Vibration Solutions

1. Motor Accesories – Disconnect the belts of all motor accessories and run motor. Many vibrations come from fans, water pumps, etc. out of balance.

2. Throwout Bearing - When you install the (new) throwout bearing, remember that the fork AND the springs go INSIDE THE GROOVE in the bearing - I see them installed wrong all the time, with the curled ends of the spring capturing the flange on the back end of the bearing - result is inability to get correct clutch adjustment/free play.

3. Motor Mounts - There were 2 styles of sb frame brackets for 1969 along with 2 styles of motor mount. 307/327 brackets used the non-interlock mount and were wider and taller than the 302/350 bracket. 302/350 brackets used the thicker, narrower interlock mount. Unfortunately most parts jockeys don't know this. The 307/327 mount will be a sloppy fit on the 302/350 bracket and position the engine too low. This mis-aligns the driveshaft and can cause vibration and clutch chatter. If the balancer is close to the sway bar you probably have the wrong mounts. The correct mount is a very tight fit on the frame bracket.

4. Pinion Angle - As a general rule, the pinion angle shouldn't be set relative to the ground, or exact level, but to the output shaft of the transmission.

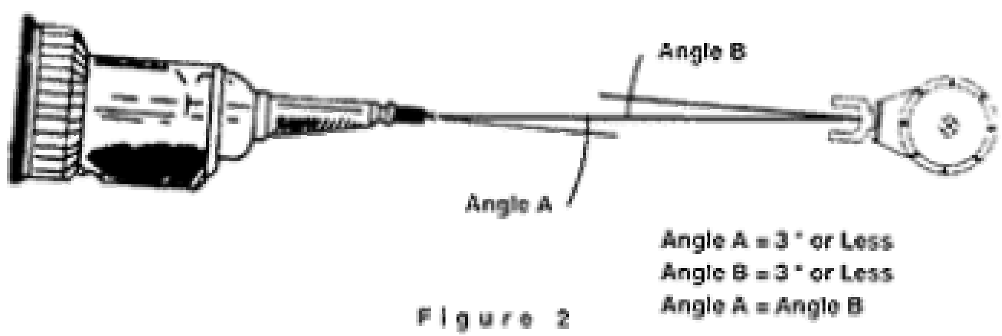


Figure 2

The important thing is that the two center lines are parallel, and that the angle of them to the driveshaft isn't too large, 3 degress max according to the photo above.

The standard configuration for a 1st gen Camaro using standard motor and transmission mounts puts the transmission at approximately 4 degrees down. The pinion needs to be up 4 degrees to be parallel.

While it is possible to run at zero degrees through the U-joints, something more than actual zero and less than three degrees seems to run smoothest.

Angle induced vibration will be high frequency, twice engine RPM in direct drive. It may show up only on acceleration or deceleration. Adjust the pinion down to correct acceleration and up to correct deceleration vibrations, plus or minus one degree is usually enough. Before adjusting anything, make sure the U-bolts holding the driveshaft to the pinion yoke are not overtightened. Correct torque is 17 foot pounds and no more.

5. Misc. Items – Motor or trans or bellhousing hitting the body. Lean misfire or bad/fouled plug. A very common cause of vibrations is a misfiring cylinder. A cracked spark plug insulator, smashed gap or broken ground strap, are some of the causes. If you suspect a misfiring cylinder, the best was to isolate it is to pull each spark plug wire one by one, at idle, and notice the resulting rpm drop. A misfiring cylinder will not result in an rpm drop.

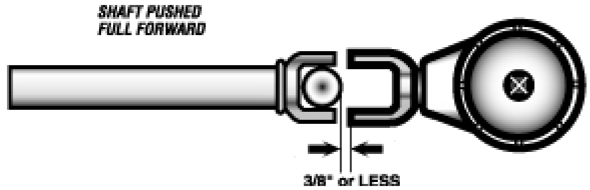
Transmission Mount - Internally-separated trans mount. Aftermarket clutch packages are not known for their balance characteristics. They should be balanced with flywheel.

6. Muncie - transmission mainshaft run-out. I have been building 50 to75 muncie's since 1985 and had problems early on with vibration. It all stopped once I started checking run-out on centers with a dial indicator. I have found that .004" total run-out at the mid bearing surface is max allowable for street use and then you still could get a little high speed vibration. When I build road race or oval track transmissions I only use .001" or less.

7. Driveshaft - Typically, if the shaft is out of balance it will start to vibrate (and make a droning sound) somewhere around 50-60 mph and then get worse as speed increases to a point, and then get somewhat better at even higher speed.

