeller shaft – 6 o'clock position – less total weight is required. Proceed to step 23.4.
    - 23.4. Move the position of the clamp heads an equal distance on either side of the light spot between 1 and 120 degrees apart from each other to reduce the total amount of weight in relation to the light spot.
    - 23.5. Using the *J 38792-25*, or equivalent, recheck the positioning of the propeller shaft marks.
    - 23.6. If necessary, continue to move the position of the clamp heads an equal distance on either side of the light spot to a maximum of 120 degrees apart from each other, until the greatest improvement to balance is achieved.
    - 23.7. If improvement has been made to the balance of the propeller shaft, but the balance is still not satisfactory, still more total weight may be required. Perform the following steps:
        - 23.7.1. Add a third clamp to the propeller shaft, next to the first and second clamps and with the clamp head directly on the light spot.

23.7.2. Move the position of the first and second clamp heads an equal distance on either side of the light spot between 1 and 120 degrees apart from each other to arrive at a total amount of weight greater than two weights, but less than three weights in relation to the light spot.

23.7.3. Using the *J 38792-25*, or equivalent, recheck the positioning of the propeller shaft marks.

23.7.4. If necessary, continue to move the position of the first and second clamp heads an equal distance on either side of the light spot to a maximum of 120 degrees apart from each other, until the greatest improvement to balance is achieved.

23.8. If a third clamp was used on the propeller shaft and sufficient balance could still not be achieved, the propeller shaft requires replacement.

24. If the clamp head over the original light spot is now 90 to 180 degrees – at or above the 9 o'clock or the 3 o'clock positions – from the original position at the bottom of the propeller shaft – 6 o'clock position – less total weight is required. Perform the following steps:

24.1. Add a second clamp to the propeller shaft, next to the first clamp and with the clamp heads aligned.

24.2. Move the position of the clamp heads an equal distance on either side of the light spot between 120 and 180 degrees apart from each other to reduce the total amount of weight in relation to the light spot.

24.3. Using the *J 38792-25*, or equivalent, recheck the positioning of the propeller shaft marks.

24.4. If necessary, continue to move the position of the clamp heads an equal distance on either side of the light spot to a maximum of 180 degrees apart from each other, but not less than 120 degrees apart, until the greatest improvement to balance is achieved.

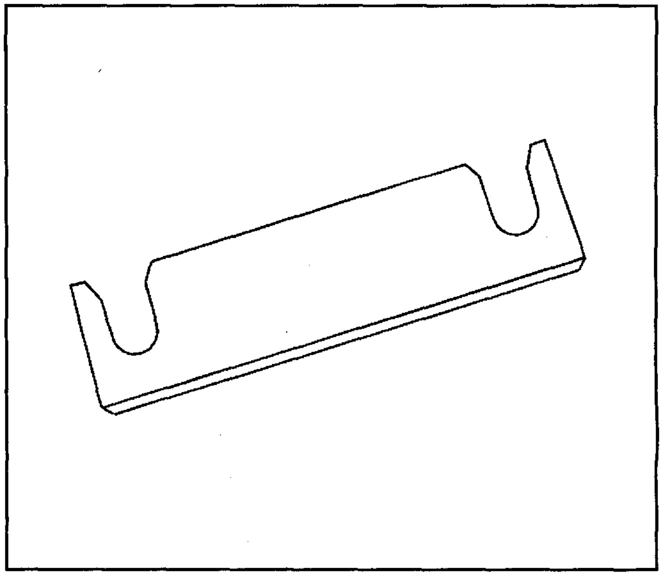
25. If the marks on the propeller shaft now appear to move erratically, compare the current amplitude of the vibration frequency to the original amplitude recorded previously.

If the amplitude has decreased from the amplitude recorded, the balance achieved may be sufficient and the vehicle should be road tested to determine the effect on the vibration concern.

Driveline Working Angles Adjustment

Rear axle wind-up may cause launch shudder even when all of the working angles are within specifications. Rear axle wind-up occurs when heavy torque during acceleration causes the pinion nose to point upward. In order to compensate for axle wind-up, the transmission output shaft can be raised slightly. Perform a road test after each shim to determine the affects on the vibration concern. Add shims until the road test indicates that the shudder is eliminated.

Transmission Shims



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If a transmission requires shims, order the shims through the parts distribution system.

Installing most shims will change the transmission angle approximately 1/2 degree.

When shimming transmissions, use a shim made from steel stock at the necessary thickness. Ensure that the shim contacts the full width of the area to be shimmed. Do not use washers.

Propeller Shaft Phasing Correction

One Piece Propeller Shaft Phasing Correction

An out of phase single-piece propeller shaft is very unusual. If the shaft is visibly out of place, the end yokes are welded on in the wrong position, or the shaft is damaged due to twisting, the propeller shaft requires replacement.

Multiple-Piece Propeller Shaft Phasing Correction

There are two possible causes for an out of phase multiple-piece propeller shaft:

1. Inspect the shaft to see if it is visibly out of place, the end yokes are welded on in the wrong position, or the shaft is damaged due to twisting. If any of these conditions apply, the propeller shaft requires replacement.
2. If the propeller shaft assembly has no visual physical defects and the propeller shaft phasing inspection procedure indicated that the propeller shafts were out of phase, perform the following:
   - 2.1. Remove the yoke from the spline shaft and determine if it is possible to correct the out of phase condition by reinstalling the yoke on a different position on the spline shaft.
   - 2.2. If it is possible to reinstall the yoke on a different position on the spline shaft, determine the correct location, reinstall the yoke to the spline shaft, and reinspect the phasing of the propeller shafts.
   - 2.3. If it is not possible to reinstall the yoke on a different position on the spline shaft and the propeller shaft phasing inspection procedure indicated that the propeller shafts were out of phase, the defective propeller shaft requires replacement.

Description and Operation

Vibration Theory and Terminology

Vibration Theory

The designs and engineering requirements of vehicles have undergone drastic changes over the last several years.

Vehicles are stiffer and provide more isolation from road input than they did previously. The structures of today's stiffer vehicles are less susceptible to many of the vibrations which could be present in vehicles of earlier designs, however, vibrations can still be detected in a more modern vehicle if a transfer path is created between a rotating component and the body of the vehicle.

There are not as many points of isolation from the road in many vehicles today. If a component produces a strong enough vibration, it may overcome the existing isolation and the component needs to be repaired or replaced.

The presence/absence of unwanted noise and vibration is linked to the customer's perception of the overall quality of the vehicle.

Vibration is the repetitive motion of an object, back and forth, or up and down. The following components cause most vehicle vibrations:

- A rotating component
- The engine combustion process firing impulses

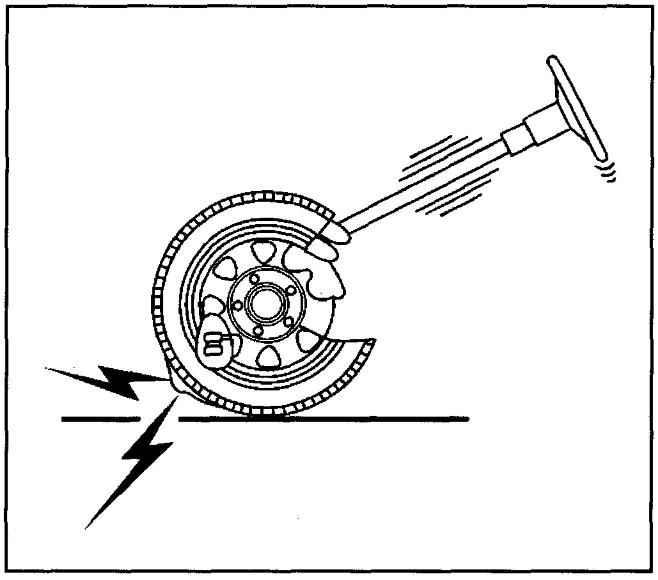
Rotating components will cause vibrations when excessive imbalance or runout is present. During vibration diagnosis, the amount of allowable imbalance or runout should be considered a TOLERANCE and not a SPECIFICATION. In other words, the less imbalance or runout the better.

Rotating components will cause a vibration concern when they not properly isolated from the passenger compartment: Engine firing pulses can be detected as a vibration if a motor mount is collapsed.

A vibrating component operates at a consistent rate (km/h, mph, or RPM). Measure the rate of vibration in question. When the rate/speed is determined, relate the vibration to a component that operates at an equal rate/speed in order to pinpoint the source. Vibrations also tend to transmit through the body structure to other components. Therefore, just because the seat vibrates does not mean the source of vibration is in the seat.

Vibrations consist of the following three elements:

- The source – the cause of the vibration
- The transfer path – the path the vibration travels through the vehicle
- The responder – the component where the vibration is felt



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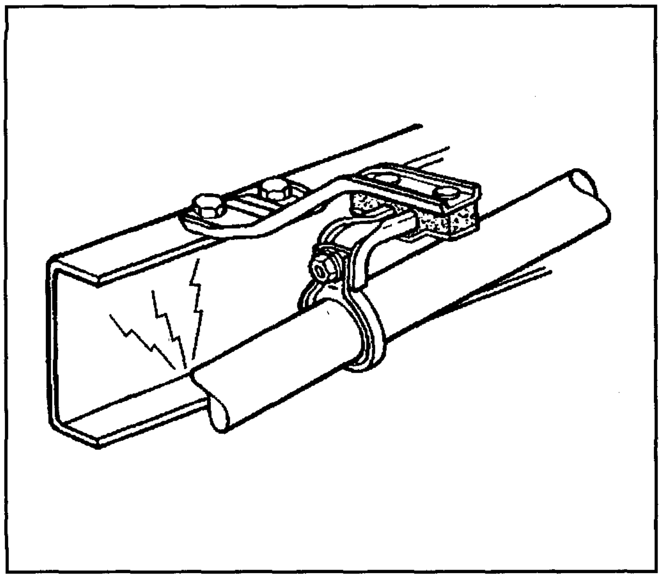
In the preceding picture, the source is the unbalanced tire. The transfer path is the route the vibrations travels through the vehicle's suspension system into the steering column. The responder is the steering wheel, which the customer reports as vibrating.

Eliminating any one of these three elements will usually correct the condition. Decide, from the gathered information, which element makes the most sense to repair. Adding a brace to the steering column may keep the steering wheel from vibrating, but adding a brace is not a practical solution. The most direct and effective repair would be to properly balance the tire.



