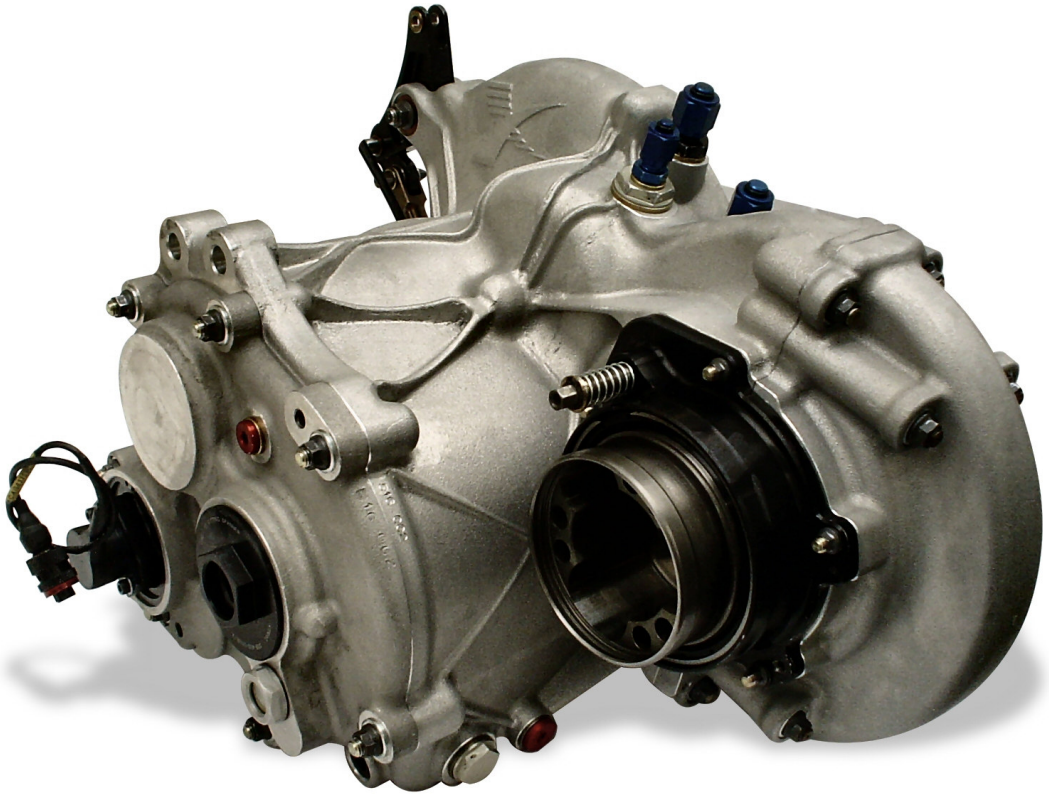
PRODUCT MANUAL

Xtrac 516 Customer Touring Car Gearbox Manual



Issue 3 – 09/04/09 516 Customer Touring Car Gearbox Manual
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1. Operating requirements

For optimum Performance and Safety – Warranty issues

Xtrac is extremely proud of the quality, success and reputation of their products and we are delighted that you have chosen to use the 516 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 2000km (1250 miles) for touring car applications) the gearbox should be carefully inspected and stripped as appropriate. In the manual there are lifing recommendations for critical components detailed in section 4.4. 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 XG2, 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.

Your attention is drawn in particular to section 11 of the Terms and conditions of Sales which includes 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. Similarly prototype, experimental or components manufactured to the Customer's design are supplied subject to warranty only against manufacturing

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defects. Furthermore such components, by their very nature, are not warranted as to their suitability for use or performance.'

'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.'

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2. Specification

The 516 gearbox has been designed for use in FWD applications ranging from the World Touring Car Championship to the SCCA, using many existing tried and tested parts packaged to suit the specific needs of high duty touring car formulae. The unit is a transversely mounted design for use in front wheel drive vehicles and uses six forward gears and reverse. The gearbox features an externally adjustable differential preload as standard.

Xtrac Part Description:	Customer Touring Car Gearbox
Xtrac Part Number:	516-900-000A

2.1. General Items

The specification is as follows:-

Drive is fed from the clutch via a customer specific input shaft directly to the gear ratio cluster. From the cluster, drive is transmitted by a spur final drive pinion and wheel to the Salisbury plate type differential.

The change gears are non-synchromesh using 5 flat top dogs, engaged using a full length barrel. The cluster can be removed as a single unit.

The sequential gearchange operates in the following sequence R, N, 1, 2, 3, 4, 5, 6.

Gearbox is rated at ~ 300Nm (221 lbf.ft) input torque * (see note below).

Casings The casing material is Aluminium L169, and all casings have o-ring face sealing.

Change Gears Six hobbed gears with optimised tooth width (12.0mm max) The gears are spaced on 3.346” (85.0mm) centres, with 1st gear or 1st & 2nd gear integrated into the layshaft, dependent on application. For more details see Appendix E – 516 Ratio List.

Final Drive A 13:50 ratio is standard fitment for the 516 gearbox. See Appendix E – 516 Ratio List for details of other

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	ratios options.
Differential	Salisbury plate type with adjustable preload fitted as standard.
Output flanges	To suit Xtrac modified G182 tripode joints with increased articulation. The left hand flange is part of the standard differential assembly 516-949-000B.
Oil Pump	A 6mm wide single stage eccentric lobe oil pump is available to pressure feed the gearbox lubrication circuit. For more details see section 3.2.
Weight	29.8 kg (65.6 lb) dry weight in standard configuration.
Gearchange Actuator	Uses a 1:1 bellcrank requiring allowance for up to 10.5mm (0.415") fore and aft rack movement, designed to fit a Ø6.33mm (1/4") x 9.7mm (3/8") rod-end.
Gearchange	Xtrac Ratchet & Pinned Pawl gearchange system packaged within the gearbox maincase.
Dowels and Studs	Included for gearbox to bellhousing face.

* * The rating figure given is considered an approximate and is dependent on engine characteristic as well as absolute value. The method upon which engine torque is delivered through the transmission can vary considerably depending on the physical engine characteristic, firing order, fuel and spark strategy and any traction limiting system that is utilised. The life and durability of the gearbox internal parts is also considerably influenced by factors other than engine output characteristics, for example oil type, operating temperature and operating environment.

2.2. Standard Options (no cost)

Clutch Shaft	Designed to suit customer installation.
Gearing	Change and final drive gear ratios can be selected from the ratio list. See Appendix E – 516 Ratio List. A separate set of ratios for endurance applications is also available

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Differential Settings	Various ramp angles and pre-loads are available, and the number of friction faces in the plate differential can also be adjusted. See section 3.3 for more details.
Gearchange Petal	To protect the engine and gearbox the gearchange petal profile has a positive stop preventing the driver selecting neutral and reverse accidentally during downshifts. A lifter cable is supplied for manual operation.
Reverse Cable	The gearbox is provided with a 2m (6.6ft) cable to join to the reverse/neutral detent. 3m (9.8ft) and 4m (13.1ft) lengths can also be supplied.

2.3. Optional Extras (cost options)

Quick Release Detent	A quick release assembly can be provided to ease separation of the reverse/neutral cable. For more details see section 3.1.
Gear Position Potentiometer	A spring blade style potentiometer can be fitted. No connector is provided. For more details see Appendix B – Electrical Component Data Sheets.
Gear Position Display Assembly	Xtrac would be happy to quote for the supply of the 00P-192-0063E gear display system if required.
Gear Ratios	Available Xtrem polished.
Final Drive	Available Xtrem polished.
Gearchange Actuation	A bellcrank with three mounting positions is available, giving additional motion ratios of 1.4:1 and 1.2:1.
Drive Shaft Assembly	This kit includes an Xtrac manufactured driveshaft, Xtrac modified tripode joint, inboard driveshaft boot and joint retention device.
Cross Shaft Assembly	This includes the cross shaft, remote RH output flange, bearings and circlips. The cross shaft is designed to the customer's specific installation.

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Remote Output Flange Housing	An aluminium housing to locate the remote flange to the engine block can be supplied with the cross shaft assembly.
Clutch Actuation	An AP Racing part no. CP3859-1250/Xtrac part no. 190-0206 can be supplied fitted to the gearbox. Other options are available on request.

2.4. Excluded Items

Bellhousing Assembly	Xtrac would be happy to quote for the design, manufacture & supply of a bellhousing assembly to suit the individual customer requirements.
Assembly Tooling	See drawing 516-999-000A for a list of assembly tooling.
Gearbox Mounting	Dowels, studs, bolts etc.
Oil Temperature Sensor	See section 3.2.3 for details.
Oil Pressure Sensor	See section 3.2.3 for details.
Oil Cooler & Lines	See section 3.2.1 for details.
Clutch	Customer supplied.
In-Car Gear Lever Assembly	Xtrac would be happy to quote for supply of the 420 gear lever assembly if required.
Outboard CV joints	Xtrac offer various 6 ball Lobro, non-plunging, outboard joints

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3. Gearbox Operation

3.1. Gearchange Description

The 516 gearchange system is a ratchet and pawl system utilising Xtrac's stop guide plate profile to reduce risk of overthrows. Xtrac's 'key pawl' has been designed to reduce gearbox damage and improve engagement during swift gearchanges. The gearchange rack is manufactured from high strength maraging steel and is a race proven design

The standard gearchange sequence is 'R-N-1-2-3-4-5-6', which is controlled by the gearchange barrel (516-432-001C). In the manual system, selection of both neutral and reverse are inhibited by the petal profile of the standard ratchet body against the detent plunger. A cable connected to a manually operated lift lever in the cockpit lifts the detent allowing neutral and reverse to be selected.

Note: It is vital that if a cable is fitted it has a minimum of 1mm of slack in it and cannot preload the plunger without the lift lever engaged. Failure to do this will result in severe dog damage.

A quick release (QR) option (406-903-200) is available for the reverse/neutral cable to allow simplified removal of the cable and reduce the time it takes to remove the gearbox. Please note that the QR kit comes in cable lengths of 80mm, 230mm and 430mm when measured between the cable locking screw and the QR housing. Another cable (406-803-200) connects the QR housing to the gear lever, and comes in lengths of 1.5m, 2m, 3m and 4m.

The standard detent plunger reacts directly against the ratchet petal profile and ensures complete gearchanges are made and overthrows do not occur. The detent plunger and rack systems are contained in separate sub-assemblies, which can be easily removed and replaced in the event of gearchange issues. The ratchet system is housed within the gearbox maincase while the gearchange barrel and selectors are contained within the cluster. More details on the gear cluster can be found in section 3.4.

An upward motion of the gearchange rack is required for up shifts. The handset inside the cockpit (if applicable) should be set up so a rearward motion performs an up-change and a forward motion performs a down change. The gear lever returns to

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its central position after each shift and there are 'stops' at each end of the sequence preventing any further increment of the lever.

Gears can only be selected in turn and there is no ability to change more than one position without re-centring the gear lever. The engaged gear can be shown on a dashboard display via a signal from a potentiometer driven by the gearchange barrel.

Please refer to Appendix G – Xtrac Standards for information on gear change installation and recommendations for the in-car lever assembly and linkage.

3.2. Oil System

3.2.1. Description

An internal single stage eccentric lobe style pump, fitted on the right hand side of the gearbox and driven by the reverse idler gear, operates as part of a simple re-circulating system. Details on the pump performance are given in Appendix C – Oil Pumps and Flow. The oil is picked up through the oil filter within the scavenge area in the rear portion of the cluster housing. The scavenge area is positioned to provide pickup independent of car accelerations and reduce the effects of windage. The oil can be fed to a remote cooler from the oil-out port (-6) and returned using external hose (not Xtrac supplied) to the gearbox oil-in port (-6). The use of an oil cooler is recommended when the gearbox is expected to run for extended periods of time or in ambient temperatures generally greater then 25.0ºC (77ºF). However, the use of a cooler is also largely dependent on the in car installation and the extent to which cool air is allowed to circulate around the outer surfaces of the gearbox casing. The cooled oil is distributed internally through the dedicated oil feeds within the gearbox.

NOTE: If an oil cooler is not fitted, optional fittings and oil feed adaptor, supplied with the gearbox, must be fitted to ensure internal circulation of the oil.

3.2.2. Dedicated Oil Feeds

A graphical layout of the oil system is given in Appendix C – Oil Pumps and Flow.

There are dedicated oil feeds to the dog rings, final drive pinion bearing, mainshaft gear hub bearings, final drive mesh and differential bearing.

The dog rings are lubricated via an oil feed into the selector rail, and then out of the selector fork grooves.

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The mainshaft bearing at the final drive end of the gearbox, is fed via a direct feed into the bearing journal.

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

A feed on the final drive mesh ensures friction and head are kept to a minimum to help improve performance and efficiency.

There are two feeds supplying oil to the differential.

All other components are adequately lubricated from the 'splash' lubraction of the oil inside the gearbox.

3.2.3. Sensors

Provisions have been made for oil temperature and pressure sensors. A temperature probe (non Xtrac supplied) can be positioned on the underside of the gearbox where a M12 x 1.5 thread is provided.

The pressure sensor (non Xtrac supplied) is positioned next to the oil drain plug at the rear of the gearbox using a M10 x 1.0 thread. Xtrac recommend using the Bosch NTCM12 & PSC-10 sensors respectively – see Appendix B – Electrical Component Data Sheets.

3.2.4. Filtration & Magnets

A steel mesh filter (125 micron (0.005") gauze size), which is easily accessible from the underside of the gearbox can be readily checked to reveal any evidence of tooth / dog damage and replaced accordingly. If there is a build up of debris, the filters MUST be replaced with new items. The oil drain plug has an integral magnet which will attract and retain debris. This can also be used as an indication of tooth/dog wear.

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3.2.5. Setup/ Running Conditions

Oil Type	Xtrac XL1 or other fully synthetic SAE 75W90
Oil Quantity	1.0 litre (1.1 quarts) + line/cooler volume
Optimum Sump Temperature	90 - 110°C (194 - 230 °F.)
Minimum System Pressure	0.2 Bar (2.9 psi)

3.3. Differential

The gearbox is fitted with an Xtrac plate type differential as standard.

3.3.1. Description

The differential is a Salisbury type plate differential, shown in section view in Figure 1. The side gears are axially supported by thrust bearings and do not react against any locking part of the differential. The 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 independantly of the ramp forces.

The standard factory setting for the differential is:-

- 45/60 ramp angle
- 8 friction faces per side
- 100Nm preload

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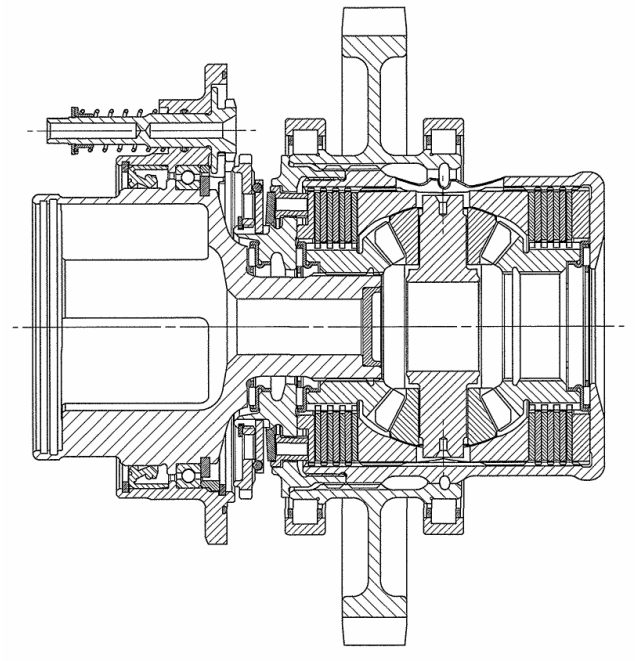

Figure 1 - Section View of Plate Differential

3.3.2. Ramp Angle

A number of ramp angles are available for the differential. Note that a cross pin of the correct angle is also required. The following combinations are given in Table 1.

Table 1 - Available Ramp Angles

Available Angles	Side Gear Ring	Cross Pin
45/85	443-449-109A	443-290-009A
30/45	443-449-109B	443-290-009B
30/75	443-449-109C	443-290-009C
45/60	443-449-109D	443-290-009D

Note: Lower angles give higher locking values. The first value specifies drive and second value specifies coast. (I.E. 45/60 = 45˚ drive and 60˚ coast). However, the ramps can be fitted in reverse if requested, e.g. ramp angle of 30/75 fitted in reverse would give 75˚ drive and 30˚ coast.

3.3.3. Pre-load Setting

A disc spring is used to provide an axial pre-load on the friction pack of the differential. The amount by which the spring is deflected is controlled by an adjuster plate. This adjuster plate can be adjusted by Xtrac tooling when the differential is

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removed from the gearbox. Alternatively, an adjuster wheel, positioned upwards from the left hand output flange, can be adjusted by an 8mm hex spanner whilst the gearbox / differential is fully assembled and still installed in the vehicle. A detent plate is used to provide a positive location in each position. 'Clicks' can be felt as the adaptor wheel is rotated and these can be calibrated to give a measure of how much extra preload has been applied / removed. 6-9Nm preload per 'click' is typical with 8 friction faces per side.

The effects of preload on differential locking can be seen in Appendix D - Differential Characteristics. The available disc springs are given in Table 2.

Table 2 - Available Disc Springs

Part Number	Free Length (mm)	Crushed Length (mm)	Load Reading (kg/mm)	Recommended Preload Range (Nm)
00P-190-002A	4.25	2.25	465	0-80
00P-190-002B	4.0	2.5	504	50-120
00P-190-002C	4.0	2.5	541	100-200
00P-190-002D	4.2	2.6	608	175-250

3.3.4. Number of Friction Faces

The number of friction faces in the differential can be adjusted from 2 to 8 faces per side, in order to produce different friction characteristics. The number of friction faces must be kept equal on each side of the plate unit to ensure the differential has symmetrical characteristics. The effect of the number of friction faces on differential locking can be seen in Appendix D - Differential Characteristics.

