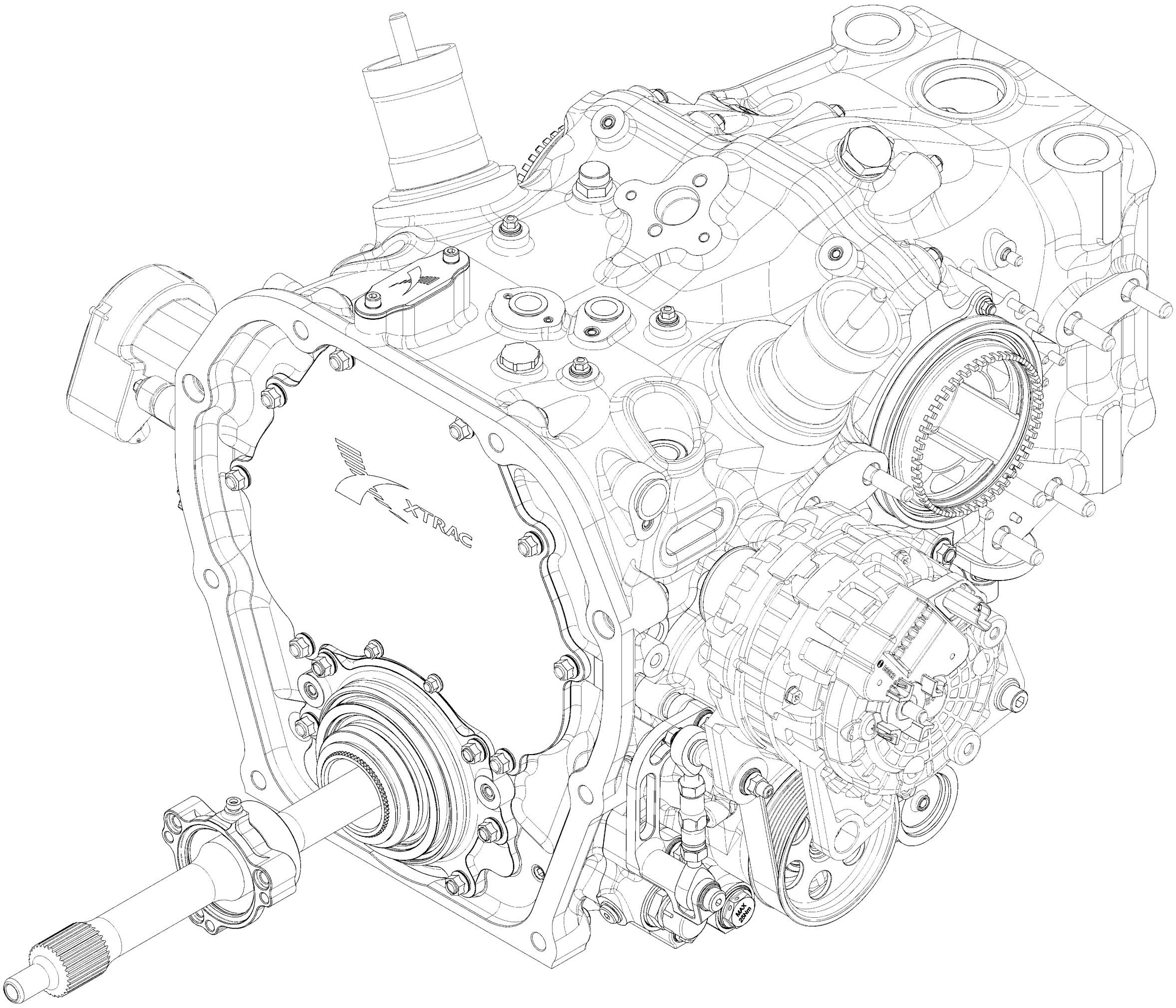
1324

7-Speed LMH Sportscar Gearbox Manual



1. Specification

The P1324 gearbox has been designed for use in sportscar endurance and sprint races. The gearbox is configured with seven forward gears and one reverse gear transversely mounted ahead of the rear axle line. The P1324 has been designed to be compliant with the crash test requirements as defined by the 2021 LMH regulations.

Xtrac Part Description: Gearbox Assembly

Xtrac Part Number: 1324-900-000A

1.1. General Items

Drive is transmitted from the engine, through the clutch shaft and bevel set to the transverse mounted layshaft. The layshaft in turn drives the mainshaft through the gear ratios. The mainshaft gears are mounted on hubs on the mainshaft and transmit drive to the shaft itself through sliding dog rings. A spur gear final drive then completes the torque path from the mainshaft, through the Salisbury type plate differential, to the gearbox output flanges.

The 1st – 6th change gears are 5 dog flat top, non-synchromesh, engaged using a full length barrel. The 7th change gear is a 3 dog flat top, non-synchromesh, engaged using a dedicated 7th/Rev barrel. The cluster (1st – 6th gears) can be removed as one unit from the RHS, with 7th and the reverse gear on a separate plate on the LHS.

The gearchange operates sequentially in the following order: R, N, 1, 2, 3, 4, 5, 6, 7.

Note: A torque limit applies when reverse gear is engaged. Please refer to Technical Bulletin TB-1159-21A for more information.

Input/Output Height	158.0mm (6.22”).
Casings	The maincase and rear cover are cast aluminium L169. All other casings are cast magnesium RZ5. All casings have O Ring face sealing.
Input Bevel	Standard ratio 23:21. (Xtrem polished, full form spiral bevel ground as standard).
Change Gears	Seven speeds. All gear ratios are full form ground except for the integral 1st and 2nd layshaft gears. Ratios selected from the ratio list. For more details see Appendix D
Final Drive	Options available. For more details see Appendix D
Differential	Salisbury type plate differential with nitrogen charged, externally adjustable, positive preload and viscous coupling (VC).
Output Flanges	To suit 38.0mm tripode rollers on 61.0mm PCD.
Oil Pump	A single stage eccentric rotor pump with two scavenge positions is standard.
Weight	≈79.2kg
Gearchange Actuator	MEGA-Line E-Shift Actuator “GT”

1.2. Excluded Items

Assembly Tooling	See drawing 1324-999-000A for the customer assembly tooling.

2. Summary of Lubricants and Greases

The following lubricants and greases have been used by Xtrac during the assembly and testing of the P1324 gearbox.

Gearbox Oil Type	Xtrac XL1 or any other fully synthetic SAE 75W90
O-ring Assembly Grease	PolyLub Gly 151

3. Operating requirements

Xtrac is extremely proud of the quality, success and reputation of their products and we are delighted that you have chosen to use the P1324 gearbox. The design of each gearbox is the subject of much research and development, technical analysis and detailed testing. However, as with all motorsport products, it is vital that they are correctly maintained and adjusted for each individual circumstance. This manual is intended to ensure that you obtain the maximum performance and reliability from this gearbox.

We would stress that after each event or prolonged period of running (suggested to be 3,000km (1860 miles) for sports car applications) the gearbox should be carefully inspected and stripped as appropriate. This manual contains lifing recommendations for critical components detailed in Section 6.6. If in doubt please contact our Commercial Department who will advise you or, if necessary, put you in contact with one of our engineers.

It is important to ensure that the correct lubricants are used, such as Xtrac developed XL1 and XG1, and that all adjustments and tolerances are as specified. The use of parts not supplied by Xtrac will automatically invalidate any warranty or other liability which would normally be assumed by Xtrac.

4. Gearbox Warranty

The gearbox should be operated within the temperature and pressure limits given. Gearbox oil level must be maintained at all times and the oil needs to be replaced regularly. Gearbox oil and other lubricants used must be as listed in the Xtrac service documentation.

The life and durability of the gearbox internal parts is considerably influenced by factors other than engine and chassis characteristics. These can be classified as gearbox misuse:-

- If the gearbox is damaged in transit, during incorrect installation or as a result of accident, puncture damage or abnormal weather conditions.
- Inadequate cooling and exceeding operating temperature. Un-approved or insufficient oil or grease.
- Incorrect maintenance or adjustment or work by unauthorised and/or untrained personnel.
- Modification or work to any component or use of non Xtrac parts.
- System related sensor, valve and pump failures.
- Aerodynamic, suspension, engine, gearchange or clutch and driveline loads beyond the design limits.
- Exceeding designated life or failure to keep adequate lifing records.
- Engine and/or vehicle dynamometer and rolling road use.

Full and comprehensive lifing records must be maintained by the Customer during use. Your attention is drawn in particular to section 11 of the Terms and Conditions of Sales and the following:

Goods intended for motorsport or any related application, or for product development, evaluation or experimentation are supplied subject to the Customer recognising that such goods may operate under extreme loads and conditions and that it is the Customer's responsibility to ensure that the goods are correctly inspected, adjusted and maintained at all times to suit the specific conditions in which they may be used.

Lightweight and weight optimised components are supplied subject to warranty only against manufacturing defects. It is possible that in certain conditions operating life may be reduced.

Xtrac shall have no liability to the Customer (other than liability for death or personal injury resulting from Xtrac's negligence) for any loss or damage of any nature arising from any breach of any expressed or implied warranty, term or condition of the contract or from any negligence or breach of statutory or other duty on the part of Xtrac in connection with the performance or purported performance of or failure to perform the contract other than as set out in this Condition. In no circumstances shall Xtrac be liable for any claims for indirect or consequential injury or damage (including loss of profits) arising from any such matters.

Gearboxes and components can only be supplied subject to warranty for manufacturing defects and not for suitability for use or performance. Any liability for consequential loss is specifically excluded. Xtrac cannot accept any liability for gearbox failures or premature wear of any parts. The Customer will not be able to delay payment or renegotiate the contract whilst failures are being rectified.

Conditions attaching to this manual:

This manual is supplied for exclusive use of the recipient and may only be used by the recipient in respect of the applications described therein. It may not be revealed to any third party or placed in the public domain without the express written permission of Xtrac. Unless otherwise agreed, the Intellectual Property Rights generated by Xtrac which are contained in this report are the exclusive property of Xtrac.

Xtrac retain sole manufacturing rights for any component of Xtrac origin and also for any variations discussed in this report.

Whilst this manual has been prepared in good faith and every attempt has been made to ensure its accuracy, Xtrac cannot accept any liability for the use of the information contained herein. Acceptance of this manual will be deemed to signify acceptance of the above conditions.

5. Gearbox Operation

5.1. Gearchange Description

5.1.1. MEGA-Line E-Shift Actuator “GT” (Standard Fitment)

Sequential gearchange operated by Xtrac’s well proven and latest technology polynomial barrel, mated to MEGA-Line’s electronic gearchange system via a dedicated gearchange cover. The gears are engaged sequentially R, N, 1, 2, 3, 4, 5, 6, 7. No mechanical reverse lock out is required, as the lock out will be enabled by the AGS gearchange strategy.

5.2. Oil System

5.2.1. Oil System Description

An internal single stage eccentric rotor is located in the maincase, behind the left hand side cover, within a simple re-circulating oil system. Details on the performance of the oil pump are given in Appendix C Front and rear scavenge positions, combined with baffling, enables pickup independent of car accelerations and reduces the effects of windage. The oil should be fed to a remote cooler from the oil-out port (-8 bulkhead fitting) and returned using external hose (not Xtrac supplied) to the gearbox oil-in port (-8 bulkhead fitting). The cooled oil is distributed internally through the dedicated oil feeds within the gearbox.

5.2.2. Oil Feeds

There are dedicated oil feeds to the crownwheel & pinion bearings, crownwheel & pinion gear mesh, final drive gear mesh, mainshaft & mainshaft hub bearings, RH mainshaft & layshaft bearings, LH mainshaft & layshaft bearings, diff internals & gear ratio meshes.

Oil is fed directly into the crown wheel and pinion housings between the bearings. Feeds within the maincase are used to lubricate and cool the bevels and final drive in the meshed position.

Oil is fed to the outside of the RH layshaft and mainshaft bearings via a feed in the selector rail and through drillings in the gearchange housing.

Oil is fed through the middle of the mainshaft and centrifuges out though holes to lubricate the hub needle roller bearings.

Sprays in the selector forks, which are fed from the selector rail, are activated in their ‘in gear’ positions providing lubrication for the ratios and dog rings.

The differential internals are also lubricated via a feed from the selector rail, which passes through the RH side cover and into the maincase adjacent to the RH output flange. The LH side cover delivers oil to the layshaft and mainshaft bearings and through the centre of the mainshaft

For more details on the oil system feeds see Appendix C

5.2.3. Filtration & Magnets

Two steel mesh filters (161-0032, 125 micron (0.005”) gauze size) are easily accessible from the right hand side of the maincase and can be checked to reveal any evidence of tooth / dog damage. Depending on the condition of the filters, they can be re-used but cannot be fully cleaned to remove debris from inside. If there is significant build-up of debris, the filters must be replaced with new items.

There is one drain plug (00P-976-375B) on the LH side cover with integral magnet to attract and retain debris. An additional magnet, mounted to the cluster baffle, is located adjacent to each of the two scavenge pick up points.

5.2.4. Sensors

Provisions have been made for oil temperature and pressure sensors. A temperature probe (non Xtrac supply) port with an M8 x 1.0 thread has been provided on the rear of the maincase, adjacent to the gearbox oil out.

A pressure sensor (non Xtrac supply) port with an M8 x 1.0 thread has also been provided on the left hand side cover adjacent to the gearbox oil in.

5.2.5. Setup/ Running Conditions

Oil Type	Xtrac XL1 or other fully synthetic SAE 75W90
Oil Quantity	2.5 Litres (2.64 US Qts) + Line/Cooler Volume
Optimum Sump Temperature	90 – 110°C (194 – 230°F)*
Minimum/Maximum System Pressure (with vehicle static)	0.5 / 2.0 BAR (7 / 29 PSI)

**** The gearbox oil must be allowed to reach a minimum sump temperature of 60°C (140°F) before full torque is applied, to ensure maximum durability of the gearbox. Highly loaded running of a cold gearbox is not recommended due to***

the risk of premature bearing failure caused by the additional preload applied from cold casings.