Vibration problem in 3rd & 4th above 70mph. I pulled the driveshaft to have it balanced and found the yolk and tail bushing wallered out. A new lengthed driveshaft and a bushing & seal corrected the problem. I suggest replacing the bushing & yolk anytime you suspect vibration at high speeds. It did not take long to get bad harmonics with the driveshaft that was too short. The proper way to measure a driveshaft correctly is put the yoke in until it bottoms out and pull it back 3/4 of an inch. Measure the length of the U Joint centerlines and have a shaft made with that length. If the yoke is too short to accomodate this correctly and the problem your having is typical of this. Try a new Spicer Yoke Part# 2-3-6081X available from any Dana/Spicer Dealer.

Check your drive shaft for proper fit. Put the car on a drive on rack or on jack stands. With the cars weight on the suspension as you would drive it, disconnect the shaft from the pinion yoke. Push the drive shaft forward till it bottoms into the transmission. You should be able to drop the rear u-joint cleanly past the pinion yoke without resorting to a tool of any kind. Any clearance up to 3/8 inch is fine.



More than 3/8 inch clearance and you are running short by the excess. The greater the excess clearance, the sooner you will be headed for the transmission shop.

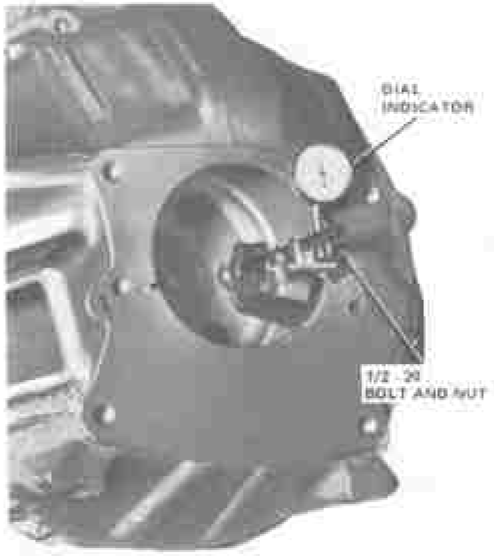
********** If your shaft is not balanced with the actual end yoke and U-joints, you have not fixed the potential vibration problems. A driveshaft will not run smooth and vibration-free unless it is straight and in balance. The recommendation is to dynamically high speed balance the entire shaft assembly at 10,000 rpm.**

8. Pilot Bushing   The pilot bushing is seldom thought of as a part of the clutch system but it is one of the most vital parts of the system. It pilots the end of the transmission input gear in the crankshaft. If it is worn or not running "true", it can cause serious clutch problems or transmission failure. Pilot bushing bore runout should always be checked with a dial indicator and should be within .002 total. The bronze bushing type should be a press fit in the crankshaft bore. It must be installed carefully. It should have between .001 and .003 clearance on the transmission shaft when installed. The pilot bushing is only functional when the clutch is disengaged but it is a factor in input gear alignment at ALL times.

Most people have no idea what an important part the pilot bushing plays in the life of the transmission and clutch. The job of the pilot bushing is to support the end of the input (main drive) gear in the crankshaft and it only acts as a bushing when the clutch is depressed. This pilot bushing should be a light drive fit into the crank bore. Care should be taken when installing any pilot bushing as they are soft and easily damaged by crude installation techniques. A damaged pilot bushing can bind on the input gear giving symptoms of clutch drag. Transmission damage and early failure can be caused by a pilot bushing or crankshaft bore that "runs out" in relation to the transmission locating bore in the bellhousing.

It is advisable to check the bore of the crank with a dial indicator before installing the pilot bushing (see below). If the bore runs out more than .003 total, the crank should be set up in a lathe and the bore trued up OR a special pilot bushing should be made that runs out the same amount as the crank bore.

To check alignment, use a dial indicator with the base mounted to the crank flange to check the transmission pilot hole for concentricity to the crankshaft center line with +/- .010”. Check the face of the bellhousing (where the transmission bolts up) for squareness to the back of the block. Variance should be no more than +/- .010” side-to-side and top to bottom. <u>Also check the fit of the</u>



<u>transmission to the bellhousing and the fit of the pilot bushing to the transmission input shaft.</u>

9. Bellhousing Alignment

On any engine using a standard shift transmission, with or without an adapter, it is important to check the bellhousing locating bore location relative to the crankshaft. The potential for transmission failure or premature wear is so great, due to misalignment at this point, that no engine should be assembled without being checked. The checking procedure is quite simple. Correcting misalignment is not so simple but must be done to insure normal service from the transmission. A dial indicator is required, as well as a suitable means to mount this instrument on the engine crankshaft.