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Vibration can also produce noise. As an example, consider a vehicle that has an exhaust pipe grounded to the frame. The source of the vibration is the engine firing impulses traveling through the exhaust. The transfer path is a grounded or bound-up exhaust hanger. The responder is the frame. The floor panel vibrates, acting as a large speaker, which produces noise. The best repair would be to eliminate the transfer path. Aligning the exhaust system and correcting the grounded condition at the frame would eliminate the transfer path.

Basic Vibration Terminology

The following are the 2 primary components of vibration diagnosis:

- The physical properties of objects
- The object's properties of conducting mechanical energy

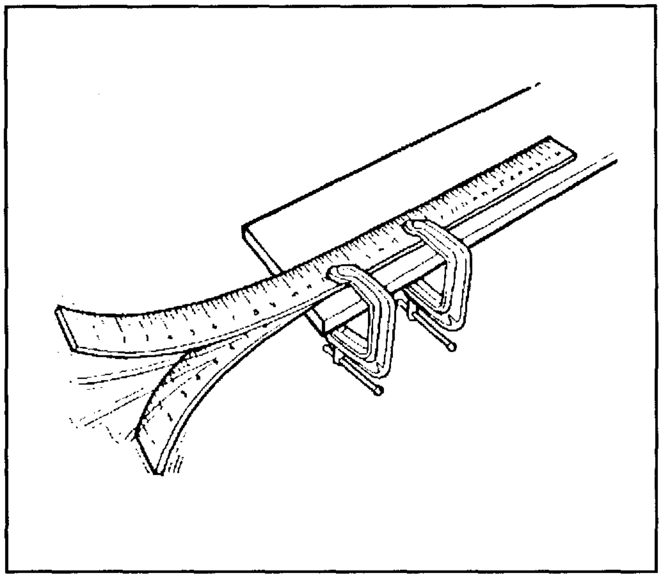
The repetitive up and down or back and forth movement of a component cause most customer vibration complaints. The following are the common components that vibrate:

- The steering wheel
- The seat cushion
- The frame
- The IP

Vibration diagnosis involves the following simple outline:

1. Measure the repetitive motion and assign a value to the measurement in cycles per second or cycles per minute.
2. Relate the frequency back on terms of the rotational speed of a component that is operating at the same rate or speed.
3. Inspect and test the components for conditions that cause vibration.

For example, performing the following steps will help demonstrate the vibration theory:



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1. Clamp a yardstick to the edge of a table, leaving about 50 cm (20 in) hanging over the edge of the table.
2. Pull down on the edge of the stick and release while observing the movement of the stick.

The motion of the stick occurs in repetitive cycles. The cycle begins at midpoint, continues through the lowest extreme of travel, then back past the midpoint, through the upper extreme of travel, and back to the midpoint where the cycle begins again.

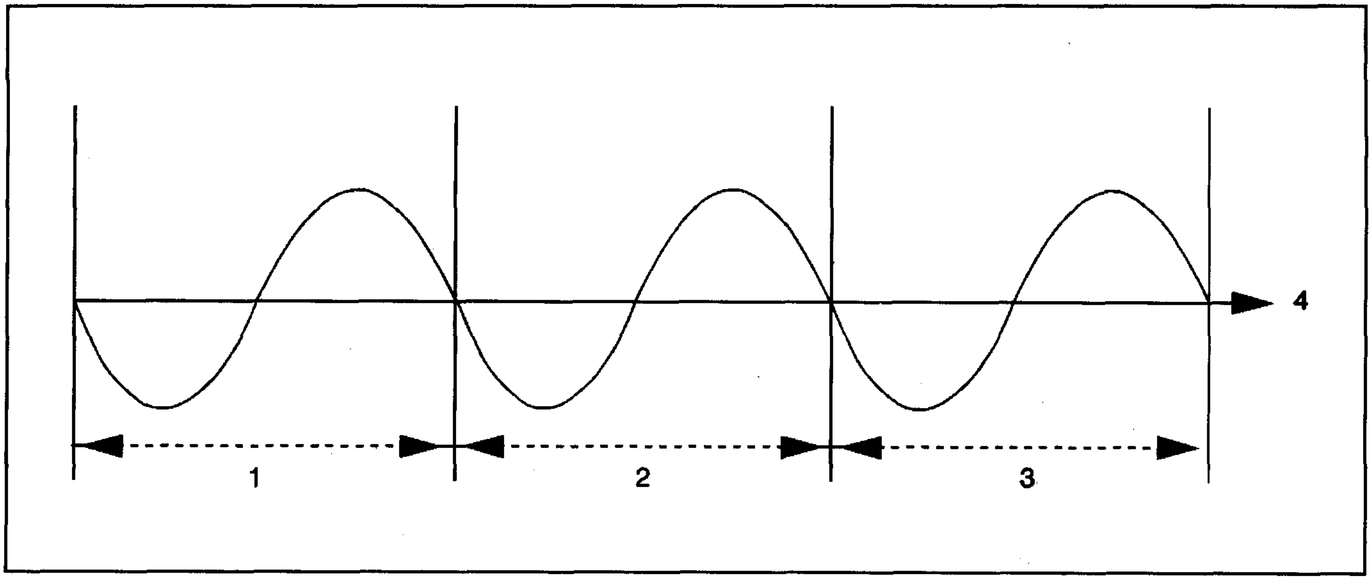
The cycle occurs over and over again at the same rate, or frequency. In this case, about 10 cycles in one second. If we measure the frequency to reflect the number of complete cycles that the yardstick made in one minute, the measure would be 10 cycles x 60 seconds = 600 cycles per minute (cpm).

We have also found a specific amount of motion, or amplitude, in the total travel of the yardstick from the very top to the very bottom. Redo the experiment as follows:

1. Reclamp the yardstick to the edge of a table, leaving about 25 cm (10 in) hanging over the edge of the table.
2. Pull down on the edge of the stick and release while observing the movement of the stick.

The stick vibrates at a much faster frequency: 30 cycles per second (1,800 cycles per minute).

Cycle



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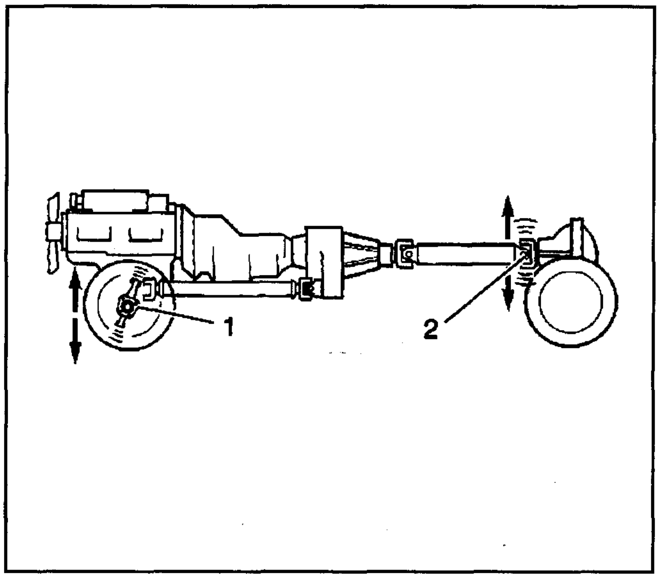
Legend

(1) 1st Cycle
(2) 2nd Cycle
(3) 3rd Cycle
(4) Time

Vibration Cycles in Powertrain Components



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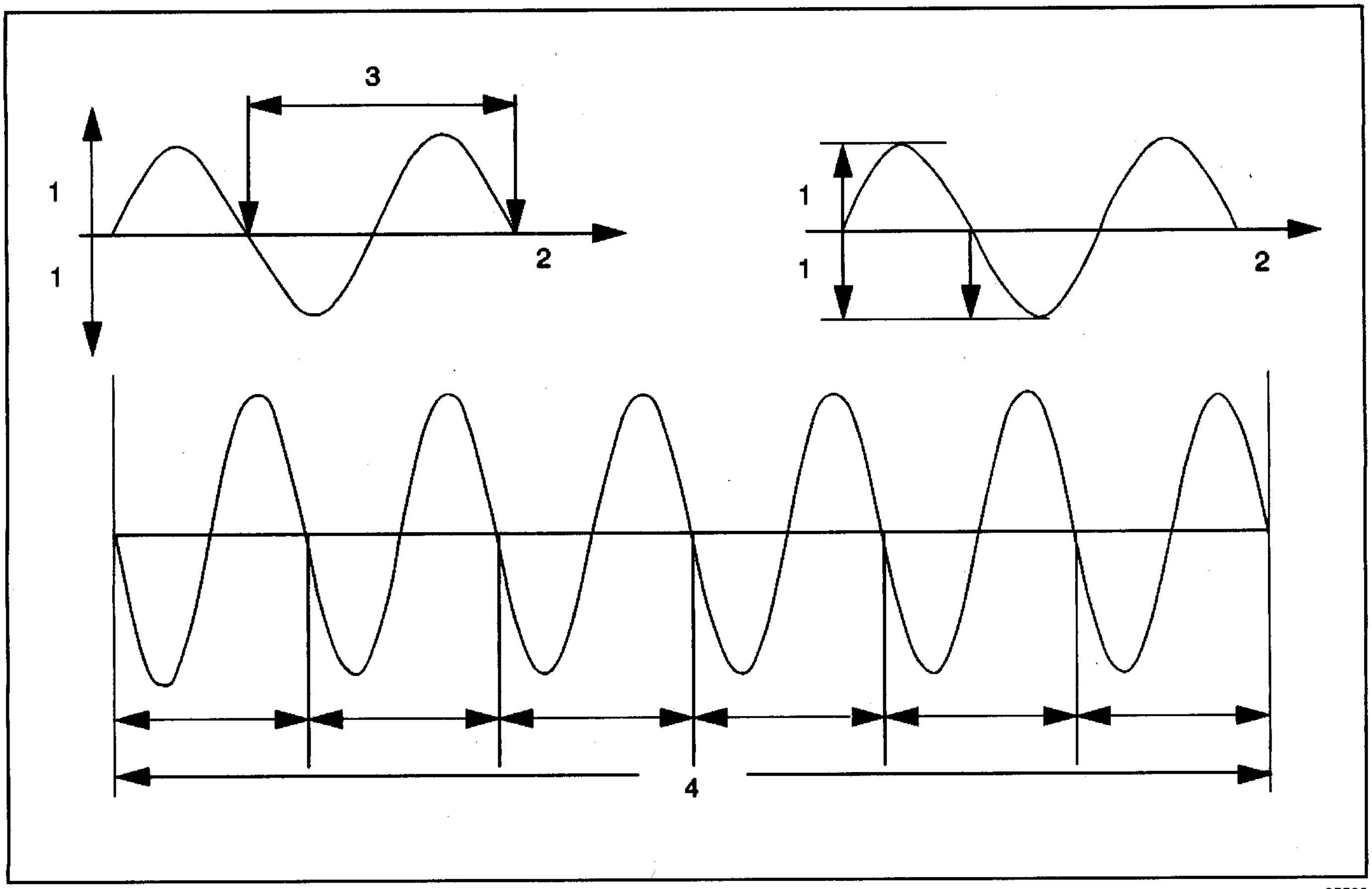
Legend

(1) Spindle
(2) Pinion Nose

The word cycle comes from the same root as the word circle. A circle begins and ends at the same point, as thus, so does a cycle. All vibrations consist of repetitive cycles.

