Before You Install Your Transmission

There are certain inspections and steps you want to take before installing a new or different transmission in your car or truck that will assure a "one-time" installation. Doing these steps only take a few minutes and will save you headaches and head scratchin' down the road. We recommend performing each check before trying to assemble-as-you-go following the below steps.

1) Pilot Bushing or Pilot Bearing – Both accomplish the same goal to support the pilot tip of the transmission input shaft. Not all engines can accept a bearing due to limited space available in the crankshaft and in some applications a bearing may stick out and cause interference with either the clutch disk or the splines on the input shaft. Your retailer may not have this information so some homework may be required on your part to make sure you'll have enough room if you're trying to run a bearing.

   There are two common things to make sure of when it comes to pilot support… one is did you put one in? We've seen transmissions get destroyed and clutches not release properly because someone forgot to install a pilot bushing/bearing. Oops! Secondly is the right size pilot bushing or bearing. Too big you get premature bearing/gear wear and clutch chatter, too small and you get an energized input shaft… which we'll talk about later. So verify this: the pilot tip and the bearing or bushing should have about .0005 to .003 clearance. Not to be confused with an interference fit which is a NO-NO. This check can be preliminarily checked with the bearing or bushing not installed in the crank but MUST be verified after it is installed in the crank because the inside diameter will shrink.

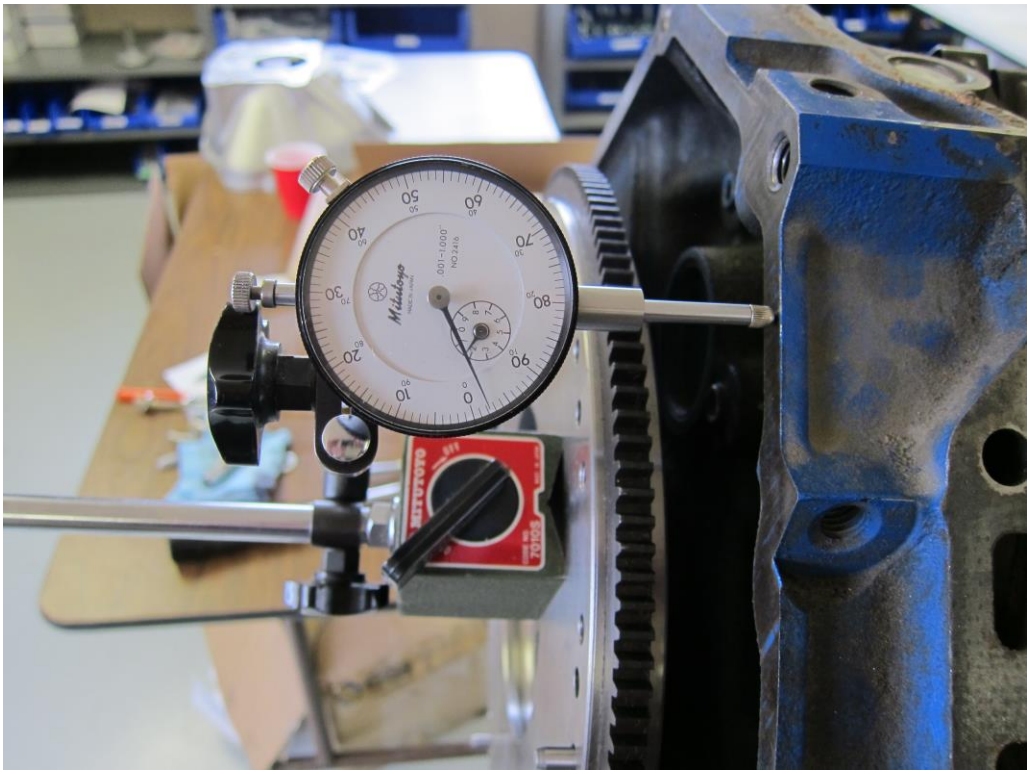
   Story time – the whole reason this article was written was because a customer had purchased a brand new crate engine with a pilot bearing installed in the crank. When the engine assembler installed the bearing they must have used a massive hammer which deformed the bearing making it too small and energizing the input shaft we spoke of above. Why would a person even question this? It's a brand new part right? It must be good. Well… now we know differently. The customer fought for two weeks questioning the clutch, clutch release and the transmission before taking the trans back out to find this simple error. The bearing was replaced with nothing else done and the problem was solved.

2) Flywheel Balance – Depending on the engine, it could be externally balanced or internally balanced. You will want to make sure the crank, flywheel AND harmonic balancer all have the same *Zero Balance* or *Imbalance*, as it's called. Ask your engine builder if you're not sure. Aftermarket engine stroker kits typically follow existing motor balancing, but not always. The stroker kit manufacturer will have this information for you. Yeah I know… more than just the flywheel info here but it all plays together on the engine.

Shown is a Ford billet flywheel with a 28oz imbalance.

