



TECH FEATURE

THE HOW-TO WORKSHOP: COMMODORE AUTOMATIC-TO-MANUAL CONVERSION

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WANT TO MAXIMIZE THE FUN FACTOR OF YOUR COMMODORE? THEN YOU'LL NEED TO DITCH THE AUTO TRANSMISSION FOR A MANUAL. FOLLOW US AS WE FIND OUT THE STEPS INVOLVED



There are many people who enjoy driving. If you, like us, fall into this camp, it is likely you'll also feel that the driving experience of an automatic car just doesn't quite match the hands-on feel a third pedal and DIY shifter yields.

Just for clarification, we're talking bland automatic boxes like what you'll find in a typical Commodore or Falcon (so not the manual valve-bodied, over-stalled race-spec auto behind a fire-breathing V8).

Thankfully, an automatic-to-manual conversion is, for most vehicles, not the black magic that it may seem. Of course, you'll still need all the correct equipment, tools, a bit of time, and no fear of black hands, and it's advisable to also check whether the conversion will require LVVTA certification.

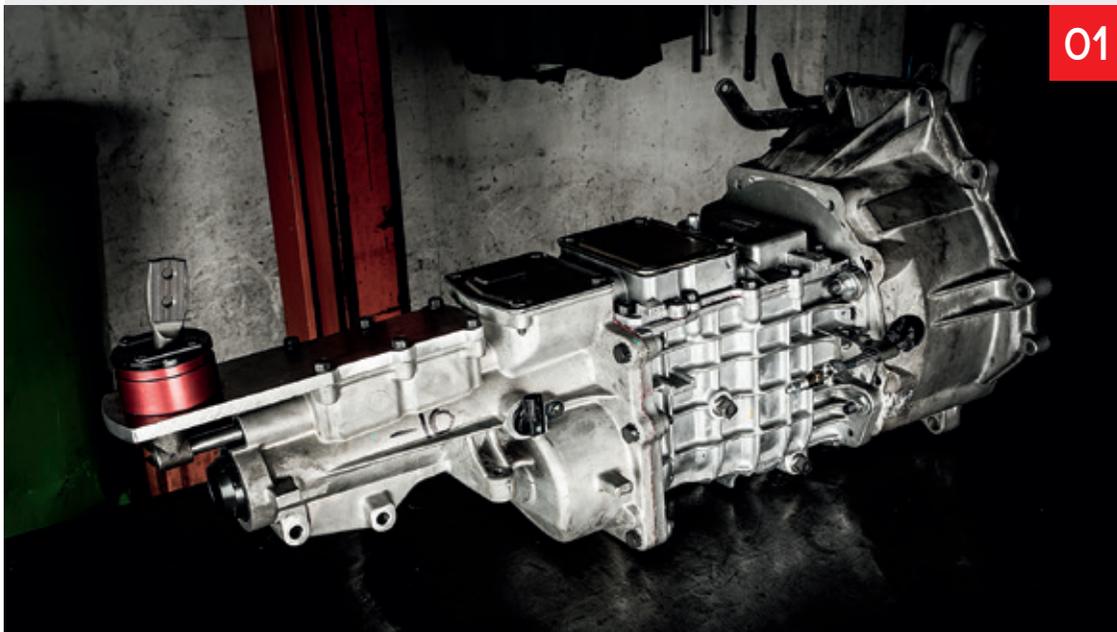
The team at The Gearbox Factory, led by the owner, Keith Lane, was recently doing a manual conversion on a Monaro, and we decided to tag along to find out the process involved. The vehicle in question

was a Holden Monaro with a supercharged V6. The supercharger had been upgraded to a larger-displacement item, and the engine's bottom end had had a stroker kit installed. Given the resulting substantial power and torque increases, the decision was made to over-engineer the drivetrain combination to avoid potential problems relating to drivetrain weakness.

This walkthrough of the conversion covers the installation of the manual gearbox and supporting components but not the removal of the automatic gearbox.