Frequency



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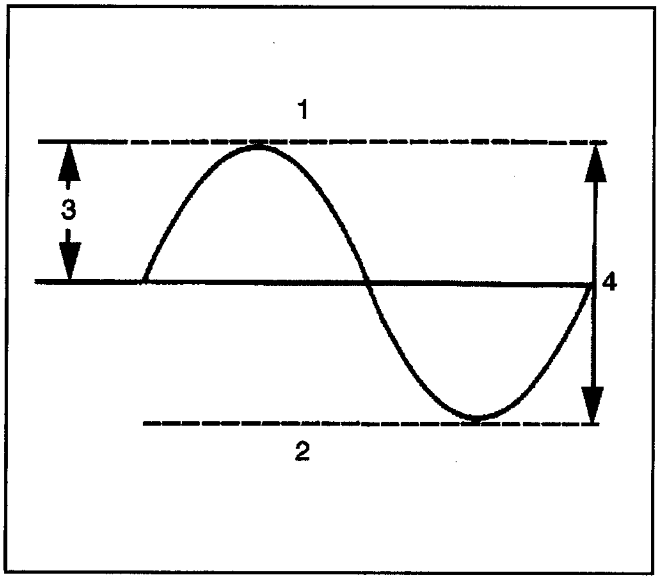
Legend

(1) Amplitude
(2) Reference
(3) Time in Seconds
(4) 1 Second

Frequency is defined as the rate at which an event occurs during a given period of time. With a vibration, the event is a cycle, and the period of time is 1 second. Thus, frequency is expressed in cycles per second.

The proper term for cycles per seconds is Hertz (Hz). This is the most common way to measure frequency. Multiply the Hertz by 60 to get the cycles or revolutions per minute (RPM).

Amplitude



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Legend

(1) Maximum
(2) Minimum
(3) Zero-to-Peak Amplitude
(4) Peak-to-Peak Amplitude

Amplitude is the maximum value of a periodically varying quantity. Used in vibration diagnostics, we are referring it to the magnitude of the disturbance. A severe disturbance would have a high amplitude; a minor disturbance would have a low amplitude.

Amplitude is measured by the amount of actual movement, or the displacement. For example, consider the vibration caused by an out-of-balance wheel at 80 km/h (50 mph) as opposed to 40 km/h (25 mph). As the speed increases, the amplitude increases.

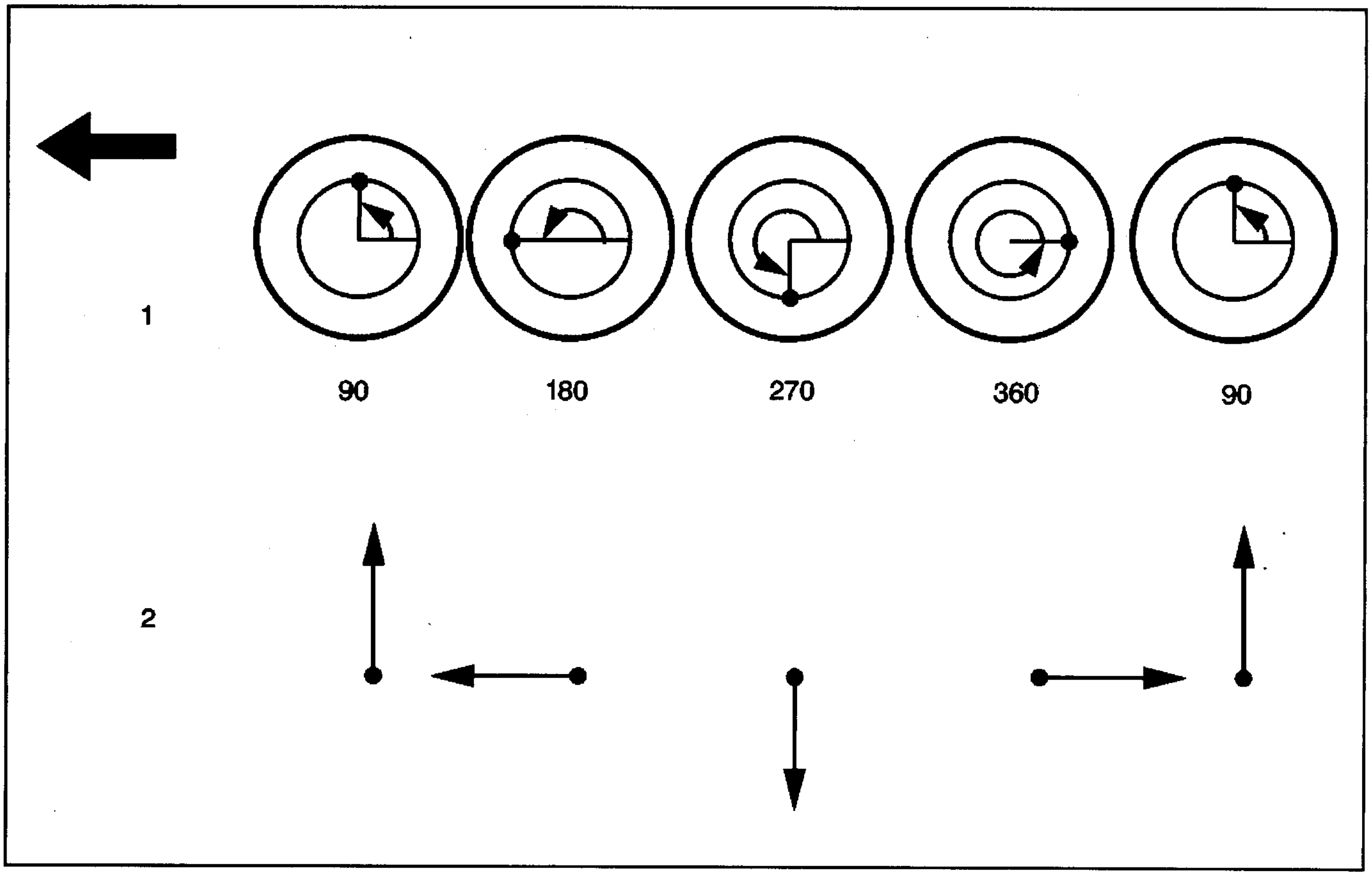
Free Vibration

Free vibration is the continued vibration in the absence of any outside force. In the yardstick example, the yardstick continued to vibrate even after the end was released.

Forced Vibration

Forced vibration is when an object is vibrating continuously as a result of an outside force.

Centrifugal Force Due to an Imbalance



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Legend

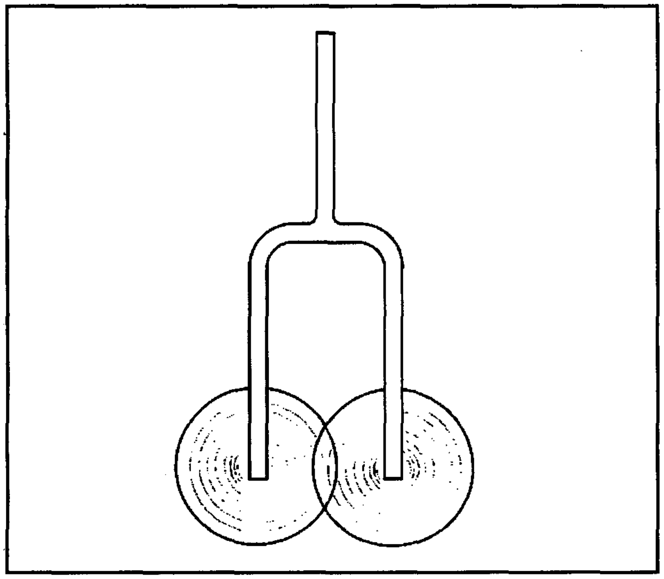
(1) Location of Imbalance (Degrees)
(2) Centrifugal Force Acting on Spindle

A spinning object with an imbalance generates a centrifugal force. Performing the following steps will help to demonstrate centrifugal force:

1. Tie a nut to a string.
2. Hold the string. The nut hangs vertically due to gravity.
3. Spin the string. The nut will spin in a circle.

Centrifugal force is trying to make the nut fly outward, causing the pull you feel on your hand. An unbalanced tire follows the same example. The nut is the imbalance in the tire. The string is the tire, wheel, and suspension assembly. As the vehicle speed increases, the disturbing force of the unbalanced tire can be felt in the steering wheel, the seat, and the floor. This disturbance will be repetitive (Hz) and the amplitude will increase. At higher speeds, both the frequency and the amplitude will increase. As the tire revolves, the imbalance, or the centrifugal force, will alternately lift the tire up and force the tire downward, along with the spindle, once for each revolution of the tire.