3) Flywheel Tolerance – This check will require a dial indicator and a magnetic base. Flywheel must be installed and torqued to specification. Check the flywheel run-out by placing the magnetic base mounted to the transmission mounting surface of engine block and set the dial indicator on the flywheel. Rotate the engine and monitor the run-out of the flywheel rotation. The industry standard allowable tolerance is .0005" per 1". Ex: 14" diameter FW is allowed .007 run-out.

Shown is the Flywheel Run-out check. Mount the magnetic base to the block and dial indicate the flywheel to check flywheel run-out.



Shown is the block run-out.

4) Bell Housing & Block Plate – Multiple checks to do here. You'll want to check five things before assembling all your components: Bell housing fit to engine and transmission, perpendicular alignment, bell housing run-out, and block plate interference. All of these checks will require a dial indicator and a magnetic base, except the block plate check (not applicable to some applications).

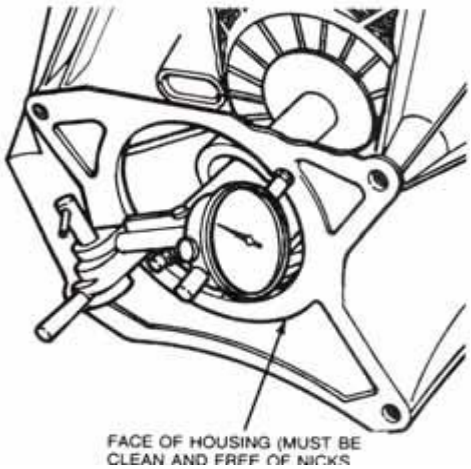
   Let's start with the Block Plate. AKA Starter Plate, Separator Plate, Engine Plate, (the flat piece of metal that goes between the bell housing and the motor). We've heard it all. Make sure there are no interferences with the oil pan lip (edge), back-of-block protrusions, and crank. You'll also want to pre-fit your flywheel, looking for pinch (crush) of the block plate to the forward side of the flywheel. Some flywheel models are not undercut in this area and can interfere.

   Fit-check the bell housing to the transmission. The registration opening should fit snugly and smoothly on the bearing retainer of the transmission. Make sure any painted block and bell surfaces are smooth and evenly painted. Make sure there is no build-up of rust (high surfaces).

   Ford – Cable pivot studs, located in the passenger side of the bell housing, are critical height at 3.1" to 3.2" high, as measured from the top of the mushroom head to the transmission mounting surface (back surface of the bell). Make sure the lock-washer is installed under the pivot stud – this assures correct clutch lever (fork) geometry.

Install the bell housing to the engine and torque to specifications. It should fit snugly on the two alignment pins located in the engine block. *Make sure any painted block and bell surfaces are smooth and evenly painted. Make sure there is no build-up of rust (high surfaces).*

To check the bell housing perpendicular alignment (to back of block), attach the magnetic base to the flywheel and set the dial indicator on the transmission mounting surface of the bell housing. Rotate the engine and check the mounting surface in various locations. The surfaces should be within .0015 of Zero difference.



The biggie is to verify the registration opening in the bell housing is aligned with the crank. To do this, attach the magnetic base to the flywheel and set the dial indicator on the inside edge of the registration opening and rotate the engine. The difference in inches should be no more than .010 total run-out which would .005 off center. This is the max allowable mis-alignment allowed.

5) Clutch Pressure Plate – Does it fit the flywheel you have? Some flywheels have multiple clutch patterns on them to accommodate various equidistant, LONG (aka Borg & Beck pattern) or custom patterns. Make sure you can install the pressure plate properly. Never modify the mounting holes in the flywheel, never drill new mounting holes in the pressure plate or flywheel, and ALWAYS use the correct fasteners. There will either be locating pins and non-stepped bolts OR step-bolts and no locating pins. If you install a pressure plate that does not use pins and install non-stepped bolts you will get a vibration. Also… clutch pressure plates are balanced independently of any other assembly. Never balance an engine with the pressure plate installed. You can check the balance with the pressure plate installed but do not re-balance the pressure plate. If your engine builder finds a problem with the balance of the pressure plate… replace it or rebalance it. And never check this with the disk installed since the disk cannot be perfectly centered.

6) Clutch Disk – the life decision maker of the whole manual transmission set-up. Install it correctly. The top-hat side of the disk goes towards the transmission. There may also be a sticker on the clutch disk indicating which side goes which way. Verify the spline of the disk matches the spline of the input shaft of the transmission. Verify the clutch disk fits within the pressure plate opening and the edge of the disk comes to or very near the outside edge of the pressure plate surface. Too small of a disk will not be as effective. Additionally, set the disk in the opening of the flywheel and check for the same clearances. Make sure the disk does not come in contact with the flywheel bolts. The flywheel must be installed on the engine to do this check.

   Story time – we had a customer that returned a clutch assembly on a prototype flathead for review and upgrade. The customer described how well the clutch acted in the car but started having problems. It turned out that the sprung hub of the clutch disk interfered with the flywheel bolts. This interference caused an energized shaft. We switched to ARP bolts (which have a lower profile head) and the problem was solved.