3.3.5. Differential Test Rig

As part of Xtrac's research and development department, we have 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.

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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 commercial manager.

3.4. Gear Cluster

The 516 gear cluster comprises of straight cut, hobbed gears mounted within a single, easy to remove subassembly. The gearchange operation is a 'dog' type. Options exist on the gear type. Please refer to section 2.3 for more details.

The cluster comprises of:

- A layshaft with integral 1st or 1st & 2nd, reverse and pump drive gear. All other drive gears are slide on fitment.
- Mainshaft with integral final drive pinion and 6 mainshaft gears on 3 hub assemblies.
- A full length barrel with 3 selector forks mounted on a selector rail.

Drive is transmitted from the clutch shaft directly 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, ensuring drive from the mainshaft gear, to the dog ring and in to the mainshaft itself. The entire cluster can be removed as one assembly from the left hand side of the gearbox (as installed) for ease of inspection and maintenance. The barrel should be shimmed to ensure it holds the selector forks and dog rings central to the gear cluster. A cluster setting jig 516-999-002A) is available for this operation after cluster part replacement. It is essential that this is checked periodically and when the barrel is replaced. Please refer to the assembly procedure given in section 4.2.2.

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4. Gearbox Assembly and Maintenance

4.1. General Assembly Notes

Only genuine Xtrac parts should be used when overhauling the gearbox. Xtrac's key steel components are made with our own specification of steel, either X36C or XVAR1. 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.

The oil filter fitted to the gearbox is NOT cleanable and must be replaced at least every 1000km (2000 miles) or sooner if debris has started to collect. The filter is situated on the suction side of the pump, so any blockage will show up as a reduced pressure in the feed lines to the gearbox feeds.

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, 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 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 extra heating cycles being required.

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4.1.1. Torque Settings

If not stated on specific build sheets or assembly drawings, all fasteners in the transmission should be tightened as per the Xtrac Standard XS036 given in Appendix G – Xtrac Standards. Any non-standard tightening torques are listed in Appendix A – Non Standard Tightening Torques.

Studs should be inserted tight into the casting using Loctite 270 threadlocker. 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.

At 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

4.2. Cluster Setup

The cluster should be assembled to the Xtrac assembly drawings in conjunction with the instructions presented here

4.2.1. Mainshaft Locking Nut

The mainshaft components are locked by a shaft nut and held with a locking shaft. The thread should be oiled and the torque setting on the drawing should be adhered

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to. The nut can be 'backed off' should the alignment of the locking shaft need adjustment.

4.2.2. Selector Barrel Setup

The tolerance stack up on individual parts across the assembly can affect the alignment of the dog rings. The barrel should therefore 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.

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

1. Assemble the cluster assembly in to the right hand side cover assembly and mount in to a vice using the cluster setting jig assembly shown in drawing 516-999-002A.

2. Rotate the barrel to each 'in gear' position and measure the dog stand off using feeler gauges, as shown in Figure 3. 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 (0.002" to 0.008").

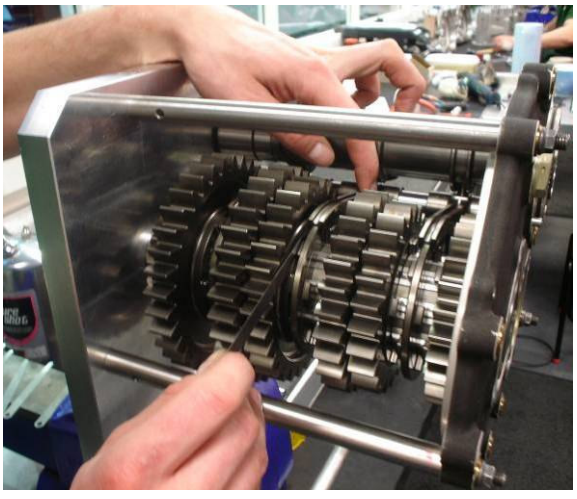

Figure 3 - Measuring Dog Stand Off

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3. The dog rings reside between pairs of gears (i.e. 1st and 2nd, 3rd and 4th, 5th and 6th). If the dog stand off values are biased toward the odd gears or the even gears 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.

Please note that the gearchange barrel spacer between the two barrel bearings should be ground to the same size as the casing shoulder between the two bearings upon initial assembly, and hence requires no further adjustment unless the casing is changed.

4.2.3. Ratio Change Procedure

The instructions presented below describe the simplest method of changing a gear set.

1. Remove the cluster from the gearbox and remove the mainshaft cover from the cluster plate. Remove the eared circlip from the end of the mainshaft and then the locking shaft. Use the extraction thread if it is jammed.

2. Mount the mainshaft holding tool in a vice and fit the mainshaft final drive gear into it. Slacken the mainshaft nut using a 5/8” hex drive.

3. Remove the cluster assembly from the holding tool and fit it onto the cluster stand assembly (516-999-003A). Remove the mainshaft nut by hand. Carefully withdraw the mainshaft upwards from the hub assemblies.

4. Remove the reverse mainshaft gear and reverse hub by rotating the parts about the selector rail axis until the fork pin is clear from the barrel, allowing the parts to be lifted upwards.

5. Remove the layshaft circlip retaining the gears, which will allow the layshaft gears to be removed as necessary.

6. The 5^{th} / 6^{th} mainshaft gear / hub / dog ring assembly can be removed as one by rotating the parts around the selector rail axis until the fork pin is clear from the barrel, allowing the parts to be lifted upwards.

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7. For the removal of the 3rd / 4th assembly, the selector barrel needs to be rotated so that the slot in the selector track is in line with the selector fork pin. This will allow the assembly to be lifted straight up, until the 3rd gear has cleared the baffle plate and then rotated and fully removed.

8. The 1st / 2nd assembly needs to be removed a part at a time.

Ratios can then be swapped / inspected. Reassembly is in the reverse order of points 1 to 8.

4.3. Differential Setup

The differential should be assembled as per Xtrac assembly drawings and in conjunction with the instructions presented here. Please note the orientation of the side gear rings, as shown in Figure 5.

4.3.1. Setting the Stack Height and Preload

1. Assemble all of the differential internals, friction plates, etc. vertically on a flat surface, as shown in Figure 4. Place a 4kg (8.8lb) weight on top of the stack to settle the plates and discs, then measure the distance between the mounting face of the differential end cap and the stepped friction plate at the top of the stack shown as Dimension A in Figure 4.

2. Measure the distance between the differential casing and stack mounting faces of the differential end cap shown as Dimension B in Figure 4.

3. Dimension A should be 0.1mm (0.004") less than Dimension B, so that there is a 0.1mm nominal clearance between the plate stack and the differential end cap. Adjust accordingly using a suitable size thick friction plate. The plate can be ground if the required thickness is between sizes.

4. Assemble the differential end cap and tighten by hand. Fit the differential through the differential tightening tool and in to the differential holding tool, mounted in a vice. Tighten the end cap using a ½" drive wrench, fitted in the tightening tool, to a torque of 200Nm (148 lbf.ft).

5. Back off the differential cap to the nearest aligned differential body spline tooth, using the window on the top of the holding tool to view the alignment. Do not over torque the differential cap to achieve alignment.

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6. Mount a differential preload setting tool into a vice and mount the differential cassette on to it, adjuster side up.

7. Using the second differential preload setting tool, turn the differential over a few times using a torque wrench. Once the differential feels consistent, measure the turnover torque across the differential.

8. This value is the preload. This can be adjusted by changing the disc spring (See section 3.3.3 for more details) or by altering the adjuster wheel. To change the preload using the adjuster wheel, clamp the differential holding tool in to a vice and fit the cassette, ensuring the differential cap and body lock together. Using the adjuster wheel socket, tighten or loosen the adjuster wheel. Re-measure the preload torque and continue to alter the adjuster wheel accordingly until the desired turn over torque is achieved.

Due to the varying thicknesses and frictional properties of the friction plates and the variation in the disc spring stiffness throughout the components lives, the preload should be periodically checked and adjusted. A differential with new friction plates can take up to 500km before the friction plates are fully bedded in.

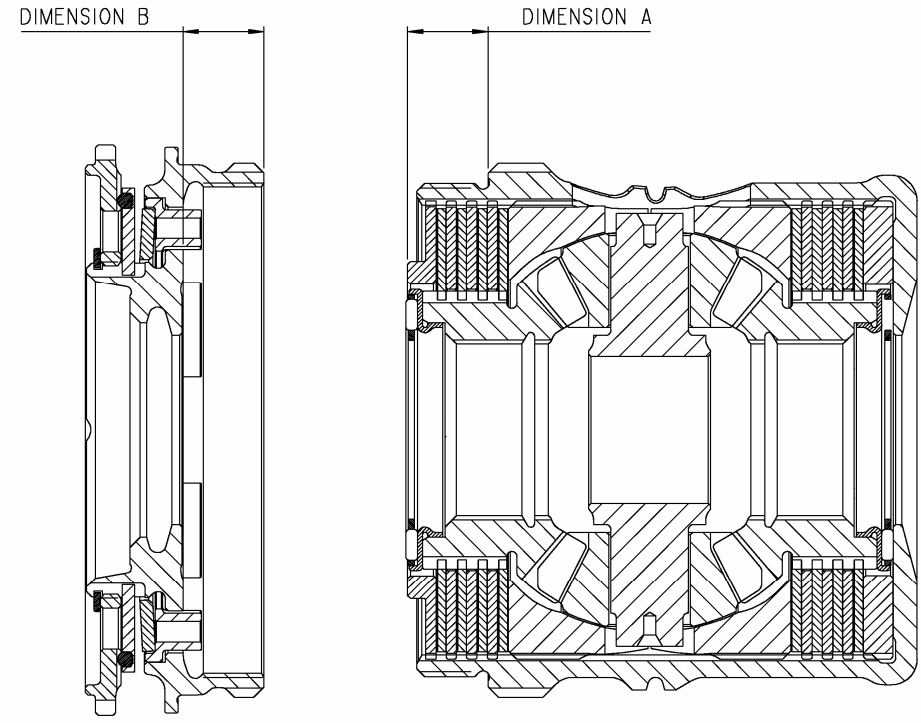

Figure 4 - Section view of the differential assembly

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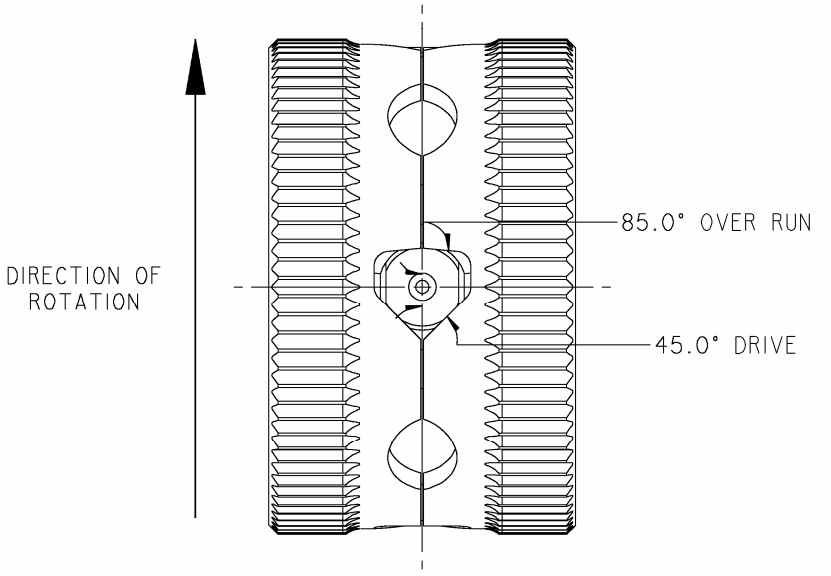

Figure 5 - Orientation of side gear rings

Note – The side gear ring and cross-pin combination shown is suffix 'D'

4.4. 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. The lives of the most critical parts are tabulated below. All parts not included in the list require inspection after 2000km (1250 miles). Visual inspection should flag up any parts with dents, scratches, significant wear or corrosion. Please note that this list does not imply any warranty periods of any items.

Component	Visual Inspection Every (km)	Crack Check Every (km)	Typical Life (km)
Clutch Shaft	800	1600	6400
Layshaft	800	800	3200
Selector Barrel	800	1600	6400
Selector Rail	1600	3200	6400
Selector Forks	800	1600	4800
Dogs Rings	800	800	2400
Gear Ratios	800	800	2400

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Mainshaft	800	1600	4800
Mainshaft Hubs	800	1600	6400
Reverse Gear	-	3200	6400
Reverse Selector Fork	-	1600	6400
Detent Plunger	-	-	-
Ratchet Body	1600	3200	4800
Ratchet Housing	1600	3200	4800
Gearchange Rack	3200	3200	6400
Pump Shaft	-	3200	6400
Oil Pump Rotors	1600	-	6400
Oil Filter	500	-	1000
Final Drive	800	1600	3200
Preload Adjustor Plate	-	3200	6400
Differential End Cap	800	1600	4800
Friction Plates	-	-	6400
Side Gears	800	2400	4800
Pinion Mates	800	2400	4800
Side Gear Rings	800	2400	4800
Output Flanges	600	1200	3200
Cross Shaft	1600	3200	4800
All Bearings	3200	-	6400
All Springs	3200	-	6400
All K-nuts, O-rings & Seals	Fit New When Removed		

Please Note: - This list does not imply any warranty periods of any items.

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5. 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.

5.1. Customer Support

5.1.1. Gearbox & Parts Supply

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

5.1.2. 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.

Product-training sessions at our UK facility are available to provide technicians with the basic knowledge to carry out their own routine maintenance work. However, if required, Xtrac will be able to carry out maintenance/rebuild at facilities in the UK and 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.

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5.1.3. Contacts

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6. Appendix A – Non Standard Tightening Torques

Description	Location (Sub-assembly)	Torque	Comments
Nut – Mainshaft (195-422-002A)	516-904-000B	68 Nm (50 lbf.ft)	Apply Loctite 270
M5x12 Low Head (131-0151)	516-904-000B	8 Nm (6 lbf.ft)	Apply Loctite 241
Socket Cap Screw M5 x 16 (131-0007)	516-912-000	10 Nm (7 lbf.ft)	Apply Loctite 270
Knut – M10 x 1.5 (133-0029)	516-928-000	41 Nm (30 lbf.ft)	
Knut ¼" – 28 UNF (133-0003)	516-932-000A	14Nm (10 lbf.ft)	
Shaft Nut (519-422-004B)	516-996-000B	100 Nm (75 lbf.ft)	
Lock Nut M32 x 1.0 (516-421-005A)	516-996-000B	68 Nm (50 lbf.ft)	

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7. Appendix B – Electrical Component Data Sheets

7.1. Bosch Absolute Pressure Sensor PSC-10

BOSCH

Absolute Pressure Sensor PSC-10

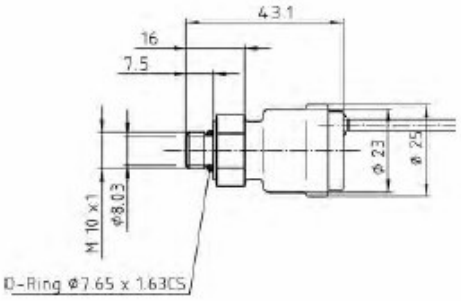
Pressure range: 0 ... 10 bar nominal

A M10 x 1 sensor for various fluid pressure measurement. The sensor range covers pressure measurement up to 10 bar. It is manufactured in a DR-25 sleeve, various connector options are available. Gauge and absolute pressure sensors are available.

Mechanical data	
Measurement transducer	piezoresistive
Max. pressure	20 bar
Thread	M10 x 1
Tightening torque	10 Nm
Wrench size	17 mm
Weight	70 g
Sealing	O-ring 7,65 x 1,63

Conditions for use	
Temperature range	-40 ... 125°C
Max. vibration	15 g/30 ... 200 Hz

Characteristic	
Sensitivity	400 mV/bar
Offset	100 mV



Electronic data	
Power supply	5 ... 6 V/8 ... 16 V
Compensated range	25 ... 85 °C
Current supply	8 ... 16 mA
Non linearity	1 %
Therm. zero point drift	< 1 %
Therm. sensitivity drift	< 1 %
Long time drift	< 1 %
Full scale output	0,5 ... 4,5 V
Time of reaction	1 ms (90 %)

Order numbers	
5 ... 6 V supply	
KPTA 6E6-4P-C-DN	**B 261 209 342**
Offer drawing	**A 261 209 342**
8 ... 16 V supply	
KPTC 6E8-4P-C-DN	**B 261 209 063**
Offer drawing	**A 261 209 063**
AS 6-06-05PN	**B 261 209 068**
Offer drawing	**A 261 209 068**
KPTA 6E6-4P-C-DN	**B 261 209 069**
Offer drawing	**A 261 209 069**
AS 6-08-98PN	**B 261 209 077**
Offer drawing	**A 261 209 077**
ASL 6-06-05PC-HE	**B 261 209 079**
Offer drawing	**A 261 209 079**
ASU 6-03-05-PD-HE	**B 261 209 958**
Offer drawing	**A 261 209 958**

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7.2. Bosch Temperature Sensor NTC M12-L

BOSCH

Temperature Sensor NTC M12-L

Temperature range: -30 ... 130°C

A shockproof sensor for measurements under pressure up to 25 bar. Good thermal conductivity allows fast response temperature measurement. The integrated connector provides a low-cost connection for automotive applications.

