

THE ZF TRANSAXLE - PANTERA VERSIONS  
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I. GENERAL

Let it be said at the outset that your ZF transaxle is expensive. Expensive to buy, fix, or replace components. It is the single most costly component in your Pantera - much more so than the engine and deserves the best of care. It is expensive because it is German, because it is genuine quality, because it is produced in relatively low volume, and because it has no competition.

The ZF 5DS-25/series is the only transaxle featuring all synchronised gears designed for high torque output engines. It has remarkably low maintenance requirements and given proper care could outlast - at virtually no upkeep cost - the life of the entire balance of your Pantera!

The transaxles in Panteras are "descendants" of the racing ZF's used in the GT-40's and as late as 1976 in the Gulf Mirages. In pure racing applications the 5DS-25/1 has generally been replaced by a big English Hewland which is slightly lighter, features quick change of intermediate gear ratios, has cheap engagement "dogs", but also requires as much maintenance as a helicopter, has no synchronisers and is noisy as hell.

Technically, your ZF is a gearbox with axle drive, having 5 fully synchronised forward gears and one reverse gear assembly with sliding gear. It is so assembled that the main gear box and the axle drive are accommodated in one housing. The axle drive consists of a spiral toothed crown wheel and pinion and is equipped with a ZF limited spin differential (Lok-o-Matic). The front part of the gearbox is constructed as a bell housing and accommodates the clutch release mechanism with an external control lever. Thus the gearbox can be flanged directly to the engine and forms with this a complete unit. The shift connection is built for a remote gear change and is placed on the left side of the gearbox as it sits in a Pantera.

The input shaft runs over the axle drive into the main gearbox. The output shaft lying below is at the same time the input pinion for the spiral toothed crown wheel and pinion and transmits the torque to the differential. From the two output flanges the power is transmitted directly to the driving wheels of the vehicle by means of the 1/2 shafts. The mating gears of the forward speeds are constantly in mesh. While a wheel of each gear is fastened firmly on the shaft, the needle bearing counter wheel can turn freely. During gearchange, the speed of the members to be coupled are synchronised by ZF-B Synchronisers. The respective gear wheel is coupled with the shaft by means of the toothed sliding sleeve and thus the power flow is guided over the corresponding gears. The sliding sleeves are protected against jumping out of gear. Built in shift locks ensure that only one gear can be engaged at a time. In reverse gear, the direction of the output speed is altered by intermediate selection of the reverse gear wheel.

The ZF limited spin differential (Lok-o-Matic) consists of a bevel gear differential with 2 disc brakes and is placed between the side gears and the differential body. As against a normal differential, it prevents spinning of one wheel on starting up or traveling when one side is on a road with poor adhesion. Moreover, it will reduce the tendency of a bouncing wheel to spin and thus lessen the danger of skidding.

Since all forward gears on the 5DS-25/2 are fully synchronised, a fast, reliable, and noiseless gear change can be effected without double de-clutching on shifting up and without revving up when shifting down. On shifting, the selector lever of the synchronised forward gears should be pressed in evenly and smoothly. Due to the construction of the synchronisation, only when the synchro process is at an end does the selector lever move into the final selected position. To protect synchronising components in the transmission, in the main clutch and the engine, shifting down should be effected only when the driving speed corresponds to the maximum speed of the next lowest gear.

Reverse gear should be engaged only when the vehicle is stationary as otherwise the dog teeth may be damaged.

II. LUBRICATION/CARE

Now that you know all about your ZF, what can you do to protect your investment in this marvel? Simple: Keep it clean. Keep clean proper lubricant in it of the right

amount. And don't mishandle it. The majority of "boxes" sent to ZF-America need repairing because of (a) worn or broken synchronisers, or (b) "burn-ups" or "wear-outs" due to inadequate lubrication. ZF-America's recommendations for you as an owner are:

Occasionally spray your transaxle (when it is warm) with engine degreaser and hose it off. You'll have to remove the fiberglass luggage tray to properly get at it. Temporarily tape closed the breather tube so water doesn't get in it. We consider it important to keep the box externally clean in order to keep it cool so the proper weight lubricant doesn't thin out. Team-Pantera had an oil cooler pump fail during racing last year. Within 15 minutes the temperature went right off a 320 degree gauge and subsequently blistered the paint off the tail cover. While your ZF is not used in racing with 500+ hp being fed through a full locker rear end, it still gets plenty hot. Keep it clean to keep it cool. Forget about adding an oil cooler, it is not worth the problems and expense of pumping the oil to it.