Natural or Resonant Frequency



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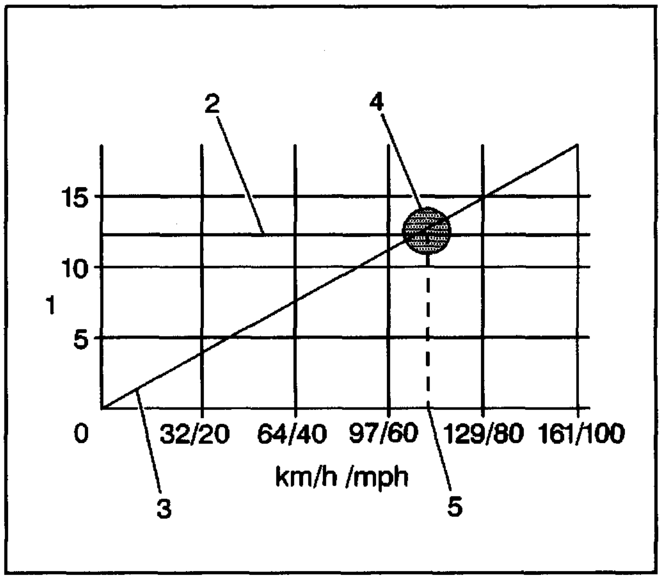
The natural frequency is the frequency at which an object tends to vibrate. Bells, guitar strings, and tuning forks are all examples of objects that tend to vibrate at specific frequencies when excited by an external force.

Suspension systems, and even engines within the mounts, have a tendency to vibrate at certain frequencies. This is why some vibration complaints occur only at specific vehicle speeds or engine RPM.

The stiffness and the natural frequency of a material have a relationship. Generally, the stiffer the material, the higher the natural frequency. The opposite is also true. The softer a material, the lower the natural frequency. Conversely, the greater the mass, the lower the natural frequency.

Resonance



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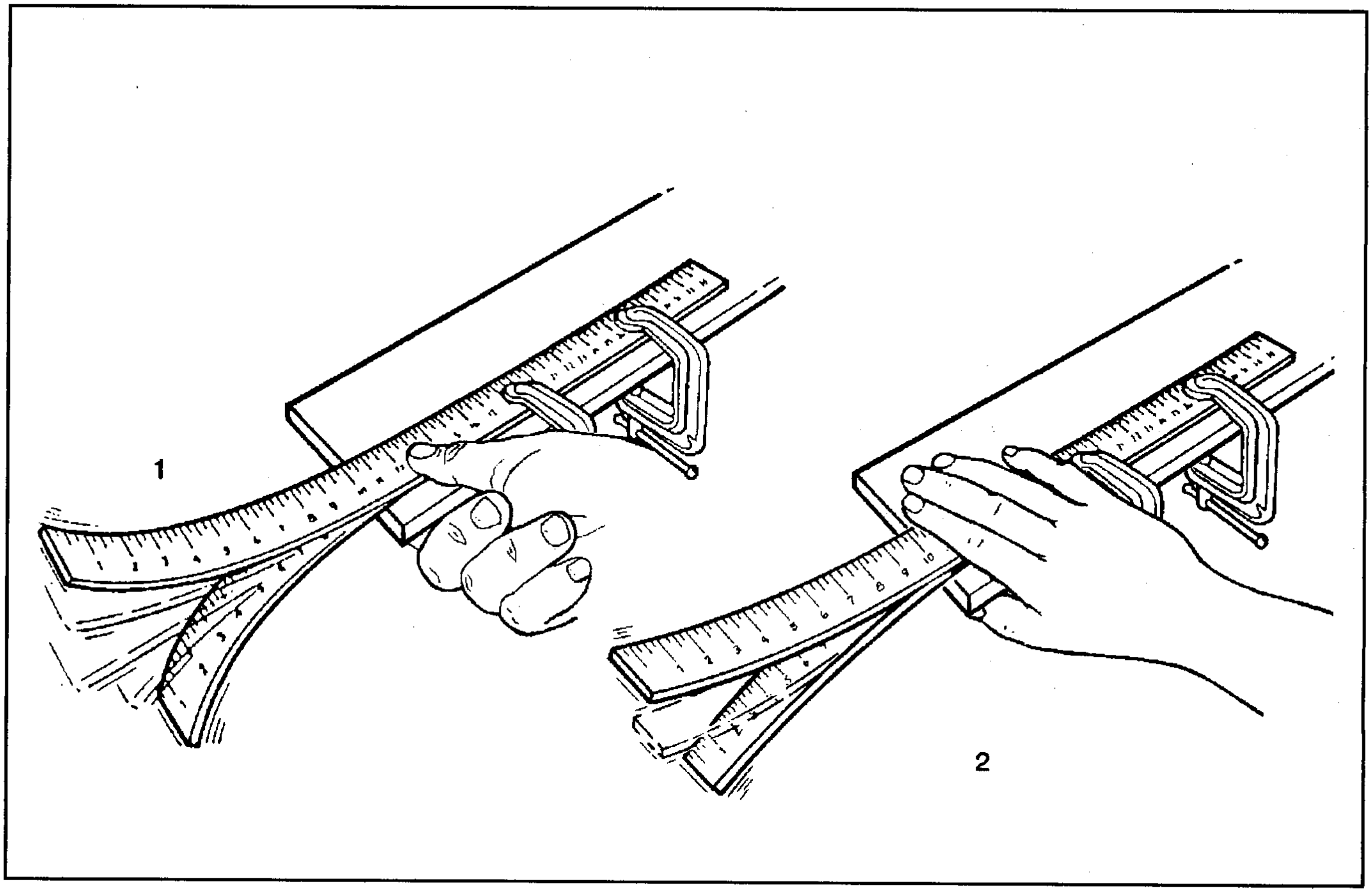
Legend

(1) Frequency – cps
(2) Suspension Frequency
(3) Unbalanced Excitation
(4) Point of Resonance
(5) Problem Speed

All objects have natural frequencies. The natural frequency of a typical automotive front suspension is in the 10–15 Hz range. This natural frequency is the result of the suspension design. The suspension's natural frequency is the same at all vehicle speeds. As the tire speed increases along with the vehicle speed, the disturbance created by the tire increases in frequency. Eventually, the frequency of the unbalanced tire will intersect with the natural frequency of the suspension. This causes the suspension to vibrate. The intersecting point is called the resonance.

The amplitude of a vibration will be greatest at the point of resonance. While the vibration may be felt above and below the problem speed, the vibration may be felt the most at the point of resonance.

Damping



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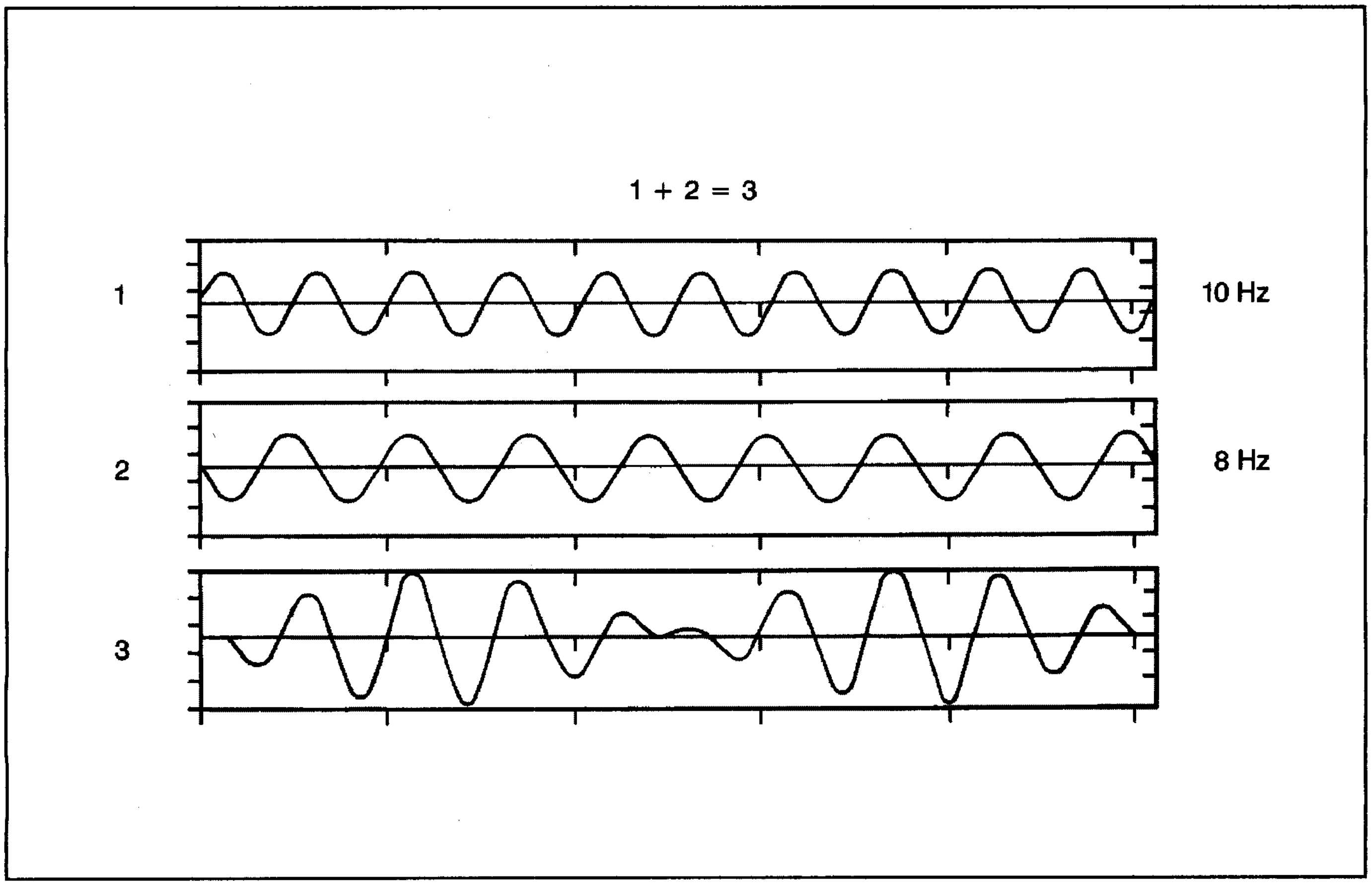
Legend

(1) Low Damping

(2) High Damping

Damping is the ability of an object or material to dissipate or absorb vibration. The automotive shock absorber is a good example. The function of the shock absorber is to absorb or dampen the oscillations of the suspension system.