It is worth noting that although the engine appears unsupported until the gearbox cross member is installed, this is not the case. When removing a gearbox from most front-engined rear-wheel-drive vehicles, it is important to ensure that the engine's weight is supported from the rear to avoid placing excessive strain on the engine mounts. A trolley jack can be used for at-home conversions, but, in the example shown here, The Gearbox Factory placed a block of wood between the engine and the subframe.

To replace the standard 4L60E automatic transmission, a Tremec TKO600 was chosen, with a custom-made shifter relocater to correctly position the gearstick in the car. The old automatic gearbox bellhousing was retained and modified to fit the Tremec. Some manual gearboxes will have readily available factory bellhousings to suit the engine they're being mated to; some will require aftermarket units. For the most part, this is determined by whether your car came out with a manual gearbox and whether the manual gearbox being used was a factory feature behind that engine. The Gearbox Factory is able to source, modify, and custom-fabricate bellhousings to suit nearly any gearbox and engine combination. So, for example, you won't find a factory bellhousing to join a Toyota W58 gearbox to a small block Chev engine, but The Gearbox Factory could modify a bellhousing to suit the W58 if they were unable to source an aftermarket unit. >





02

The particular set-up shown here features a McLeod hydraulic release bearing, which Keith can't speak highly enough of. It is extremely important, however, to ensure that this is set up properly, as access is nigh on impossible once everything's together. The bearing must be securely fastened, the hydraulic lines must be on tight, and the gap between the bearing and the pressure-plate fingers must be re-checked. In this case, it is set to 4mm, which is a relatively universal standard. It is important to double-check the clearance for your own application, though.



03

Here, a Mantic twin-plate clutch was used. Because the flywheel diameter of the six-cylinder engine is smaller than that of the V8-engined Holdens, less surface area can be used on the flywheel alone. The twin-plate clutch gives four friction surfaces instead of two, meaning that the overall diameter can be smaller without compromising clutch performance.

The clutch alignment tool is one of the most important little tools needed for this job and is very easy to overlook – make sure you've got one! It ensures that the clutch friction discs are perfectly aligned with the spigot bush in the crankshaft, by essentially taking the place of the gearbox input shaft. You can make one up with a dowel or use an old input shaft if you happen to have one lying around (it must match your manual gearbox input shaft), but it's far easier to purchase one off the shelf at your local auto-parts store.



04

Before the clutch assembly is installed, the spigot bush (sample picture used below) must also be installed. This is a bush, usually made of brass, that sits in the recess in the centre of the crankshaft. It supports the input shaft, ensuring that no undue strain is placed on it, which could lead to



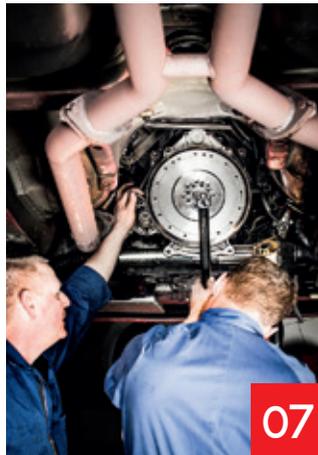
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input-shaft bearing failure. Being a newly manual-converted vehicle, the Monaro required a new spigot bush. Installation requires packing grease firmly into the old bush, before hammering a rod with an outer diameter approximately the same as the bush inner diameter into the bush centre, causing hydraulic pressure to force the old bush out. The new spigot bush is then driven squarely in.



06

This spacer was made to fit between the crankshaft and the flywheel, ensuring that the starter motor correctly engages the ring gear on the aftermarket flywheel. In this case, the starter motor was able to be reused, although it is always advisable to check first whether a different starter motor will be required.



07



Also very important are the little things, like flywheel bolts. The ones pictured here are for dummy purposes, and couldn't be used to install this flywheel, meaning special bolts needed to be sourced. Ensure you use high-quality flywheel bolts and that they are torqued to the correct specifications.