Be certain the clutch is properly gapped. When Panteras were being delivered new from dealers, over 1/2 of those we saw had improperly adjusted clutches! They did not fully disengage, causing "dragging" shifts and grinding of gears. The problem was not in the box as commonly supposed. Left uncorrected, this condition not only makes driving unpleasant, but will "eat-up" your ZF, making for expensive repairs.

Lubricate the shifting shaft where it passes through the support below the left hand exhaust header. Stick the tip of a long-nosed oil can under the rubber lip to do this. "Sticky" shifting can also be caused by having the shifting shaft rotationally misaligned so that the gear shift lever rubs against the numbered gate. This is why so many owners have found need to grind off the "fingers" on the gate. This trick surely makes the shifting easier but invites other damage if the driver is not careful. Fixing shaft misalignment is as easy as properly adjusting the clutch, since it is only held in it's rotational position by a jam nut.

With clutch adjusted, shaft lubricated and properly positioned, your ZF should shift just like the factory expected it to, unless there is something wrong inside. Before moving on to internal lubrication, some important advice on gear changing follows.

Broken or damaged synchronisers (characterised by grinding when going into one or two gears) is caused almost always by the driver who thinks he is Clay Raggazoni (Ferrari Formula I ace and former Factory Pantera driver) who throws a lightning fast shift (usually from first into second) resulting in ruined synchron rings. Heed our advice above on shifting. It will save you much money. The ZF was not designed for "speed shifts".

Worn or broken synchron rings must be replaced immediately as this condition will begin to erode the mating surface of the gear wheel. And since gears are only sold as sets, costing 10-15 times as much as synchron rings, you can greatly minimize the cost by fixing it now!

Worn out synchronisers are invariably due to wrong lubrication, as are almost all other ZF failures. The gear lube is critical. Only mild EP gearbox oils of viscosity SAE 80 should be used. Mild gear oil types are those EP (extreme pressure) oil grades which in the presence of condensation do not cause corrosion on steel and non-ferrous metal parts or hardening of gaskets and seals. Therefore the 5DS-25/1 and 2 require an SAE 80 EP gear lube corresponding to specification MIL-L2105A and API classification GL-4.

Do not be under the impression that a higher viscosity oil (such as 90-140) of otherwise acceptable specification will be better, or that GL-5 or GL-6 will prolong the ZF's life, as this is not necessarily true. The lubricant must simultaneously meet the needs of a hypoid ring and pinion, a limited slip differential, bearings of all types, transmission gears, the ZF-B synchroniser, while not attacking aluminum, steel, and brass. Avoid GL-6 gear lubes. They were made for tremendously high impact loads (as in fuel dragsters) and the additives are usually corrosive. GL-5's are not needed for your box either, but they are generally OK.

A few readily available brand name gear lubes which are right for the job are:

PENNZOIL - "Audi-VW Special Gear Lubricant MIL-L 2105-GL4"

KENDALL - "VW-Porsche-Audi Manual Transmission Lubricant S.P. SAE80W90"

QUAKER STATE - "Special 2105 Gear Oil SAE80W90"

## CASTROL - "Hypoy 80W90 (GL4)"

There are many other available good gear lubes, but the above list was furnished by Ford Motor Company after consultation with Zahnradfabrik Friedrichshafen, and these oils were especially designated since they do everything properly including giving the ultimate protection to the synchronisers.

Oil changes in the Pantera ZF should be made on a new or repaired gearbox after 2500-3000 miles and then every 10,000-12,000 miles. If your car has been out of service for 6 months, drain and refill. Before draining the gear lube, run the car for a short while. This warms up the oil, stirs up any water (condensation) or other contaminants. Be certain the car is level and drain while still warm out of the hole at the bottom of the box. We cannot recommend flushing with any kind of solvent. While this may further cleanse the internals, it also removes most of the residual lubricant adhering to many critical to reach parts, and pockets of solvent will dilute your fresh gear lube. Clean the magnet on the drain plug.