Beating (Phasing)



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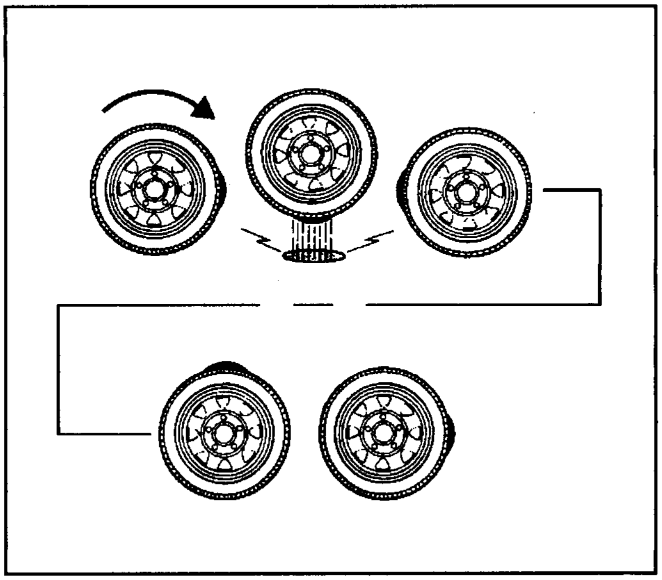
Two separate disturbances that are relatively close together in frequency will lead to a condition called beating, or phasing. A beating vibration condition will increase in intensity or amplitude in a repetitive fashion as the vehicle travels at a steady speed. This beating vibration can produce the familiar droning noise heard in some vehicles.

Beating occurs when 2 vibrating forces are adding to each other's amplitude. However, 2 vibrating forces can also subtract from each other's amplitude. The adding and subtracting of amplitudes in similar frequencies is called beating. In many cases, eliminating either one of the disturbances can correct the condition.

Order

Order refers to how many times an event occurs during 1 revolution of a rotating component.



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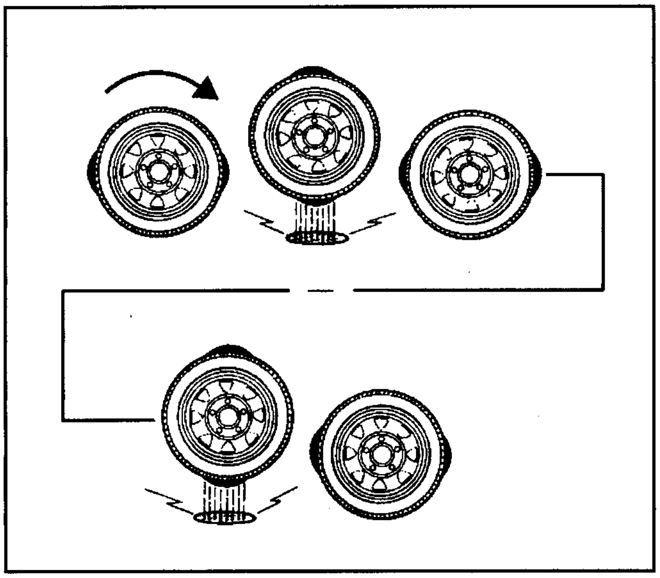
For example, a tire with 1 high spot would create a disturbance once for every revolution of the tire. This is called first-order vibration.



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An oval-shaped tire with 2 high spots would create a disturbance twice for every revolution. This is called second-order vibration. Three high spots would be third-order, and so forth. Two first-order vibrations may add or subtract from the overall amplitude of the disturbance, but that is all. Two first-order vibrations do not equal a second-order. Due to centrifugal force, an unbalanced component will always create at least a first-order vibration.

Electronic Vibration Analyzer (EVA) Description and Operation

Tools Required

J 38792-A Electronic Vibration Analyzer

The *J 38792-A*, electronic vibration analyzer (EVA), is a 12–volt powered hand-held device, similar to a scan tool, which receives input from an attached vibration sensor or accelerometer and displays the most dominate input frequency(ies) (up to three) on its liquid crystal display. The vibration concern frequency(ies) are obtained through the use of the *J 38792-A* while following the Vibration Analysis Diagnostic Tables. The frequency(ies) obtained, when applied to the Vibration Analysis Diagnostic Tables, are used as a primary input to help determine the source of the vibration concern.

EVA Vibration Sensor

The *J 38792-A* vibration sensor incorporates a 6.1 m (20 ft) cord, that allows the sensor to be placed on virtually any component of the vehicle where a vibration concern is felt.

The *J 38792-A* contains 2 sensor input ports which can be activated individually to allow for 2 individual vibration sensor inputs. The vibration sensors can then be placed in 2 different locations in the vehicle and their individual inputs can be read without having to stop a test, move the sensor and resume the test. The use of 2 vibration sensors can help in more quickly finding and recording an accurate frequency of the vibration concern, and in more quickly making comparisons between 2 different areas of a single component, or a vehicle system, during the diagnostic process.

EVA Vibration Sensor Placement

Proper placement of the *J 38792-A* vibration sensor (accelerometer) is critical to ensure that proper vibration readings are obtained by the *J 38792-A*. The vibration sensor should be placed on the specific vehicle component identified as being the most respondent to the vibration. If no component has been identified, install the sensor to the steering column as a starting point.

EVA Vibration Sensor-to-Component Attachment

Important: The *J 38792-A* vibration sensor must be attached to vehicle components in the manner indicated in order to achieve accurate frequency readings of the vibration disturbance.

The vibration sensor of the *J 38792-A* is designed to pickup disturbances which primarily occur in the vertical plane, since most vibrations are felt in that same up-and-down direction. The *J 38792-A* vibration sensor is therefore directional sensitive and must be attached to vehicle components such that the side of the sensor marked UP is always facing upright and the sensor body is as close to horizontal as possible. The sensor must be installed in the exact same position each time tests are repeated or comparisons are made to other vehicles.

The *J 38792-A* vibration sensor can be attached to vehicle components in various ways. For non-ferrous surfaces, such as the shroud of a steering column, the sensor can be attached using putty, or hook and loop fasteners. For ferrous surfaces, the sensor can be attached using a magnet supplied with the sensor.

EVA Software Cartridge

The *J 38792-A* uses a software cartridge, the J 38792–60, which provides various information to the *J 38792-A*. The J 38792–60 provides the *J 38792-A* with an additional feature which can be selected and utilized to assist in diagnosing vibration concerns.

Important: The Auto-Mode function of the *J 38792-A* cartridge, J 38792–60, is designed to be used in SUPPORT of the Vibration Analysis Diagnostic Tables ONLY.

This support-feature is available through the *J 38792-A* Auto-Mode function. When selected, the *J 38792-A* will prompt the user to select which one of 2 vehicle systems (vehicle speed or engine speed), is the SUSPECTED source of the vibration concern. Using the inputted vehicle data parameters along with the most dominate vibration frequency obtained, it will identify a SUSPECTED source of the vibration concern, such as first-order tire and wheel. This can be a useful feature when used in conjunction with the Vibration Analysis Diagnostic Tables, to confirm results obtained through the diagnostic process.

EVA Smart Strobe Function

The *J 38792-A* can be used to identify some rotating components/systems which exhibit imbalance IF the component rotational speed is the dominant frequency of the vibration concern. The *J 38792-A* is equipped with a strobe light trigger wire which can be used with an inductive pickup timing light, *J 38792-25*, or equivalent included with the J 38792–KIT, or available separately. Using the Smart Strobe function enables the user to input the vibration frequency to which the strobe will flash. By marking the suspected rotating component, such as a pulley, adjusting the strobe frequency to match the dominant vibration frequency at the engine RPM noted during diagnosis, and then operating the engine at that specific RPM, the mark on the object will appear to be stationary if that object is imbalanced.

EVA Strobe Balancing Function

The *J 38792-A* can be used to identify the light spot on a propeller shaft IF the propeller shaft rotational speed is the dominant frequency of the vibration concern. The *J 38792-A* is equipped with a strobe light trigger wire which can be used with an inductive pickup timing light, *J 38792-25*, or equivalent included with the J 38792–KIT, or available separately, and in conjunction with the *J 38792-A* vibration sensor to identify the light spot on a propeller shaft and to help in making a determination as to when propeller shaft balance is obtained.

Averaging/Non-Averaging Modes

The EVA provides 2 modes of displaying the most dominate frequencies which the EVA vibration sensor (accelerometer) detects; averaging and non-averaging (instantaneous).

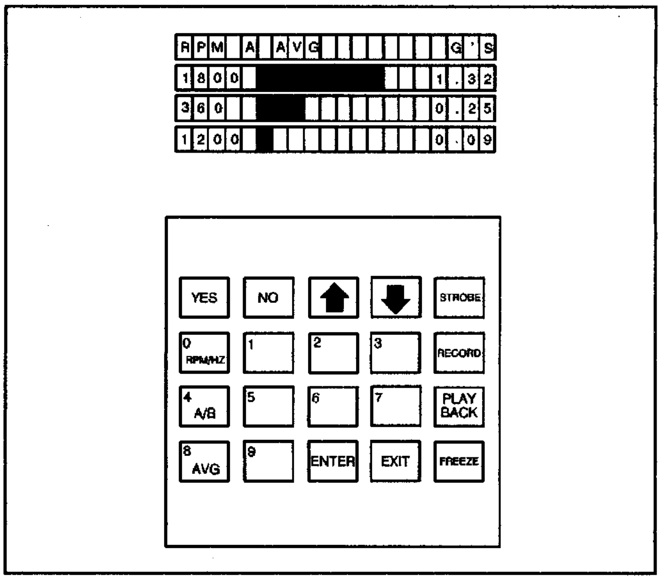
The averaging mode uses multiple vibration samples taken over a period of time and then displays the most dominant frequencies which have been averaged-out. Using the averaging mode minimizes the distractions caused by a sudden vibration frequency being displayed that is not related to the concern vibration, such as from pot holes or from uneven road surfaces.

The non-averaging (instantaneous) mode is more sensitive to vibration disturbances than the averaging mode. Using the non-averaging mode will generate instantaneous frequency displays which are not averaged across multiple samples over a period of time; the specific vibration frequencies that occur at a specific moment during diagnostic testing will be displayed at that moment. The non-averaging (instantaneous) mode is useful when measuring a vibration disturbance that exists for only a short period of time or during acceleration/deceleration testing.

When operating the EVA in the averaging mode along with the Auto Mode, “A” will be displayed along the top of the screen to the left of the vibration sensor input port being used. When operating the EVA in the averaging mode and the Manual Mode, “AVG” will be displayed along the top center of the screen.