The gearbox oil can be preheated by running of the powertrain with the vehicle on stands, the use of an external oil heater or an oil-to-water cooler connected to the engine cooling system. Where these systems are unavailable, it is imperative that the vehicle is driven in a sympathetic manner until the minimum gearbox oil temperature is reached.

Note: The approximate oil quantity remaining in the gearbox (when drained in a straight and level position and only removing the drain plugs) is 0.5 litres. It is therefore recommended that the oil filters are also removed when draining the oil.

5.3. Gear Cluster

The P1324 gear cluster comprises of straight cut, full form ground gears mounted within the two easy to remove side cover assemblies. The gearchange operation is a ‘dog’ type.

The cluster, mounted within the RH side cover assembly comprises of:

- A layshaft (integral 1st/2nd) and slide-on 3rd – 6th gears.
- A mainshaft (integral final drive pinion) and 1st – 6th mainshaft gears on 3 hub assemblies.
- A 1st – 6th gearchange barrel with 3 selector forks mounted on the RH selector rail

The LH side cover assembly contains:

- A LH layshaft with slide-on 7th gear & integral reverse.
- A LH mainshaft with 7th and reverse mainshaft gears.
- A 7th & reverse gearchange barrel with a selector fork mounted on the LH selector rail.
- Reverse idler gear
- Pump drive gear

Drive is transmitted from the engine, through the clutch shaft and bevel set to the layshaft. All layshaft gears are either integral or slide on and drive at layshaft speed. All mainshaft gears are in permanent mesh with these gears but are not coupled to the mainshaft. A dog ring is engaged to the selected gear by a selector fork, transmitting drive from the mainshaft gear, via the dog ring, to the mainshaft itself.

The cluster assembly can be removed from the right hand side of the gearbox for ease of inspection and maintenance whilst the reverse gear and associated components can be removed and inspected as part of the LH side cover assembly. Components should be replaced if the dogs show signs of damage to avoid inconsistent gearchanges and further damage to other systems. Refer to Appendix G

The barrels are shimmed on initial assembly to ensure they hold the selector forks and dog rings central to the gear cluster. It is essential that this is checked periodically and when the barrels are replaced. Please refer to the assembly procedure detailed in Section 6.2.

5.4. VCP Differential

The gearbox is fitted with a Viscous Combined Plate (VCP) differential. The VCP differential is a combination of two types of differential; a viscous coupling and a Salisbury type plate differential, providing a unit which is both speed and torque sensitive.

The plate differential has nitrogen charged, externally adjustable positive preload.

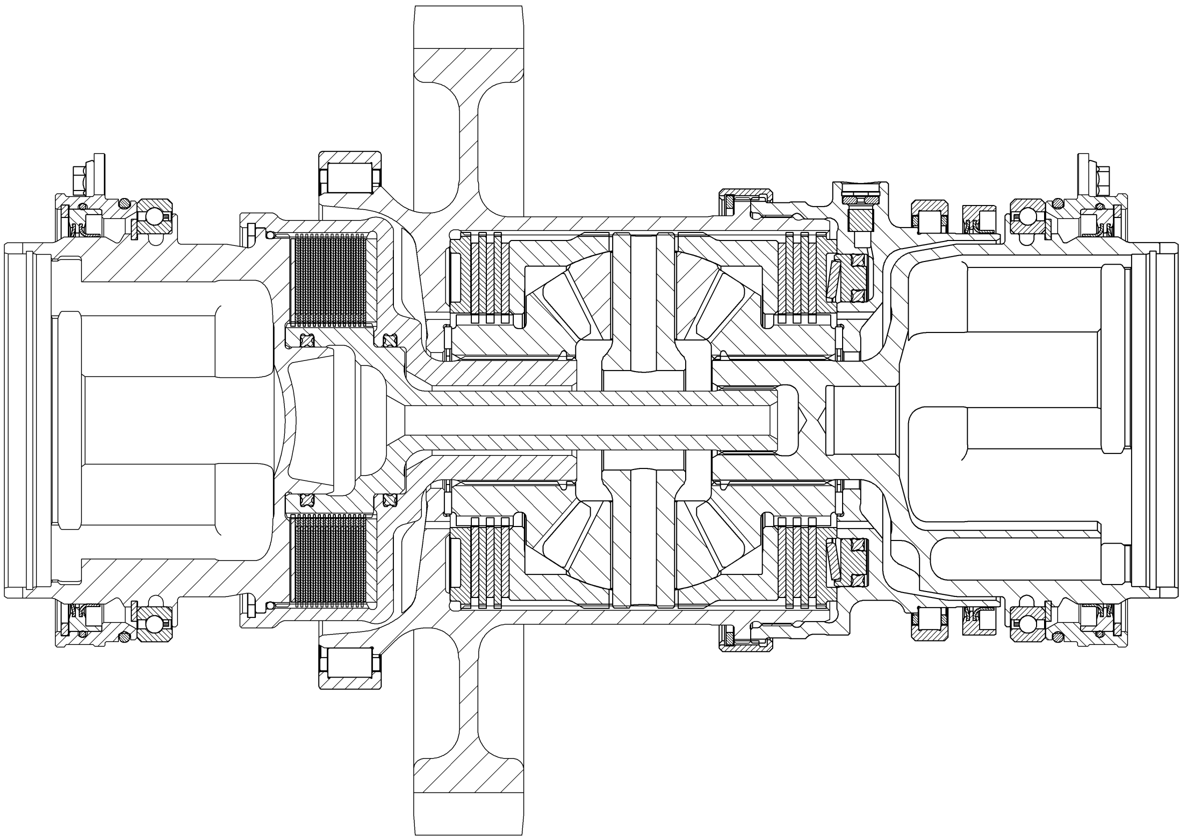


Figure 1 - Section View of Viscous Combined Plate Differential

5.4.1. Description – Viscous Coupling Unit

The driveshaft differential speed sensitive viscous unit negates the pre-load requirement in the plate differential and ensures drive through both driveshafts on mixed μ surfaces. The initial action of the viscous unit can help to dampen the harsh ramp action of the plate unit.

It is still possible to add preload to the plate unit to suit the characteristics of the car, but typically with a VCP differential both the plate preload and viscous settings are lower than they would be if only a single type of differential were used. Low or zero preload can greatly assist the turn in qualities of the car as understeer will be reduced.

5.4.2. Viscous Settings

The most commonly available viscous settings are shown in Table 1.

Table 1 - Commonly Available Viscous Settings

Viscous Setting (Nm)	Notes
70	
85	
110	Standard Factory Setting

These settings are correct at a wheel speed difference of 50 RPM and a temperature of 80°C. This setting is not user adjustable or serviceable. The viscous pack assembly must be returned to Xtrac for this setting to be adjusted or re-calibrated using specialist equipment.

5.4.3. Description –Salisbury Type Differential

The Salisbury type plate differential is locked by ramp forces through two symmetrical friction plate packs, giving the differential very linear and predictable locking forces. The side gear rings (ramps) act against a matching cross pin when torque is applied across the differential. The side gear pinion mates are free to rotate about the cross pin legs independently of the ramp forces, whilst the side gears are axially supported by thrust bearings and do not react against any locking part of the differential.

5.4.4. Pre-load Setting

Preload is applied to the differential by the application of pressurized nitrogen behind the piston. The piston then acts through the disc spring and provides positive pre-load to the friction pack – see Section 6.5.2.

A non-adjustable pre-load arrangement is available, using a disc spring and shims, acting on the friction pack of the differential. A range of springs and shims are available to provide a range of preload adjustment from 0 to 200Nm turnover torque.

5.4.5. Number of Friction Faces

The number of friction faces in the differential can be adjusted to 2, 4 or 6 faces per side, in order to produce different friction characteristics. It is recommended that the number of friction faces is kept equal on each side of the plate unit to ensure the differential has symmetrical characteristics in cornering. Ramp angles coupled with No. of friction faces produce varied locking performance which can be seen in Appendix E

5.4.6. Differential Test Rig

Xtrac's R&D department has developed the Quasi-Transient Differential Test Rig (QT-DTR), which enables testing of mechanical plate, VCP and VLP type differentials. The differential can be subjected to varying levels of input torque and differential speed to study the locking characteristics of available configurations. The following rig operational modes are available:

- Manual operation.
- Sequenced testing which will result in a differential characteristic map.
- Quasi-transient testing. A combination of closed/open-loop testing within a time domain to analyse differential response.

Output data is available in various recognised formats. The data recorded in the test can then be used to accurately set up the differential to best suit the customer needs, dramatically reducing track testing time.

The QT-DTR is available for rental use on a daily basis including Xtrac technician support. Xtrac will design and manufacture the appropriate tooling to mount the customer's differential onto the rig and, in conjunction with the customer, determine the most appropriate test strategy and procedure. Testing is then undertaken and a fully documented results package is available as required. For more information or to arrange testing, please contact your Xtrac business manager.

6. Gearbox Assembly & Maintenance

6.1. General Assembly Notes

Only genuine Xtrac parts should be used when overhauling this gearbox. Xtrac's key rotating components are made with our own specifications of steel and all Xtrac components are manufactured to our own in-house quality standards and are inspected at multiple stages of manufacture.

Lip seals and k-nuts should always be replaced after removal. O Rings, oil filters, circlips and bearings can be reused, but they must be inspected regularly and replaced as soon as any sign of wear or degradation is evident. Lightly oil the parts before assembly and do not use any lubricants other than those stated in this manual.

The oil filters fitted to this gearbox must be replaced at least every 6000km (3750 miles), or sooner if debris has started to collect. The filters are situated on the suction side of the pumps, so any blockage will manifest as a reduced pressure in the feed lines to the gearbox bearings.

Lint free cloths are recommended for wiping down internals. If paper tissue is used, care must be taken to ensure fibres are not left behind which will result in a blocked oil filter.

All joint faces are sealed with O Rings. Silicon sealant **MUST NOT** be used anywhere on the gearbox unless expressly specified, as excess sealant can enter the oil system and clog the filter or oil jets around the gearbox. This will lead to premature failure of the crownwheel and pinion bearings, and ultimately failure of the complete transmission.

All components are supplied from Xtrac as "ready to fit". Extra polishing and fettling of components is not required and may, in the case of gearchange components, cause failure to other parts, especially gear dogs and dog rings.

Since bearings have press fit tolerances, always heat the casings for the fitment or removal of bearings, to avoid damage to the bearings or casings. Do not heat the gearbox casings above 135°C (275°F) when fitting bearings, as this will weaken the casting material. Xtrac recommend the use of an oven to control the temperature and to ensure the heat is distributed evenly. Fit bearings promptly, after removing the casing from the oven, to avoid additional heating cycles.

6.1.1. Torque Settings

If not stated on specific build sheets or assembly drawings, all fasteners in the transmission should be tightened as per Xtrac Standard XS036 detailed in Appendix J

Studs should be inserted tight into the casing using Loctite 270 thread locker. They must then be allowed to cure for 1 hour at room temperature before further assembly.

Bolts must *either* be inserted with Loctite 270/272 (when internal) or be inserted with Loctite 241 (when external) and wire-locked unless otherwise stated.

A summary table of non-standard tightening torques is shown in Appendix A

Throughout each build, mark the torque tightened position of all nuts, bolts and screws, by applying Torque Seal across the fixing and stationary part, to indicate any loss of tightness or movement, thus avoiding unnecessary spanner checks, which can lead to over tightened fasteners and stripped casing threads. An example of the use of Torque Seal is shown in

Figure 2.

Figure 2 – Correct Application of Torque Seal.

6.2. Cluster Setup

The cluster should be assembled to the Xtrac assembly drawings 1324-902-000A, 1324-903-000A & 1324-996-000A in conjunction with the instructions presented here.

6.2.1. RH Mainshaft & Layshaft Locking Nuts

Referring to 1324-999-007A, use holding tool 1159-499-004B and socket 1336-499-020A to tighten the locking nuts to the values given on the 1324-996-000A assembly drawing.