08

With the clutch and pressure-plate assembly correctly mounted, the distance from the pressure-plate 'fingers' to the flywheel is measured. This measurement is carried over to the manual gearbox input shaft to check that the clearance between the pressure-plate fingers and the hydraulic release bearing will be satisfactory. If your conversion makes use of an OEM bellhousing and OEM-specification clutch kit and release bearing, clearance should not be a problem. It is still an important measurement to double-check, though.

With the flywheel mounted, the clutch alignment tool comes into play to ensure that the friction disc(s) are centred. Push it through the splined centre hole in the friction disc and locate it in the spigot bush. The pressure plate can now be bolted onto the flywheel. Again, it is critical that the correct torque settings are used.



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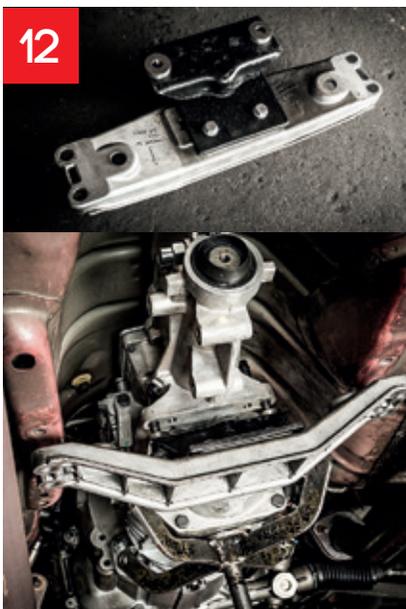
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The fun part of fitting the manual gearbox can now begin. The Gearbox Factory prefers to perform manual conversions with the engine still in the car to avoid the time and hassle of first removing, then reinstalling it. Though this throws in the challenge of fastening the upper bellhousing bolts (attaching the bellhousing to the engine block), this is not normally a problem given patience and dextrous hands. Since they have access to a hoist, The Gearbox Factory team used a special hydraulic ram with a cradle to jack the gearbox into the transmission tunnel. If you're performing a conversion at home, you'll most likely use a trolley jack, which works fine, but, in the interests of safety, you should ensure the gearbox is secure before getting under there.

The gearbox must be correctly lined up with the engine – that is, the input shaft must be aligned with the centre line of the crankshaft, not angled up or down, left or right. The input shaft should slot nicely in the spigot bush, and the bellhousing's mounting face should sit flush with the engine block. Most engine blocks have locating dowels to assist with lining up the bellhousing. The bellhousing bolts can now be fastened, securing the gearbox to the engine. As always, these bolts must be torqued correctly.

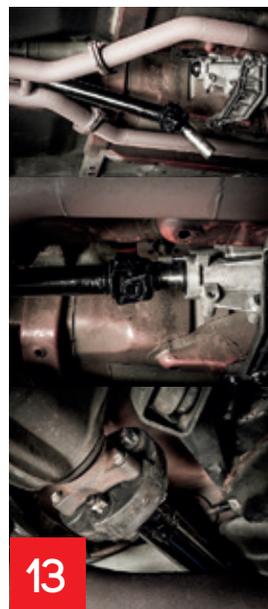


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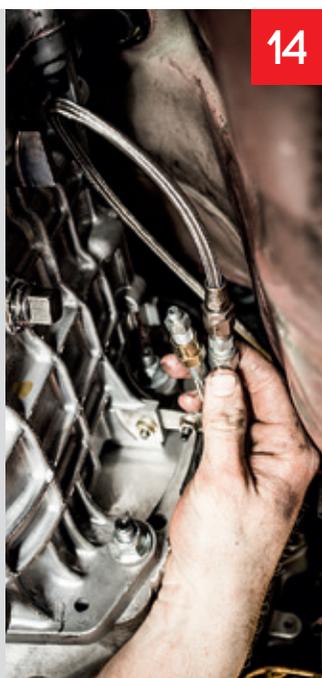
With the gearbox and engine mated together, it is time for the gearbox to be secured to the chassis. You may be able to reuse the existing cross member and gearbox mount, you may need to source one from a manual model of the same or a similar car, or you may need a custom cross member fabricated to suit. It is advisable to research what's required before commencing the conversion, as you won't want to be stuck with a half-mounted gearbox and no cross member that'll work. In the example here, the factory cross member could be retained but required a custom mount to suit the Tremec gearbox. This was crucial to avoid the unwanted vibration that may result from an unsuitable mount being used.