General fields of application: oil-, fuel-, air temperature measurement

Mechanical data	
Thread	M12 x 1,5
Tightening torque	15 Nm
Wrench size	19 mm
Weight	26 g

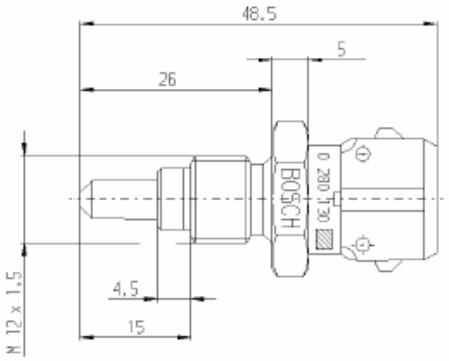
Electronic data	
Nominal resistance	2,5 kΩ/20°C
Measuring range	-30 ... 130°C
Accuracy	± 1,5 K
Response time 90 %	< 10 s

Conditions for use	
Temperature range	-30 ... 130°C
Vibration	60 g/50 ... 250 Hz

Connector	
Cable harness connector	D 261 205 288

Characteristic
NTC 2,5 kΩ

Order number	
	0 280 130 039
Offer drawing	A 280 130 206



21 Jun. 06 motorsport@bosch.com 1/2

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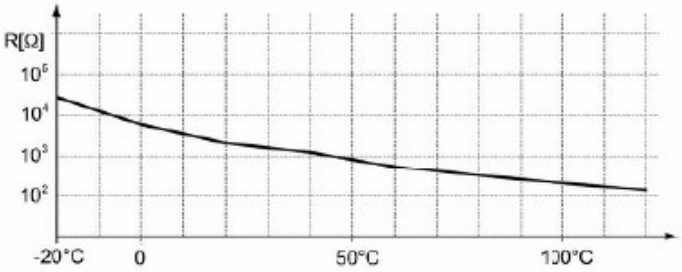
BOSCH



°C	R(Ω)
-40	45 313
-35	34 281
-30	26 114
-25	20 003
-20	15 462
-15	12 002
-10	9 397
-5	7 415
0	5 896
5	4 712
10	3 792
15	3 069
20	2 500
25	2 057
30	1 707
35	1 412
40	1 175
45	987,6
50	833,9
55	702,8
60	595,5

°C	R(Ω)
65	508,3
70	435,7
75	374,2
80	322,5
85	279,6
90	243,2
95	212,7
100	186,6
105	163,8
110	144,2
115	127,3
120	112,7
125	100,2
130	89,30
135	79,65
140	71,20
145	63,86
150	57,41
155	51,82
160	46,88

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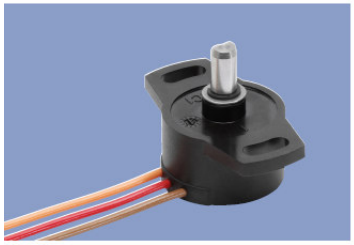
7.3. 192-0045 Single Track 345° Rotary Potentiometer

novotechnik
Siedle Group

Sensor Potentiometers

Series SP2800



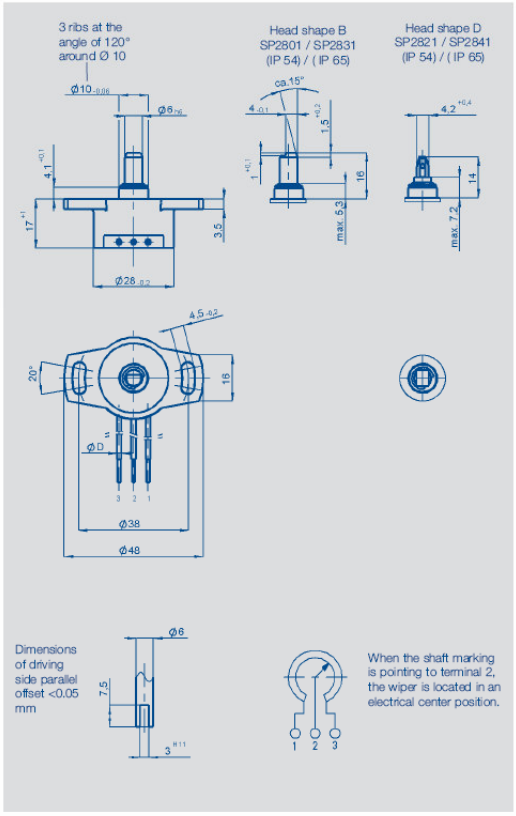
Special features
- available with marked shaft (shape B) or with push-on coupling (shape D)
- Simple mounting
- Protection class IP 54 or IP 65
- long life
- good price/performance ratio

Designed to convert rotary movement into a proportional voltage, these sensors utilize conductive plastic technology on both the resistance and collector tracks.

The housing and bearings are produced in a special high-grade temperature-resistant plastic material. Fixings are in the form of elongated slots which allow simplicity in mounting together with ease of mechanical adjustment.

The special backlash-free push-on coupling ensures extremely quick and simple installation. The sensor is not sensitive to either dirt or dampness. Electrical connections are made via conductors which are sealed into the housing. They are suitable for use with any of the termination methods currently in use. The use of elastomer-damped precious metal multi-finger wiper ensures reliable contact even under the severest of working conditions.

Special models with different electrical travels and shaft dimensions are available.



Description	
Case and bearing	high-grade, temperature-resistant plastic
Shaft	stainless steel
Resistance element	conductive plastic
Wiper assembly	precious metal multi-finger wiper
Mounting position	any optional position
Electrical connections	3 conductors, TPE-PEE-insulation

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Mechanical Data				
Dimensions	see drawing			
Mounting	with 2 M4 fillister-head screws + washer			
Mechanical travel	360, continuous			°
Permitted shaft loading (axial and radial) static or dynamic force	20			N
Torque	0.2 (IP54), 0.5 (IP65)			Ncm
Maximum operational speed	120			min^{-1}
Weight	30			g
Electrical Data				
Actual electrical travel	100	308	345	° ± 2°
Nominal resistance	3	5	5	kΩ
Resistance tolerance	±20			%
Repeatability (dependent from mounting tolerances)	with shaft shape B ≤ 0.03 with shaft shape D ≤ 0.06			° °
Effective temperature coefficient of the output-to-applied voltage ratio	typical 5			ppm/K
Independent linearity	1.0	0.3	0.3	±%
Max. permissible applied voltage	42			V
Recommended operating wiper current	≤ 1			µA
Max. wiper current in case of malfunction	10			mA
Insulation resistance (500 VDC, 1 bar, 2 s)	≥ 10			MΩ
Dielectric strength (50 Hz, 2 s, 1 bar, 500 VAC)	≤ 100			µA
Conductor length, bared, tinned	approx. 300			mm
Conductor diameter	approx. 1			mm^2
Environmental Data				
Temperature range	-40 ... +120 (temporary 150°C, max. 1 h)			°C
Vibration	5...2000 A_{max} = 0.75 a_{max} = 20			Hz mm g
Life	50 x 10^6			movements
Protection class	IP 54 or IP 65 (DIN 400 50 / IEC 529)			

Order designations

Type	Art.no.	
SP2801 308 000 001	019520	∢ 308°, 6 mm shaft, IP 54
SP2821 308 000 001	019540	∢ 308°, push-on coupling, IP 54
SP2831 308 000 001	019521	∢ 308°, 6 mm shaft, IP 65
SP2841 308 000 001	019541	∢ 308°, push-on coupling, IP 65
SP2801 100 002 001	019522	∢ 100°, 6 mm shaft, IP 54,
SP2831 100 002 001	019527	∢ 100°, 6 mm shaft, IP 65,
SP2841 100 002 001	019542	∢ 100°, push-on coupling, IP 65
SP2841 345 065 001	019564	∢ 345°, push-on coupling, IP 65
SP2841 100 067 006	019565	∢ 100°, push-on coupling, IP 76, redundant

Important
All the values given in this data sheet for linearity, lifetime and temperature coefficient in the voltage dividing mode are quoted for the device operating with the wiper voltage driving on operational amplifier working as a voltage follower, where virtually no load is applied to the wiper ($I_e \leq 1$ µA).

Recommended accessories
Processor controlled indicators MAP... with display,
Signal conditioner MUP.../ MUK ... for standardized output signals

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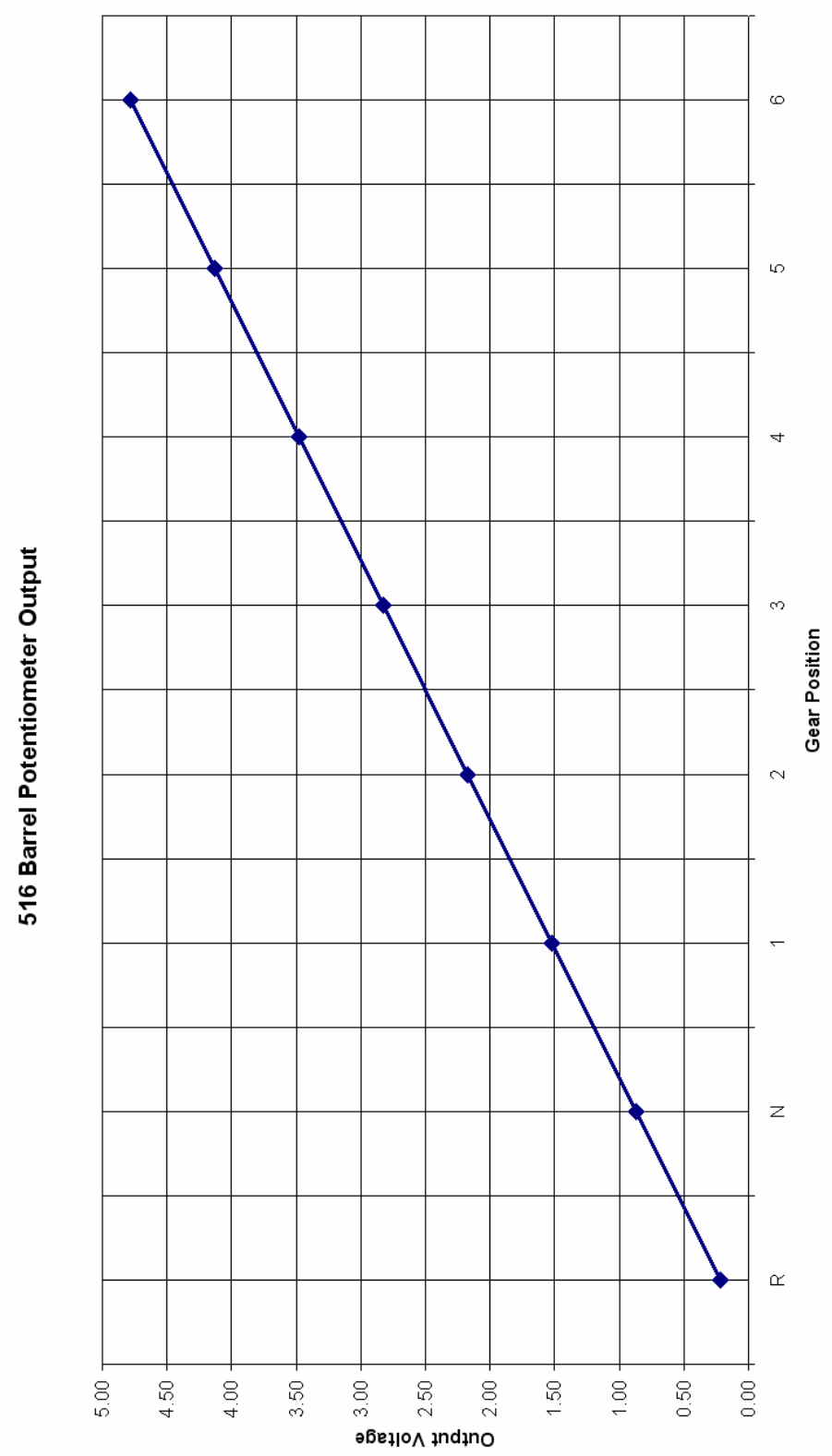
7.4. Gearchange Barrel Potentiometer Output Voltages



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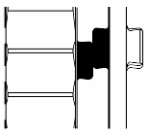
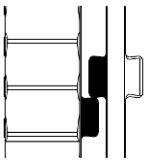
7.5. 192-0045 Output Voltages against Barrel Position

Dog Position		Pot Angle	Voltage
END DB		7.50	0.00
R	CTR	22.50	0.22
	LPE	41.10	0.49
	LC	45.50	0.55
N	CTR	67.50	0.87
1	FC	98.14	1.31
	FPE	102.78	1.38
	FE	110.00	1.49
	CTR	112.50	1.52
	FE	115.00	1.56
	LPE	126.46	1.72
	LC	132.17	1.81
2	FC	137.83	1.89
	FPE	143.54	1.97
	FE	155.00	2.14
	CTR	157.50	2.17
	FE	160.00	2.21
	LPE	167.22	2.31
	LC	171.86	2.38
3	FC	188.14	2.62
	FPE	192.78	2.69
	FE	200.00	2.79
	CTR	202.50	2.83
	FE	205.00	2.86
	LPE	216.46	3.03
	LC	222.17	3.11
4	FC	227.83	3.19
	FPE	233.54	3.28
	FE	245.00	3.44
	CTR	247.50	3.48
	FE	250.00	3.51
	LPE	257.22	3.62
	LC	261.86	3.69
5	FC	278.14	3.92
	FPE	282.78	3.99
	FE	290.00	4.09
	CTR	292.50	4.13
	FE	295.00	4.17
	LPE	306.46	4.33
	LC	312.17	4.42
6	FC	317.83	4.50
	FPE	323.54	4.58
	FE	335.00	4.75
	CTR	337.50	4.78
	FE	340.00	4.82
STARTDB		352.50	5.00

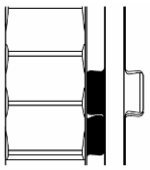
Note: Potentiometer adjustment is ±10° equating to a voltage of ±0.145V.



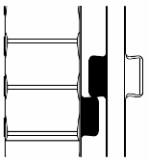
First Contact
FC – First contact of dog to gear



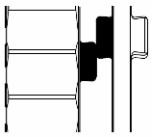
First Point of Engagement
FPE – First point of dog engagement when considering dog radii



Fully Engaged
FE – 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

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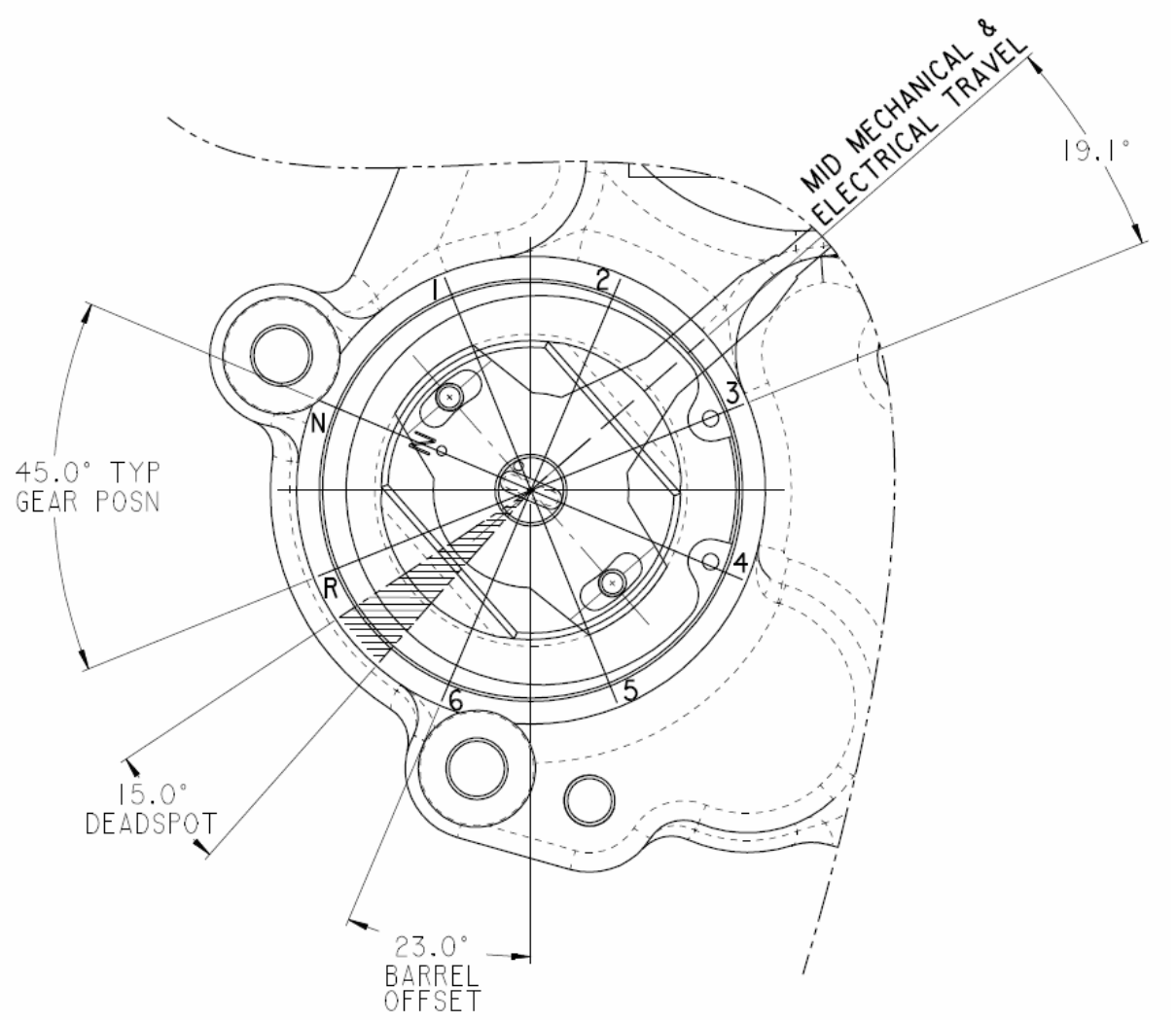
7.6. Gearchange Barrel Potentiometer Installation Details