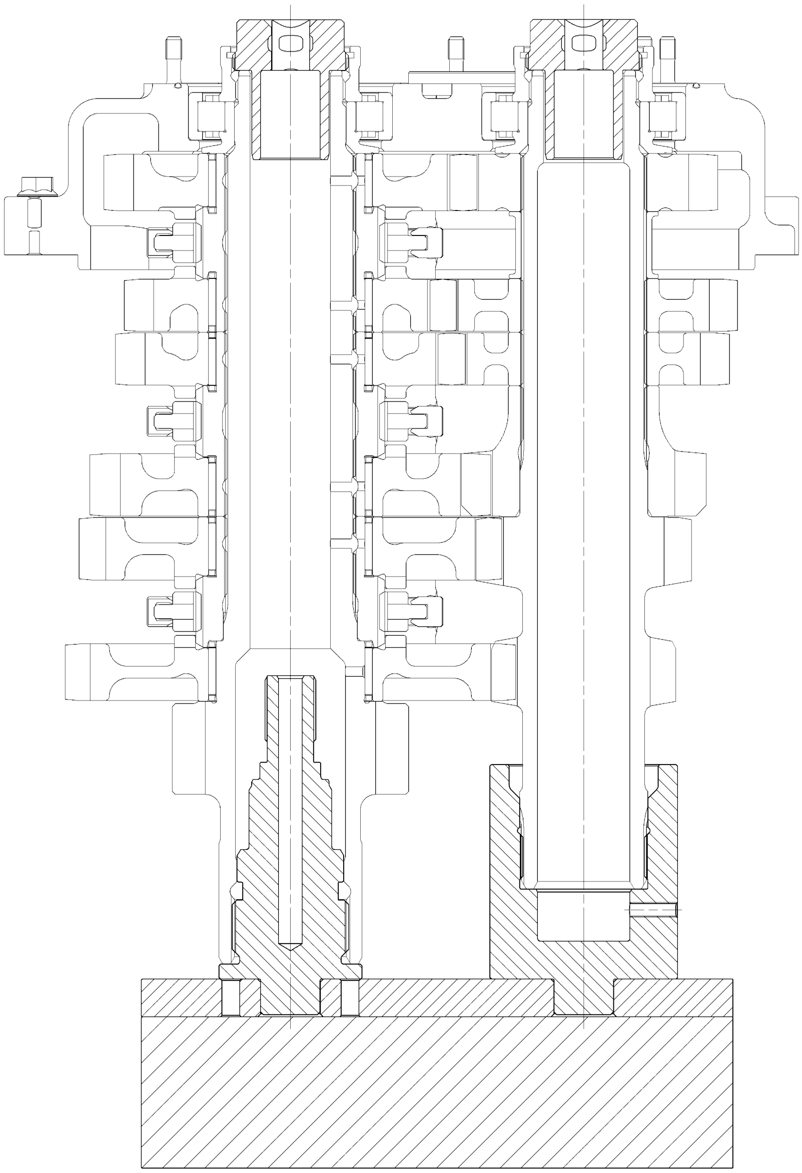


Figure 3 – Cluster Holding Tool for Tightening/Loosening of RH Layshaft/Mainshaft nuts

6.2.2. LH Layshaft & Mainshaft Locking Nuts

Referring to 1324-999-007A, use holding tool 1159-499-007A, adapters 1159-499-014A & 1159-499-015A and sockets 1159-499-044A & 1159-499-013A to tighten the locking nuts to the values given on drawing 1324-902-000A.

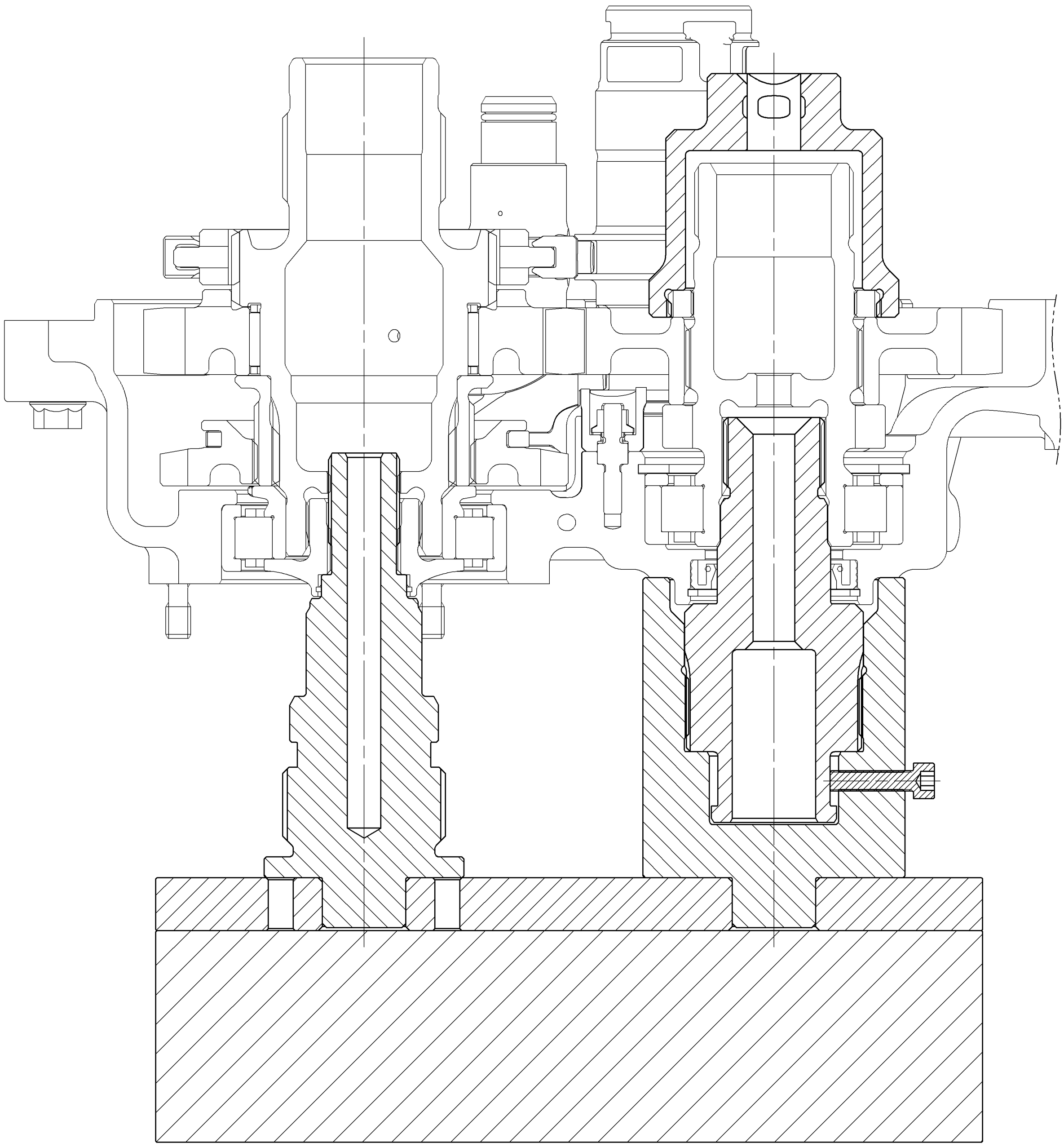


Figure 4 - Cluster Holding Tool for Tightening/Loosening LH Layshaft Nut

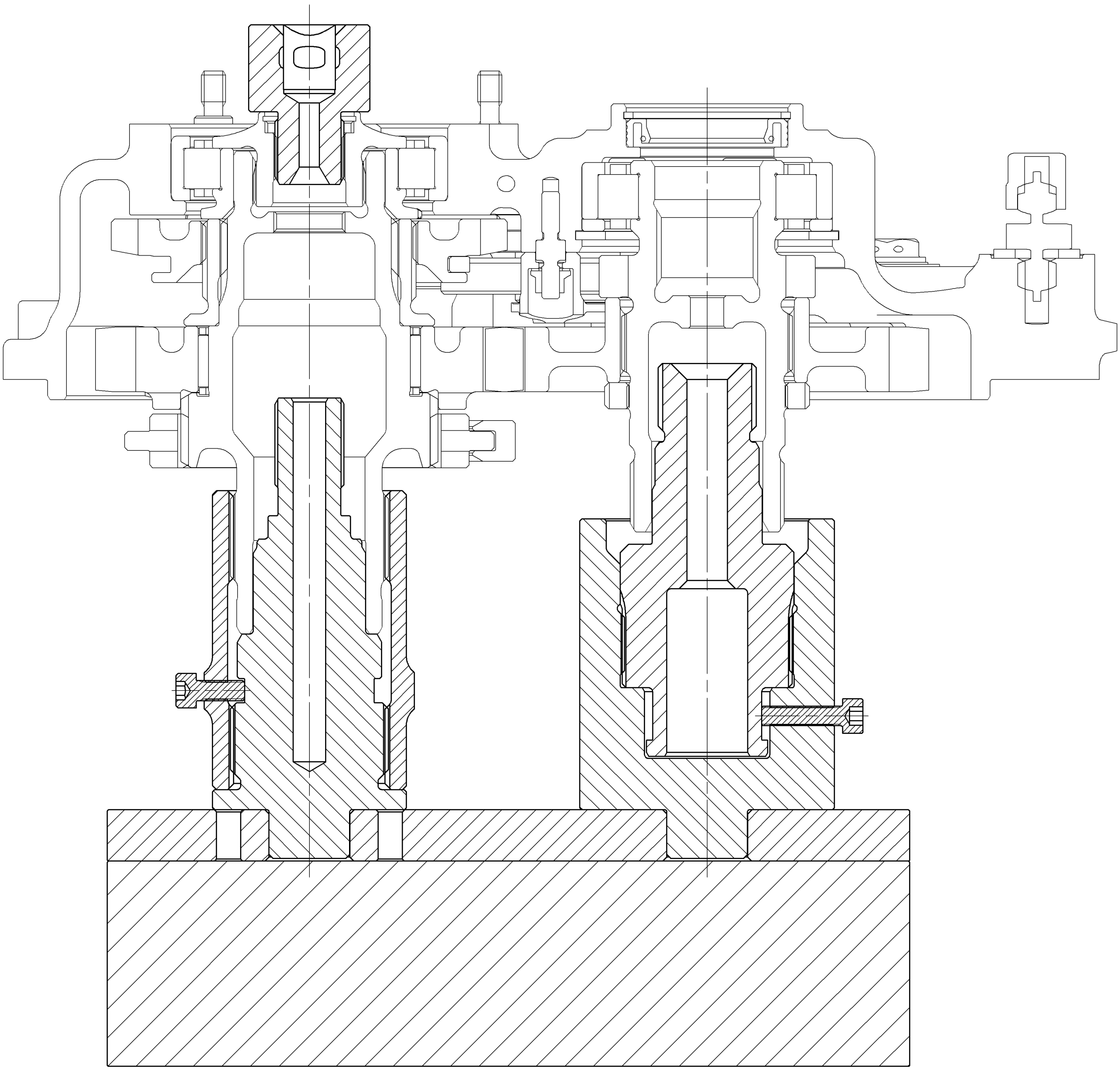


Figure 5 - Cluster Holding Tool for Tightening/Loosening LH Mainshaft Nut

6.2.3. Selector Barrel Setup

The tolerance stack up on individual parts across the assembly can affect the alignment of the dog rings. Therefore the barrel should be shimmed to ensure it holds the selector forks and dog rings central to the dogs of the gear cluster gears. The alignment needs to be checked and altered when a new selector barrel or mainshaft assembly is fitted in to the gearbox.

Note that the spacer fitted to each barrel between the inner races of the two bearings should be ground to the same size as the respective casing shoulder between the outer races of the two bearings on assembly to achieve zero preload.

Xtrac can offer more advanced training on the following procedure. If help is required during setup please contact your business manager.

1. Assemble the cluster assembly and the LH cluster components in to the right and left hand side cover assemblies respectively and mount in to a vice using the cluster setting jig assembly as detailed in drawing 1324-999-004A, and shown in Figure 6.

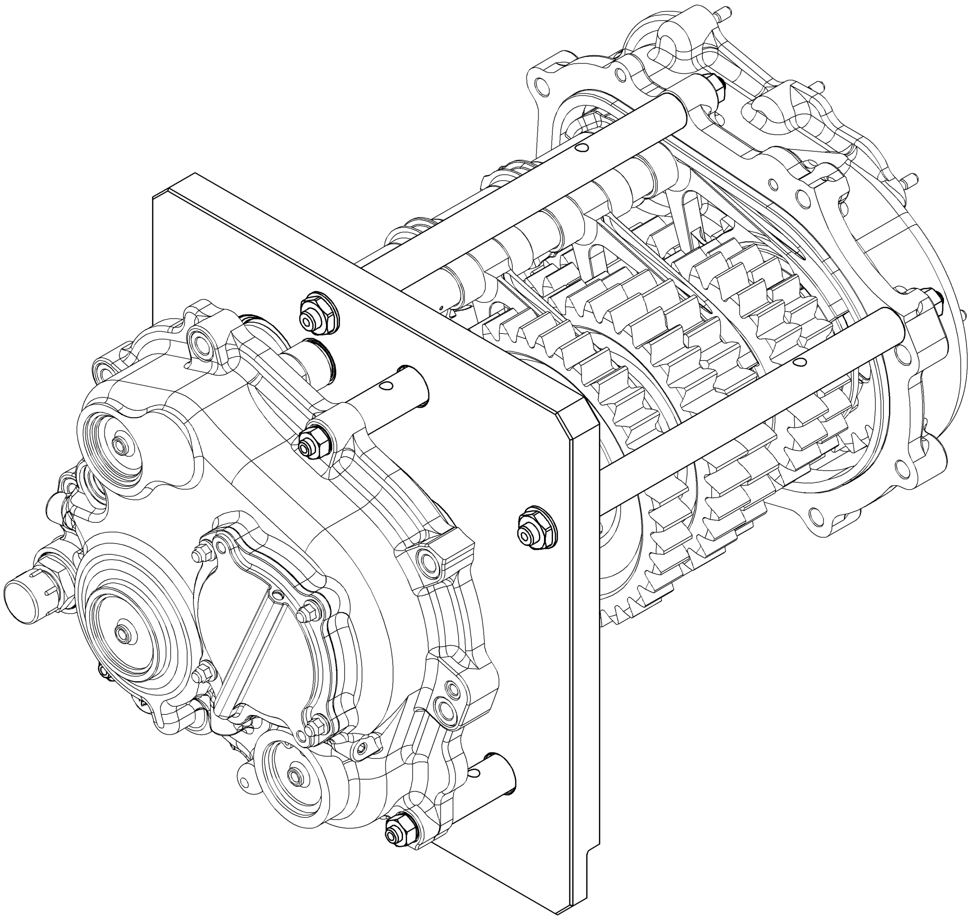


Figure 6 – 1159-999-001B Cluster Setting Jig

2. Rotate the barrel to each ‘in gear’ position and measure the dog stand off using feeler gauges as shown in Figure 7. The dog stand off is the distance between each gear dog root and the tip of the dog ring dog. A small amount of force should be exerted on the fork (at the selector rail journal) to remove backlash. Dog stand off values are typically 0.05mm to 0.2mm.