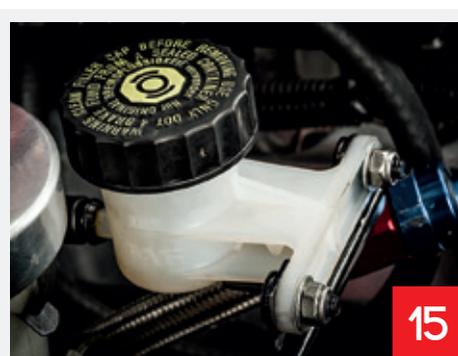
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With the gearbox mounted, the driveshaft is the next big step. Most cars' manual gearboxes will require an alternative driveshaft to an equivalent automatic, due mainly to the fact that different transmissions' output shafts require different yokes, and varying gearbox lengths need a different length of driveshaft. In the Monaro here, a custom heavy-duty yoke was made up to suit the Tremec, mated to a custom heavy-duty driveshaft. Measurements were made to determine the required driveshaft length. It was then manufactured and balanced before being installed. Keith stresses the long-term importance of over-engineering, saying "just enough isn't quite enough". Some cars should have readily available second-hand driveshafts to suit a manual gearbox in a particular vehicle model, but, to ensure you don't run into complications come installation time, make sure to research what is required first.

The next crucial step is getting the clutch assembly to engage and disengage correctly. With the hydraulic release bearing used here, the braided hydraulic lines for the master cylinder are connected to those for the release bearing. If your clutch assembly uses a fork to engage the clutch, you'll go down a different route. For a hydraulic system, the bellhousing will hopefully already have a mounting point for the slave cylinder. If it's an aftermarket unit that doesn't feature one, The Gearbox Factory will not have a problem fabricating a suitable mounting point onto the bellhousing. A cable-clutch system will require a clutch cable to be made up to suit both the clutch pedal and the clutch fork, and be the correct length. Though The Gearbox Factory has no problem sourcing custom clutch cables, it prefers to use a hydraulic system for ease of maintenance.



14



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The clutch master cylinder used here is a reconditioned second-hand unit from a late-model manual Commodore. Some cars will have master cylinders available off-the-shelf; others may require one from a different application be made to fit. Most cars that came out of the factory with a manual option have a mark on the firewall (it may be on the inside of the firewall) showing where the master cylinder should be mounted for manual applications. If your car has one, make sure it looks correct for the master cylinder you have and complements the clutch-pedal position before taking to it with a power drill and a hole saw. If your car has no such mark, you'll need to position the clutch-pedal box where you want it and ensure that the corresponding master-cylinder location doesn't foul on any engine-bay componentry such as the brake booster or the engine itself. If it's all clear, go for gold with the hole saw, but do remember the old "measure twice, cut once" rule! Before installing a new master cylinder, you may wish to bench-bleed it to eliminate airlocks. The master cylinder can be bled in-car, though, which is what The Gearbox Factory tends to prefer, as it makes less of a mess. The clutch pedal actuates the master-cylinder 'plunger' rod via the U-bracket on the end of the rod, which bolts to the clutch pedal. >

16



A very important component that can't be overlooked is the clutch pedal, which, in most cases, comes as a pivoting component in a fixed pedal-box assembly, bolted to the body of the car. If your car came from the factory with a manual option, second-hand pedal boxes should be readily available. If it is an uncommon car or a sought-after manual conversion, you may be entering the dark realm of custom pedal boxes, which we aren't going to cover here. Likewise, with the factory stamp for the master cylinder, many cars that came out with a manual option from factory will have the pedal-box mounting-bolt holes stamped on the inner firewall, giving a clear indication of where the pedal box should end up and where to drill to mount it.

