Additional Backlash Issues that are NOT Caused by a Loose Mesh Between the Worm Gear and Worm Wheel These instructions apply to the Mach1GTO, 900GTO and 1200GTO

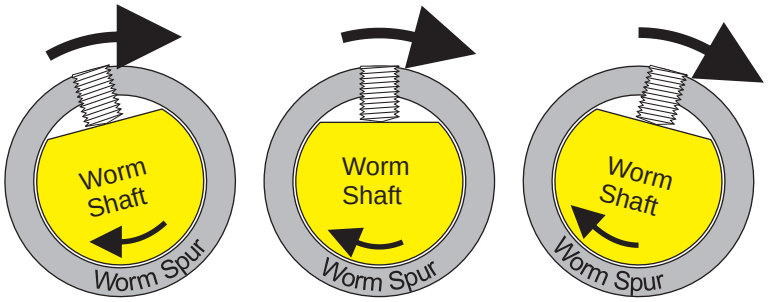
Backlash and related backlash-like problems are often discovered when reversing direction to center an object in the eyepiece or when manually guiding or autoguiding while imaging. You might also experience pointing inaccuracies. The symptoms can be either a long delay in movement when reversing direction, or a small movement in a perpendicular direction before correct movement begins. This is especially an issue with the declination axis where corrections can actually involve a change of gear direction as opposed to the RA axis where a direction reversal when guiding is really either just a slow-down or momentary stoppage of the continuous forward tracking and no full reversal of direction in the gears is occurring.

These instructions will deal with issues other than the direct mesh of the worm gear with the worm wheel which are discussed fully in other documents. If you discover these symptoms, you should first verify that you have a proper meshing of the worm and worm wheel. Perform ALL diagnostic tests with keypad and software backlash settings at zero or none! If the problem persists, it is time to try the solutions outlined below. Note that these instructions apply to Mach1GTO, 900GTO and 1200GTO mounts that have been produced since the late 1990's. The instructions do not apply to older non-GTO mounts like the QMD or HD series. Do not worry if the photo doesn't look exactly like the axis you are concerned about. The concepts and procedures outlined below will be the same regardless.

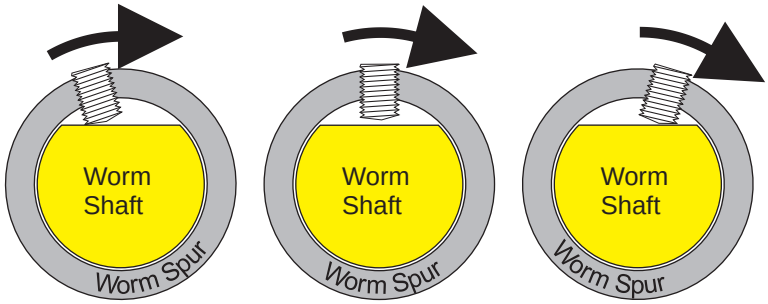
The Loose Spur Gear Set Screw

If you are experiencing long delays in direction reversal, but you are confident that your worm gear to worm wheel mesh is good, then the problem is most likely a loose spur gear on the worm gear shaft. Be sure first that your gear mesh is correct as described in the backlash document for your mount. The spur gear becomes suspect when you cannot feel backlash in the system, but you experience delays in direction reversal when moving with the direction buttons at slow speed like 1X or in autoguiding. A loose spur gear will not cause a perpendicular motion, but since that problem may require the removal of the spur gear, it is suggested that you read on and not skip ahead.

The illustration at right shows what happens when the set screw is loose or is not centered on the flat surface on the worm shaft. This is a relatively easy thing to both diagnose and repair.



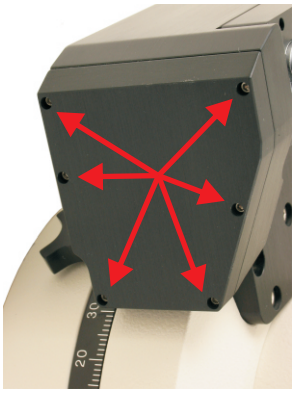
Correct - Tight Set Screw Centered on the Flat Spot on the Worm Shaft Causes Worm to Turn with Spur Gear

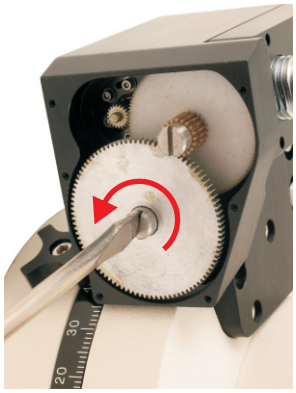


Loose Spur Gear Set Screw Causing Slop in Gear Train. Spur Gear Turns Without Turning Worm Gear.

Diagnosis and Repair

Start by removing the gearbox cover from the motor / gearbox on the axis in question. To remove the cover, simply remove the socket head cap screws indicated by the arrows at right. Be careful not to lose the screws!