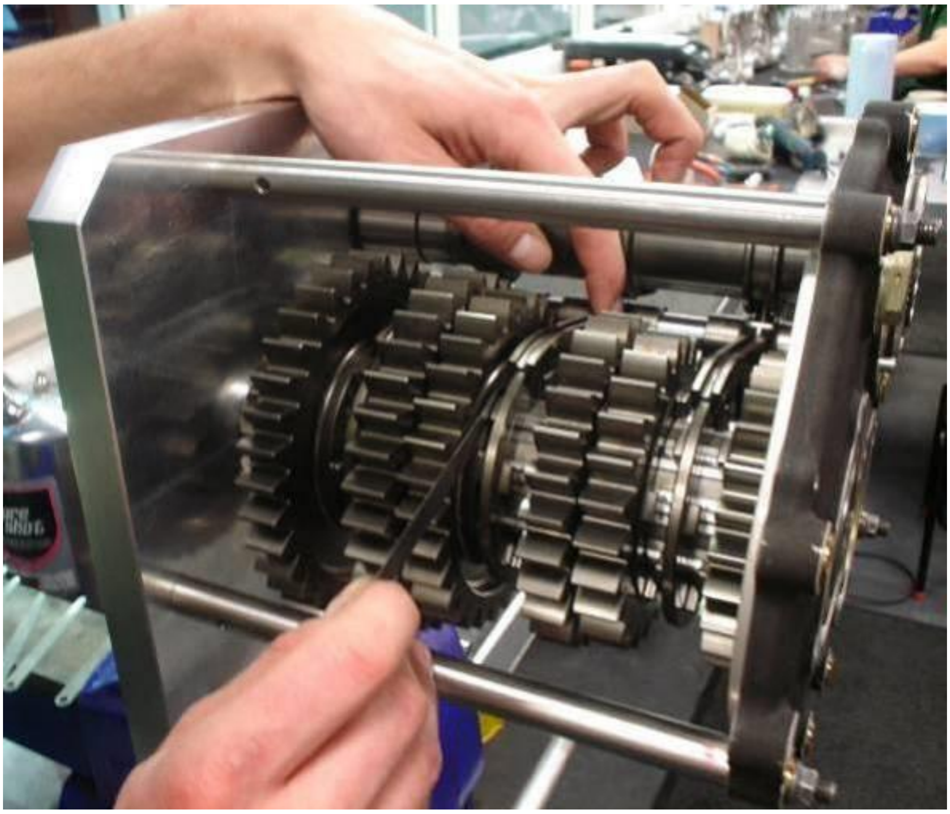


Figure 7 – Measuring Dog Stand Off (Generic sportscar cluster shown)

3. The dog rings reside between pairs of gears (i.e. 1st and 2nd, 3rd and 5th, 6th and 4th). If the dog stand off values are consistently biased in a single direction then the gearchange barrel spacer should be adjusted to balance these values.

4. After adjusting the gearchange barrel spacer (by surface grinding or selecting a larger size) and re-assembling, check all of the values again to ensure the change was satisfactory.

6.3. Bevel Gear Assembly

The input & output bevels should be assembled to the Xtrac assembly drawing 1159-925-000C, using the tooling assembly drawing 1159-999-004C. The input & output bevels should only be replaced by technicians experienced in bevel setup. Xtrac recommends that teams have Xtrac training prior to attempting such changes. Xtrac also offer an overhaul service.

Each gearbox is supplied with Bevel Setting sheets and Bevel Set Mounting Dimension sheets, samples of which are included in Appendix B Please refer to these and relevant assembly drawings in conjunction with the instructions presented here. All named dimensions in the following section are explained on the relevant Bevel Set Mounting Dimension sheet.

1. Select a nominal size input bevel position shim and record dimension PSnom. Fit the shim and press fit the first taper bearing inner track on to the input bevel.

2. Heat the input bevel bearing carrier as described in the drawing general assembly notes and fit both the input taper bearing outer races.

3. Fit the bearing carrier and a nominal size bearing spacer on to the input bevel followed by the remaining taper bearing inner track.

4. Fit the input seal journal, followed by the input bevel nut and torque to the lower value shown in *Appendix A* . Hold the assembly and, using a measuring torque wrench, measure the turning torque when cool.

5. Select a suitable bearing spacer to achieve a turning torque of 1.5Nm (1.1 lbf.ft). The spacer can be ground by taking equal amounts from each side if the thickness required is between standard spacer sizes. Decreasing the spacer size will increase the preload and vice-versa.

6. The output bevel is assembled in much the same way as the input bevel. First, select a nominal size output bevel position shim and record dimension WSnom. Fit the shim and press fit the first taper bearing inner track on to the output bevel.

7. Although the taper bearing outer tracks and the output bevel housing have a loose fit, the housing can be heated, as explained in the drawing general assembly notes, to make fitment easier.

8. Fit the bearing housing and a nominal size bearing spacer on to the output bevel, followed by the remaining bearing inner track.

9. Fit the output bevel nut and torque to the lower value shown in *Appendix A* . Referring to drawing 1324-999-007A, check the spline alignment between output bevel, bevel nut & LH layshaft & nut using tool 1159-499-033A. **Spline alignment can be achieved by over torqueing the bevel & LH layshaft nuts up to the maximum values shown in *Appendix A* .**

10. Hold the assembly and, using a measuring torque wrench, measure the turning torque. Select a suitable bearing spacer to achieve a turning torque of 1Nm (0.74 lbf.ft) when cool. The spacer can be ground by taking equal amounts from each side if the thickness required is between standard spacer sizes. Decreasing the spacer size will increase the preload and vice-versa.

11. Before the fitment of the output bevel assembly in to the maincase, measure dimension ‘Z’ and make a note of dimensions ‘Md2’ and ‘Lw2’. (Given on Bevel setting sheet)

12. Complete the output bevel setup calculation (refer to Appendix B) to determine the required shim thickness. The shim should be swapped for a different thickness accordingly. The shim can be ground (equal amounts off each side) if the required thickness is between sizes.

13. Heat the maincase in an oven to avoid local heating and fit the output bevel assembly. Torque the k-nuts to Xtrac standard XS036. Allow maincase to cool.

14. Check measurement dimension ‘Y’ to ensure correct setting. Adjust output bevel shim if required.

15. The output bevel assembly is now set and can remain in the maincase. Apply Loctite 241 to the K-nuts and re-torque to Xtrac standard XS036 (see Appendix J)

16. For the fitment of the input bevel assembly, measure dimension ‘A’ and record dimensions ‘Md1 and ‘Lw1’ (given on bevel setting sheet).

17. Complete the input bevel setup calculation (refer to Appendix B) to determine the required shim thickness. The shim should be swapped for a different thickness accordingly. The shim can be ground (equal amounts off each side) if the thickness required is between sizes.

18. Heat the maincase in an oven to avoid local heating and fit the input bevel assembly. Apply Loctite 241 to the k-nuts and torque to Xtrac standard XS036. Allow maincase to cool.

19. Measure the backlash of the input bevel by using a DTI gauge through the cluster opening. The gauge should be positioned on an input bevel tooth, half way up its length. The backlash should be 0.10mm (0.004”).

20. Adjust the input bevel shim to increase or decrease the backlash. Do not adjust the output bevel assembly.

21. Paint three input bevel teeth, using an acrylic based paint, and refit to check the tooth contact pattern is correct to the Bevel Setting sheet diagram. Xtrac recommend using a brightly coloured paint to aid the visibility of the contact pattern on inspection and photo graphs, as shown in Figure 8.

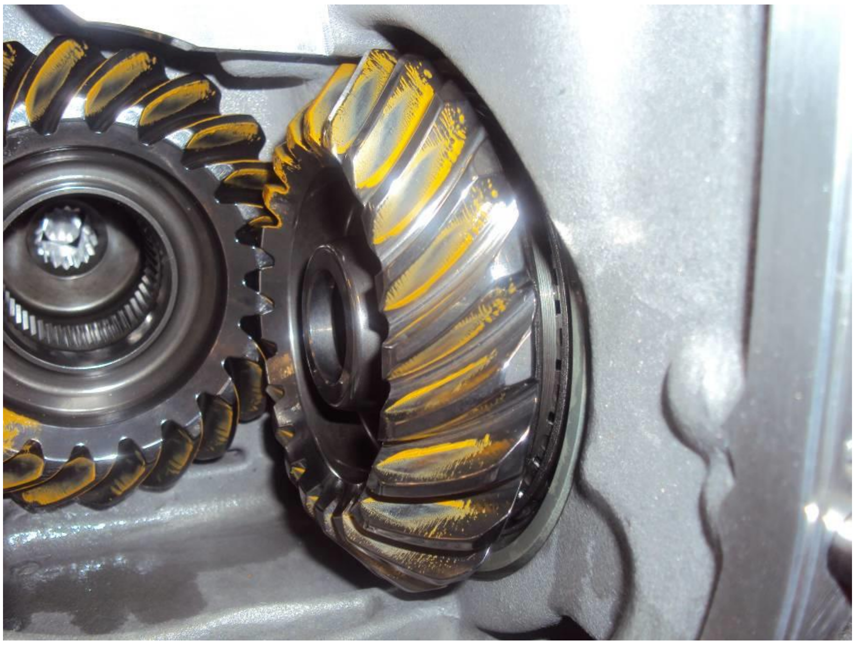


Figure 8 - Painted Bevel Teeth Showing Unloaded Contact Pattern (Generic Sportscar Bevels Shown)

22. When the correct setup has been achieved, ensure that all bolts and k-nuts have been secured accordingly.

6.4. Clutch Shaft Assembly

The clutch shaft is retained inside the input bevel using an M5 K-nut. To install and remove the clutch shaft the use of tool 1159-499-036B is necessary.

6.5. Differential Setup – Xtrac Plate Type Differential

The differential should be assembled as shown in the differential assembly drawings 1324-949-100A & 1324-946-000A in conjunction with the instructions presented here.

6.5.1. Setting the Stack Height

1. Measure the diff lid height as shown in Figure 9 (Dim A)

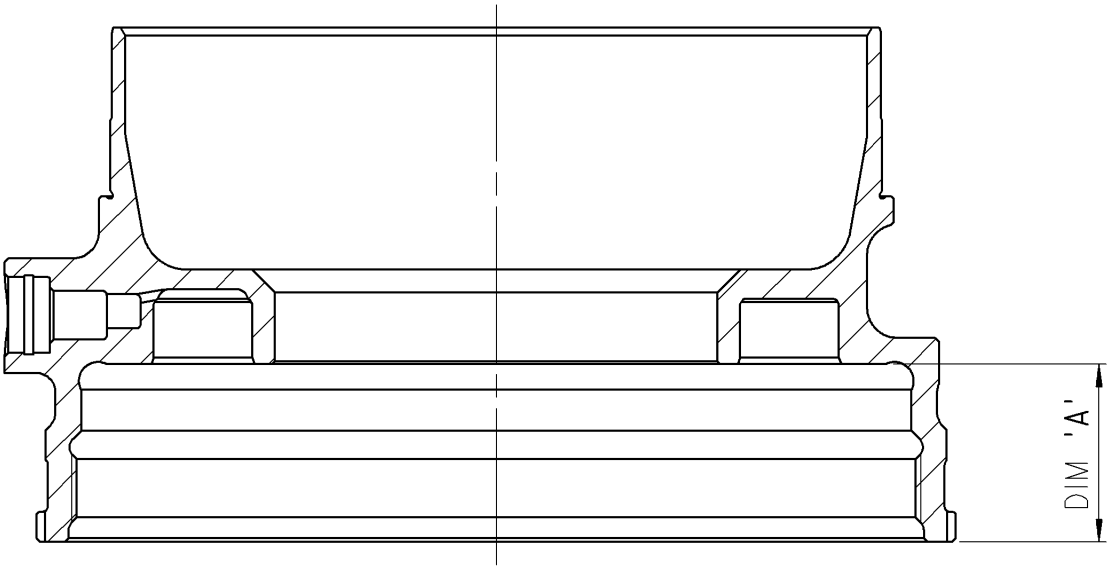


Figure 9 – Diff Lid Height Measurement

2. Measure a nominal setting spacer width (1011-290-005*) as shown in Figure 10 (Dim C_{NOM}). NOTE this *must* be the same for both spacers.
3. Assemble in the friction pack & nominal setting spacers along with the side gear rings with the crosspin in situ into the diff body.
4. Place a 4kg (8.8lb) weight on top of the friction pack to settle the plates and discs
5. Measure the distance from the diff body abutment to the top of the stack as shown in Figure 10 (Dim B)
6. Select/grind both setting spacers (1011-290-005*), using *Equation 1* to calculate the required width (Dim C), to give 0.05/0.1mm nominal clearance between the plate stack and the diff lid.