In the example here, rather than install the brake pedal box from a manual car, the boys trimmed the edges of the existing automatic brake pedal – as the auto brake pedal is wider than the manual equivalent in most cars, it is trimmed down to provide a clear gap between brake and clutch pedal. For a functional and clean-looking finish, the modified brake pedal was covered with a Wilwood non-slip pedal pad.



17

With a functioning clutch pedal, the hydraulic system can now be bled. If the master cylinder has not been bench bled it will normally need to be bled in-car (before bleeding the remainder of the hydraulic system), and though it can be time consuming, it is a method favoured by The Gearbox Factory for its relative lack of mess. The principle of bleeding the hydraulic clutch system is essentially identical to that of bleeding brakes. It involves opening the bleed nipple as the pedal is depressed, forcing compressible air from the hydraulic lines, and closing the bleed nipple when the pedal is released, ensuring the air is not sucked back into the lines. This is repeated as many times as is necessary until the bled fluid contains no air bubbles, and the clutch pedal feels firm and direct. Though the hydraulic release bearing system used in The Gearbox Factory's example looks different to a conventional slave cylinder set-up, the principles are the same.

18

With the bulk of the mechanical side sorted, work can now start on the finishing touches. We mentioned earlier that the TKO600 box had its shifter plate moved backwards to aid in positioning the gearstick. To ensure the gearstick ends up in the most ergonomically efficient position, a custom 'Z' gearstick was fabricated by The Gearbox Factory to shift the gear-knob position further back from the dash fascia. These gearsticks are made in-house to suit each application.



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To keep noise and harshness out of the cabin, the boys made up a custom gear surround. Made from a fibreglass plate covered in Dynamat, it includes a generic rubber boot to grip the gearstick, minimizing any unwanted noise that may reach the cabin from beneath the car.

The automatic gearstick surround was reused with the automatic selector removed and a leather boot glued in place. Such is the attention to detail that the leather boot and Tremec shift knob have been colour matched to complement the car's grey interior, with the finished effect showing that everything about this conversion has been done to the highest standard.



21



Being a brand-new gearbox, this TKO600 was run in using Dexron III automatic transmission fluid, with fully synthetic gear oil to be used once this process has been completed. It is recommended that you research what gear oil is best suited to your gearbox.

Special thanks must go to Keith and the team at The Gearbox Factory for taking the time to run us through this procedure. You can contact The Gearbox Factory on 0800 4 Gearbox (0800 4432 7269) or at gearboxfactory.co.nz.

The Electrical Stuff

Being a gearbox specialist, The Gearbox Factory covered the installation procedure for the manual gearbox and its ancillary components, while the electrical side of things was, for the most part, left to those qualified in that field. Because this car runs an electronic speedometer, the existing set-up from the 4L60E gearbox would not work directly with the Tremec. A correcting box was required to calibrate the speedometer. Almost all automatic-to-manual conversions will require a speedometer amendment. For older-style vehicles with gear-driven speedometer cables, this is not normally a problem, as gears can usually be easily sourced by The Gearbox Factory. But, getting electronic-style speedometers to work with a manual conversion will normally require the magic touch of a qualified auto electrician. The Monaro's ECU did not need to be changed for the car to be run with a manual gearbox. However, there are cars out there that require their ECU to either be replaced with one from a manual model or reflashed by a tuner to suit the manual gearbox. The Monaro was sent to the dyno at Torque Performance to have its ECU reconfigured to suit any changes the manual conversion required.