7) Clutch Installation – When installing your clutch assembly on the flywheel make sure all the above was addressed. Check the alignment tool. Verify it is the same spline count and pilot tip diameter as the bearing/bushing and the transmission tip. The wrong size tool may not center your disk correctly making transmission installation difficult. Tighten down the pressure plate bolts evenly. Not doing this could temporarily warp the pressure plate and bind the alignment tool throwing off the disk center as you finish

tightening down the bolts. The alignment tool should slide in and out easily if the alignment of the disk is correct.

8) Throw Out Bearing Installation – Whether it's a mechanical bearing or a CSC (Concentric Slave Cylinder – hydraulic bearing) it must be installed correctly before installing the trans. Mechanical bearings get installed on forks (levers) and CSC's get set-up with the req'd .125" clearance. Individual instructions vary by manufacturer or type. Refer to those instructions for proper set-up.

   Additionally… mechanical throw out bearings used to require a gap, otherwise they would wear-out prematurely. The new generation of sealed mechanical throw out bearings allow for constant-contact of the throw out bearing. Constant contact is standard for hydraulic clutch actuation, and cable release on some cars.

9) Clutch Fork and Clutch Lever – A Clutch Fork rocks on a fulcrum on the driver's side of the bell housing and a Clutch Lever attaches to a pivot stud on the passenger side of the bell. The ideal geometry for both of these is the throw-out bearing, pivot/fulcrum, and actuation attach point (Z-bar linkage, cable or external hydraulics) are all parallel with the flywheel when the pressure plate fingers are depressed ¼". Having this correct geometry will provide you with the most consistent feel of the pedal and least amount of travel requiring the clutch disk to release. There are some standard dimensions for various applications and using matching parts with non-adjustable pivots/fulcrums should give you this favorable condition.

10) Transmission Stack-up/Clearance Checks – Make sure the pilot tip penetrates the pilot bearing or pilot bushing by atleast ¾ of the way on the smallest surface. EX: a pilot bushing that is ½" thick, you want atleast 3/8" surface of the pilot tip touching. It is okay to completely penetrate a bushing or bearing.

    There should be at least 1/16" clearance between the pilot bearing/bushing and the (next step) splines of the input shaft. Make sure there is 1/8" (.125") gap between the guide tube and the clutch disk. No gap will result in catastrophic failure. There must be room for the disk to wear and "room for release" when the pressure plate is released.

11) Transmission Installation – DO NOT DRAW IN THE TRANS WITH THE BOLTS! When installing the transmission it should go in as smoothly as the fitment you did on each of the components individually and the trans should slide all the way in and make contact with the bell. Make sure the bearing retainer guide tube does not hang-up on a mechanical t/o bearing.

    Story-time – we had a customer install a transmission and draw in the trans with the bolts. Car started up and ran okay and after the trans got warm… it leaked. As it turned out the customer had an interference issue with debris in the end of the crankshaft that jammed up the input shaft of the transmission during the install. When the car started it overcame the debris and the input shaft was fine. However the interference was enough that it cracked the transmission case and it wasn't noticeable until the oil warmed up and found a leak path. This has happened more than once. So… be careful.

12) Engine Thrust Bearing – Manual transmission cars endure more stress than an automatic transmission equivalent. The engine trust bearing can determine the amount of "push" needed to release a bearing. Make sure the thrust bearing falls within spec requirements.

    Story-time – my sister once had a '92 V-6 Camaro with 5 speed trans. The factory grind on the crank wasn't smooth enough to prevent wear. Needless to say, they got a fresh motor having over .100 play by the time it was noticed what was wrong. Ouch!

13) Grease & Sealant – Always seal the flywheel bolts on a crank with open holes going into oil pan, when final installing them, whether it's a thread locking compound or Teflon sealant. Not sealing the threads will result in oil getting on the disk surface. Always grease the pocket on a mechanical bearing – this is the surface that rides on the guide tube of the input shaft. DO NOT grease the splines of the input shaft or the splines of the disk – this must be dry for the same reason. Pilot bearings and bushings are treated differently. Do not pack the crankshaft with grease. Lightly grease a pilot bearing, DO NOT grease a pilot bushing.

14) Energized input shaft – An energized input shaft is a term used to describe constant turning of the transmission gears, with the clutch pedal pushed in and in neutral, and it's hard to shift in or out of gear, while the engine is running. There are a few reasons this can happen and each of those things were discussed in the individual sections. Bottom line is you have a mis-alignment, interference, or clutch release issue.

Things that can cause an energized input shaft are:
Defective or missing pilot bearing/bushing, discussed above.
Not enough clutch release.
Too much Marcel in the clutch disk – this is the springiness of a clutch disk. You will be able to squeeze the disk with your fingers to flatten it out. Too much of this spring can cause drag when clutch is released, tasking the synchronizers in the transmission to work extra hard and cause premature wear. The Marcel is what allows the disk to align itself between the flywheel and pressure plate and eliminate that chatter during a slow clutch release. On the flip side, not having any Marcel will cause jerking and chatter. It's such a small thing that plays a huge part in how a vehicle performs.
Misalignment of the input shaft to the crank, also discussed above.

FAQ – shifts good when cold vs. hot.
Adjust clutch.