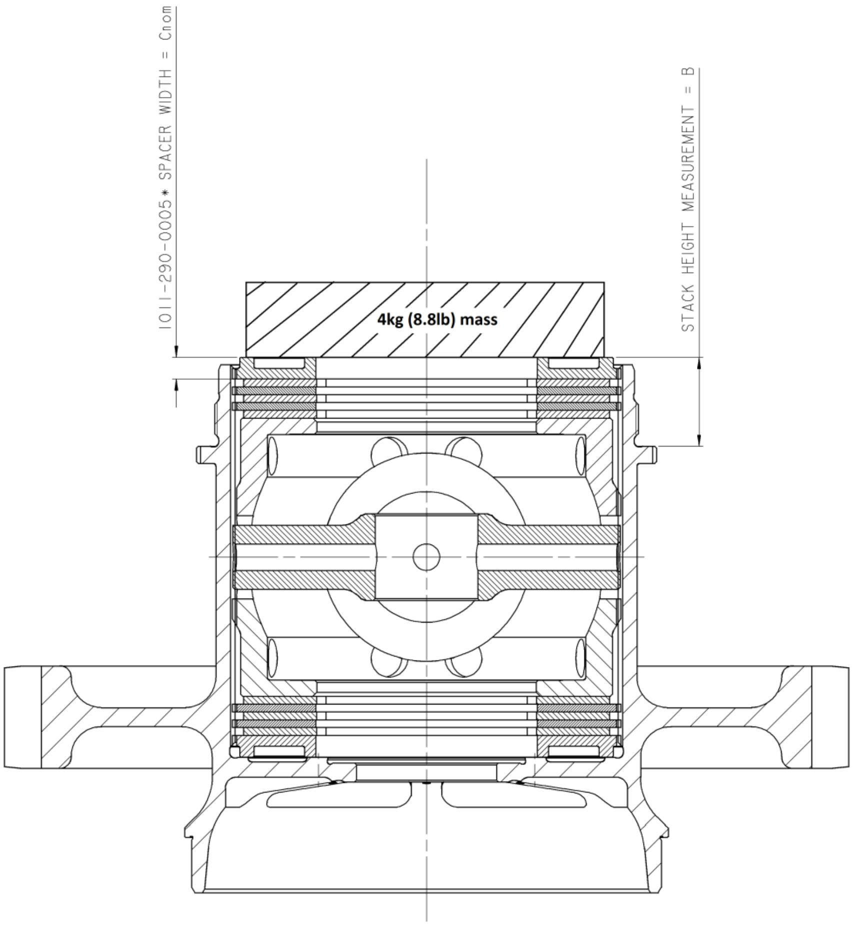


Figure 10– Diff Set Up Measurements

$$\boxed{C = [(A - B - 0.1) \times 0.5] + C_{NOM}}$$

Equation 1 – Diff Set Up Spacer Width Calculation

6.5.2. Setting & Checking Pre-load

Preload is applied to the differential by the application of pressurized nitrogen behind the piston. The piston then acts through the disc spring and provides positive pre-load to the friction pack. The disc spring also helps maintain stability with temperature variations and acts as a return mechanism for the piston.

To set the preload:

1. Preload is checked with the complete diff assembled on the preload setting tool 233-499-004A and securely mounted in a vice. See Figure 11 & drawing 1324-999-001B
2. A second preload setting tool is then inserted into the opposing side gear spline.
3. Turn the differential over a few times using a torque wrench on the upper differential preload tool.

4. Once the differential feels consistent measure the turnover torque across the differential. This value is the preload.
5. Apply pressurized nitrogen using the preload adjustment tooling (1159-999-050A) and repeat steps 3 & 4. Refer to Appendix E and continue this process until the desired preload is achieved.
6. To apply pressure in the car, insert the guide tube (1187-999-003C) via the fill plug access hole and locate on the diff filling boss. Then insert the needle tool, with a pressure source attached to the tool and the regulator set to the required pressure. Equalise the pressure between the differential and regulator, then close the valve, remove the tool and withdraw the guide tube.

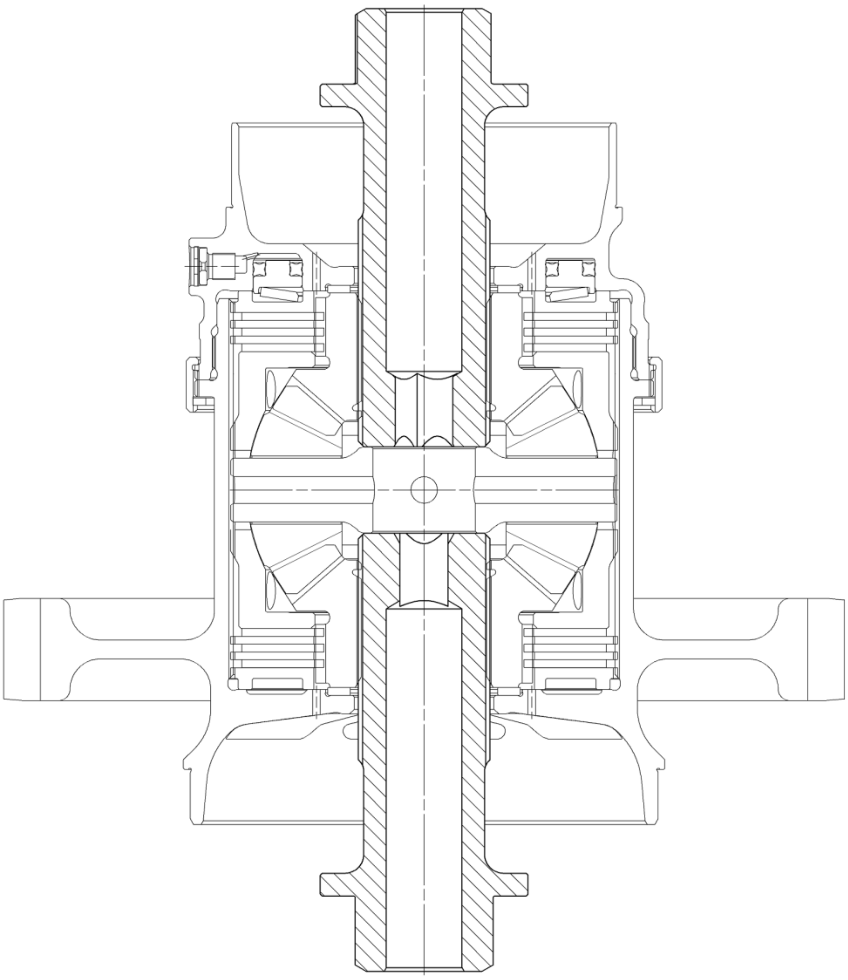


Figure 11 – Measuring the preload

6.6. Lifing Chart

The following chart should be used to ensure that component life is not exceeded and premature failures are prevented by regular inspection. Check and replace in accordance with the recommended distances below.

Mark all parts for lifing purposes and note in build records. Typical life in km of the most critical parts are tabulated in *Table 2*. All parts not included in the list require inspection after 12,000km. Visual inspection should identify any parts with dents, scratches, significant wear or corrosion.

For the purposes of lifing the race distance is taken as 4500km for Le Mans and 1500km for all other rounds.

NOTES: ***The table below is provided for guidance on the expected life of key components based on Xtrac's experience in LMP applications, however no warranty is implied by the figures stated and lifing targets are no substitute for testing and regular inspection of the gearbox internals.***

The P1324 gearbox is designed for endurance events and it is capable of running the full 6000km of a 24hr race and warm up without the need for visual inspection or crack checking the parts. However, if the gearbox is run under normal use in shorter events it is recommended that the visual and crack check intervals are adhered to.

Component life is affected by the precise application and can be influenced by circuit layout and conditions as well as driver style. Many of the components stated with a maximum 'typical' life of 12000km may be found to perform successfully for extended mileage however extended running above 12000km is done at customer's risk.

Table 2 - Typical Component Life Ratings

Component	Visual Inspection Every (km)	Crack Check Every (km)	Typical Life (km)
Clutch Shaft (standard & Torque Sensing)	1500	DO NOT MAGNETISE	12000
Cross Pin	-	6000	12000
Diff Body / Final Drive	3000	6000	12000
Dog Rings	3000	6000	6000
Gearchange Barrel	3000	6000	12000
Hubs	3000	6000	12000
Input Bevel Gears	3000	6000	12000
LH Layshaft	3000	6000	12000
Mainshaft/LH Mainshaft	3000	6000	12000
Oil Pump Rotors	6000	-	12000
Output Flanges	-	6000	12000
Pinion Mates	-	6000	12000
Selector Forks	3000	6000	12000
Selector Rails	3000	6000	12000
Side Gear Rings	-	6000	12000
Side Gears	-	6000	12000
Viscous Cross Shaft	6000	6000	12000
Viscous Pack Assembly (inc. LH Flange)	6000**	-	12000
Barrel Nut	-	3000	6000
Friction Plates	-	-	6000
Ground Gear Ratios	1500	3000	6000
Hobbed Gear Ratios	1500	3000	4500
Input Bevel Nuts	-	3000	6000
Input Bevel Preload Spacers	-	-	6000
Input Bevel Setting Spacers	-	-	6000
Layshaft	1500	3000	6000
Layshaft/Mainshaft Nuts	-	3000	6000
LH Layshaft Nut	-	3000	6000
Mainshaft Inner Track	3000	3000	6000
All Bearings	3000	-	6000
All Springs	6000	-	12000
Alternator Belt	3000	-	6000
All K-nuts, O Rings & Seals	Fit New When Removed		
Gearbox Oil	Drain and Replace Every 1500km		
**Viscous Differential torque setting check only at 6000km			

7. General Information

Please note that all Xtrac products and services are supplied subject to our Terms & Conditions of Sale, a copy of which is available on request.

7.1. Customer Support

7.1.1. Gearbox & Parts Supply

Standard gearbox assemblies and spare parts are generally held in stock at our UK facility. All gearbox assemblies are thoroughly rig tested and inspected prior to dispatch to check the gearchange operation, lubrication system and build integrity.

7.1.2. Training/Servicing

The gearbox is designed and manufactured for use in cost control categories and thus great emphasis is placed not only on its reliability but also on ease of servicing and assembly.

A technician from each team will be invited to attend product-training seminars in the UK, which will provide them with the basic knowledge to carry out their own routine maintenance work. However if required Xtrac is able to carry out maintenance/rebuild at facilities in the UK and, subject to demand, at our service centre in the USA.

Customers will receive parts lists, manuals, assembly drawings and appropriate technical bulletins containing updates on maintenance procedures, parts information, performance and safety issues.

7.2. Contacts

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Thatcham
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Senior Business Manager
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Appendix A - Non-Standard Tightening Torques

Table 3 - Non-Standard Tightening Torque Values

Description	Location (Sub-assembly)	Torque	Comments
Barrel Nut (195-422-002A)	1324-903-000A	70Nm (50 lbf.ft)	Oil threads
Input Bevel Nut (100-475-001A)	1159-925-000C	300-350Nm (221-258 lbf.ft)	Oil threads
Output Bevel Nut (1159-425-007A)	1159-925-000C	350-400Nm (258-295 lbf.ft)	Oil threads
Differential Lid (1324-449-001A)	1324-949-100A	300-400Nm (221-295 lbf.ft)	Oil threads
Layshaft / Mainshaft Nuts (634-421-005B)	1159-996-000A	100Nm (73 lbf.ft)	Oil threads

Table is for reference only. Refer to assembly drawings for tightening torques.

Appendix B – Example Bevel Setting Sheets

Example P1324 Bevel Set Mounting Dimension Sheet

BUILD SHOP PROCEDURE SHEET

Description:	1159 Bevel Reduction Mounting calculations
Assembly Part No(s).	1159-925-000D
Produced By:	AYB
Date Produced:	12/10/17

Notes:

1) This sheet is to be used in conjunction with the corresponding assembly drawings.
2) Correct bearing preload to be established prior to adjusting the mounting distance.

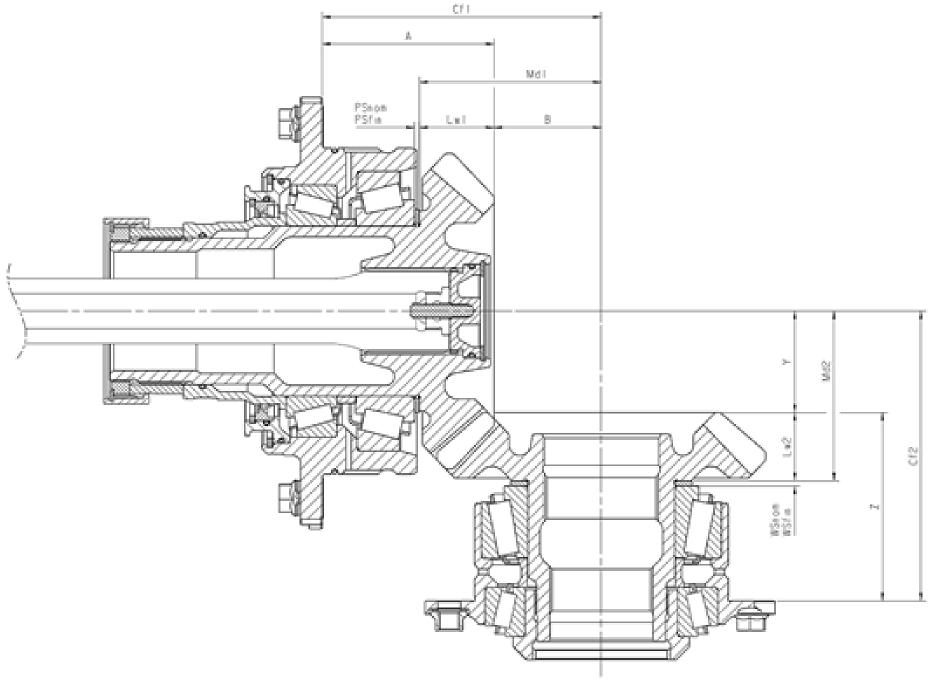
Gearbox Serial No. = 1159J-075

Bevel Matched Pair No. = B009

CF1 = Maincase Input Face to Output Bore c/l	104.551
CF2 = Maincase Output Face to Input Bore c/l	108.467

INPUT BEVEL FITTING	
Md1 = Input Bevel Mounting Dimension	68
Lw1 = Input Bevel Head Thickness	25.26
Psnom = Input Bevel Shim Nominal	2.003
A = Input Bevel & Housing Assembly Dimension	61.92
B = Md1 - Lw1	42.74
Psfin = Psnom + Cf1 - (A + B)	1.894

OUTPUT BEVEL FITTING	
Md2 = Output Bevel Mounting Dimension	63.5
Lw2 = Output Bevel Head Thickness	16.04
Wsnom = Output Bevel Shim Nominal	2.034
Z = Output Bevel & Housing Assembly Din	61.16
Y = Md2 - Lw2	47.46
WSfin = Wsnom + Cf2 - (Z + Y)	1.881



Page 1 of 2

Example P1324 Bevel Setting Sheet

Note: each bevel gear set will have a specific setup sheet – copies available on request.