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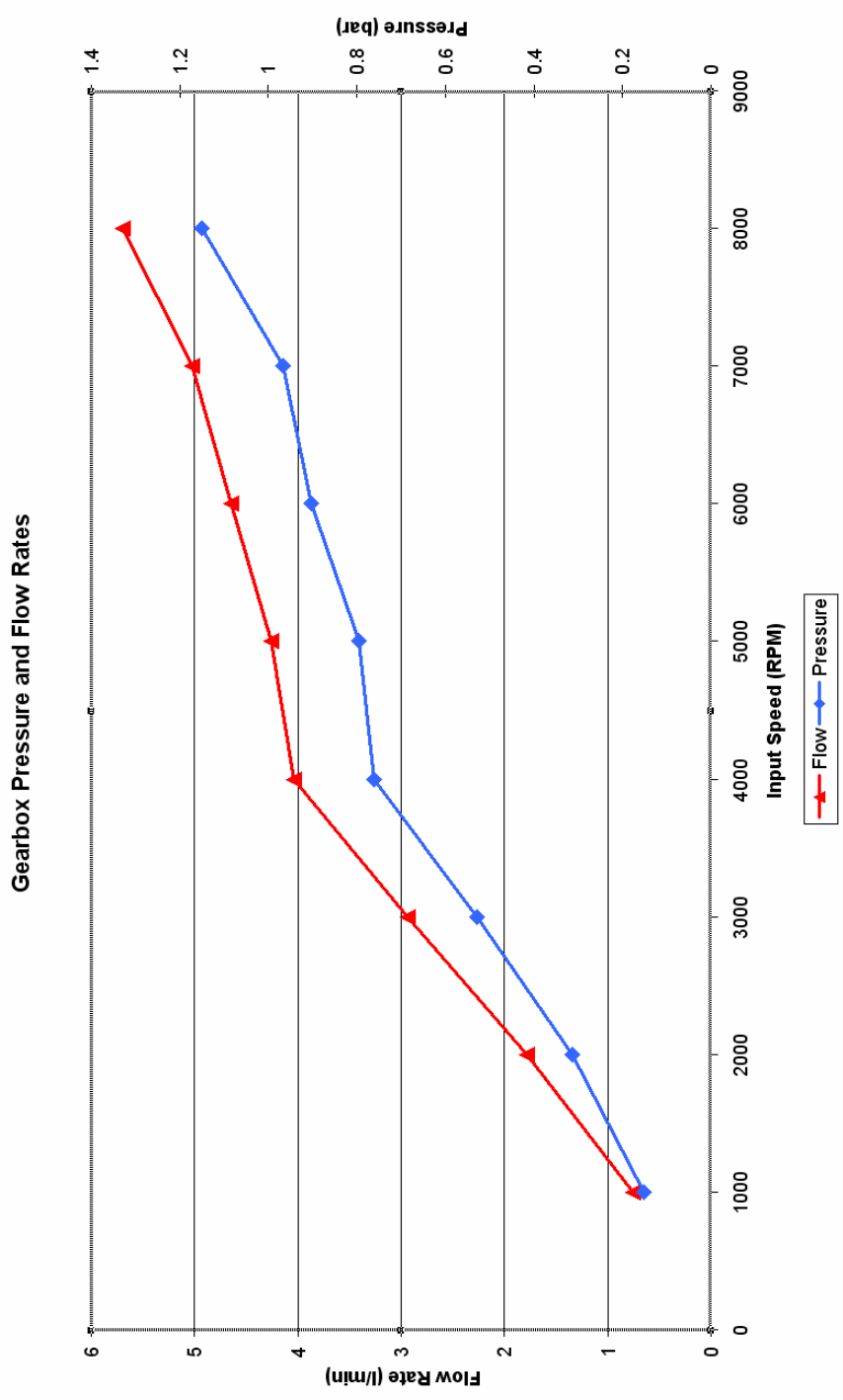
8. Appendix C – Oil Pumps and Flow

8.1. Oil Pump Pressure and Flow Rates



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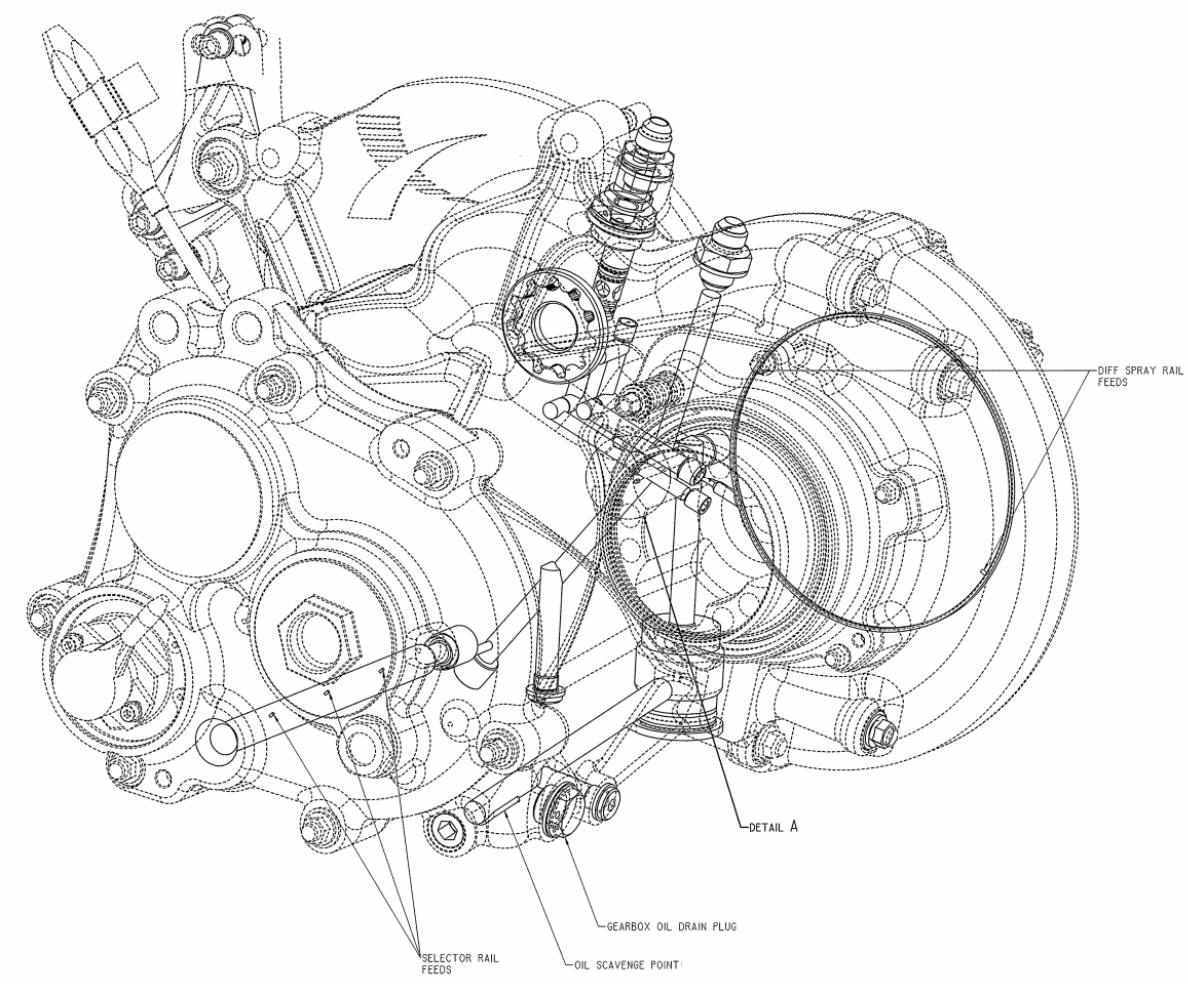
8.2. Oil Flow Diagram



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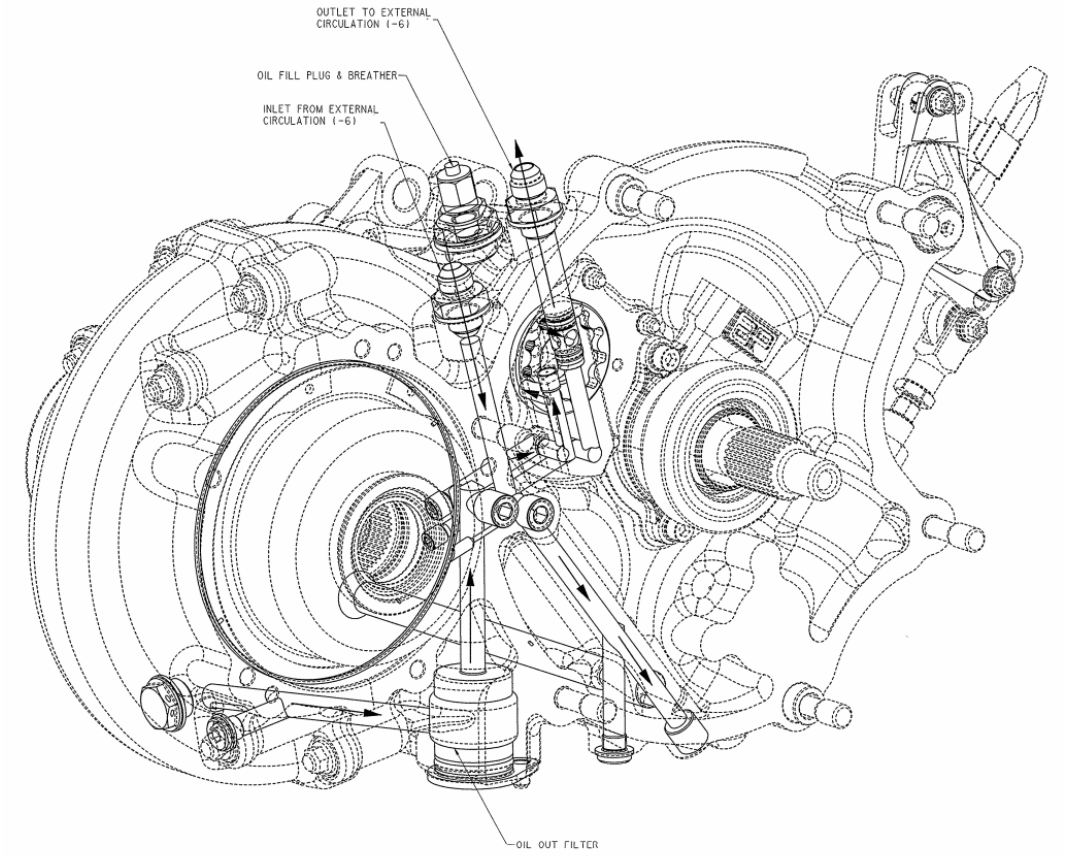
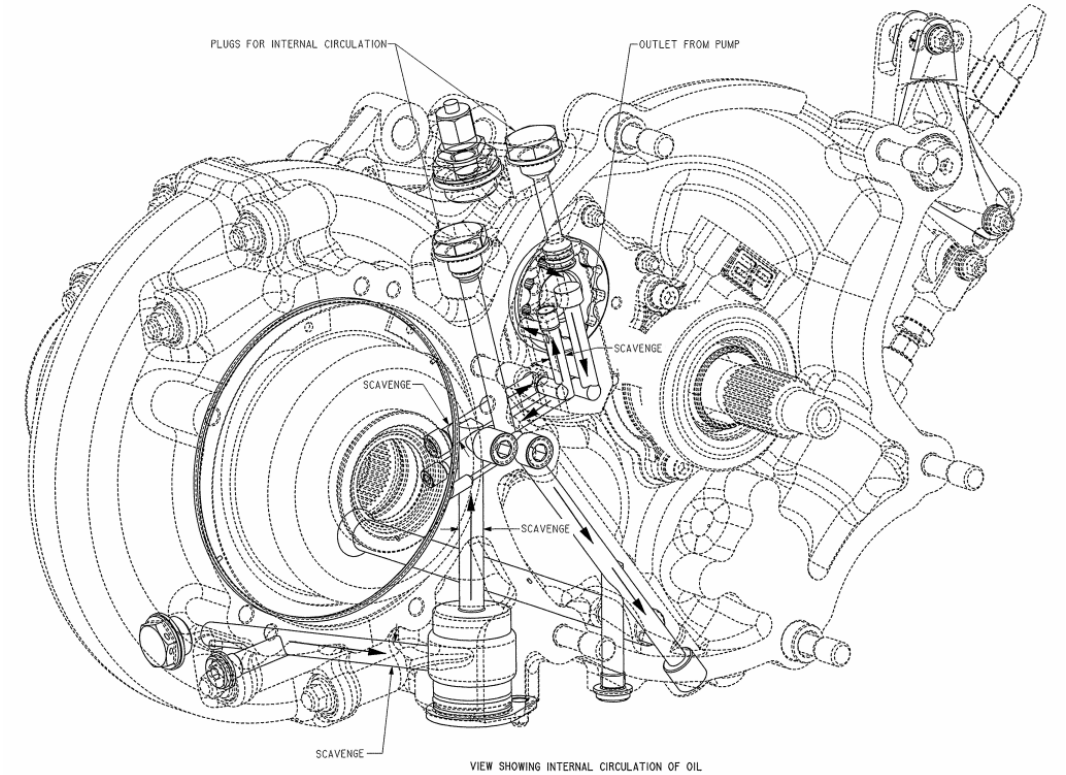


VIEW SHOWING EXTERNAL CIRCULATION OF OIL
(FOR USE WITH A COOLER)



VIEW SHOWING INTERNAL CIRCULATION OF OIL

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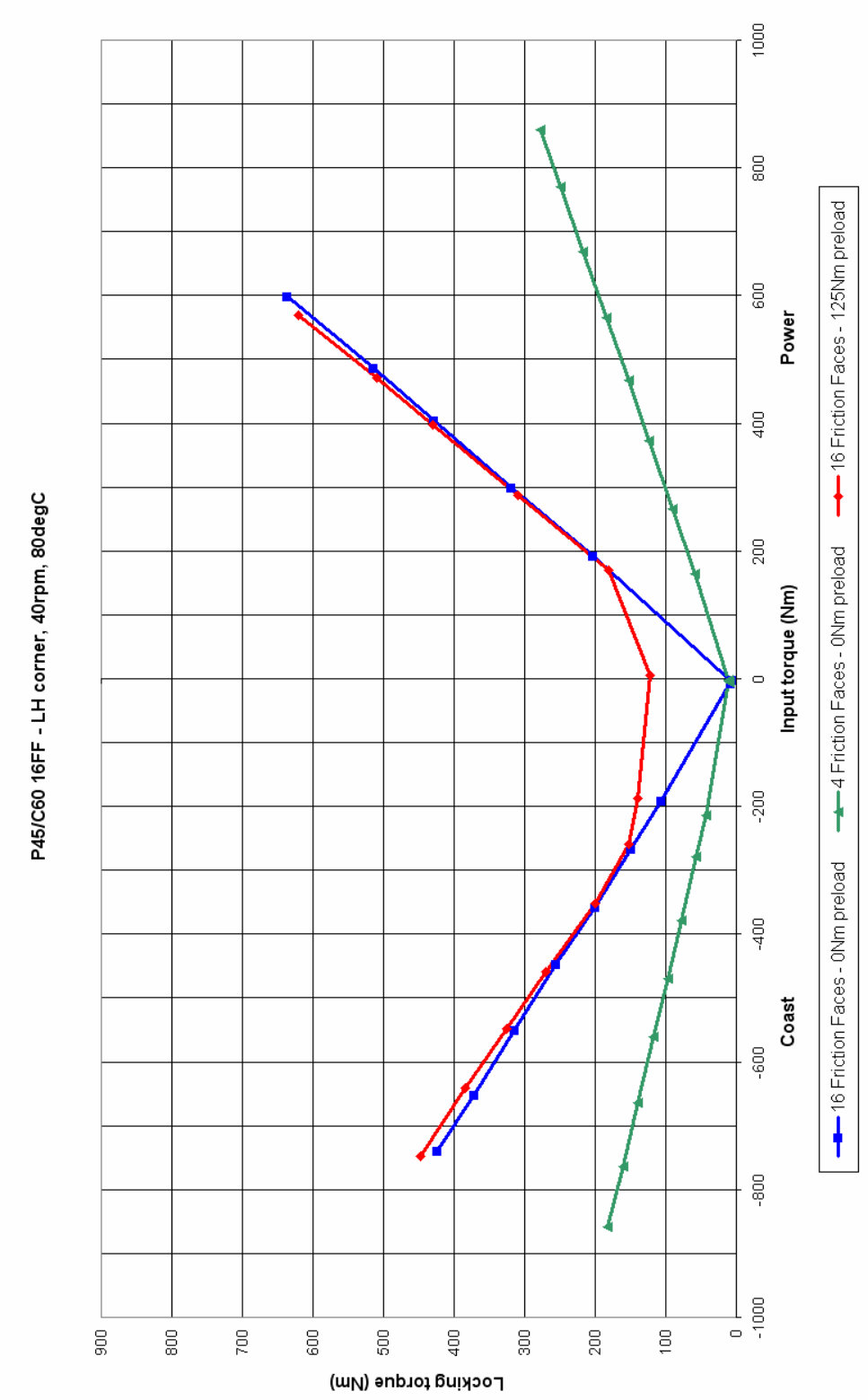
9. Appendix D - Differential Characteristics



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Appendix E – 516 Ratio List

Tel: +44(0) 1635 293 800
Fax: +44(0) 1635 293 700
e-mail:sales@xtrac.com

Web Site: www.xtrac.com

Gearbox Type: 516

1st/2nd Integral Layshaft

516-42M-000C*

(516-421-000C /516-422-008A)

1st					2nd			
Code	Input	Output	Sum	Ratio	Input	Output	Sum	Ratio
A	12	38	50	3.167	14	34	48	2.429

1st Integral Layshaft

516-42M-0B

(516-421-000B /516-422-008A)

Input	Output	Sum	Ratio
12	38	50	3.167
12	36	48	3.000
13	38	51	2.923 ①
13	35	48	2.692

3rd Collared

516-42M-3A

(516-421-003A / 516-422-008A)

Input	Output	Sum	Ratio
13	26	39	2.000

2nd – 6th

516-42M-4A

(516-421-004A / 516-422-008A)