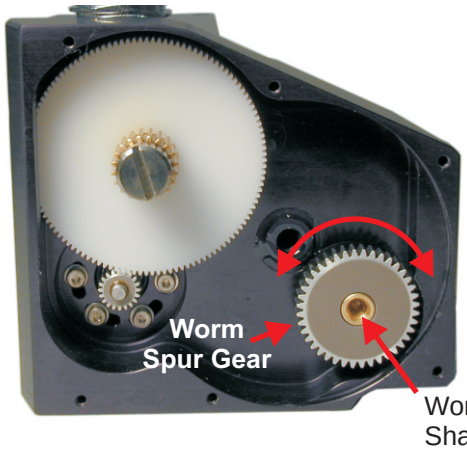




Remove the cover to expose the clustered spur gears beneath. The worm's spur is hidden underneath the large spur gear that is on top of the cluster. This top cluster gear must be removed.

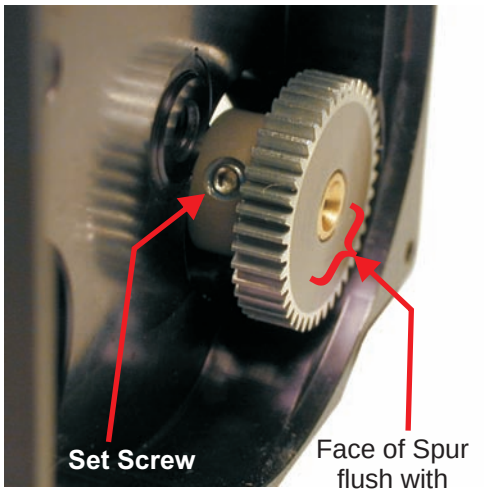
Use a standard flat head screwdriver (900GTO & 1200GTO) or 3/8" socket (Mach1GTO) to undo the shoulder bolt that holds the gear in place and then remove the gear. See the photo at left.

Take hold of the worm's spur gear and turn it back and forth. If the set screw is loose, you will feel some slop between the spur and the worm shaft. The spur gear should feel as if it were welded to the worm. If the spur can turn without subsequently turning the worm, you have found the source of the problem.



The set screw is on the collar on the back side of the spur gear. You will probably have to turn the spur and worm to get clear access to the screw. On older 900/1200 mounts, the set screw probably takes a 1/16" Allen (hex) wrench. Newer mounts including all Mach1s will have larger set screws requiring a 5/64" Allen wrench.

Be careful to fully seat the wrench into the socket of the set screw so that you don't wallow out the socket hole. The Bondhus™ Allen wrench set that is included with your mount has a ball end on the long leg of each wrench that will be helpful.



Before tightening the set screw, you need to properly position the spur gear on the worm shaft. There are two parts to this. The spur gear must be positioned laterally along the shaft to properly engage the next gear, and it must have the set screw centered radially over the flat spot on the worm shaft.

For the lateral positioning on the 900/1200 mounts, start by making sure that the spur is roughly flush with the end of the worm shaft. With some mounts, you may need to push the spur gear on a tiny bit further to prevent contact with the gearbox housing. For the Mach1GTO, fully seat the spur gear until it stops.

To align the set screw with the worm shaft's flat spot, turn the spur back and forth and position it in the center of its free play. Turn the set screw in just until it makes contact, and then test the centering of the spur over the worm shaft's flat spot by turning it back and forth again. It is very important that the set screw is dead-centered over the worm shaft's flat spot.

If you are unsure where the center of the flat spot is, remove the spur gear completely and make a small mark on the end of the worm shaft with a Sharpie marker to mark the spot so that you can see it when the spur gear is re-installed.

Tighten the set screw, and give the spur gear one final test by turning it back and forth. The spur gear and worm should feel like they are made from one piece of material, and should have NO play or slop whatsoever between them. (Of course, you must distinguish any play between the spur and worm from any play caused by the mesh between the worm gear and worm wheel.)

If you wish to re-grease the spur gears while the gearbox is open, use a good quality lithium grease rated for the temperatures that the mount is likely to encounter. It will not generate significant additional heat in operation, so a high temp grease is unnecessary. You should probably be more concerned about the cold end of the grease's temperature rating. Astro-Physics uses Lubriplate 105, but this is certainly not a requirement.

As important as lubricating the gears themselves, is to place some lubricant onto the shoulder bolt shafts that serve as the axles for each reduction spur gear. In ALL applications of lubricant, only a very light greasing is recommended. Do not pack in extra grease!

Replace the top spur gear that connects the worm spur to the motor side of the reduction gear train and firmly tighten the shoulder bolt. DO NOT OVERTIGHTEN! This is especially true with the MACH1GTO where you will have the leverage of a 3/8" wrench on the bolt! You are now ready to replace the gearbox cover and its socket cap screws. Pat yourself on the back for a job well done!

Adjusting the Worm Bearing Pre-load

This section is currently in process. This adjustment is to remedy a possible perpendicular motion at the start of any direction reversal. In other words, if reversing directions in declination, you first experience a small shift in R.A., you may need to adjust the worm bearing pre-load. This is a rare problem that will require different instructions for different generations of mounts. Identical symptoms can also be caused by problems other than the worm bearing pre-load. For now, please contact Astro-Physics if you believe that you have this issue.