BEVEL SETTING SHEET

1159425WPA2123	2123A009

XTRAC TRANSMISSION TECHNOLOGY
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Match Set Part Number:	1159425WPA2123
Data Sheet Number:	109742511
Pinion hand specification:	Right Hand Pinion
Match Set Serial Number:	2123A009
z1 (pinion):	21
z2 (wheel):	23

Issue:	1
Date:	30 January 2015
Ratio:	1.095

		Metric (mm)	Inch (REF)
Pinion offset:		0.000	0.000
Backlash @ Contact zone:		0.080	0.003
Pinion Mounting Dimension:	M_{d1}	68.000	2.677
Wheel Mounting Dimension:	M_{d2}	63.500	2.500
Pinion Head Thickness:	L_{W1}	26.750	1.053
Wheel Head Thickness:	L_{W2}	26.010	1.024

Unloaded Contact Pattern:
See Photograph

Photograph Set Number:
2123A009

Inspection Approval:
Jason Woodley

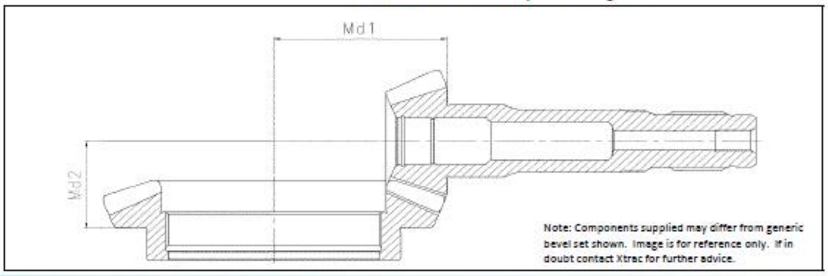
Comments:

Assembly Values

Pinion Part Number:
1159-425PA-2123

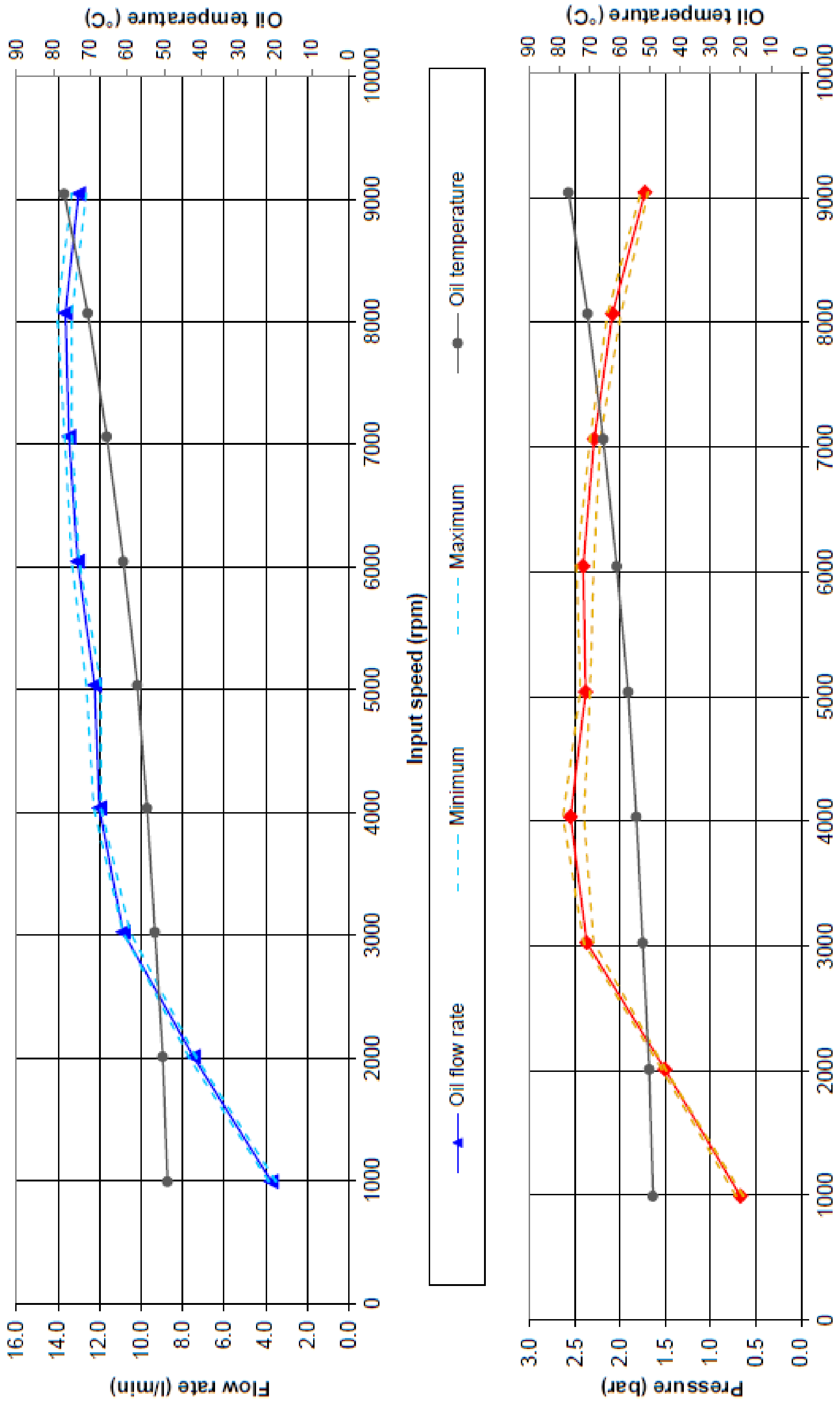
Crown Wheel Part Number:
1159-425WA-2123

1st build date:
Casing Measurement:
Pinion Shim Height:
Pinion Preload Spacer Height:
Crown Wheel Shim Height:
Crown Wheel Preload Spacer Height:

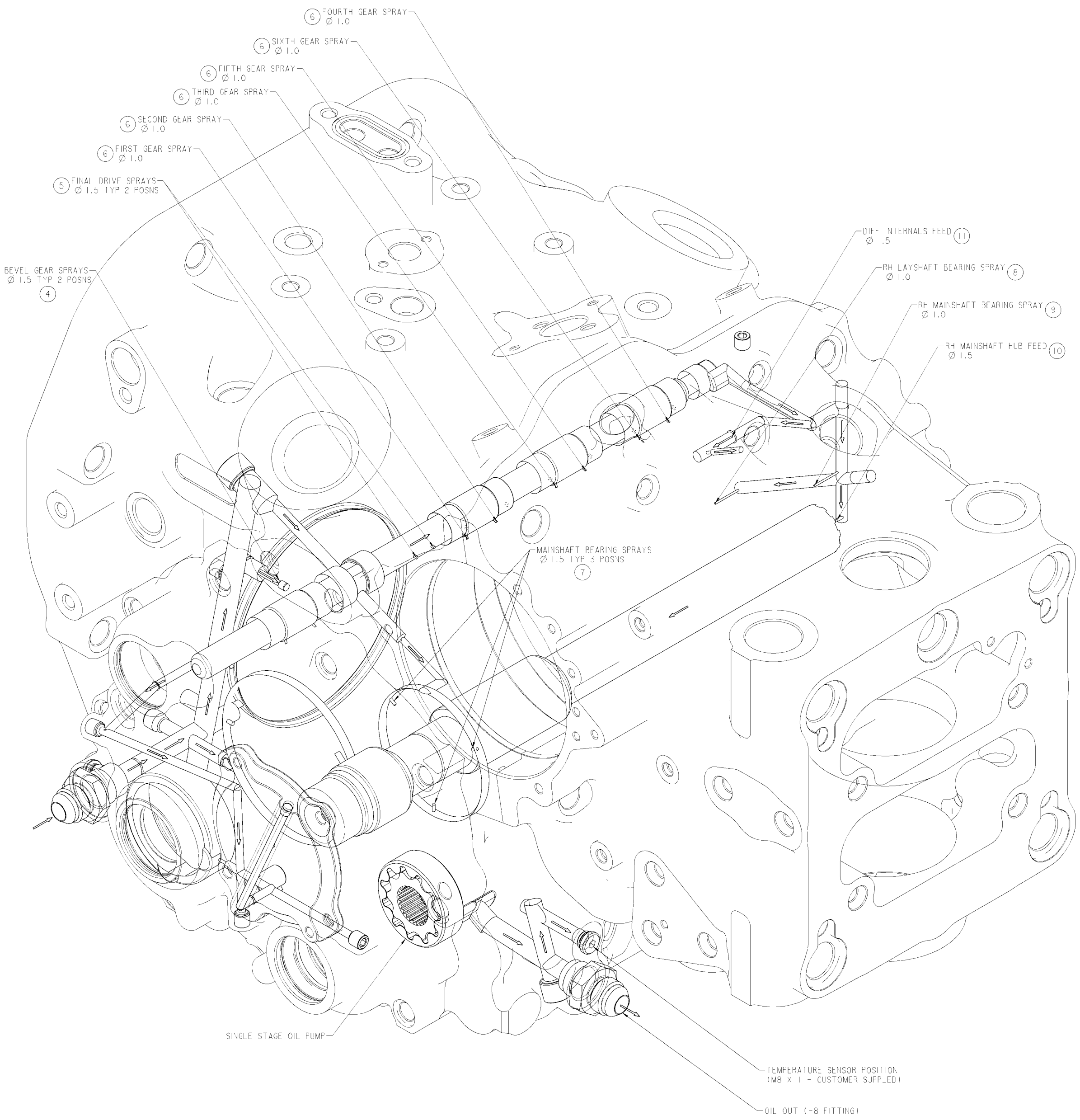


Appendix C – Oil System

Oil Pump Pressure and Flow Rates
Shown with 23:21 input bevels



Oil System Diagrams



Oil System Diagrams

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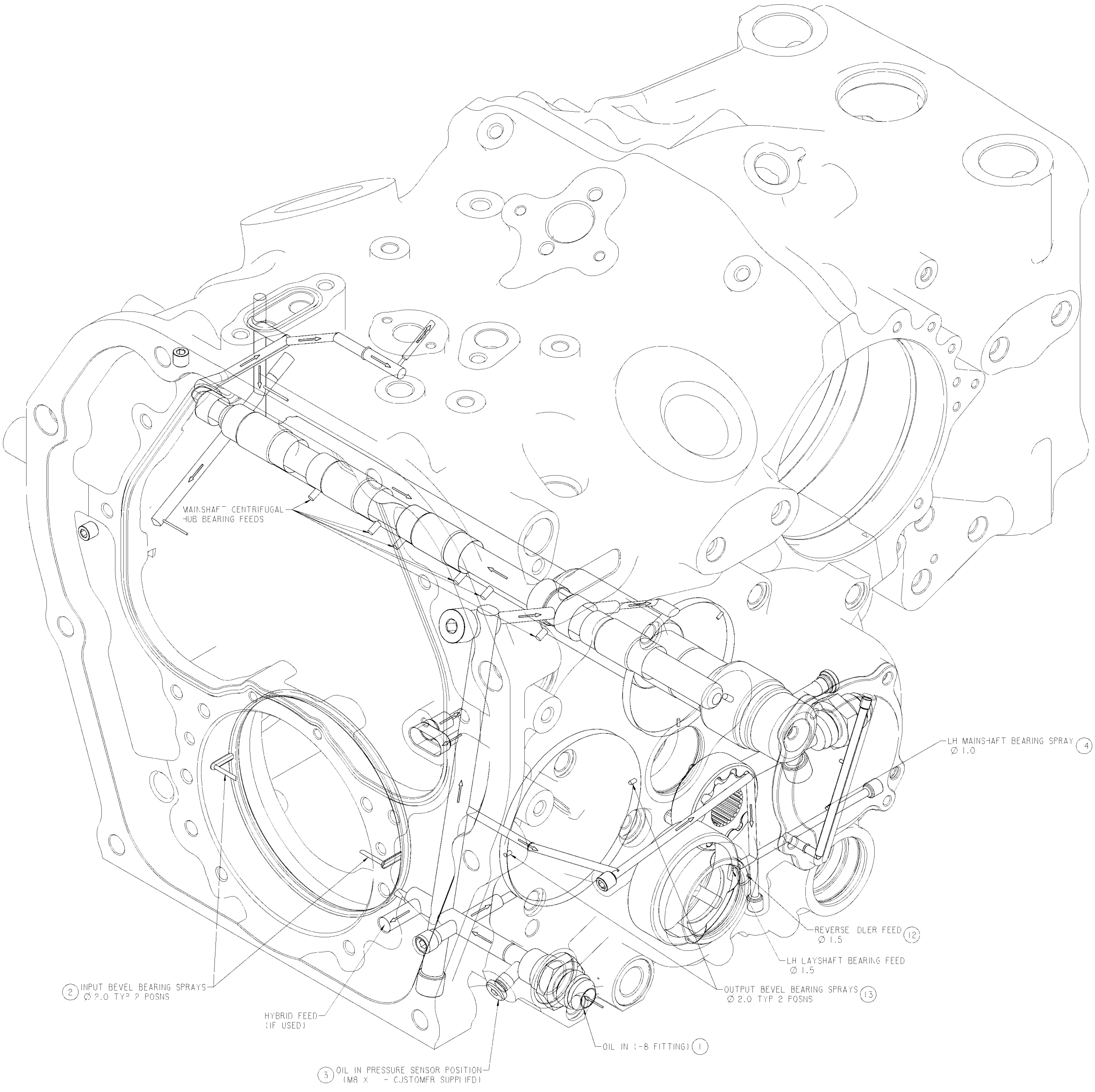