When operating the EVA in the non-averaging (instantaneous) mode along with the Auto Mode, “I” will be displayed along the top of the screen to the left of the vibration sensor input port being used. When operating the EVA in the non-averaging (instantaneous) mode and the Manual Mode, the top center of the screen will be blank.

EVA Display



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The most dominant input frequencies, up to three, received from the *J 38792-A* vibration sensor, are displayed in descending order of amplitude strength.

The frequency readings are displayed along the left side of the screen, followed to the right by either a bar graph or the suspected source of the vibration – depending upon the mode selected, then the amplitude reading for each frequency along the right side of the screen. The top row of the screen indicates the units of measure being displayed for the frequencies along the left side and for the amplitudes along the right side. The top row also indicates the vibration sensor input port which was selected on the keypad (A or B) and which mode was selected: averaging or non-averaging (instantaneous).

The frequency(ies) can be displayed in either revolutions per minute (RPM) or revolutions per second; Hertz (Hz). The selected display type (RPM or Hz) will be indicated at the left side of the screen, above the frequency readings.

When the AUTO MODE function is not in use, a bar graph is displayed next to each frequency to provide a quick visual indication of the relative amplitude strength.

When the AUTO MODE function is being used, the suspected source of the vibration is displayed next to each frequency to provide support to the diagnostic process.

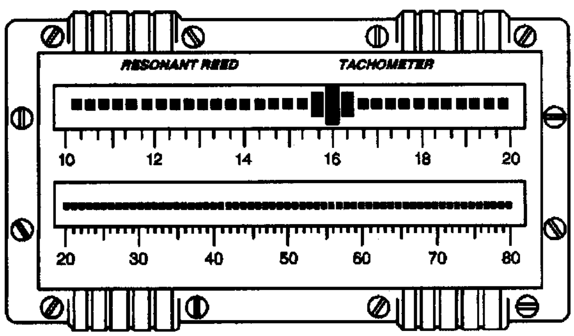
The actual amplitude strength of each frequency is displayed at the right side of the screen and shown in G's-of-acceleration force.

Vibrate Software Description and Operation

The *J 38792-VS*, Vibrate Software, is a computer software program which is designed to be used in support of the Vibration Analysis diagnostic tables, along with the *J 38792-A*, Electronic Vibration Analyzer (EVA) and a scan tool, to help in determining the source of a vibration concern. The *J 38792-VS* is designed to provide quick calculations and produce a chart of the rotational speeds and frequency ranges for specific vehicle systems and components, based upon vehicle data parameters inputted by the user.

The *J 38792-VS* uses the vehicle data parameters, such as axle ratio, number of engine cylinders, etc. to create the base chart, depicting the relationships of the various vehicle systems and/or components. The chart view can be modified to show data related to vehicle speed only, engine speed only, or both vehicle speed and engine speed. The user can then plot the dominant frequency reading obtained on the *J 38792-A* which correlates with the vibration concern, and the engine RPM obtained on a scan tool which correlates with the concern. Once these pieces of data are correctly plotted, the chart will point to the source of the vibration concern, which should confirm the results obtained through the following the Vibration Analysis diagnostic tables.

Reed Tachometer Description



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The reed tachometer consists of 2 rows of reeds arranged side-by-side. Each reed is tuned to vibrate or resonate when it is excited by a specific frequency. The reeds are arranged by their specific resonant frequency, increasing from left to right, ranging from 10–80 Hz. This arrangement allows for a visual display of the most dominate frequencies which fall within this range.

The reed tachometer can be a helpful diagnostic tool, however it is extremely sensitive to external inputs that are not related to the vibration concern, such as rough road surfaces, etc., and it is difficult to master its use. Due to these conditions, the reed tachometer has limited diagnostic capability.

Due to the limited diagnostic capability, limited availability and increasing costs of the reed tachometer, it is NOT recommended as the primary tool to use in diagnosing a vibration concern.

When diagnosing a vibration concern, use the *J 38792-A*, electronic vibration analyzer (EVA). The *J 38792-A* has been designed to overcome the shortcomings to the reed tachometer. Refer to *Electronic Vibration Analyzer (EVA) Description and Operation on page 0-86.*

Special Tools and Equipment

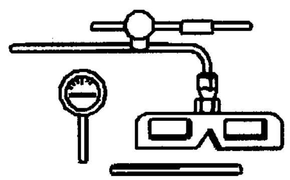
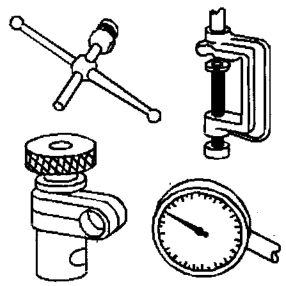
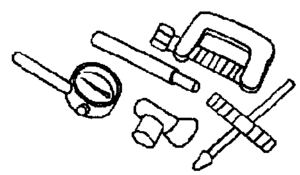
Illustration	Tool Number/Description
 35463	J 7872 Magnetic Base Dial Indicator Set
 2014	J 8001 Dial Indicator Set
 3415	J 8001 Dial Indicator Set

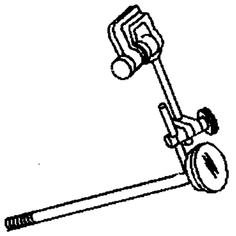
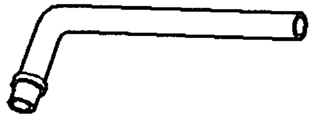
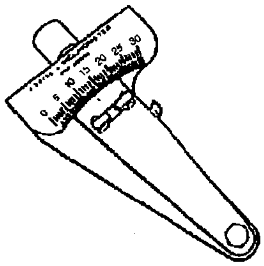
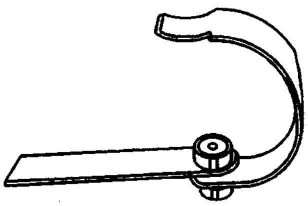
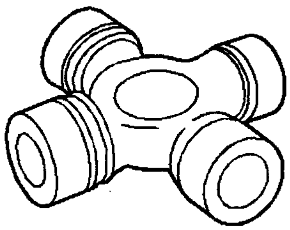
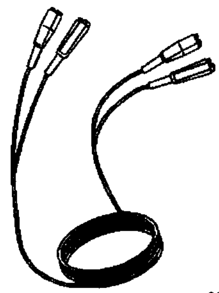
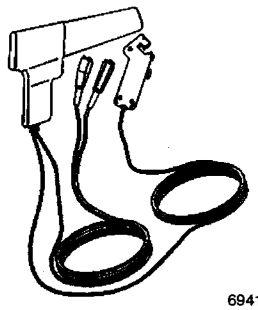
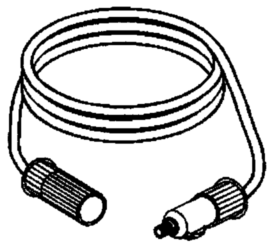
Illustration	Tool Number/Description
 9223	J 8001 Dial Indicator Set
 1517	J 23409 Dial Indicator Extension - 7 5/8 in
 8224	J 23498-A Driveshaft Inclinometer
 180348	J 23498-20 Driveshaft Inclinometer Adapter
 1512	J 35819 Flange Runout Gage

Illustration	Tool Number/Description
 694161	J 38792-A Electronic Vibration Analyzer 2
 694124	J 38792-VS Vibration Damper Installer
 694179	J 38792-20 20-Foot Timing Light Power Cord Extension
 694115	J 38792-25 Inductive Pickup Timing Light
 694192	J 38792-27 6-Foot EVA Power Cord Extension

Air/Wind Noise

Diagnostic Information and Procedures

Air/Wind Noise

Tools Required

- *J 39570* Chassis Ear
- *J 41416* Ultrasonic Leak Detector

Caution: Refer to Assistant Driving Caution on page P-3 in Cautions and Notices.

To analyze a reported windnoise condition, test drive the vehicle to determine the origin of the noise.

Choose a regular route with smooth and straight streets that run in all 4 directions: North, South, East, and West. The area should have little traffic or little noise in order to eliminate interference with the test.

Important: Often there is one primary leak source and one or more secondary leaks that contribute to the noise condition. Repairing only one of the contributing leak sources may not completely repair the total condition but only reduce the condition.

Drive the vehicle at the speed in which the noise was noticed, or until the noise is heard. Maintain safe and legal speeds.

Many of the waterleak diagnosis tests are also used for the windnoise diagnosis.

Most windnoise is caused either by leaking seals or by misaligned body surfaces. You can diagnose the following types of windnoise with the aid of *J 41416* or *J 39570* :

- Wind whistle
- Wind roar
- Wind rush

When moving at highway speeds, air pressure inside the vehicle becomes greater than the air pressure outside. When a leak occurs, the escaping air causes a hiss or a whistle.

Wind roar occurs when air passes over or through an opening between the 2 body surfaces. To correct the condition, adjust the alignment to the body surfaces.

Wind rush occurs when air presses over the vehicle's body, and is related to the aerodynamics of the vehicle. Wind whistle and wind roar are repairable. Rule out wind whistle and wind roar before concluding that the wind noise is due to wind rush.

Use the following inspections in order to aid in diagnosing wind whistle or wind roar:

1. Note the details for wind noise:
   - The perceived location
   - The location where the noise is loudest
   - When the noise occurs
   - The vehicle speed
   - The interior fan speed
   - The position of the windows
   - What the noise sounds like
2. Inspect the vehicle for the possible cause of the windnoise.
3. Test drive the vehicle and determine if the windnoise is external or internal.
4. Perform a visual inspection of the following components:
   - Loose fasteners
   - Torn weatherstrips
   - Broken weld joints
   - Sealer and/or adhesive skips

Tracing Powder or Chalk Test

Clean the weatherstrips and the contact surfaces with cleaning solvent.

1. Apply powder or chalk in an unbroken line to the contact surface of the weatherstrip surrounding the perimeter of the suspected areas.
2. Close the panel completely without slamming the panel. Closing the panel completely presses the weatherstrip firmly against the mating surface.
3. Inspect the applied line on the weatherstrip. The applied line is marred where contact is good. A corresponding imprint is on the mating surfaces.
4. Gaps or irregularities in the powder or the chalk line on the mating surfaces indicate the areas with a poor seal.