Input	Output	Sum	Ratio
15	35	50	2.333
14	32	46	2.286 ①
14	31	45	2.214
14	30	44	2.143
14	29	43	2.071
13	26	39	2.000
15	28	43	1.867 ①
15	27	42	1.800
13	23	36	1.769
15	26	41	1.733
13	22	35	1.692
14	23	37	1.643
15	24	39	1.600 ①
15	23	38	1.533
14	21	35	1.500
15	22	37	1.467
16	23	39	1.438
17	24	41	1.412
18	25	43	1.389
16	22	38	1.375
17	23	40	1.353 ①
16	21	37	1.313
17	22	39	1.294
18	23	41	1.278
16	20	36	1.250
18	22	40	1.222
20	24	44	1.200
22	26	48	1.182 ①

2nd – 6th (cont'd)

Input	Output	Sum	Ratio
18	21	39	1.167
20	23	43	1.150
23	26	49	1.130
17	19	36	1.118
19	21	40	1.105
21	23	44	1.095
23	25	48	1.087
17	18	35	1.059
21	22	43	1.048
24	25	49	1.042
25	25	50	1.000

Final Drive

Input	Output	Sum	Ratio
13	50	63	3.846
13	47	60	3.615 ①

① BTCC BUILD SPECIFICATION

Note: 2nd – 6th alternative ratios exist for higher duty applications

Drawn	Drg	Date	Approved	Issue
Mark Brogden	120-516-001	23/01/09	AJT	8

Xtrac reserve the right to change ratios without notice.
Alternative ratios may be supplied on request

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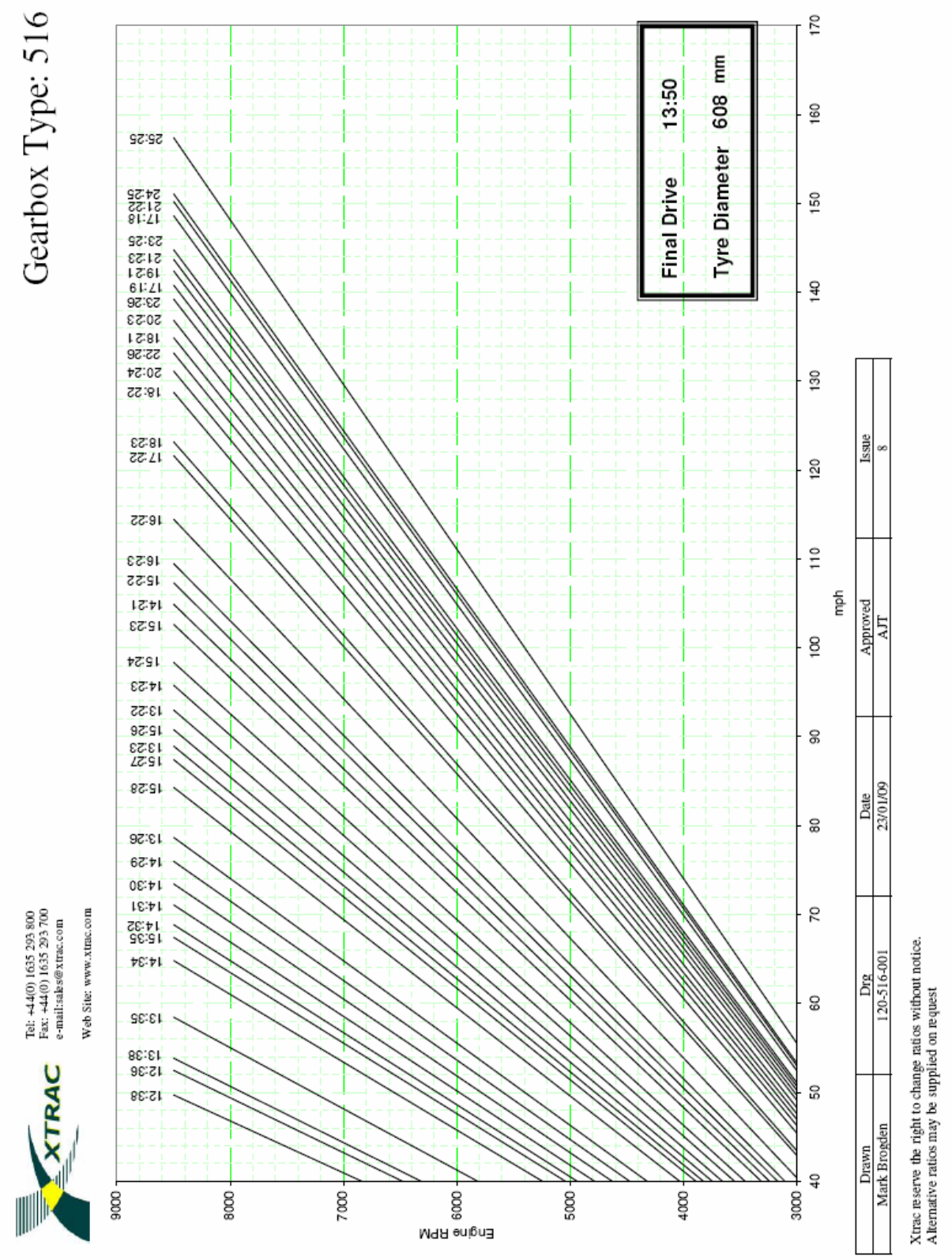

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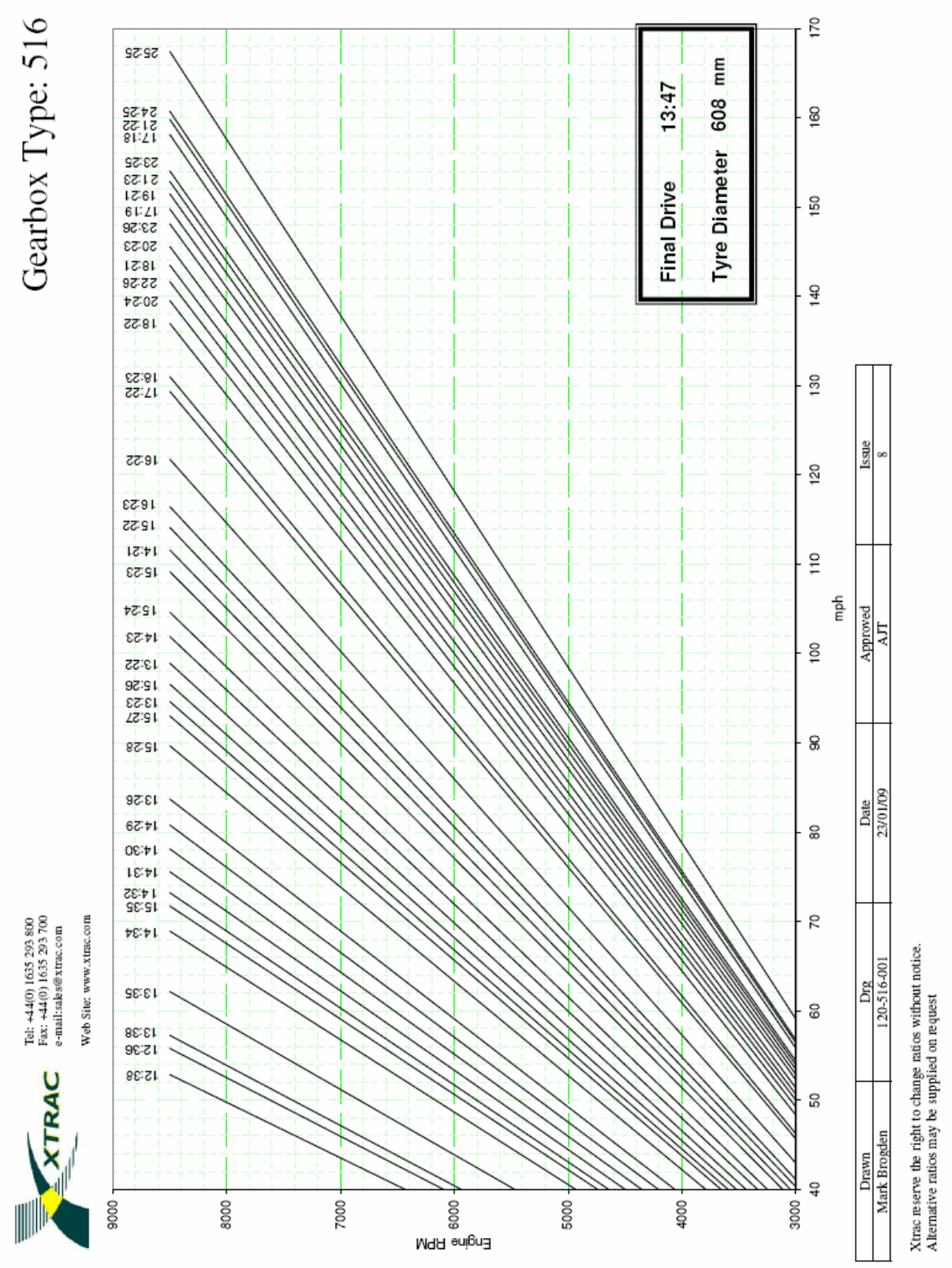

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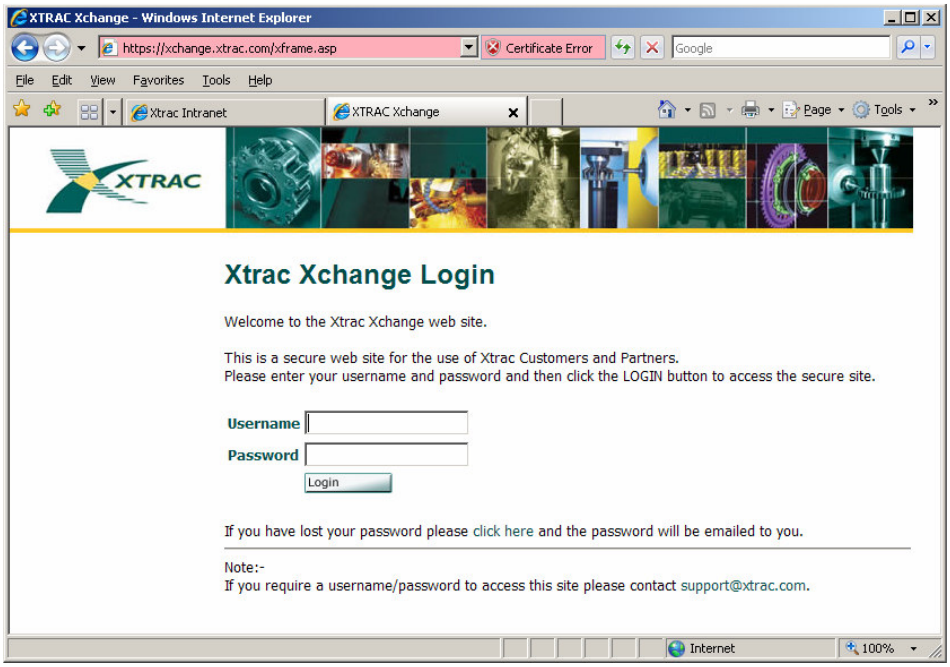
10. Appendix F – Exchange Server Log-In Procedure

Go to Xtrac's website at www.xtrac.com, and select 'Xchange Login' from the menu on the left hand side

Enter your company login details at the Xchange login screen and click on the login button:

For your username and password please contact your commercial manager.



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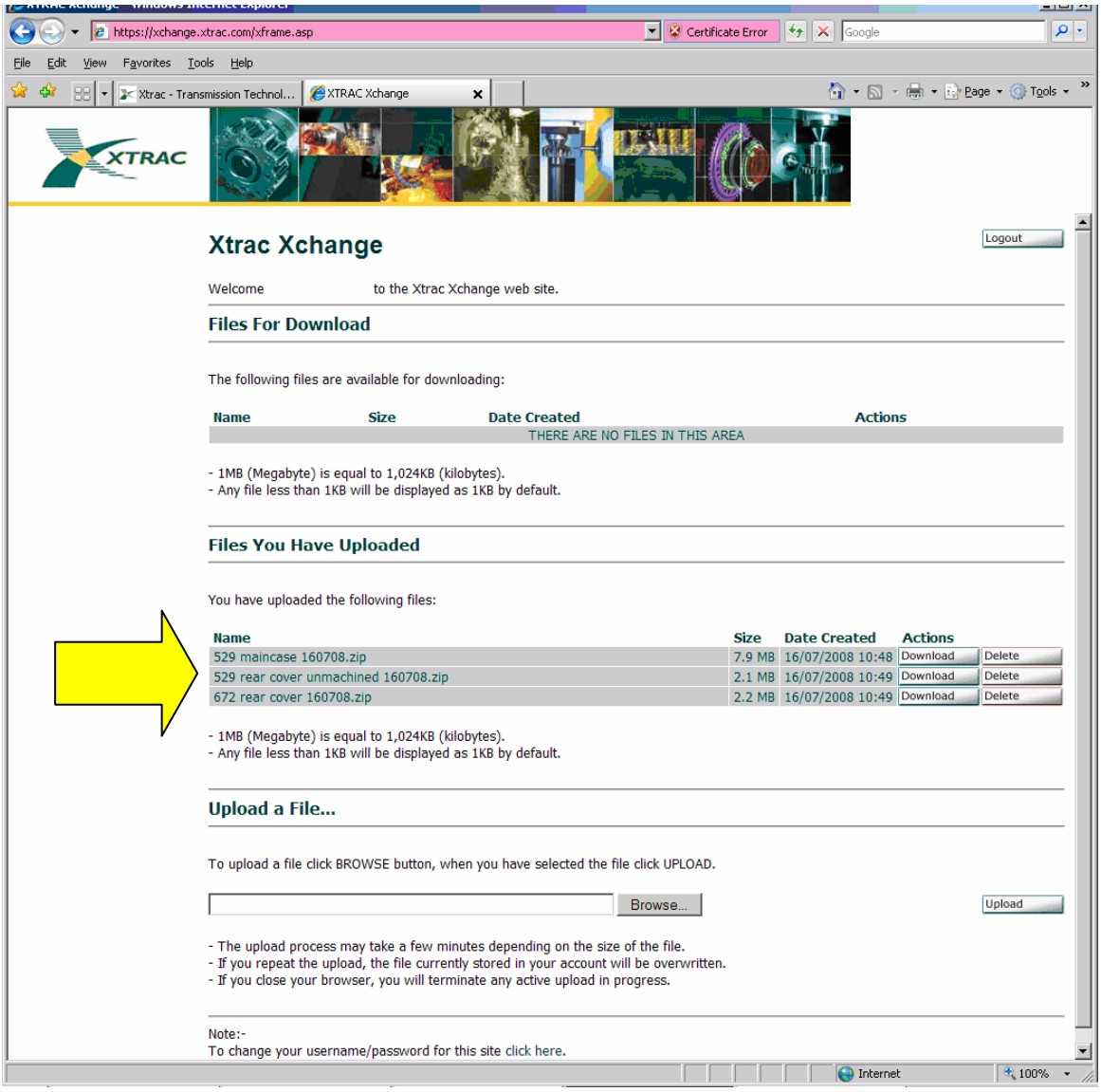
This will take you to the download area where a list of files will be visible for download



To download each file click on the 'Download' button next to each file in the list.

IMPORTANT NOTES:

The 516 Xchange account is a generic product account and cannot be used to send any data to Xtrac.

Please use your own customer Xchange account to send large data files to Xtrac – if you do not have an account and wish to set one up, please contact your Xtrac commercial manager or engineering contact.

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11. Appendix G – Xtrac Standards

Xtrac standards have been included for reference purposes only.

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XTRAC STANDARD

DOCUMENT TITLE	XS022 – In Car Sequential Gear Change Installation
DOCUMENT REFERENCE	XS_PN_GRCHNG_02
AUTHOR	Chris Cholmeley
APPROVED BY	
AGREED BY	

Version No.	Date Produced
2.0	10/02/09

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Document Amendment History

Date	Author	Version	Description of Change
10/02/09	Chris Cholmeley	2.0	Rewritten, removed reference to comb gearchange actuator, added 420 gearlever, gearlever ratio, 529 ratchet, 519 rack & 245 detent plunger diagrams

Document Distribution List

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Scope

1.1 This document is to help Xtrac customers to design their manual, sequential gearbox, in-car gear change linkage to a standard that will optimise the performance advantages of choosing an Xtrac designed and manufactured gearbox.

1.2 The Xtrac sequential gear change system is a very quick, positive & reliable method of shifting from one gear to another in a racing gearbox. This is achieved only if certain fundamentals for the design of the in car gear change linkage are adhered to.

1.3 The following text is a guide through the basic design requirements for the linkage, which will ensure that most of the common faults that induce premature failures in the gearbox can be avoided.

2 The Ratchet Mechanism

2.1 The Xtrac gear change mechanism has been designed and developed to give a reliable rotation of the gear shift barrel to actuate the shift forks. This mechanism has been optimised through continuous improvement, and customers should not modify it in any way, including polishing and fettling, without first consulting with Xtrac engineers.

2.2 The shifting system is designed to rotate the barrel a set angle, normally 45 degrees for a 6 speed gearbox with reverse, and then reset itself and the in car gear lever to the mid position ready for the next shift. The system consists of three distinct elements, the ratchet mechanism (Fig 1), the detent plunger assembly (Fig 2) and the actuator assembly that is normally a rack system (Fig 3) on modern Xtrac gearboxes.

2.3 The springs fitted to the ratchet pawls, gearchange rack and detent plunger are carefully balanced to ensure that over throws do not occur, and the mechanism does not ‘hang up’ in the event of a baulked shift. These springs should be checked and replaced regularly, but not

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modified in any way without consulting Xtrac. The standard springs fitted have a high temperature capability, and should not be swapped for seemingly similar springs that may not have the same temperature operating range as the original specification.