Appendix D – 1324 Ratio List

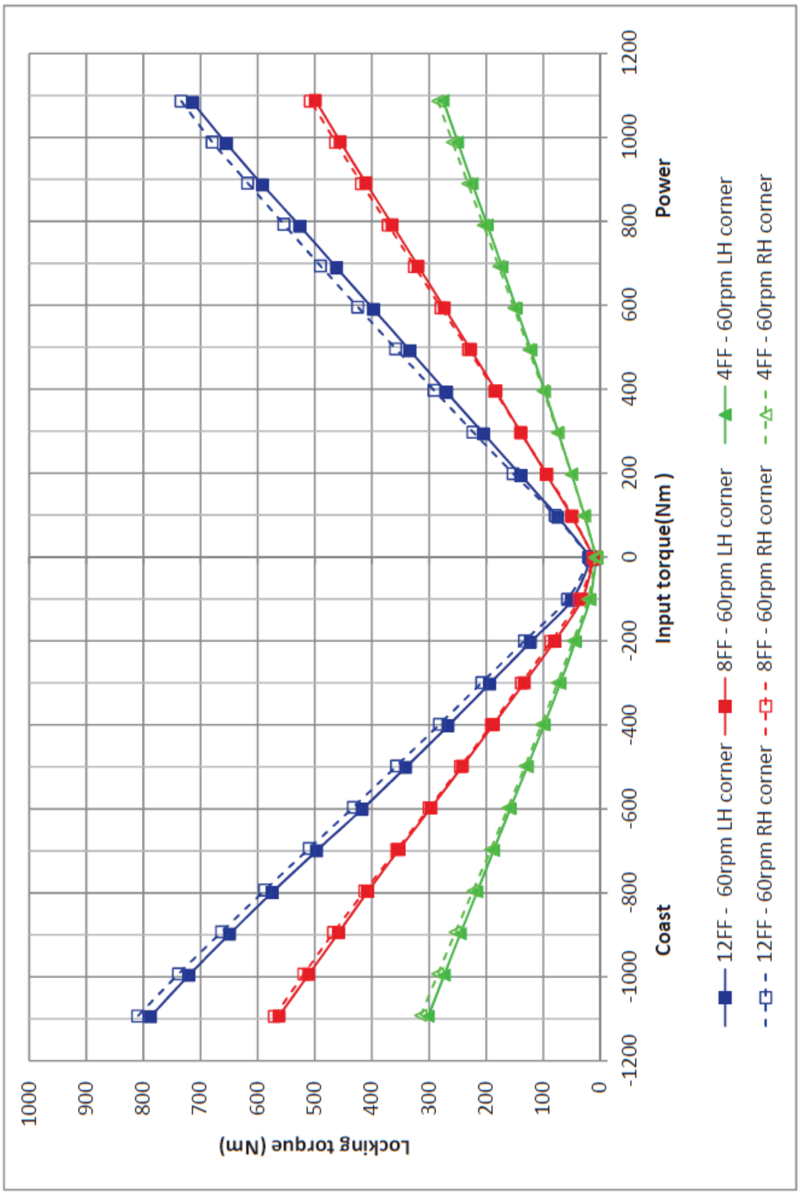
For the latest revision of the Ratio List and Speed Chart please contact your Xtrac Business Manager.

Appendix E – Differential Characteristics

Xtrac Plate Type Differential

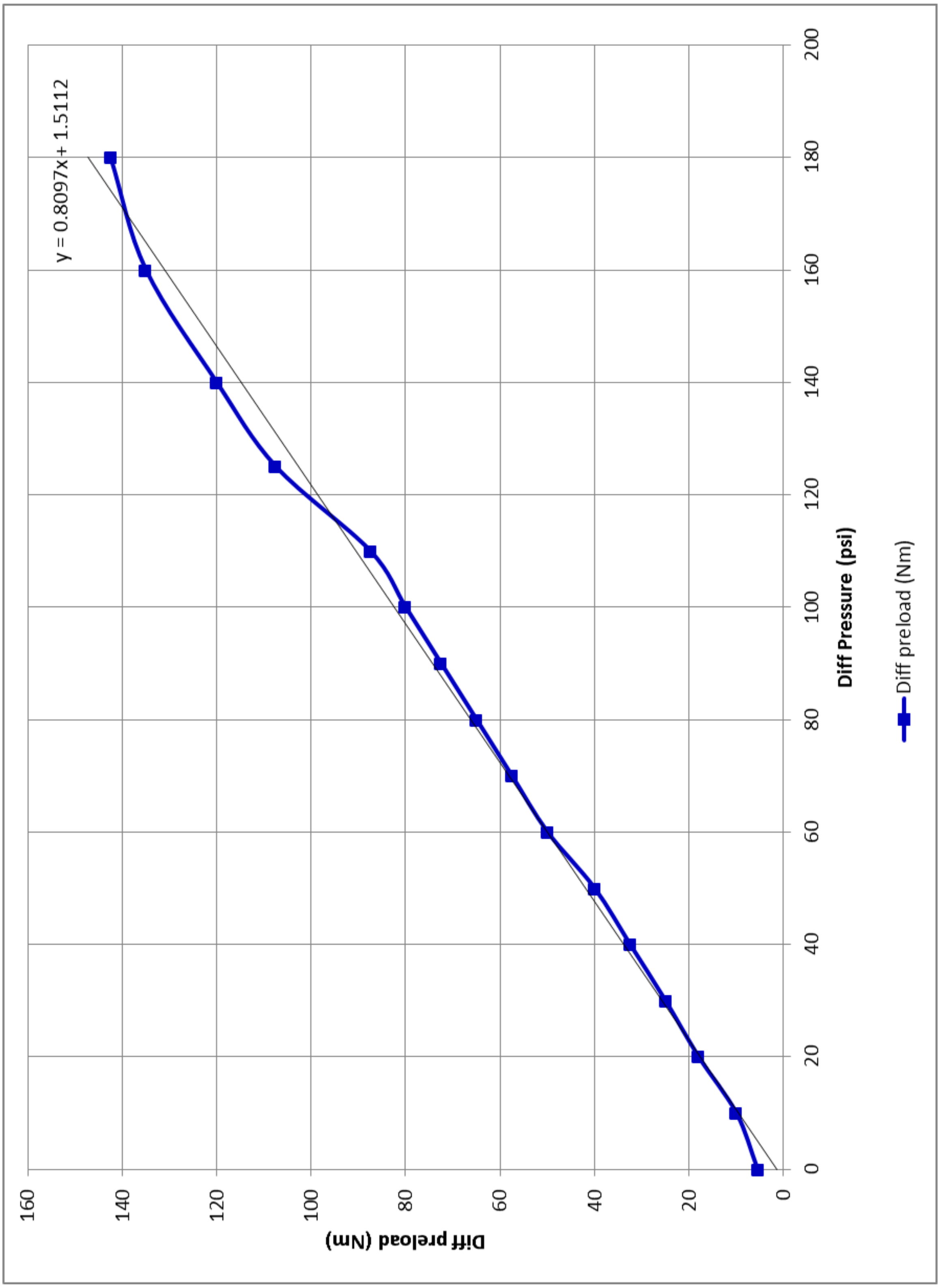
Differential testing – FF configuration test

Fig. 10



Comments: *P50/C45 0psi*

1324 Differential Preload Adjustment



Differential Characteristics

Table 4 - Differential Comparative Locking Data

RAMP ANGLE (DEG)	FRICTION FACES	BASELINE (%)
30	12	100
35	12	84
40	12	70
30	8	67
45	12	59
35	8	56
40	8	47
45	8	39
30	4	33
60	12	33
35	4	28
40	4	23
60	8	22
45	4	20
75	12	13
60	4	11
75	8	8
80	12	7
80	8	4
75	4	4
80	4	2
85	8,12	0

This data is provided as a reference guide to aid differential setups and maps the expected locking performance of the differential compared to a baseline where a 30° ramp with 12 friction faces is the maximum achievable locking.

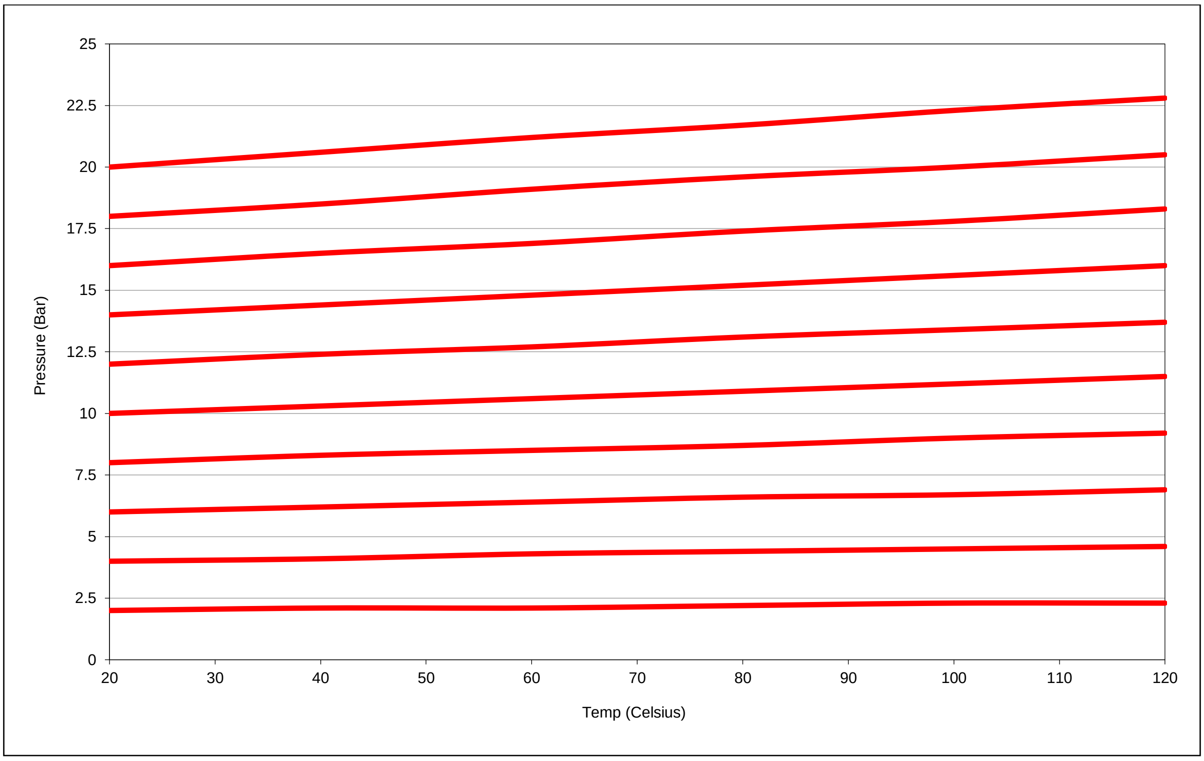
This data has been calculated based on a mixture of theoretical and experimental data and is a guide only; values are not exact

Appendix F – Differential Pressure/Temperature Correction

The following tables show the theoretical change in pressure for various working temperatures.

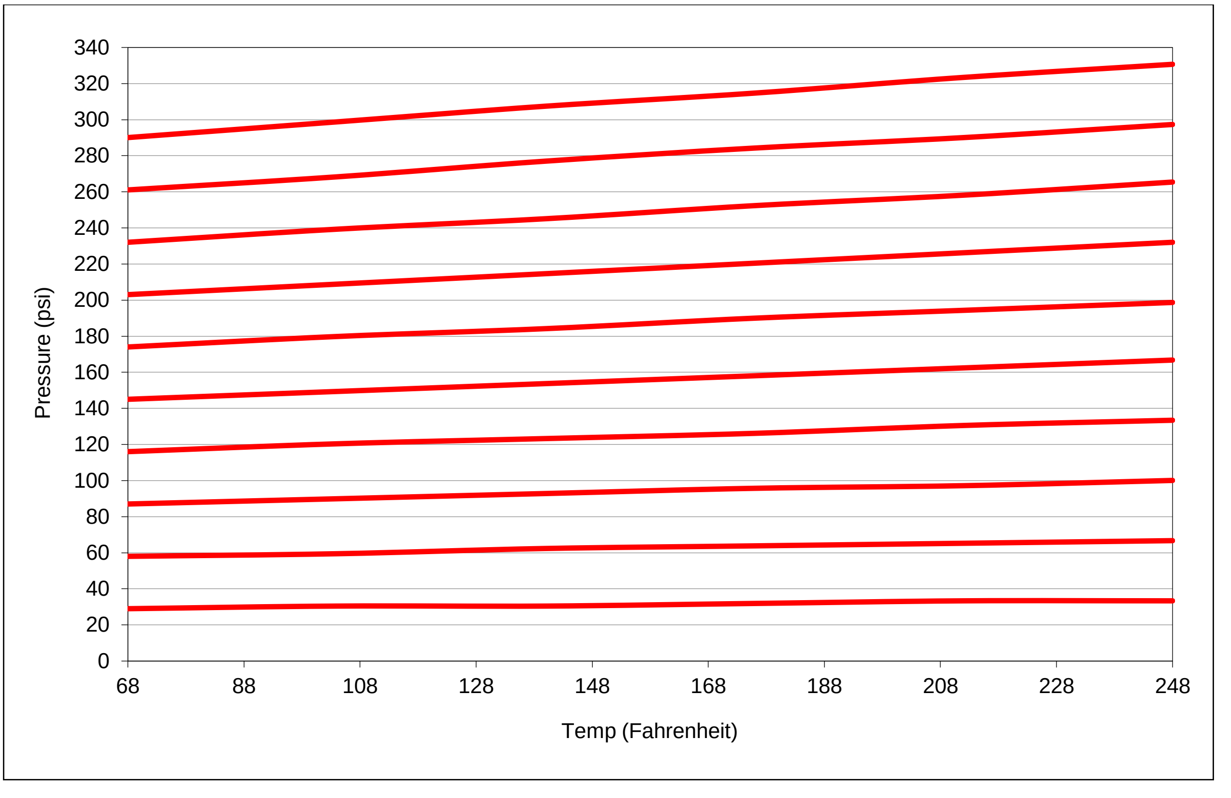
Temperature in Celsius vs Pressure in Bar