Air Pressure Test

1. Mask off both the pressure relief valves.
2. Close all the windows.
3. Turn the vehicles ventilation fan to the on position, with the selector on high speed and in the defrost mode.
4. Unlock and close the doors.
5. Listen for escaping air along the door and the window seals with a stethoscope or a length of heater hose.

Soap Suds or Bubble Test

1. Mask off the pressure relief valves.
2. Close all the windows and the doors.
3. Turn the vehicles ventilation fan to the on position, with the selector on high speed and in the defrost mode.
4. Unlock and close the doors.
5. Apply the soap solution to the potential leak areas.
6. Look for bubbles revealing escaping air.

Repair Instructions

Exterior Windnoise

Caution: Refer to Assistant Driving Caution on page P-3 in Cautions and Notices.

Exterior windnoise is louder when the vehicle is driven with one or more windows down. Exterior windnoise occurs when air passes over the body panels, the seams, or the openings. Use the following items during the test drive in order to aid in the detection of leaks:

- Mechanic's stethoscope or heater hose
- Masking tape–51 mm (2 in) width
- Strip caulk
- A water soluble marking pencil

1. While driving, determine the location of the exterior windnoise by lowering one window at a time. If the location corresponds with the condition in step 2, pull over and make a temporary repair with 51 mm (2 in) wide masking tape.
2. Tape over the gaps and the moldings one at a time. Test between each taping. Taping over the gaps and moldings will correct the condition.
3. Temporarily repair the condition with masking tape. Adjust the tape when needed.
4. Continue testing in order to determine if the noise has been eliminated or other leak areas exist.
5. When all the reported leak conditions are located, make permanent repairs using the proper alignment techniques and the sealing materials.

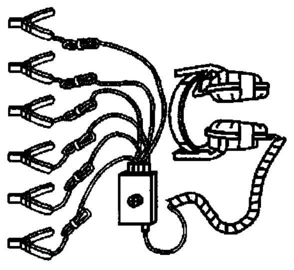
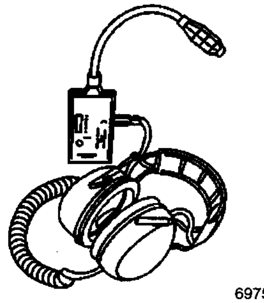
Interior Windnoise

Caution: Refer to Assistant Driving Caution on page P-3 in Cautions and Notices.

Interior windnoise is not heard when the window is lowered. Interior windnoise is caused by the air leaving the inside of the vehicle through a seal or a seam.

1. Tape over the relief valves to cause added air pressure within the vehicle.
2. Test drive the vehicle and listen for windnoise or a whistle.
3. Pull the vehicle over and make the temporary repairs using masking tape. If you cannot determine the source of the windnoise, perform one or more of the following diagnostic tests: Tracing Powder or Chalk Test, Air Pressure Test, Soap Suds or Bubble Test in this sub-section.

Special Tools and Equipment

Illustration	Tool Number/ Description
 643842	J 39570 Chassis Ear
 69758	J 41416 Ultrasonic Leak Detector

Squeaks and Rattles

Diagnostic Information and Procedures

Squeaks and Rattles

Tools Required

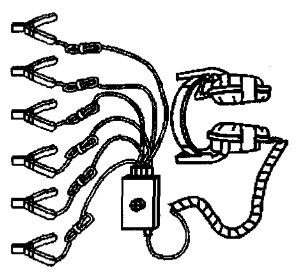
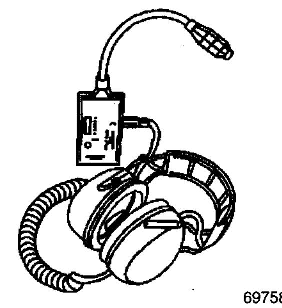
- *J 39570* Chassis Ear
- *J 41416* Ultrasonic Leak Detector

Important: Squeaks and rattles are caused by improperly controlled relative motion between vehicle components. There are 4 ways to prevent squeaks and rattles.

To aid in diagnosing, use *J 39570* or *J 41416.*

- Attach the component that squeaks or rattles securely.
- Separate the components that squeak or rattle to prevent contact.
- Insulate the components that squeak or rattle.
- Insulate low uniform friction surfaces to eliminate stickslip motion.

Special Tools and Equipment

Illustration	Tool Number/ Description
 643842	J 39570 Chassis Ear
 69758	J 41416 Ultrasonic Leak Detector

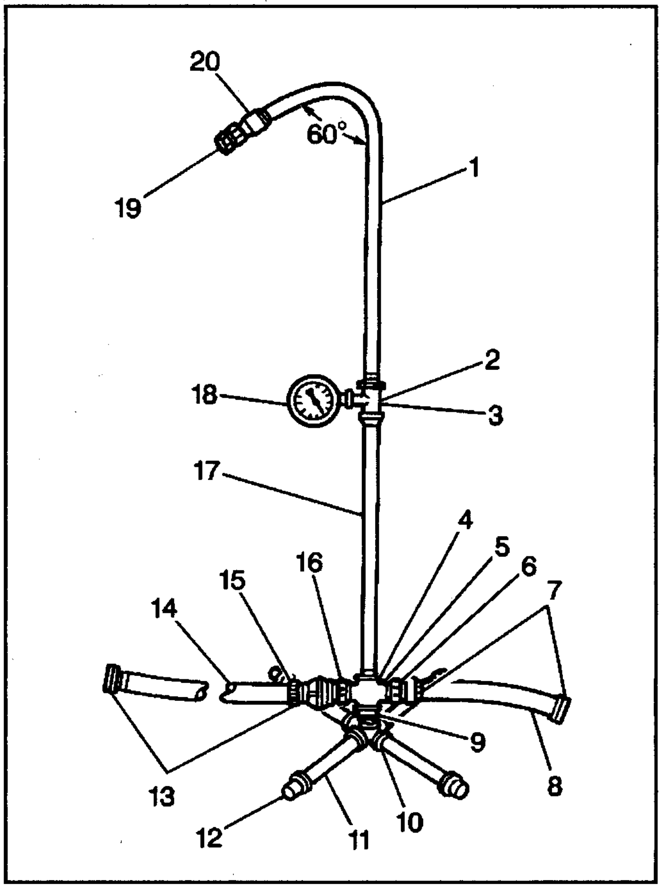
Waterleaks

Diagnostic Information and Procedures

Waterleak Test Preparation

- GM vehicles are designed to operate under normal environmental conditions.
- The design criteria for sealing materials and components takes into consideration the sealing forces required to withstand the natural elements. These specifications cannot take into consideration any artificial conditions, i.e., high pressure car washes.
- The water leak test procedure has been correlated to the natural elements and will determine the ability of a vehicle to perform under normal operating conditions.
- The first step in diagnosing a leak is determining the conditions under which a leak occurs. If the general leak area can be found, the exact entry point can be isolated using a water hose or an air hose. Some trim panels or components may need to be removed in order to repair the leak.
- If leaks are found around a door, door window, rear compartment lid or liftgate area this does not necessarily indicate a bad weatherstrip. An adjustment to these areas may resolve the condition.

Watertest Stand Assembly



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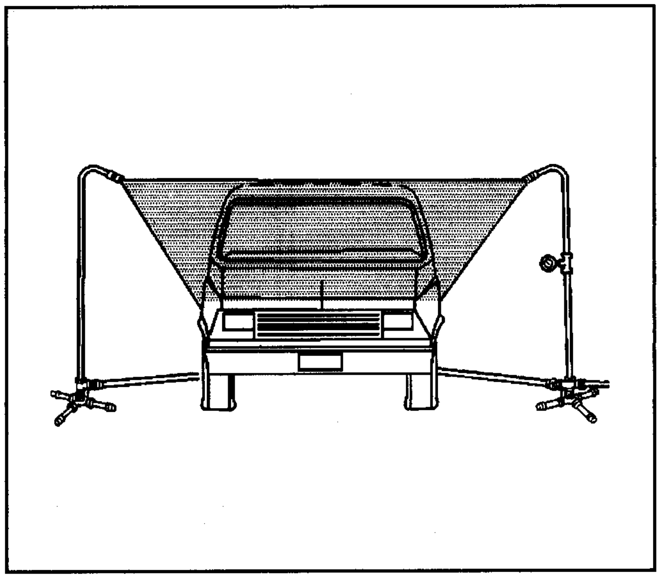
Legend

(1) Pipe (0.5 x 36 in)
(2) Reducing Tee, Right Stand Only (0.5 x 0.5 x 0.25 in)
(3) Coupling, Left Stand Only, (0.5 in)
(4) Tee, Left Stand Only (0.5 in)
(5) Cross, Right Stand Only (0.5 in)
(6) Pipe to Hose Nipple, Right Stand Only (0.5 in)
(7) Female Hose Coupling (5/8 in)
(8) Input Hose, Right Stand Only (2.0 ft) (5/8 in diameter)
(9) Close Nipple (0.5 in)
(10) Cross (0.5 in) with Weld-On Cap (0.5 in)
(11) Nipple (0.5 x 12 in)
(12) Cap (0.5 in)
(13) Female Hose Coupling (5/8 in)
(14) Cross Hose (12 ft) (5/8 in diameter)
(15) Hose Quick Connect
(16) Pipe to Hose Nipple (0.5 in)
(17) Pipe (0.5 x 60 in)
(18) Water Pressure Gage, Right Stand Only

(19) Full Jet Spray Nozzle, No. 1/2GG-25 or Equivalent
(20) Coupling (0.5 in)

1. Assemble the water test stand as shown.



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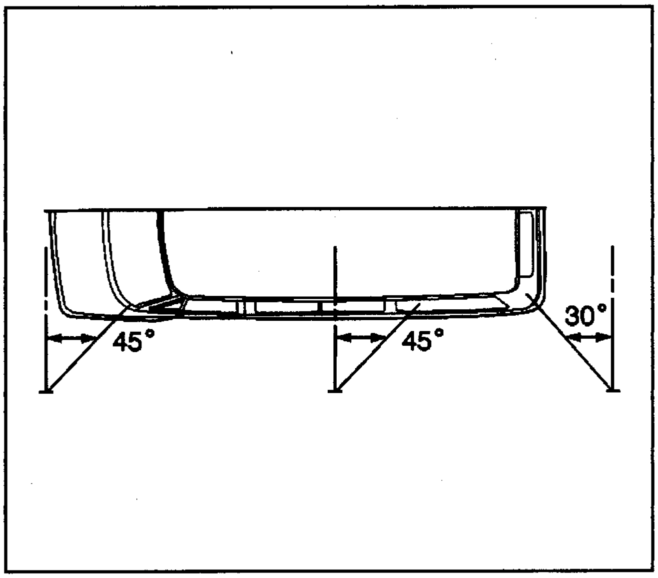
2. Position the stands as shown.