2.4 If a mechanical neutral/reverse interlock is fitted to the gearbox, this will normally utilise a Bowden cable to lift the detent plunger by a driver operated handle on the in car gear lever. Care must be taken to ensure that the interlock cable is routed smoothly and secured to the chassis of the car, also that there is a small amount of free play in the inner cable with the cable routed and secured. Failure to allow slack in the interlock cable can result in loss of positive location of the gearchange barrel in each gear position and rapid deterioration of the mainshaft gear and dog ring dogs.

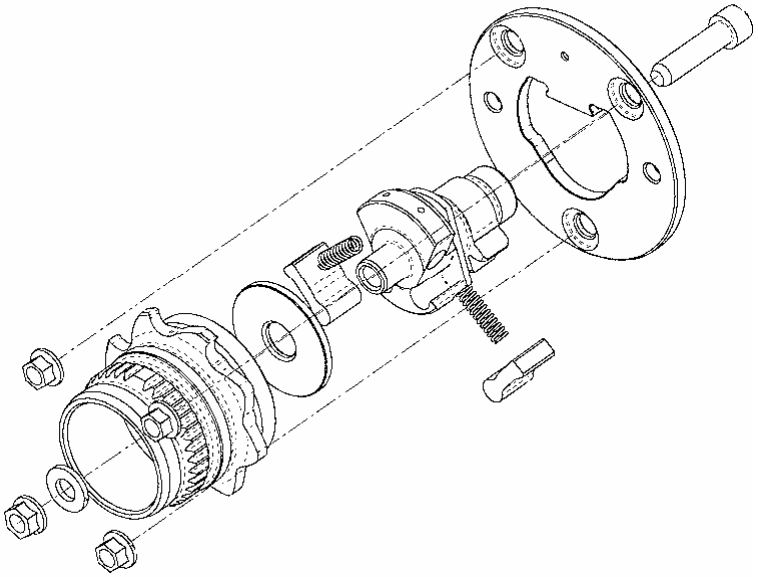

Fig 1. Typical Xtrac Ratchet Components

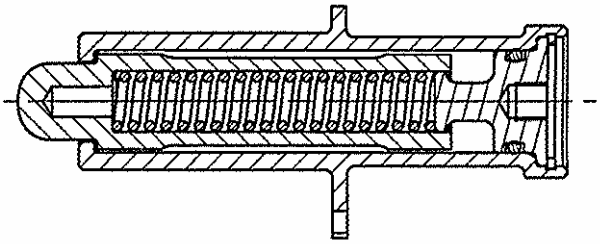

Fig 2. Typical Xtrac Detent Plunger Assembly

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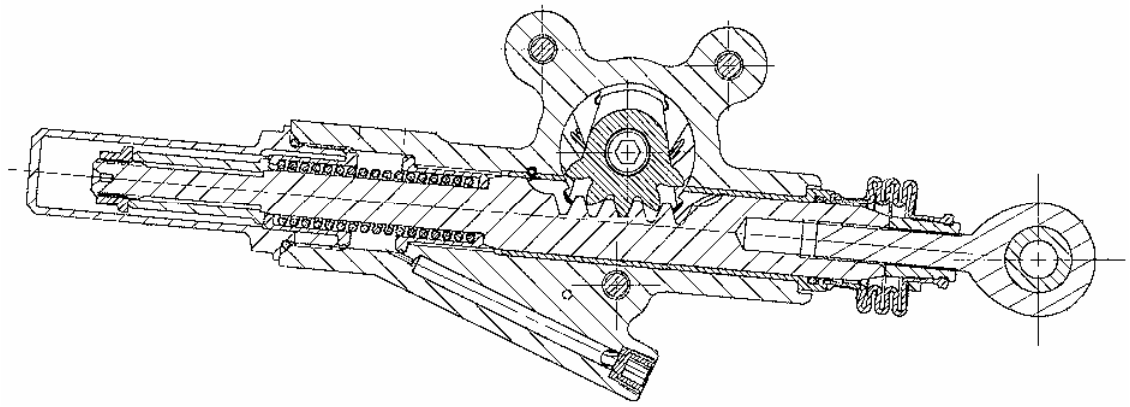

Fig 3. Typical Xtrac Gearchange Rack Assembly

3 The Gear Lever

3.1 The driver initiates a gear change using the gear lever, which must be rigidly mounted in the car, either on the floor, from the dashboard or from the steering column. It is normal for the upshift to be initiated by the driver pulling the lever towards them (rearward), and a downshift by pushing the lever forward.

3.2 The gear knob on the gearlever must be in close proximity to the steering wheel to ensure that the driver uses the least movement of their hand to instigate the gear change. The gear lever must also be approximately in line with the driver's shoulder to provide the maximum mechanical advantage, and the least effort. Care must be taken to ensure that the seat or vehicle equipment does not foul the driver's arm during the arc of movement required whilst the gear change takes place.

3.3 In a typical saloon or sports car the recommended gear knob travel is +/- 25.0-30.0mm (0.98"-1.18"). If less 'throw' is provided then the gearchange can be perceived to be too 'heavy' by the driver, and will feel 'dead'. If the throw is greater then it is likely that the driver in certain situations will undertake a 'lazy' throw which does not move the gear lever sufficiently and may not result in a completed gearchange.

3.4 On a single seat formula car the same 25.0-30.0mm (0.98"-1.18") throw is recommended, although it is understood that due to the vehicle package constraints the gearchange is often actuated by a wrist

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movement rather than a hand and arm movement, and so the throw may need to be slightly reduced for driver comfort.

3.5 The mechanical travel of the shift mechanism at the input to the gearbox is typically +/-10.5mm (maximum) for an Xtrac gearbox with rack gearchange system. The in car gearlever can be of a bottom pivot or centre pivot design, as shown in Fig 4, to suit the installation package and shift direction. Note that a centre pivot design will reverse the shift rod movement direction relative to the gear knob direction.

3.6 To provide the correct hand knob weight and mechanical travel at the gearbox, a gear lever ratio of approximately 3:1 is recommended. The lever ratio is defined as the distance from the centre of the hand knob to the lever pivot (3), and then the distance from the pivot to the bearing (1) that connects the lever to the linkage, (see Fig 4).

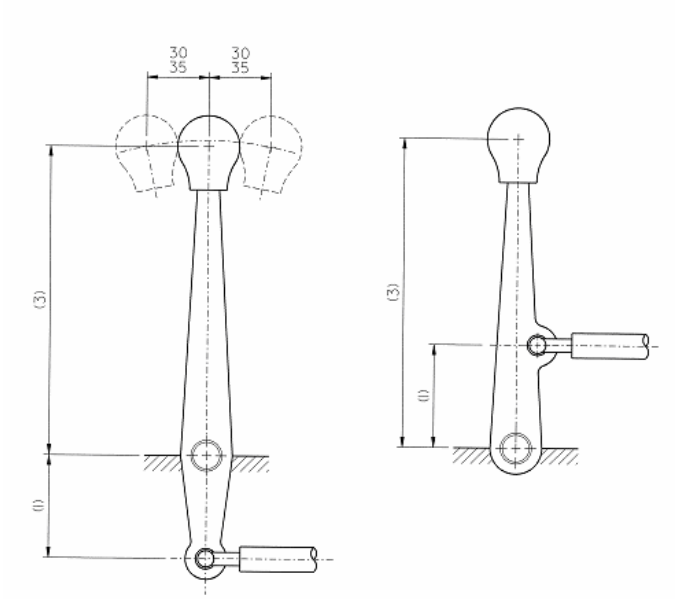

Fig 4. The Correct Gear Lever Ratio and Movement

3.7 The gear lever itself should be light and stiff in construction with consideration given to the mounting and actuation of the reverse detent lifter cable, if the car has one. The gearchange rack return spring inside the gearbox provides the force to return the gear lever to the mid position, and normally no additional springs are required on the gearlever or linkage. The lighter the gear lever assembly, the quicker it will return to the mid position between shifts, and the less susceptible the gearchange will be to involuntary shifting over rough terrain in off

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road applications. Xtrac has a range of suitable in car gear lever assemblies available, such as the '420' gearlever shown below in Fig 5.

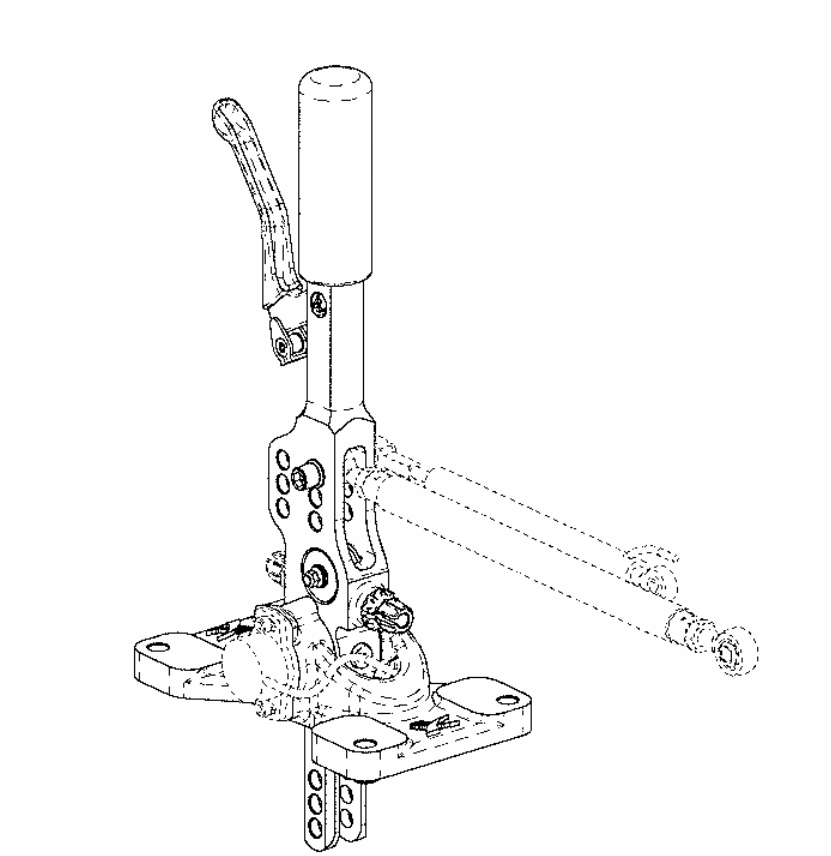

Fig 5. The Xtrac '420' In Car Gearlever Assembly

3.8 The in car gear lever should be mounted from ball bearings or aircraft specification control bearings, and not plain bushes. Bearings should be of the sealed type to prevent dirt ingress. It is essential that the gear lever rotation is as free and as low friction as possible to ensure a rapid return to the mid position.

3.9 The position of the gear lever should ideally be data logged, either with a rotary potentiometer or with a linear potentiometer. A number of alternative sensor options are shown dashed on the '420' gearlever assembly in Fig 5. Having the lever position logged will be useful for diagnostic purposes in the event of a gearchange issue, allowing it to be assessed if the correct full stroke input has been applied.

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4 The Gear Linkage and Bearings

4.1 The shift linkage from the in car gear lever to the gearbox lever or rack connection must follow the most direct route, a straight line being the best solution. A bell crank device must be used to accommodate any bends or changes of direction, rather than a 'helicopter' style spherical bearing. Bell cranks must be as close to 90 degrees as possible, the consequence of not doing so will result in the in car gear lever having unequal movements for up and down changes.

4.2 A bend or kink in any shift rod will result in poor gearchange quality and feel, as the bent rod will act as a spring, (see Fig 6). All link rods used should be manufactured from a high quality fabrication steel, and be sufficiently stiff in compression so as not to buckle under the gearchange loads. In practice, Xtrac recommends that all shift rods are fabricated from mild steel tube with a minimum external diameter of 19mm (3/4") and 1.6mm (16swg) wall thickness.

4.3 If bell cranks are used they must be rigidly mounted to the transmission and not to the vehicle structure wherever possible, as relative movement between the transmission and chassis will cause displacement of the linkage. The bell crank mount should be sufficiently stiff to ensure that no deflection takes place during the gearchange.

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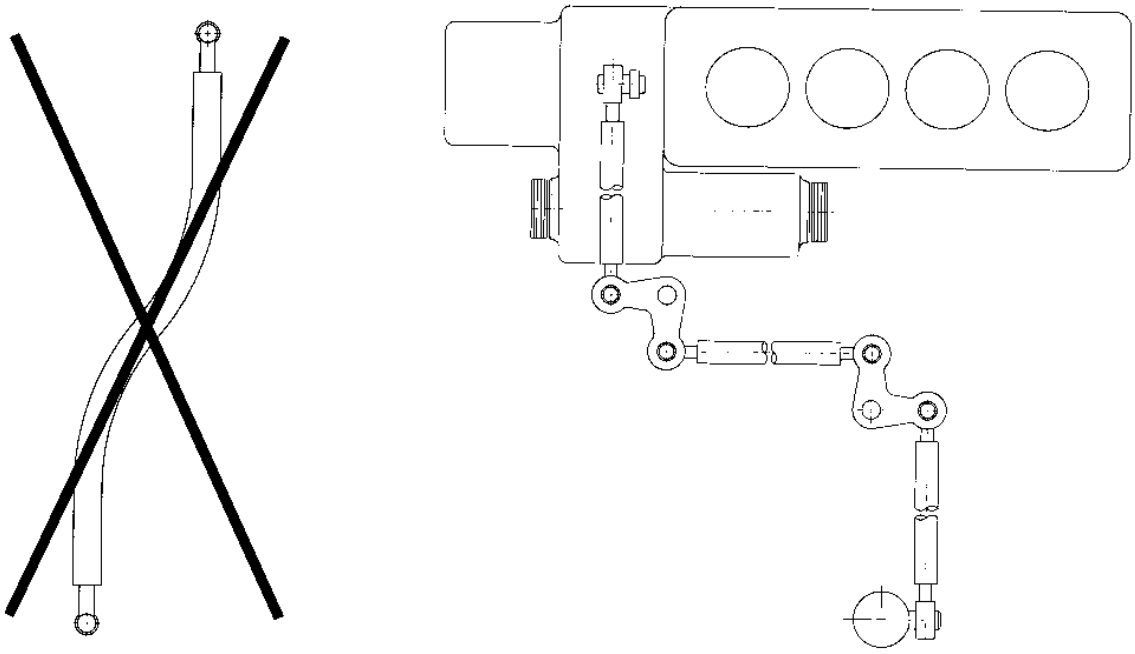

Fig 6. A Bent Link Rod (Left) Compared to a Bellcrank System (Right)

4.4 The ball joints or control bearings that connect the shift linkage to the in car gear lever and gearbox gear lever should be of a high quality, preferably to aircraft specification. They must have low break off torque and be free to rotate, but have no free play. Ball joints are usually very tight when new, so they should be worked free by rotating the inner ball using for example an air powered or an electric drill. The fixing of the joints to the clevis should be made with top hat bushes to ensure that the clamping is achieved through the bushes and the ball, so that any rotational movement is through the ball and not about the clamping bolt and no shift linkage movement is lost to side play of the joint within the clevis (see Fig 7).

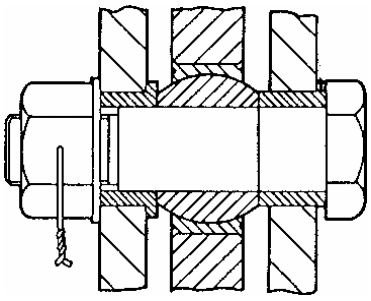

Fig 7. A Typical Spherical Ball Joint Installation

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4.5 An alternative method to a rigid shift rod is to use a push/pull cable. Cables can be used very effectively when it is impractical to use a solid link system, for example when the layout of the car will not permit the easy use of link rods, such as rear engined single seater or sports cars. The cable must be of a high quality manufacture with the minimum amount of free play, and can be attached to either the gearbox gear lever or directly on to the gear change rack at the gearbox. It is important to have the cable rigidly secured at both ends using bearings and bushes as described earlier.

4.6 The shift cable route should have the minimum changes of direction, and be routed as far away from sources of heat such as the exhaust system as possible. It is important to secure the cable to the chassis at approximately 500.0mm (20.0”) intervals, but these mountings should be compliant to allow the cable to flex a little. If the cable route has to pass near to the engine or exhaust system then it should be sleeved in a heat resistant material to prevent the cable outer sheath melting and increasing friction, and hence causing gear selection problems.

4.7 It has occasionally been found that the gear lever requires travel stops to limit movement, as when the shift cable length is longer than approx 1.5m the lever can induce cable stretch if pushed or pulled too far. Gear lever stops are normally however not recommended for solid shift rod or shorter cable gearchange installations.

5 The Consequences of Poor Gear Lever and Gear Linkage Installation

5.1 A consequence of not following the above guidelines for the gear change installation is the rapid deterioration of gear change quality; there will be missed gear changes, changing down two gears at once or not changing gear at all. A poor gear lever and linkage installation are likely to cause dog damage on the mainshaft gear dogs and the dog ring dogs; once initiated, wear is likely to escalate rapidly. This occurs because the dogs on the mainshaft gear and the dog ring once damaged will wear to such an extent that instead of holding themselves

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together they will push apart during engagement. If this is allowed to continue the damage that occurs can be quite considerable.

5.2 Other reasons for poor gear change quality apart from gear lever and linkage design are poor ratio choice leading to too great or too small a rev-drop between gears, poor engine response and engine torque cut strategy, and soft engine/gearbox mounts causing excessive movement. The driver can also cause poor gear changes, for example they must not grip the in car gear lever between shifts as this will prevent the lever returning to the mid position and not allow the ratchet mechanism to reset.

6 Electronic Gear Change Aids

6.1 The quality of gear change, speed of change and the life of mainshaft gear and dog clutch ring dogs can be greatly enhanced with the use of an electronic engine spark cut coupled with a fuel cut. This type of engine cut momentarily reduces the engine torque and removes the load from the mainshaft gear dogs, hence allowing the dog ring to disengage itself easily from the mainshaft gear dogs. The next gear is sequentially engaged during the same engine cut. The duration of this engine cut will need to vary from between 25-80 milliseconds depending on the engine characteristics and the rev drop between gears. This type of engine cut can only be used on up changes, (i.e. 2nd to 3rd gear) as there is a differential of rotating speed between the two gears which is reduced by the degrade of the engine speed. The engine cut duration should be different for different gear ratio steps if the particular sporting regulations allow. Due to the particular characteristics of turbo charged engines, vehicles thus equipped usually require more engine cut strategy development before a consistently good gear change is achieved.