Flywheel Runout - Check the face of the flywheel for runout with a dial indicator. Runout should not exceed .005". If it does, the flywheel should be resurfaced. If runout exists after resurfacing, the fault is either in the resurfacing job or there are burrs, dirt, or dings on the crankshaft or flywheel hub. Remember there is end play in the crankshaft bearings and this must be held in one direction when checking flywheel runout (or bellhousing face runout).

To check a bellhousing, mount it on the engine it's going to be used with, make sure there are no burrs or dirt on the block or bellhousing. All bellhousing to block bolts should be in and tight. Mount the dial indicator on the crankshaft of the engine using a suitable magnetic base attachment or mechanical clamping means. The contact point of the indicator should be touching the bore of the bellhousing. The indicator must be mounted rigidly enough so it does not move on its mounting to prevent false readings. Rotate the engine by hand with the spark plugs removed and observe the reading on the dial. The total number of thousandths misalignment of the bore relative to the crankshaft is read directly on the dial. Total runout should not exceed .007", with .010" being maximum. The greater the misalignment, the sooner transmission problems and failure will occur. A symptom of misalignment is unusual wear of the pilot bushing. We have checked stock Chevy bellhousings on engines that were out more than 1/32" (.032"). Some Ford one are reportedly worse. Anything over .010" runout must be corrected before the engine and bellhousing are put in service or you can count on pilot bushing, transmission, and clutch problems, followed by transmission failure. The simplest way to correct misalignment is to try another bellhousing or bellhousings. Machining the bellhousing is the best cure but offset dowel pins are simpler. Shims between the block and bellhousing will also work if you have the patience to use this method. Offset dowel pins are sometimes available from "speed shops."

The hardest part about the whole procedure is actually mounting the dial-

indicator and stand!
The commonly available magnetic stands, with all their arms and clamps, are bulky and interfere with the bellhousing as you attempt to rotate the flywheel. We spent a good hour trying to figure out how to mount the indicator so that it fits in the bellhousing without interfering with anything. We found that the best way was to mount the gauge on the stand using only one of the clamps, as shown in the photo to the right. We tried using the flexible "snake" type of indicator stand, but it doesn't bend tight enough, as you can see here the gauge needs to be at a 90 deg. angle on the stand.

We found that the best way to mount the magnetic base to the flywheel is to remove two flywheel bolts directly across from one another. This allows the base to sit flat on the flywheel and gives you room to position it as close to the crank centerline as possible. Be sure to install the Lakewood blockplate behind the flywheel, and secure the bellhousing with all six bolts before you measure the alignment! We tried measuring the alignment without it and found our numbers to be way off.

The most important thing to check for when setting up the dial-indicator is to ensure the tip makes contact with the bore lip for the full 360 degrees! The bore of the T5 bellhousing turns out to be just about the same diameter as the length of most dial indicators. Thus while it may look like the indicator tip is contacting the lip, it may not be and you'll get false readings. We ran into this problem at least a half-dozen times. You should watch the top of the plunger, if it looks bottomed out the other end is most likely not making contact.

Once the gauge is mounted correctly, set the bezel to zero and slowly rotate the crank (or have a friend do so.) As you can see in this photo you wont be able to always read the gauge as it rotates, so use an inspection mirror. If you rotate the crank and find that you're getting high-readings through half the travel, then the indicator goes back to zero for the remaining 180 degrees, it means the indicator is not contacting the lip. We'd see as much as .030" runout at the halfway point, then the indicator would come back to zero. The activity of the indicator needle should emulate a mirror image, where for example, you get 0.010" travel above zero and 0.010" below zero. In this example the total travel would be 0.020", divided by two, indicats 0.010" misalignment.

Measure until you get repeatable results! On our first attempts we were seeing numbers all across the board, from 0.010" to as much as 0.040". We found that if you only installed two of the six bellhousing bolts, while it may seem secure, the bellhousing is not flush with the block, which gives a false misalignment. We recommend that when measuring alignment you install both the bellhousing and blockplate and use all six bellhousing bolts, torqued properly. Also make sure the dowels in the block and mating surfaces are clean and free of any crud or paint. Once we went through these precautions the runout for both our bellhousings were within specifications. We removed the bellhousing and remounted it three more times to ensure we could reproduce the same reading each time. Only then can you be confident you have an accurate measurement. If you are not sure and you install corrective dowels, you may make the problem worse.