If you have a 5DS-25/1 (bell housing has 4 symmetrical mounting studs) you may refill through either the oil filler/level hole midway up the left side or via the hole in the left rear top surface of the gearbox section. The 5DS-25/2 (5 stud bell housing mounting) will usually only have the side oil filler/level hole through which to refill. Your ZF requires 3.5 liters of lube which translates into 3 2/3 quarts. Do not overfill or underfill as either will result in overheating. Be patient. Ford revised their time allowance on this job to as much as 1.1 hours. It is very easy to believe that the "full" level has been reached, since the oil will quickly rise to the level of the side hole and overflow unless it has a chance to flow out to the differential section, etc. ZF-America frequently gets in burned up boxes containing about 1-1½ quarts of oil recently changed by some gasoline station who thought they had topped it up. These transaxles are now junk. They cannot be salvaged. If you allowed adequate drainage time, your ZF will require 3 2/3 quarts of GL4, SAE 80.

### III. PERFORMANCE IMPROVEMENTS

Early Pantera transaxles (produced prior 3/71) were 5DS-25/1 and for production models were first assembly No. 1031-001-060 (80 units) and then 1031-001-061 (411 units). The approximate 5000 cars produced afterwards used the 5DS-25/2, assembly No. 1031-002-002. These assembly numbers inform the knowledgeable about the gearing among other things, although this information appears on the data plate of each ZF.

In terms of acceleration and related performance the earlier cars had it all over successively later ones. They were as much as 200 lbs. lighter, had engines producing 300-330 hp and final drive ratios in 5th of 3.54:1, using 25" diameter tires. As the years passed, the car got heavier, the engine weaker, the final drive went to 2.98:1 and tires bigger to 26" diameter. When the 55 mph speed limit went into effect even the one advantage (very economical high speed turnpike cruising) later Panteras enjoyed disappeared. By 1973-4 the Pantera had nothing left but it's good looks.

Can the Pantera's performance be restored "to the exciting days of yesteryear"? The answer is yes, by the simple but costly expedient of improving (raising the numerical ratio) of the gearing. The advantage of such an approach is that it leaves the engine stock and legal. Does not make the machine more temperamental or increase maintenance costs. But is the same as if you added gobs of horsepower and/or removed many hundreds of pounds of weight.

Obviously all or some of the intermediate gears could be changed but not only is this hideously expensive, but is not as successful an approach as replacing the crown wheel and pinion. All ZF assemblies mentioned above use the same ratio C.W./P. - 4.22:1. Which sounds zippy but is not because 4th and 5th are what we Americans call "over-drive gears" and that means that with a 5th gear ratio of .705, the final drive is a 2.98! However there are some other final ratios available such as 4.5, 4.62, 4.87 and 5.25. In 5th gear these respectively become 3.17, 3.25, 3.43 and 3.70.

Originally the rear tires (Michelin, Pirelli) were 25" in diameter. Goodyear Arrivas are 26" which worsens acceleration and makes the engine seem even weaker. However, some Pantera owners may be using a small low profile tire and consequently below is appended a chart showing the miles per hour the car would be turning at 6000 RPM with these various rear ends on different size tires. Incidentally, the very first Panteras designed and built by deTomaso (before Ford emasculated them) topped out at a genuine 125 mph at 6000, but had brilliant acceleration.

	MPH at 6000 RPM (MPH/1000 RPM)				
	4.22	4.50	4.62	4.87	5.25
24"	144 (24.1)	134 (22.3)	132 (22.0)	124 (20.6)	115 (19.2)
25"	150 (25.0)	140 (23.5)	137 (22.9)	129 (21.5)	120 (20.0)
26"	157 (26.2)	146 (24.3)	142 (23.7)	134 (22.4)	125 (20.8)

One other method of improving performance is in the limited slip differential. The 5DS-25/1/2 were manufactured with a 40% locking effect. This can be increased by substitution and re-arrangement of the disc/plates to 75% in the 5DS-25/1. This modification cannot be made on the 5DS-25/2. However, either of the "boxes" can have substituted the full racing locker (cam and pawl type) as used in the GT-40's, Gulf Mirages and Factory Group 4 Panteras. It is expensive and offers nothing to improve normal driving. However, it is an absolute must for any serious competition work such as road racing and dragging.

ZF-Synchroma-Gearbox 5 DS-25/2 with axle drive