6.2 The engine cut can be triggered by two different methods. The first method uses a proprietary strain gauge mounted within the gear lever hand knob, which once a load is applied by the driver electronically triggers the engine cut for a set time period. The second method is to use a switch that triggers the engine cut for a set time period, the switch being switched by the movement of the gear lever. Both types of engine

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cut triggers can use the gear change barrel potentiometer position to halt the engine cut once the gear change has been completed. The gear change barrel potentiometer should never be used to initiate the start of the engine cut, as the gear change barrel only moves once the gear change has begun, hence the engine cut will occur too late.

6.3 Down changes, (i.e. 3rd to 2nd gear) are more difficult to achieve than up changes as the (higher) engaged gear will be rotating faster than the (lower) gear about to be engaged. The spark cut and fuel cut system used for up changes will have no effect as the engine speed will already be decaying for a down change to be required, therefore an engine cut is not generally used on down changes. To achieve a good down change it may be necessary to de-clutch during the change to unload the mainshaft gear dogs, although in many cases this is not required.

6.4 Ideally an engine blip is required during a downchange to re-synchronise the slower mainshaft gear with the dog ring to be engaged. This used to be done by the driver double de-clutching an H pattern gearbox, however a sequential gearbox may shift too quickly for an inexperienced driver to successfully manually initiate an effective engine blip.

6.5 If the sporting regulations allow it, a software controlled throttle blip can help improve down changes, particularly where an assisted gearchange system (AGS) is fitted to the car. The throttle blip could be induced directly in a ‘drive by wire’ throttle control system as part of the engine management system, or alternatively an AGS controlled pneumatic or hydraulic blipper could be connected to the throttle linkage.

6.6 On vehicles with turbo charged engines a throttle blip can significantly improve down changes, although for normally aspirated engines the lack of throttle blip is not generally a significant problem.

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XTRAC STANDARD

DOCUMENT TITLE	XS036 - Threaded Fastener Tightening Torque Standard
DOCUMENT REFERENCE	XS_PN_TFTTRQ_01
AUTHOR	Stewart Brumpton
APPROVED BY	
AGREED BY	

Version No.	Date Produced
0.0	10 July 2008

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Document Amendment History

Date	Author	Version	Description of Change

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Scope

This standard exists to provide torque tightening information for studs and bolts in various applications.

Procedure

Xtrac uses a number of standard threaded fasteners to retain components and assemblies. Most fixings can be characterised into one of the following three applications:

1) Steel (EN24T) or Titanium stud threaded into a component of a soft casing material (e.g. L169 or RZ5), with a nut (K nut, Nyloc or similar) retaining another component. If the stud is threaded into a non-ferrous material then this thread is normally the strength limiting part of the joint regardless of the length of thread engagement.

2) Steel bolt threaded into a soft casing material. This is not often a preferred method of fastening used by Xtrac. As with (1) above, the softer material will significantly limit the strength of the joint.

3) High strength Steel (3S145D) stud threaded into a steel component, with a nut retaining another component. The strength of this joint may be limited by either thread depending on the individual material properties and/or thread engagement length, but usually a higher tightening torque can be applied than (1) above.

4) High strength Steel SHC bolt threaded into a steel component. This joint will offer the maximum joint strength, and potential for high tightening torque.

With these factors in mind, the following table of standard torque figures may be applied to Xtrac products, except where indicated otherwise on an individual assembly basis.

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Thread Size	Nut / SHC Bolt Tightening Torques			
	Nut onto Steel or Titanium stud in Ali (1) or Steel bolt into Ali (2)		Nut onto 3S145D stud in Steel (3) or SHC bolt into Steel (4)	
	Nm	ft lbf	Nm	ft lbf
METRIC				
M4 x 0.7	-	-	5	4
M5 x 0.8	8	6	10	7
M6 x 1.0	13	10	17	13
M7 x 1.0	21	15	29	21
M8 x 1.25	30	22	41	30
M10 x 1.25	48	35	84	62
M10 x 1.5	47	35	80	59
M12 x 1.5	70	52	138	102
M12 x 1.75	69	51	133	98
IMPERIAL				
10-32 UNF	-	-	9	7
1/4" UNF	14	10	21	15
1/4" UNF/UNC*	16	12		
5/16" UNF	25	18	41	30
5/16" UNF/UNC*	28	21		
3/8" UNF	46	34	74	55
3/8" UNF/UNC*	54	40		
7/16" UNF	57	42	116	86
7/16" UNF/UNC*	65	48		
1/2" UNF	75	55	177	131
1/2" UNF/UNC*	90	66		

*Assumes UNF nut onto Steel/Titanium stud with UNC thread into Aluminium Alloy

All torque figures are based on calculation to give proof stress safety factor of 2 in the weakest thread, and assumptions made for nominal friction coefficients between each component.

Notes for use with Non Ferrous casings:

- All Aluminium torques are based on **Stud – Plain – Metric (XS010**)/**Stud – Plain – Imperial (XS011)** thread engagement lengths and oiled threads between nut & stud/bolt. If the thread engagement length of the stud/bolt into the casing is less than that specified in these standards, then a reduced tightening torque should be applied.
- Aluminium tightening torques may also be used for Magnesium casings, but will result in a reduced safety factor - it is therefore imperative that the correct Loctite adhesive is applied and fully cured before nuts are tightened to stated torques
- Thread sizes marked with '-' in the table are not recommended for use with studs directly into the Ali/Mag casing material and thread inserts should always be

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used. If additional tightening torque is required for other thread sizes then thread inserts should be considered and tightening torque should be calculated for the application.

- Note that torque figures stated are for tightening of nut onto stud, or bolt into casing – torque values are not for use when tightening bottom fitting studs, shank fitting studs or thread inserts directly into the casing thread.

For all other applications, consideration should be given to the individual installation and a suitable tightening torque should be calculated using Xtrac engineering tools.

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12. Appendix H – 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.

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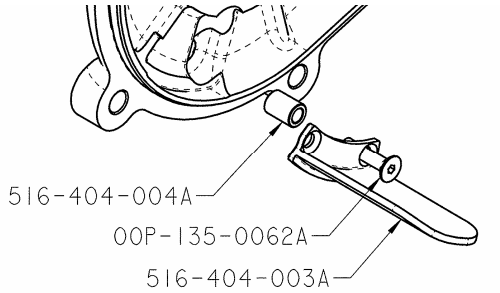
Xtrac Inc, 6183 W. 80th Street, Indianapolis, IN 46278. United States

Technical Bulletin – 516 Gearbox

Date:	4th September 2007		
To:	All Teams		
Ref:	**516-0001**	**Revised:** Development revisions	
From:	Jonathan Dean	**Position:**	Senior Design Engineer

Ref.	Description
	The following technical bulletin outlines all changes made to the 516 gearbox during initial stages of development:
	Casings:
1	The maincase (516-402-000A) has been redesigned (516-402-000B) to strengthen the region of intersection between the cluster and final drive. In addition the chassis mount areas have been strengthened. All gearbox maincases have been updated on all existing gearboxes.
2	The cluster plate (516-404-000A) has been redesigned (516-404-000B) to strengthen the mainshaft bearing bore. This new part will be phased in once stock of the 516-404-000A has been depleted. The life of the 516-404-000A has been revised to 3,500km and future ones will be sold at half price, £620.00.
	Lubrication: To improve the lubrication pickup of the gearbox the following changes have been implemented throughout all gearboxes:
3	A baffle plate (516-404-003A) has been fitted to the cluster cover to protect the scavenge area from windage of the larger mainshaft gears. The cluster plate (516-404-000A) has been modified to accept this part, a countersink screw (00P-135-0062A) and a spacer (516-404-004A) is also used for this fitment.
	 *Figure 1 – New Baffle Plate*
4	This spacer (516-404-004A) will be removed and an additional countersink screw (00P-135-0062A) will be used to retain the baffle plate when the new Cluster cover (516-404-000B) is phased in.

5 A scavenge tube (516-402-001A) has been fitted into the revised specification maincase (516-402-000B) to improve the oil scavenge. This has a small dowel (193-0022) and a revised plug (169-0112) to locate it.

6 The pump drive (516-450-003A) has been replaced with a revised design (516-450-003B) which is supported radially by an additional needle bearing (B-NR-016-0001). A new spacer (516-450-004A) is used to separate the two needle bearings within the reverse idler gear (516-431-009B) and this new pump drive. This redesign supports the pump drive and allows more uniform drive to the pump rotors.

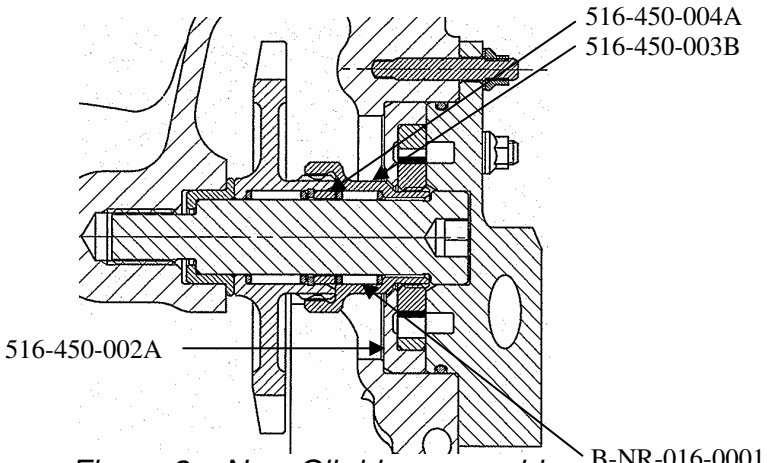


Figure 2 – New Oil drive assembly

7 The pump body (247-450-002E) has changed specification (516-450-002A). This new specification has more clearance for the rotors and a larger internal chamfer to avoid interference with the new pump drive, 516-450-003B

8 The input seal (101-0085) has been replaced with a revised specification (100-0084).

Differential:

9 The detent click 'feel' has been improved with a modified detent trough shape on the adjuster plate (407-449-002A). All existing gearboxes and stock have been modified. The change is shown in figure 3.

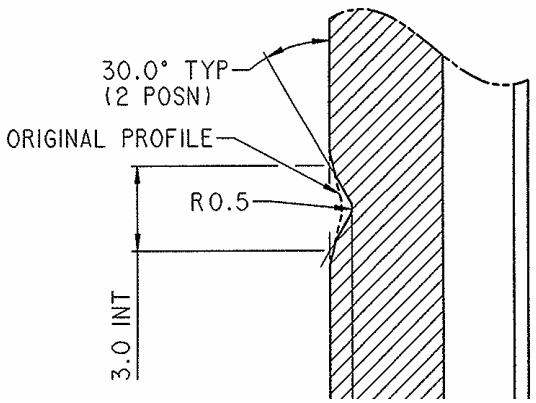
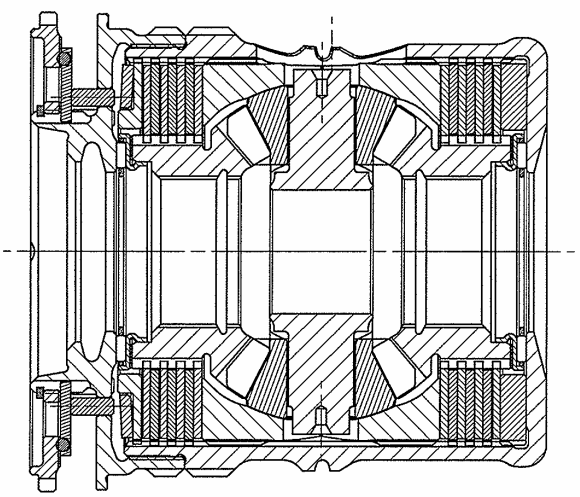


Figure 3 – Detent trough profile alteration

10	The Belleville spring has now been repositioned externally from the differential clutch pack against the adjuster mechanism directly. A pressure plate (516-449-003B) is now used to react the adjuster mechanism and spring to the clutch pack and replaces the 12 off dowel pins (193-0008). The differential end cap (516-449-002A) has been changed (516-449-002C) to accommodate this pressure plate and to increase its rigidity, against the clutch pack separation loads.
11	Xtrac have reviewed the amount of float in the differential side gears (306-290-010T). The above change to the differential end cap reduces this float and these side gears should now be run **WITHOUT** the side gear shims (406-290-004A) behind each side gear. This is reflected in the new differential cassette assembly drawing (516-949-100B), formally (516-949-100A).
12	The above change to the differential end cap also has removed the requirement of the shim (406-290-004A) from behind the output flange thrust bearing (116-0058). This is reflected in the new differential assembly drawing (516-949-000B), formally (516-949-000A).
13	Xtrac have reviewed the clutch pack height due to all of the above differential changes. As such, all friction discs are now specified with the 2.0mm (206-290-008B) specification, instead of any potential 2.1mm (206-290-008C) specification plates. The end thick friction plate will now be a 5.81mm thick (406-290-007C) instead of 6.01mm thick (406-290-007E) nominally, although this plate pack should continue to be shimmed to give 0.1mm clearance within the differential body. A cross section of the old and new differential cassette assemblies are shown below:  *Figure 4 – 516-949-100A – Original Differential Cassette Assembly*

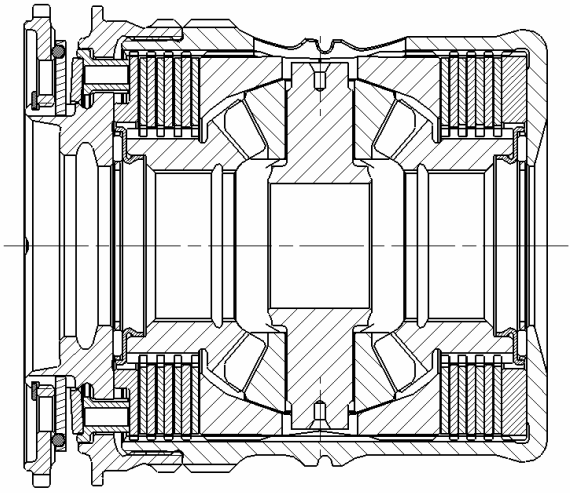


Figure 5 – 516-949-100B – Revised Differential Cassette Assembly

14 The Final Drive wheel (516-449-0A-1347) has been replaced with a wider design (516-449-0B-1347) to increase durability. All existing gearboxes have been fitted with this part.

Cluster:

15 The layshaft set (516-42M-0A-1338) has been replaced with a new specification (516-42M-0B-1338). The new layshaft allows a locking nut (516-421-005A) and a locking ring (516-421-006A) to be fitted to axially lock the layshaft assembly, reducing fretting in the layshaft gear splines and on the layshaft 10-spline. The lock ring is held by a new snap ring (152-0103) replacing the original circlip (150-0063) and both new parts utilise an O-ring (102-0692) each.

16 In conjunction with the above change the clutchshaft has been redesigned (516-420-000D/E) to dampen engine harshness into the cluster. The clutchshaft is now retained within the new layshaft (516-421-0B-1338) by a plain wire ring (152-0005); an O-ring is used on the new shaft (102-0493). The clutchshaft is now removed with the cluster. A separate layshaft reverse gear is now required (516-421-009A) along with a layshaft bung (436-350-002A) to stop oil migrating from the cluster.

The Cluster Assembly (516-996-000A) has been renamed (516-996-000B) in light of these changes.

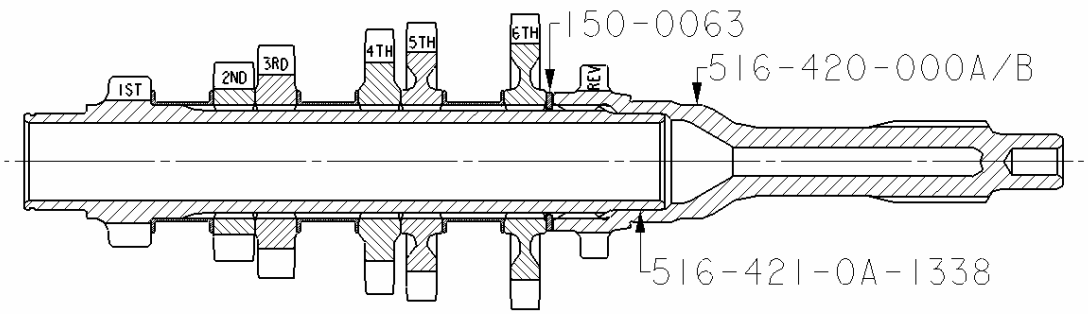


Figure 6 – 516-996-000A – Cluster Assembly (Layshaft assembly shown)

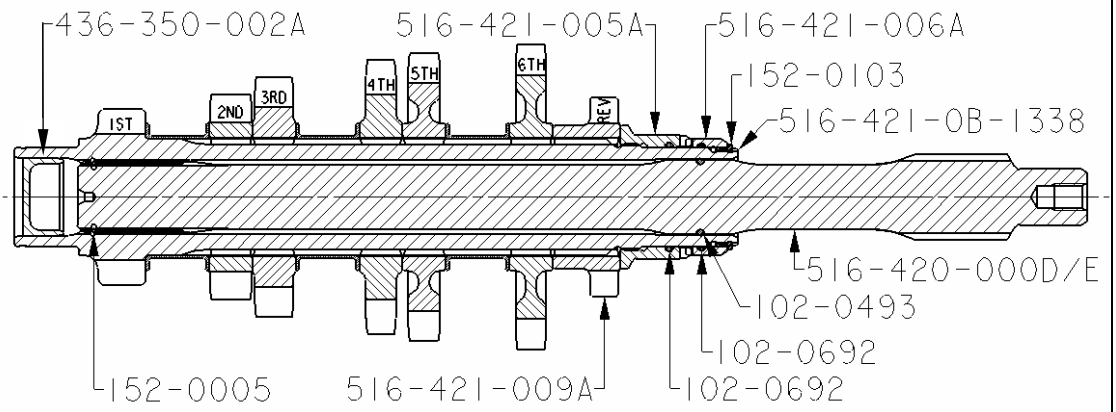


Figure 7 – 516-996-000B – Revised Cluster Assembly (Layshaft Assy shown)

17 As a reminder the tightening torque value for the mainshaft nut (519-422-004B) has been revised from 135Nm (100 lbf.ft) to **100Nm** (75 lbf.ft). The tightening value for the layshaft nut (516-421-005A) is **68Nm** (50lbf.ft). This can be achieved by using the tear drop shaped layshaft nut socket (516-499-008A) and a torque wrench. The torque wrench should be set to 68Nm (50lbf.ft) and be fitted perpendicular (or as near as possible) to the tear drop offset to reduce the effects of the offset on the true tightening value.