Correcting misalignment
If you have between 0.005" - 0.025" misalignment, you can correct it with either offset dowels or welding on washers over the dowel holes in the bellhousing itself. The offset dowels come in 0.007", 0.014" and 0.021" offsets. Insert them in the block, and use a screwdriver to 'clock' them in the right spot. You'll need to measure again to make sure you're within spec.

If you're bellhousing requires more offset than this to correct the problem, or you want a permanent fix (the dowels need to clocked every time you remove the bellhousing) you can weld on alignment washers over the dowel holes in the bellhousing. However we would be very skeptical of any misalignment over 0.020", this would indicate to us that perhaps the measurement is incorrect or there is a problem with the block or bellhousing. Before welding any washers we'd advise that you obtain another Lakewood bellhousing and recheck, or check your bellhousing on another block. To weld the washers you'll have to slightly enlarge the dowel holes in the bellhousing, then bolt the bellhousing to the block using the supplied longer dowels. Take a measurement, then carefully tap the bellhousing into position with a mallet, re-measure, and do this until it is centered. Finally torque the bolts, re-measure to make sure you didn't disrupt the alignment, then slip the washers over e dowels and weld them in place.

9. GM Clutch Release Bearings
Let's assume we are still working with a 10½" or 11" Rockford (diaphragm type) clutch on a GM engine. Install the flywheel (always have it resurfaced before this procedure), clutch disc, pressure plate and clutch housing on the engine. Be advised that there can be NO oil or grease on your hands, the flywheel or pressure plate friction surfaces, or on the clutch disc. If there is, the clutch will grab (chatter) when being engaged.

Install the correct length clutch fork on a 1½" long pivot that has the correct head type for the retainer on the fork (refer to fork and pivot information previously discussed). Position the fork so it sticks out of the clutch housing at about 4 or 5 degrees less than a right angle with the engine centerline (this would be when looking down on the engine from above—the fork should be ahead of, or less than a 90 degree angle by 4 or 5 degrees).

Install the transmission on the clutch housing. The release bearing must be able to move away from the diaphragm spring approximately 1/16 to 1/8" (this is the "free play"). At this point you should be able to move the release bearing back and forward with the fork. The bearing, when against the clutch, should leave the release fork positioned at 4 or 5 degrees LESS than a right angle with the engine centerline and allow it to be moved away from the clutch 1/16 to 1/8". If this condition does not exists, do not install the assembly into the car until it does. If not, you may need a different clutch release bearing or pivot or you may have the wrong fork.

Vehicle Vibration Diagnosis Checklist

	AREA	PART	POSSIBLE PROBLEM
☐	Body	Loose Body Mounts	
☐	Body	Rusted Body Mounts/Brackets	Check #4 First
☐	Brakes	Rotors	Out of Round, Wobbling, Cracked Fins
☐	Brakes	Calipers	Loose Caliper Bolts
☐	Clutch	Pilot Bushing	Loose, Worn
☐	Clutch	Flywheel	Out of Balance
☐	Clutch	Flywheel	Out of Balance, Surfaced too much, Loose, No Dowel Pin
☐	Clutch	Clutch Pressure Plate	Plate Off Center, Out of Balance, Bent Housing
☐	Clutch	Clutch Disk	Out of Round, Dropped, Out of Balance
☐	Clutch	Bellhousings	Cracked or Hole not Concentric to Crankshaft
☐	Clutch	Bellhousings	Wrong Size Hole for Trans Collar
☐	Engine	Water Pump Shaft	Bent,Loose Bearing
☐	Engine	Fan Clutch	Loose, Bad
☐	Engine	Fan Blade	Bent, Out of Balance
☐	Engine	Balancer	Loose, Spun on Rubber, Bad Keys
☐	Engine	Motor Mounts	Cracked
☐	Engine	Tune-up	Misfiring

