Subject:
Operating principles and diagnosis

Unit:
Tremec 3650

Vehicle Applications:
Ford Mustang, Falcon Barra (Australia), Tickford Tornado (Australia), MG-Rover

Essential Reading:
- ☑ Rebuilder
- ☐ Shop Owner
- ☐ Center Manager
- ☑ Diagnostician
- ☐ R & R

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Understanding the Tremec 3650 5-Speed Transmission

Our world of transmission repair is ever changing. The one thing you can count on is new technology to support the new models of cars produced by the world's auto manufacturers. Back in the day, BorgWarner designed and manufactured the T5 and other transmissions for cars and light trucks. BorgWarner decided to exit the standard-transmission business while keeping the transfer-case side of its manufacturing. It sold its manual-transmission business to Tremec, which is a tier-one supplier of transmissions and driveline components based in Mexico, with sales, engineering and warehousing in the United States. Tremec also now owns and manufactures the Spicer line of medium- and heavy-duty truck transmissions. Tremec has state-of-the-art manufacturing plants in Mexico and has been building transmissions for the global auto manufacturers for many years.

The T5 was one of the most widely used transmissions in history. Ford replaced it for the Mustang with the T45, which was used in the Pony cars until 1991. Tremec then designed and got accepted by Ford the Tremec 3650, which replaced the T45 in Ford Mustangs in 1991 and is being used in 2007 production. Figure 1 shows other vehicles in which the 3650 is used.

The 3650 is an evolution of the T45,

Figure 1

TR-3650 Application Information

Tremec Prod #	Ford #	Service Unit	OE	Application	Note	1	2	3	4	5	Rev	Speedo
TR3650	1R33-7003-AC		Ford	Mustang 2/2001 to 9/2001		3.38	2.00	1.32	1.00	0.68	3.38	12T Electric
TR3650-3	2R33-7003-AC	TCET2018	Ford	Mustang 9/2001 to 7/2002		3.38	2.00	1.32	1.00	0.62	3.38	12T Electric
TR3650-2	3R23-7003-DC		Tickford	Falcon Barra – Australia		3.38	2.00	1.32	1.00	0.68	3.38	None
TR3650-4	2R33-7003-AE	TCET2018	Ford	Mustang 7/2002 to 6/2003		3.38	2.00	1.32	1.00	0.62	3.38	12T Electric
TR3650-5	8438-7003-AA		Tickford	Tornado – Australia		3.38	2.00	1.32	1.00	0.62	3.38	12T Electric
TR3650-6			MG-Rover	MG-Rover		3.38	2.00	1.32	1.00	0.74	3.38	12T Electric
TR3650-7	2R3Z-7003-AA		Ford	Mustang – Service Ass'y		3.38	2.00	1.32	1.00	0.62	3.38	12T Electric
TR3650-1	4R33-7003-AD	TCET5852	Ford	Mustang 2005 S197		3.38	2.00	1.32	1.00	0.68	3.38	12T Electric
TR3650-8	3R3Z-7003-AC	TCET4783	Ford	Mustang 2004 GT	Repl by TCET2197	3.38	2.00	1.32	1.00	0.62	3.38	12T Electric
TR3650-9	3R33-7003-AD	TCET4783	Ford	Mustang 2004 GT		3.38	2.00	1.32	1.00	0.62	3.38	12T Electric
TR3650-10	3R3Z-7003-CA		Ford	Mustang 2004 GT – Service Ass'y		3.38	2.00	1.32	1.00	0.62	3.38	12T Electric
	6R3Z-7003-AA	TCET5850 ?	Ford			3.38	2.00	1.32	1.00	0.68	3.38	12T Electric
		TCET5852	Ford			3.38	2.00	1.32	1.00	0.62	3.38	12T Electric
	4R-7003-AF		Ford	Mustang 2005 S197 - Service Ass'y		3.38	2.00	1.32	1.00	0.68	3.38	12T Electric

Figure 2

but there are huge differences in design. Both models have an integral bellhousing, main case and extension housing made of aluminum, and both are five-speeds, with fifth gear overdriven for quiet and fuel-efficient highway cruising. The use of an integral bellhousing offers a stronger unit in terms of case stiffness and torque-handling ability and is generally found to have quieter operation with less NVH (noise, vibration and harshness). The T45 was never intended for use in a Mustang Cobra or Mach 1, and the stronger 3650 replaced it.

The 3650 uses a main shift rail with three internal shift rails to provide six shift positions: first through fifth and reverse. Three spring-loaded shift-rail detents are at the driver-side front of the main case (see Figure 2), and an interlock system (see Figure 3) is mounted at the back of the main case to ensure that the driver can select only one gear at a time.