20°C	40°C	60°C	80°C	100°C	120°C
2.0	2.1	2.1	2.2	2.3	2.3
4.0	4.1	4.3	4.4	4.5	4.6
6.0	6.2	6.4	6.6	6.7	6.9
8.0	8.3	8.5	8.7	9.0	9.2
10.0	10.3	10.6	10.9	11.2	11.5
12.0	12.4	12.7	13.1	13.4	13.7
14.0	14.4	14.8	15.2	15.6	16.0
16.0	16.5	16.9	17.4	17.8	18.3
18.0	18.5	19.1	19.6	20.0	20.5
20.0	20.6	21.2	21.7	22.3	22.8



Temperature in Fahrenheit vs pressure in psi

68°F	104°F	140°F	176°F	212°F	248°F
29.0	30.5	30.5	31.9	33.4	33.4
58.0	59.5	62.4	63.8	65.3	66.7
87.0	89.9	92.8	95.7	97.2	100.1
116.0	120.4	123.3	126.2	130.5	133.4
145.0	149.4	153.7	158.1	162.4	166.8
174.0	179.8	184.2	190.0	194.4	198.7
203.1	208.9	214.7	220.5	226.3	232.1
232.1	239.3	245.1	252.4	258.2	265.4
261.1	268.3	277.0	284.3	290.1	297.3
290.1	298.8	307.5	314.7	323.4	330.7

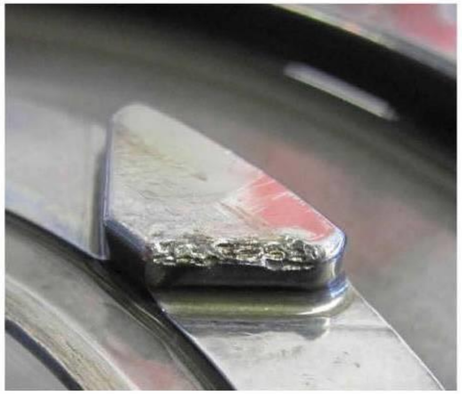


Appendix G – Dog Ring Condition Assessment Sheet

ADVANCED ENGINEERING REPORT

AE-7112-01A	Date: 01/03/11

Application	Dog Condition Assessment Sheet – After Use
Project	P1000
Report Author	Andrew McKendrick

Grade 1	Grade 2	Grade 3
		

Notes

- Pictures are representation only. Dog shape and size may differ
- Grade 1 – Re use
- Grade 2 – Practice and test use only
- Grade 3 – Scrap and instigate investigation into root cause e.g. shift strategy

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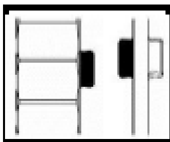
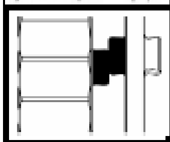
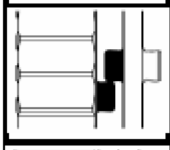
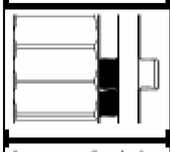
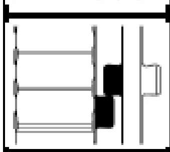
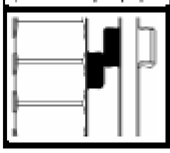
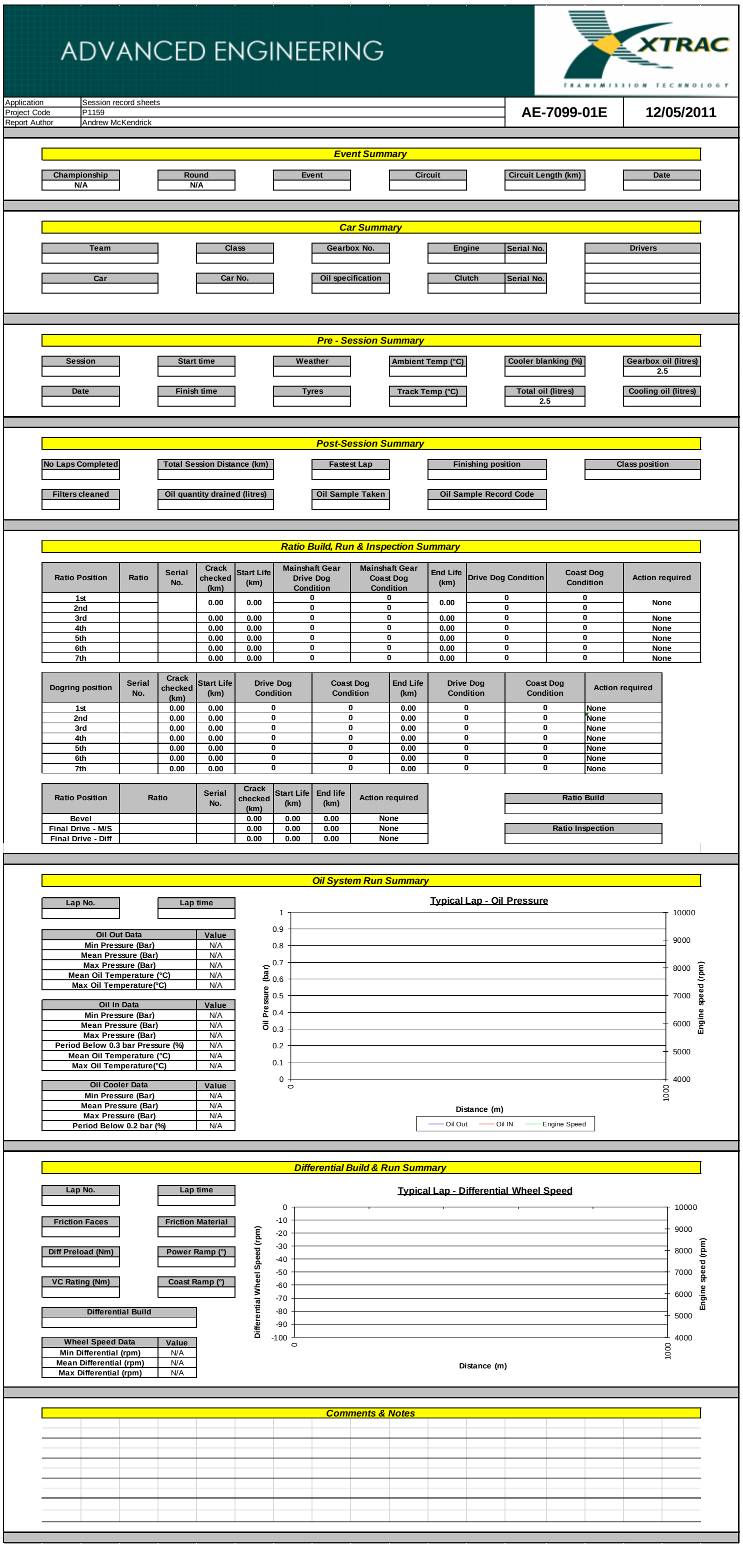
Appendix H – Dog Ring Position

Dog Position		Barrel Angle (°)
R	FEI	-45.00
	CTR	-40.00
	FEO	-38.50
	LC	-18.02
N	**CTR**	0.00
1	FC	24.00
	FPE	26.31
	FEI	37.50
	CTR	40.00
	FEO	42.50
	LPE	56.18
	LC	58.07
2	FC	61.84
	FPE	63.72
	FEI	77.50
	CTR	80.00
	FEO	82.50
	LPE	93.80
	LC	96.13
3	FC	103.87
	FPE	106.20
	FEI	117.50
	CTR	120.00
	FEO	122.50
	LPE	133.80
	LC	136.13
4	FC	143.87
	FPE	146.20
	FEI	157.50
	CTR	160.00
	FEO	162.50
	LPE	173.80
	LC	176.13
5	FC	183.87
	FPE	186.20
	FEI	197.50
	CTR	200.00
	FEO	202.50
	LPE	213.80
	LC	216.13
6	FC	223.87
	FPE	226.20
	FEI	237.50
	CTR	240.00
	FEO	242.50
	LPE	253.80
	LC	256.13

Dog Position		Barrel Angle (°)
7	FC	264.25
	FPE	266.52
	FEI	277.50
	CTR	280.00
	FEO	285.00

	**Neutral** N – Centre of barrel neutral position
	**First Contact** FC – First contact of dog to gear
	**First Point of Engagement** FPE – First point of dog engagement when considering dog radii
	**Fully Engaged (In/Out)** FEI/FEO – Fully engaged 2.5° either side of barrel track centre position (CTR)
	**Last Point of Engagement** LPE – Last point of dog engagement when considering dog radii
	**Last Contact** LC – Last contact of dog and gear

Appendix I – Session Record Sheet



ADVANCED ENGINEERING

XTRAC TRANSMISSION TECHNOLOGY

Application	Session record sheets	AE-7099-01E	12/05/2011
Project Code	P1159		
Report Author	Andrew McKendrick		

Event Summary

Championship	Round	Event	Circuit	Circuit Length (km)	Date
N/A	N/A				

Car Summary

Team	Class	Gearbox No.	Engine	Serial No.	Drivers
Car	Car No.	Oil specification	Clutch	Serial No.	

Pre - Session Summary

Session	Start time	Weather	Ambient Temp (°C)	Cooler blanking (%)	Gearbox oil (litres)
					2.5
Date	**Finish time**	**Tyres**	**Track Temp (°C)**	**Total oil (litres)**	**Cooling oil (litres)**
				2.5	

Post-Session Summary

No Laps Completed	Total Session Distance (km)	Fastest Lap	Finishing position	Class position
Filters cleaned	**Oil quantity drained (litres)**	**Oil Sample Taken**	**Oil Sample Record Code**	

Ratio Build, Run & Inspection Summary

Ratio Position	Ratio	Serial No.	Crack checked (km)	Start Life (km)	Mainshaft Gear Drive Dog Condition	Mainshaft Gear Coast Dog Condition	End Life (km)	Drive Dog Condition	Coast Dog Condition	Action required
1st			0.00	0.00	0	0	0.00	0	0	None
2nd					0	0		0	0	
3rd			0.00	0.00	0	0	0.00	0	0	None
4th			0.00	0.00	0	0	0.00	0	0	None
5th			0.00	0.00	0	0	0.00	0	0	None
6th			0.00	0.00	0	0	0.00	0	0	None
7th			0.00	0.00	0	0	0.00	0	0	None

Dogring position	Serial No.	Crack checked (km)	Start Life (km)	Drive Dog Condition	Coast Dog Condition	End Life (km)	Drive Dog Condition	Coast Dog Condition	Action required
1st		0.00	0.00	0	0	0.00	0	0	None
2nd		0.00	0.00	0	0	0.00	0	0	None
3rd		0.00	0.00	0	0	0.00	0	0	None
4th		0.00	0.00	0	0	0.00	0	0	None
5th		0.00	0.00	0	0	0.00	0	0	None
6th		0.00	0.00	0	0	0.00	0	0	None
7th		0.00	0.00	0	0	0.00	0	0	None

Ratio Position	Ratio	Serial No.	Crack checked (km)	Start Life (km)	End life (km)	Action required
Bevel			0.00	0.00	0.00	None
Final Drive - M/S			0.00	0.00	0.00	None
Final Drive - Diff			0.00	0.00	0.00	None

Ratio Build

Ratio Inspection

Oil System Run Summary

Lap No.	Lap time

Oil Out Data	Value
Min Pressure (Bar)	N/A
Mean Pressure (Bar)	N/A
Max Pressure (Bar)	N/A
Mean Oil Temperature (°C)	N/A
Max Oil Temperature(°C)	N/A

Oil In Data	Value
Min Pressure (Bar)	N/A
Mean Pressure (Bar)	N/A
Max Pressure (Bar)	N/A
Period Below 0.3 bar Pressure (%)	N/A
Mean Oil Temperature (°C)	N/A
Max Oil Temperature(°C)	N/A

Oil Cooler Data	Value
Min Pressure (Bar)	N/A
Mean Pressure (Bar)	N/A
Max Pressure (Bar)	N/A
Period Below 0.2 bar (%)	N/A

Differential Build & Run Summary

Lap No.	Lap time
Friction Faces	**Friction Material**
Diff Preload (Nm)	**Power Ramp (°)**
VC Rating (Nm)	**Coast Ramp (°)**

Differential Build

Wheel Speed Data	Value
Min Differential (rpm)	N/A
Mean Differential (rpm)	N/A
Max Differential (rpm)	N/A

Comments & Notes

Session Record Sheet available in Microsoft Office Excel format upon request. Recommended maximum export size 20 Hz.

Appendix J – Xtrac Standards

For the latest revision of XS036, Xtrac's standard tightening torques for threaded joints, please contact your Business Manager.

Appendix K - Technical Bulletins

Periodically, technical bulletins will be issued covering any issues or changes made to the gearbox.

At the earliest opportunity, please forward e-mail contact details to any of the Xtrac contacts listed in this manual, so that bulletins and other information can be passed on efficiently throughout the season.

Appendix L – Manual Revision History

The table below shows the changes made to the manual content throughout its history.

Changes from the previous revision are highlighted in red.

Issue	Description of Change	Date	Modified	Approved
1	First Release	09/12/20	JMO	AMD