☐	Engine	Carb	Misfiring
☐	Engine	Crankshaft Rear Flange	Bent, Loose Flywheel Bolts, Worn Dowel Pin
☐	Frame	Cracked Bent or Rusted Frame or Crossmembers	
☐	Frame	Cracked Front Frame Supports, Extensions	
☐	Frame	Loose Bumper Brackets, Bumpers, Impact Bars	
☐	Rear Axle	Spindles	Loose or Improperly Shimmed Bearings, Bent Spindle, Bent Studs
☐	Rear Axle	Flanges	Bent Flange or Loose Bolts
☐	Rear Axle	Flanges, Half Shafts	Wrong Combination, Wrong Alignment
☐	Rear Axle	Half Shafts	Bent, Out of Balance, Loose U-Joint Holes
☐	Rear Axle	U-Joints	Not Seated Properly, Off Center, Wrong Caps, Clips Missing
☐	Rear Axle	Axle Yokes	Bent, Not Seated U-Joints, Not Machined Correctly, Loose Bolts
☐	Rear Axle	Pinion Flange	Bent, Machined Wrong, Loose Bolts
☐	Rear Axle	Pinion Snubber Bushings	Loose or Worn Out Cushions or Loose Bolt
☐	Rear Axle	Pinion Snubber Bracket	Slotted Bracket Holes or Loose Bolts
☐	Steering	Wheel Bearings	Loose or Bad Bearings
☐	Steering	Steering Gearbox	Loose Internally or Loose from Frame
☐	Steering	Frame at Gearbox	Check for Cracks
☐	Steering	Steering Column	Loose, Bent
☐	Steering	Steering Rag Joint	Loose, Worn Out
☐	Steering	Tie Rod Ends	Loose or Indexed Wrong
☐	Steering	Idler Arm	Loose at Bearing or Frame
☐	Steering	Pitman Arm	Loose or Oblong Hole

☐	Steering	Power Steering Valve	Loose Ball, Not Properly Screwed onto Relay Rod
☐	Steering	Manual Steering Relay Rod	Bent Rod or Loose Ball Stud
☐	Steering	Relay Rod	Bent Rod or Loose Tie Rods or Oblong Holes
☐	Suspension	Front Spindles	Bent Spindles or Loose Bolts on Steering Arms, Oblong Holes
☐	Suspension	A-Frames, Shafts, Bushings	Bent A-Frames or Shafts, Loose Bushings, Missing Bolts
☐	Suspension	Ball Joints	Loose, Not Lubricated, Not Riveted or Bolted Properly
☐	Suspension	Shocks	Worn, Loose, Leaking, Bolt or Grommets Missing
☐	Transmission	Trans Input Shaft	Bent
☐	Transmission	Trans Output Shaft	Bent
☐	Transmission	Trans Tailhousing Bushing	Worn
☐	Transmission	Trans Mounts	Cracked
☐	Transmission	Trans Yoke	Worn
☐	Transmission	Driveshaft	Bent, Out of Balance, Balance Weight Missing
☐	Wheels/Tires	Hubcaps	Heavy Wire Style Hubcaps May Effect Balance
☐	Wheels/Tires	Wheels	Bent, Loose Lug Nuts, Wheel Adapters
☐	Wheels/Tires	Tires	Bad, Out of Round, Out of Balance, Broken Cords
☐	Test Drive	Check at what speed vibration comes in	
☐	Test Drive	Check whether it is MPH of RPM related	
☐	Test Drive	Check whether it goes away with clutch disengaged	
☐	Test Drive	Get up to speed where vibration is the greatest, Then:	
☐	Diagnosis	Disengage Clutch, Does Vibration Go Away?	

☐	Diagnosis	With Clutch Disengaged, Rev Motor Up & Down	
☐	Diagnosis	Does the Vibration Relate to Engine or Road Speed	
☐	Diagnosis	With Car Sitting Still, Rev Up Engine to Check for Vibration	
☐	Diagnosis	Short Out Cylinders to See if Vibration is Related to One Cylinder	
☐	Diagnosis	Disconnect All Belts to Eliminate Front Engine Accessories	
☐	Diagnosis	Install a Different Set of Wheels and Tires to Eliminate Them	
☐	Diagnosis	Run the Vehicle on the Hoist with Jack Stands at Rear to Load Suspension Properly	
☐	Diagnosis	Spin Balance Wheels on Vehicle	
☐	Diagnosis	Hoist Testing will Eliminate Front Suspension, Steering, and Road Vibration Problems	
☐	Diagnosis	Using a Stethoscope or Wooden Dowel on Components will Amplify Noises and Vibrations	
	Notes:	Clutch & Flywheel Problems Tend to Be Felt at around 1800 and 3600 RPM	
	Notes:	Tire Balance Problems Tend to Get Worse With Speed	
	Notes:	Front End Problems Can Come and Go With Different Speeds. They Plane Out Sometimes	
	Notes:	Front End Problems Tend to be Felt in the Steering Column	
	Notes:	Clutch, Flywheel, and Trans Problems Tend to be Felt in the Shifter	
	Notes:	Rear End Problems Tend to be Felt in the Seat Bottom	
	Notes:	Body, Frame and Bumper Problems Tend to be Felt in Body Vibrations	
	Notes:	Vibrations Tend to Come From Items With Great Mass at a Great Distance from Centerline	
	Example:	You Can Get a Vibration from a Tire, But You Wouldn't Get One From a Spindle Nut	