This unit has an 85mm centerline distance, which is the same as the T56. The centerline distance is measured from the center of the input shaft/mainshaft to the center of the countershaft, and the larger that distance the larger the gears can be made for improved durability and torque ratings. The T45 had an 81mm centerline distance. The factory rates the 3650 at 360 lb.-ft. of torque, which is extremely conservative. I race against Mustangs, which are easily putting out 500-600 lb.-ft. of torque with no ill effects on the transmission. Present-day America is ruled by lawyers, and most of the factories tend to be very conservative on torque ratings to prevent unnecessary litigation.

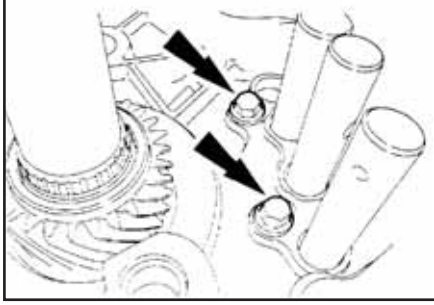
Tremec designed in an improved gear helix (angle) for maximum durability and quiet operation. The 3650 is a very quiet transmission, although when Ford made the 2005-and-up Mustang chassis and mounts much stiffer for improved handling, noise complaints began to appear. The GT and base-model Mustangs have no tunnel insulation, which creates some NVH complaints, but the transmission is not at fault. The Cobra models have a tunnel liner and a tunnel blanket to cushion the noise transfer from the stiffer chassis and operate much more quietly with the same gearbox.

In 2005 models another design change occurred when the shifter went from a direct-mount (see Figure 4) to a remote-mounted shifter (see Figure 5). When the shift selector was removed from the direct-shift models and there was no cam action, the position of the shift rails was reversed and made into a mirror image, and the forks had to be redesigned. This means that none of the internal or external shift linkage from the 2001-2004 design will fit or function in a 2005 or later version, and vice versa. Although the driver will notice no difference in the H pattern of the stick in the car, you as a rebuilder will immediately see the design difference.

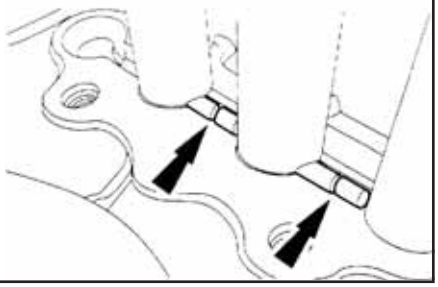
The 3650 weighs 120 pounds dry and has a 10-spline input shaft and a 31-spline output shaft. The unit uses advanced-design multiple-

Figure 3

Remove the bolts and shift-interlock plate.



Using a magnet, remove the interlock pins: one lock pin in the center rail, two between the rails.



cone synchronizers for easy shifting and improved durability. Reverse is a constant-mesh design for easier garage shifts and quieter operation. This transmission is built with an end-load design similar to that of a T56, which means you need to have the unit in a vertical position for most of the teardown and assembly, using a bench fixture.

On the 2001-04 models of the 3650 the oil-fill specification was 3.8 liters of Dexron III ATF. The unit was validated using Mobil One synthetic transmission fluid but was changed to Dexron III for a slightly lower viscosity and improved cold-shift performance. These units had a problem with a "nibble" on the 1-2 shift, particularly when cold. It is not a grind or clash, but a slight glitch on the shift. After much study and research it was found that the oil level was too high in the unit. This caused windage problems, with the excess lube causing the gears to over-synchronize.

This is because when the gear train is submerged in too much oil, the transmission fluid overheats and foams and affects the turning ratio of the gear train, similar to your trying to run on the beach in 2 feet of water. The increased resistance to turning slows the gears prematurely and alters the synchronizer timing, causing shift problems. The oil level was reduced to 3 liters and the problem was resolved.

An important note to remember in any transmission is that low oil causes problems and too much oil creates problems. Follow the specifications precisely when filling a transmission. In the 3650 especially, if you "fill until you spill" you will create a problem. Fill the transmission to exactly 3 liters by measure and use Dexron III ATF. Remember that the synchronizer design and materials (paper-lined, carbon-fiber, sintered-metal) decide which oil will work correctly, and a great many problems occur from using an incorrect oil or incorrect quantity on your lube fill. It is a great waste of time to pull and disassemble a unit because you didn't use the right type or amount of lube.

The Tremec 3650 is well designed for the cars it is in, and although it will be modified as Ford changes horsepower and torque in the engine, it should be around for the foreseeable future. The Mustang is a tried-and-true performance car, and the way most people drive them will ensure that this unit will find its way into your service bays. TD

Figure 4

Figure 5