   The water spray from the stands should overlap the vehicle as shown.
3. Have an assistant inside of the vehicle during the test in order to locate any leaks.
4. The water pressure at the nozzle should maintain a 155 kPa (22 psi), for at least 4 minutes.



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5. In order to check the windshield, aim the water spray 30 degrees down and 45 degrees toward the rear.

   Aim the water towards the corner of the windshield.
6. In order to check the side windows for leaks, position the water stand towards the center of the rear quarter, aiming the water spray 30 degrees down and 45 degrees toward the rear.
7. In order to check the back window, aim the water spray 30 degrees down and 30 degrees toward the front.

Dust Leaks

Dust may leak into the vehicle where water will not. This happens particularly in the lower portion of the interior.

Forward motion of the vehicle can create a slight vacuum which pulls air and dust into the vehicle.

In order to determine the location of dust leaks, perform the following steps:

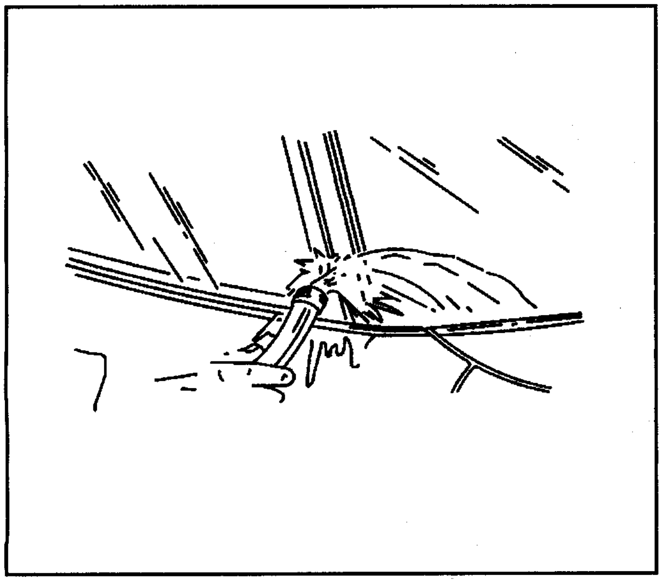
1. Remove the mats from the floor.
2. Remove the mats from the kick panel.
3. Remove the insulation from the floor.
4. Remove the insulation from the kick panel.
5. Drive the vehicle on a dusty road.
6. Examine the interior.

   Dust in the shape of a small cone or slit will usually be found at the point of leakage.
7. Mark the points of leakage.

Important: Ensure that the interior is darkened when performing this step.

8. Shine bright lamps on the underside of the floor and the cowl.
9. Have an assistant mark any points inside of the vehicle for any points where the light shines through.
   - Inspect the weld joints.
   - Inspect the body mounts.
10. Seal any leaks with an air-drying, body-sealing compound.

Water Hose Test



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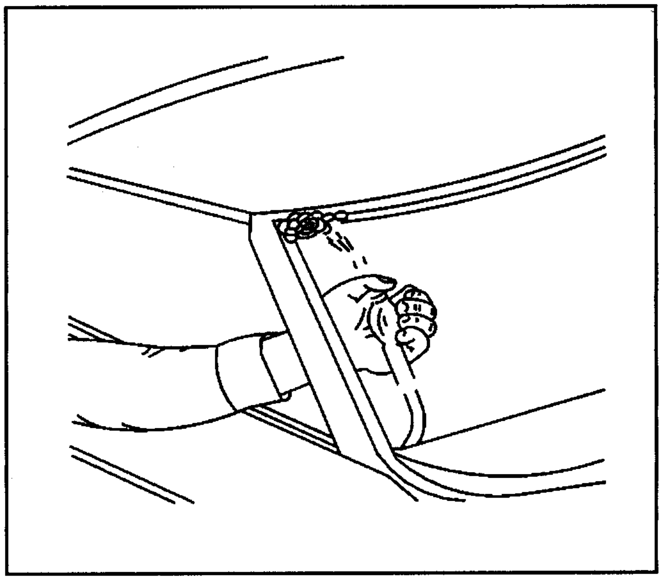
Important: Use a water hose without the nozzle attached.

1. Have an assistant inside of the vehicle in order to locate the leak.
2. Begin testing at the base of the window or the windshield.
3. Slowly move the hose upward and across the top of the vehicle.

Air Hose Test



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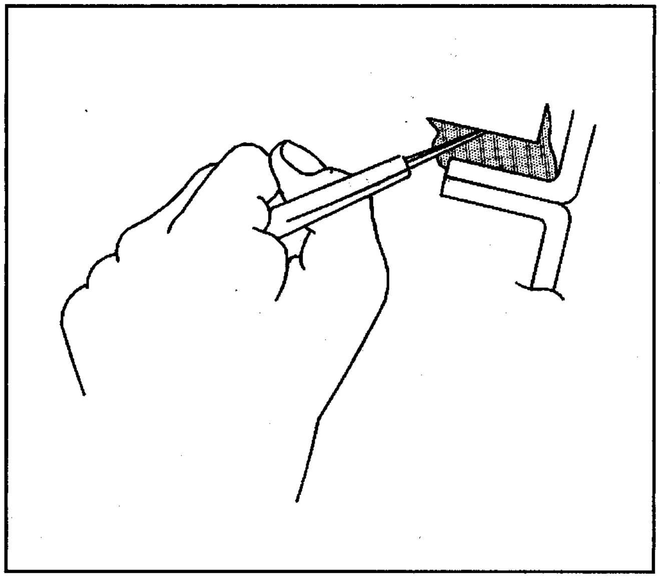
Notice: The air hose test should only be used on fully cured urethane adhesive. Otherwise, damage to the urethane adhesive bead could result in additional leaks.

1. Using a liquid detergent, diluted with water in a spray bottle, spray the window at the edges. Begin at the bottom and gradually move up and across the top.

Important: The compressed air should not exceed 205 kPa (30 psi).

2. Have an assistant inside of the vehicle with an air hose.
3. Have the assistant aim the compressed air at the suspected areas.

   Bubbles will form in the soap solution at the location of the leak.



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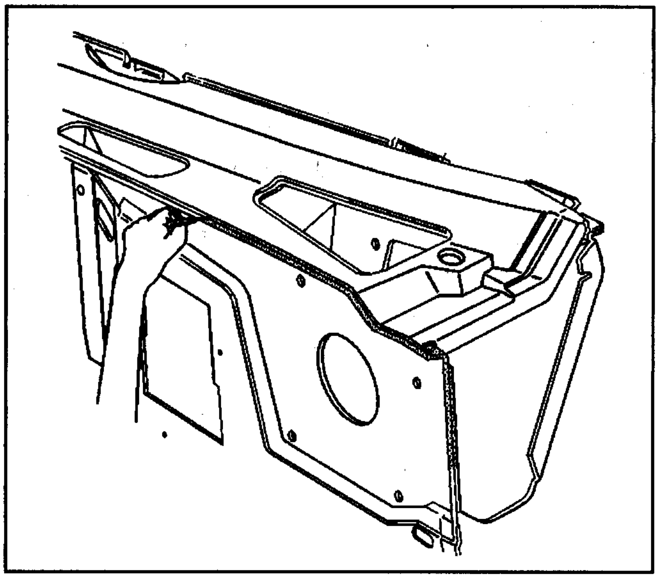

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Repair Instructions

Body Waterleak Repair

Caution: If any water enters the vehicle's interior up to the level of the carpet or higher and soaks the carpet, the sensing and diagnostic module (SDM) and the SDM harness connector may need to be replaced. The SDM could be activated when powered, which could cause deployment of the air bag(s) and result in personal injury. Before attempting these procedures, the SIR system must be disabled. Refer to Disabling the SIR System.

With the ignition OFF, inspect the SDM mounting area, including the carpet. If any significant soaking or evidence of significant soaking is detected, you must perform the following tasks:

1. ***Remove all water.***
2. ***Repair the water damage.***
3. ***Replace the SDM harness connector.***
4. ***Replace the SDM.***

Failure to follow these tasks could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

Depending on the location of the waterleak, you may have to remove certain interior components in order to repair the leak.

1. If the floor carpet is wet refer to *Floor Carpet Drying on page 8-494* in Interior Trim.
2. Cut out a portion of the adhesive caulking in the leak area from inside or outside of the vehicle.
3. Clean and remove all loose particles of the adhesive old caulking from the area.
4. Apply joint body and seam sealer where the old adhesive caulking was removed.
5. Allow the adhesive caulking to dry for several hours.
6. Test for leaks.
7. Install the trim, if removed.

Stationary Window Waterleak Repair

Caution: If any water enters the vehicle's interior up to the level of the carpet or higher and soaks the carpet, the sensing and diagnostic module (SDM) and the SDM harness connector may need to be replaced. The SDM could be activated when powered, which could cause deployment of the air bag(s) and result in personal injury. Before attempting these procedures, the SIR system must be disabled. Refer to Disabling the SIR System.

With the ignition OFF, inspect the SDM mounting area, including the carpet. If any significant soaking or evidence of significant soaking is detected, you must perform the following tasks:

1. ***Remove all water.***
2. ***Repair the water damage.***
3. ***Replace the SDM harness connector.***
4. ***Replace the SDM.***

Failure to follow these tasks could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

1. If the floor carpet is wet refer to *Floor Carpet Drying on page 8-494* in Interior Trim
2. Remove the trim moldings or the headliner in order to repair the leak, if needed.
3. Determine the source of water entry.
4. If water is leaking at the edge of the windshield, reseal the windshield using Urethane Adhesive Caulking Kit GM P/N 12346392 or the equivalent.
5. If water leaks into the vehicle at the sides of the stationary windows, reseal the window using Urethane Adhesive Caulking Kit GM P/N 12346392 or the equivalent.

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