Gearchange:

18 The barrel specification (516-432-001A) has been revised (516-432-001B) to ensure the correct dog engagement is obtained. Slots are provided in the barrel to aid assembly of the forks with the baffle plate fitted during a ratio change.

19 The potentiometer housing (516-432-001A), seal sleeve (195-432-106A) and O-ring (102-0690) have been replaced with a single piece potentiometer housing (516-432-001B) to reduce part count.

20 The selector forks (516-430-009A) have been modified to an issue 3 variant (516/430-009A/3) which reduces the contact area between the forks and the dog rings.

21 The ratchet bearing sleeve (516-432-010A) has been modified to add extraction threads for ease of removal.

22 The detent cable exits the 516 gearbox towards the front and is bent rearwards towards the gearlever. It has been found that with the shortest cable length (406-803-100A), the quick release clip is bending. This results in the spigoted cable end potentially coming out, which can preload the detent and cause gearchange problems. It is recommended that if the quick release system is ordered then the 406-803-100C cable (406-903-100C assembly) is utilised, the shortest cable length (406-803-100A) is no longer an option for the 516 gearbox.

	Driveline:
23	The output flanges' (516-412-000A and 516-413-000A) profiles has been amended to allow more tripode articulation. All parts have been modified to this effect.
24	The snap ring (152-0118) on the left hand output flange can come out of its groove during service. This has been replaced with a medium/heavy duty spiral lock ring (159-0092). All left hand output flanges have been modified to suit this new lock ring.
25	The internal fitting driveshaft boots offered with the 516 driveline (147-460-002A and 147-460-002C) reduces the plunge length permissible by interfering with the tripode rollers; this restricts some installations. As such Xtrac have invested in a new design boot (171-0027) which is smaller in design to the standard boot (171-0007). Customers can choose from either design.

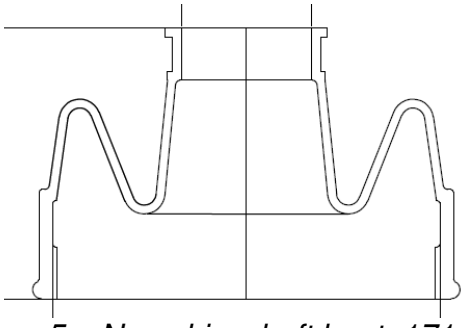


Figure 5 – New driveshaft boot, 171-0027

All of the new parts mentioned within this technical bulletin will be fitted as standard to all new gearboxes from gearbox number 009 and have been installed into all existing gearboxes, with the exception of the revised cluster plate, which will be phased in after current stock is depleted. The new specification alternative driveshaft boots (171-0027) are available to buy if required. Please contact Paul Leeming on: +44 (0)1635 293 423 or e-mail: paul_leeming@xtrac.com or Andrew McDougall at our US facility on +1 317 472 2454 or andrew_mcdougall@xtrac.com to order spares of these new components or if there is any confusion about the specification changes.

Prepared By:	Jonathan Dean	Signed:	*JAD*
Approved By:	Adrian Moore	Signed:	*APM*

Technical Bulletin – 516 Gearbox

Date:	21st November 2007		
To:	All Teams		
Ref:	**516-0002**	**Revised:** Development revisions	
From:	Jonathan Dean	**Position:**	Senior Design Engineer

Ref.	Description
	The following technical bulletin outlines some future developments for the 516 gearbox.
1	The gear lever bell crank (416-428-117A) was originally designed to suit a standard 1/4" bore diameter x 3/8" wide spherical bearing at both ends. See Figure 1.

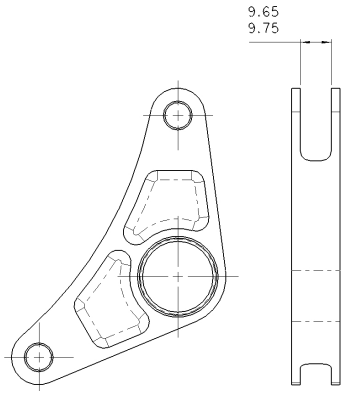


Figure 1 - Existing 416-428-117A Bell Crank

Due to customer demand Xtrac have designed a new gear lever bell crank (416-428-117C) which suits a standard 1/4" bore diameter x 7/16" wide rod end to allow for easier gear change linkage design and installation. See Figure 2.

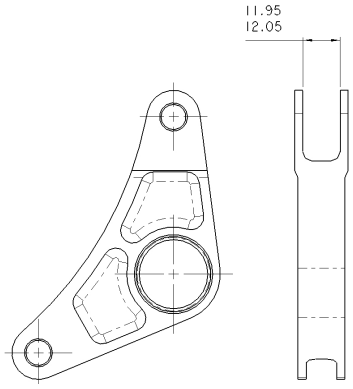


Figure 2 - New 416-428-117C Bell Crank

This new bell crank design will be the standard fitment for all future gearboxes from gearbox number 009 onwards.

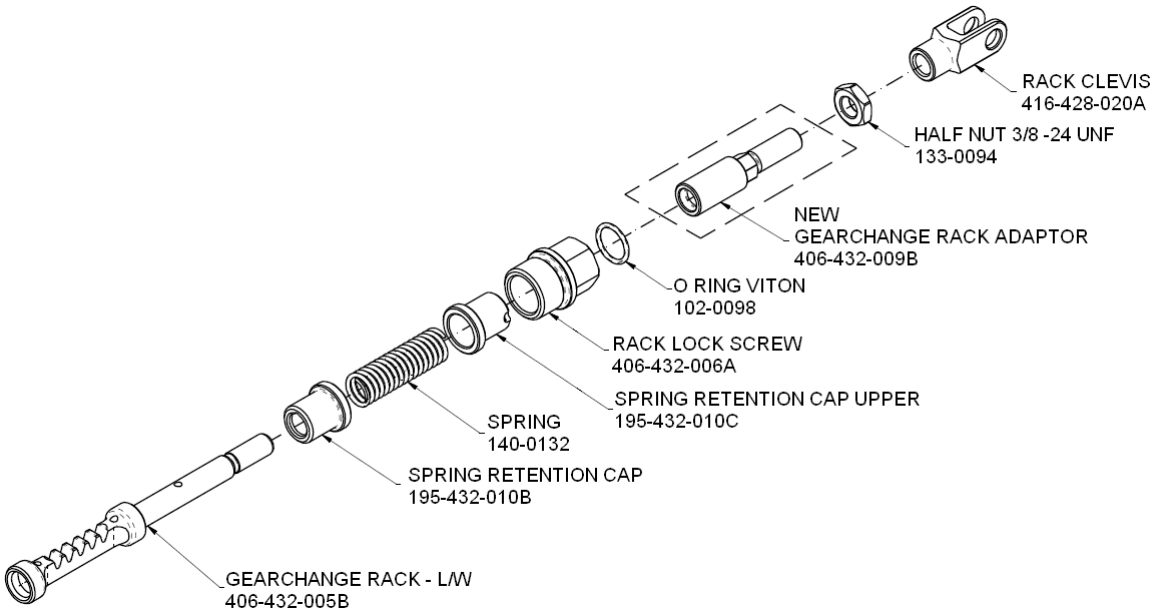
2	The reverse idler (516-431-006B) has been replaced with a new design (516-431-006C), which negates the requirement for a snap ring (152-0064) and a bearing spacer (516-450-004A) to separate the two needle bearings. This

	new reverse idler design will be phased in once stock of the current specification is depleted.
3	The mainshaft (516-422-0A-1347) has been replaced with a new design (516-422-0B-1347). The new design is manufactured with new tooling and as such the width of the final drive pinion can be increased to improve its durability. This new mainshaft design will be phased in once stock of the current specification is depleted.
4	The RH output flange (516-412-000A) has been modified to accept a different retention clip. Originally the output flange bearing (113-0141) was retained with a snap ring (152-0034) whereas now a spiral lock ring (159-0099) has been specified for use in this area. All new output flanges will be supplied to this specification. Xtrac request that existing flanges are returned for this groove to be amended once the season finishes, this will be done FOC and will be mandatory in order to avoid interchangeability issues in the future.
5	A gearchange barrel (516-432-001B) has been replaced with a new specification (516-432-001C) which has more engagement length between the barrel cam tracks and the fork engagement pins (195-430-010A) but is otherwise identical. This new gearchange barrel design will be phased in once stock of the current specification is depleted.
6	The LH output flange housing (516-449-005A) design has been modified to retain the Kaydon bearing after feedback that this bearing was able to 'walk' out of the housing during assembly. This modification requires a new bearing spacer (516-449-006A) and a snap ring (00P-152-0196) to retain it in position against the bearing outer race. All housings and complete gearbox assemblies from gearbox number 009 will be supplied to this specification in the future and all stock has been updated. Xtrac recommends that existing housings are returned for modification once the season finishes.
7	As a reminder to all teams, Xtrac is currently depleting all stock of '406' side gear rings (ramps) and cross pins (406-427-009* and 406-290-109*, respectively). New specifications of both parts (443-449-109* and 443-290-009*) are being introduced that are directly interchangeable but have a larger contact area for the ramp angles (flats), reducing contact pressures and the likelihood of bruising of these areas, increasing both parts durability. 4 choices of cross pins will be offered (A, B, C and D) representing identical ramp angle configurations as before (45/85, 30/45, 30/75 and 45/60, respectively). Revised specification side gear rings can be run with the existing specification cross pins and vice versa. Please contact Paul Leeming on: +44 (0)1635 293 423 or e-mail: paul_leeming@xtrac.com or Andrew McDougall at our US facility on +1 317 472 2454 or andrew_mcdougall@xtrac.com to arrange modification of the output flange housings or RH output flanges if required.

Prepared By:	Jonathan Dean	Signed:	*JAD*
Approved By:	Adrian Moore	Signed:	*APM*

TECHNICAL BULLETIN

Product:	516 Touring Car Gearbox		
Date:	**25/02/09**		
To:	**All 516 Customers**		
Ref:	**516-0003**		
From:	**Oliver Grant**	**Position:**	**Graduate Design Engineer**

Ref	Description
1	**Gearchange Rack Adaptor** A new gearchange rack adaptor 406-432-009B has been designed to replace 406-432-009A. The new version uses a different material and surface treatment to improve the wear resistance of the gearchange rack assembly.  The new part is now standard fitment for all new gearbox builds, rebuilds and spares supply. For further information please contact Paul Leeming on: +44 (0)1635 293 423 or e-mail: paul_leeming@xtrac.com or Andrew McDougall at our US facility on +1 317 472 2454 or andrew_mcdougall@xtrac.com.

Prepared By:	Oliver Grant	Signed:	ODG
Approved By:	Chris Cholmeley	Signed:	CGC

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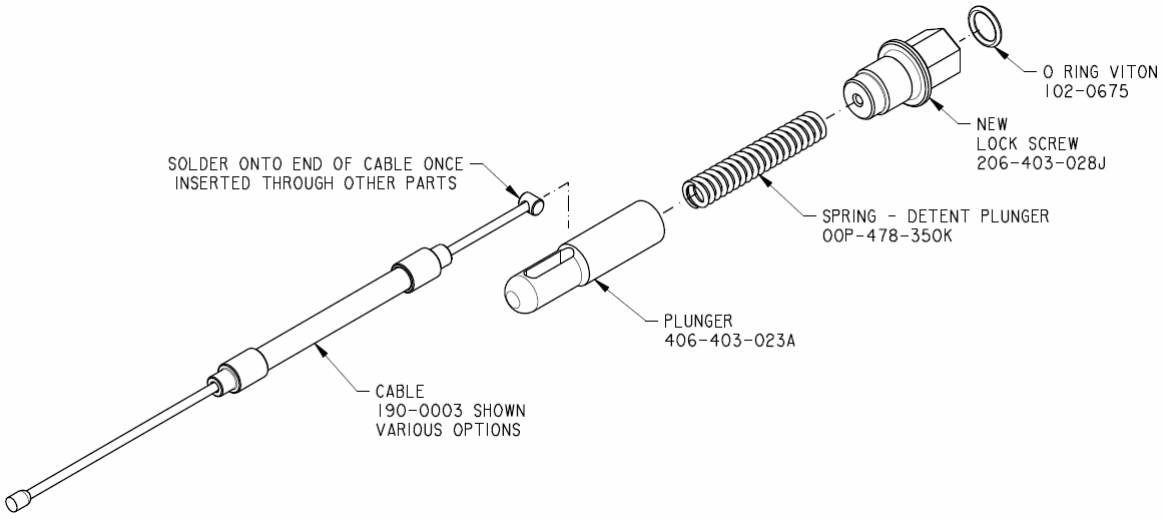
TECHNICAL BULLETIN

Product:	516 Touring Car Gearbox		
Date:	**25/02/09**		
To:	**All 516 Customers**		
Ref:	**516-0004**		
From:	**Oliver Grant**	**Position:**	**Graduate Design Engineer**

Ref	Description
1	**Detent Spring Lock Screw** The standard (406-903-202) and quick release (406-903-200) cable detent assemblies now use a revised lock screw (206-403-028J replacing 206-403-028K) which reduces the installed spring length from 52.0mm to 42.8mm. This new specification part provides a more positive gearchange feel. The new specification lock screw will be fitted to all future new gearbox builds.  For further information please contact Paul Leeming on: +44 (0)1635 293 423 or e-mail: paul_leeming@xtrac.com or Andrew McDougall at our US facility on +1 317 472 2454 or andrew_mcdougall@xtrac.com.

Prepared By:	Oliver Grant	Signed:	ODG
Approved By:	Chris Cholmeley	Signed:	CGC

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TECHNICAL BULLETIN

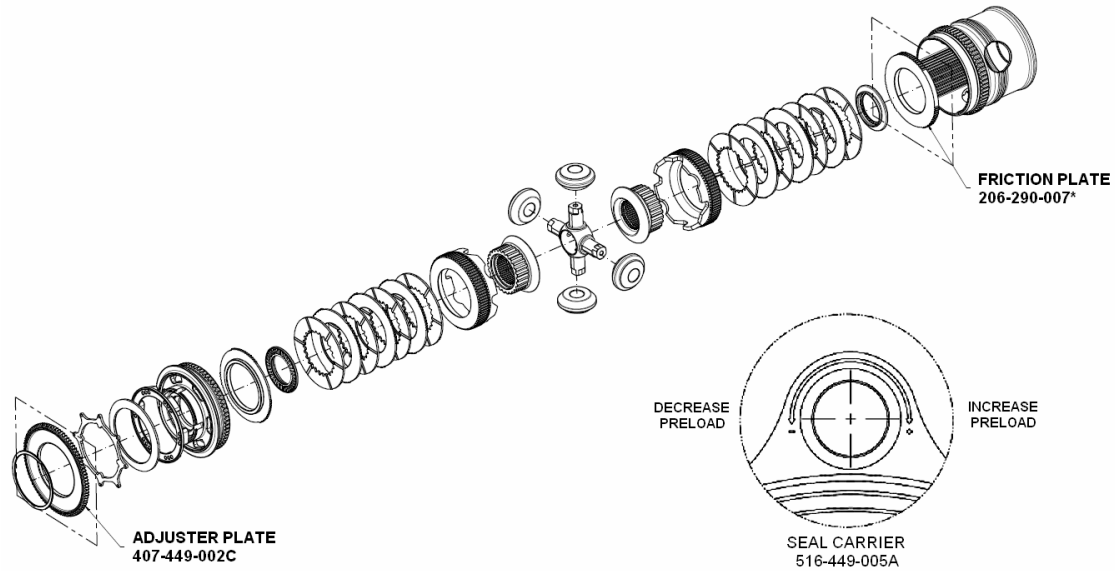
Product:	516 Touring Car Gearbox		
Date:	**25/02/09**		
To:	**All 516 Customers**		
Ref:	**516-0005**		
From:	**Oliver Grant**	**Position:**	**Graduate Design Engineer**

Ref	Description
1	**Differential Assembly Improvements**

The thick friction plate (now 206-290-007* replacing 406-290-007*) in the differential assembly (516-949-100B) is now hardened. This helps to reduce wear and maintain the consistency of the differential friction properties.

The number of detent recesses on the adjuster plate (now 407-449-002C replacing 407-449-002A) has increased from 24 to 40. This refines the preload adjustment. The preload adjustment is now ±6-9Nm per click compared to ±10-15Nm per click using the previous adjuster plate. The total range of adjustment is unaffected.

The seal carrier (516-449-005A) now has preload adjustment etching directions around the preload adjuster wheel. This helps ensure that the adjuster wheel is rotated in the correct direction for increasing or reducing pre-load (see inset).



The new parts are now standard fitment for all new gearbox builds, rebuilds and spares supply.

For further information please contact Paul Leeming on: +44 (0)1635 293 423 or e-mail: paul_leeming@xtrac.com or Andrew McDougall at our US facility on +1 317 472 2454 or andrew_mcdougall@xtrac.com.

Prepared By:	Oliver Grant	Signed:	ODG
Approved By:	Chris Cholmeley	Signed:	CGC

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