# Upgrade Freelander IRD

## Here's how the 4WD system can be improved to transform handling

When the Freelander 1 was launched, a big fuss was made about its 4WD system. With no low-range or mechanical centre diff-lock, it was dismissed by those more used to big levers and mechanical linkages. However, it didn't take long for the Freelander to prove itself as a proper go-anywhere vehicle, and every bit a 'real' Land Rover because of it.

Of course, everything can be improved on, and this is certainly the case with Freelanders that are used in competition. Tim and Alex Howard are at the forefront of fine-tuning the baby Land Rover for off-road racing and rallying, and the latest development lies in the Intermediate Reduction Drive (IRD). This contains the front differential, as well as adjusting the gear ratio and turning drive 90 degrees to send power down the propshaft to the viscous coupling and finally to the rear diff.

Tim is building up an IRD from a donor unit with an uprated crownwheel and pinion; the latter will spin inside a custom billet housing on larger, higher-capacity bearings. As well as replacing every bearing and seal, he's also fitting a new automatic torque biasing (ATB) diff from Quaife. This detects when a driven wheel loses traction, and sends the majority of drive to the wheel that still has grip instead of taking the path of least resistance.

While the build here includes these upgrades, the principle is the same for rebuilding a standard IRD. So if you've got an old one kicking about that's got the odd knock or whine, why not have a go at rebuilding it yourself?

### The Expert Tim Howard

**After gaining many years of engineering experience in powertrain research and development at Ford, Tim Howard is in charge of maintaining and improving the family's Freelander rally car, piloted by son Alex. Today, he's building a new IRD.**

### Tools and kit used

■ Socket and spanner sets ■ Torque wrench ■ Hydraulic press ■ Rubber hammer ■ Lever bars ■ Impact gun ■ Rags ■ Cleaning solution ■ Dial test indicator ■ Vice ■ Breaker bar ■ Special tools and jigs

### Safety advice

■ Wear hand and eye protection when using a hydraulic press, as well as oils and cleaning fluids

Tim Howard lowers the torque-biasing Quaife diff home

PHOTOS: TOM CRITCHELL

### THE VEHICLE

**Tim and Alex Howard's Freelander is an absolute weapon on rally stages; you can read the full feature on the car in the March 2018 LRO. Keep up with its progress at thehowardsfreelander.blogspot.com.**



### HOW LONG?

**Five hours**

### HOW MUCH?

- **Quaife ATB diff £1074 Quaife.co.uk**
- **Uprated crownwheel and pinions gears, billet rear housing £POA Sovereigngears.com**
- **IRD rebuild kit £145.99 Onestop gearboxshop.com**

### HOW HARD?

STRIPDOWN

## Remove end casing

**1** First, the whining donor IRD must be stripped and cleaned. We'll re-use the casing, input and layshafts if they're in good condition, but everything else will be new. Tim starts by undoing the end casing nuts and bolts, then tapping the casing off its dowels.

## Take out the diff

**2** The old open diff can be slid out, along with its driveshaft extension. The shaft is held into the diff with a spring clip, and the diff is easily knocked off the end of the shaft's splines. We're replacing the standard diff with a trick torque-biasing unit from Quaife.

## Free oil cooler

**3** To disassemble further, the circular oil cooler must come out of the casing. It's a stubborn blighter to remove and can take some serious persuasion with a lever bar and hammer. This one frees off after a few whacks, and into the bin it goes.

## Release pinion housing

**4** The five 13mm nuts are undone from the studs, and the IRD's pinion can be tapped out of the housing. It seals into the casing with a large O-ring, so it can take a bit of wiggling to free off, but it shouldn't be anywhere near as hard to remove as the oil cooler!

## Remove input shaft

**5** It's the input shaft's turn to emerge from the casing. The gears appear to be fine so can be re-used, but the bearings will be replaced. Everything will be deep-cleaned in petrol to remove old oil deposits and to keep everything as fresh as possible.

## Undo crownwheel nut

**6** Next, the large 36mm nut that secures the crownwheel on the end of the intermediate shaft is shocked loose and spun off with an impact gun. Once this is off, a few raps with a soft-faced mallet separates the two parts, and they can be removed.

## Fully disassembled

**7** This pile of parts will be carefully inspected, and any damaged or worn items will be replaced. The casings, shafts and gearsets will enjoy a soak in petrol to degrease them and remove all traces of dirt and old, degraded oil. All the old bearings will be pressed out of the casings and off the shafts, and new ones pressed in; we won't show every single bearing, as it's repetitive.

## How the IRD works

**8** The shaft at the bottom turns inside the input shaft, output to the nearside front driveshaft. The other side of the diff outputs to the offside front wheel. The intermediate shaft is turned by the input shaft, and drive turns 90º to the propshaft and viscous coupling.

BUILD-UP

## Assemble rear housing

**9** The new billet pinion housing must be fitted with its uprated bearings and seal. The bearing outers go in first; a smaller one at the nose and a larger one at the flange end. The smaller taper bearing then goes in, and the seal is seated by hand, to just below flush.

## Pinion shaft

**10** The pinion shaft's large taper bearing is pressed on, then the crush washer is fitted. This washer squashes down and sets the bearing preload – they're not supposed to be re-used, but they are elusive and they can do another turn without issue, so on it goes.

## Two become one

**11** The pinion is set in the hydraulic press, then the pinion housing is offered down onto the top of it. The propshaft flange is then slid onto the exposed pinion splines, and Tim carefully presses the assembly together – the bearings are an interference fit.

## Torque the torque

**12** The pinion assembly is secured in a jig, and two bolts are wound into the propshaft flange. The pinion is held with a lever bar, and the pinion nut is spun onto the thread before being torqued to 148lb ft. The pinion bearings are then lubricated with gear oil.

## Prepare the casing

**13** The IRD casing has been cleaned to within an inch of its life. A new bearing outer race has been pressed into the end of the casing to accommodate the diff bearing, and a needle-roller bearing (secured by a circlip) takes care of the intermediate shaft.

## Install oil seals

**14** There's a double oil seal arrangement in the input shaft collar, where the IRD mates to the gearbox. Tim has made a special tool that sets the depths of the small, fragile seals perfectly; it's back to the hydraulic press to set them in the IRD casing.

## Special spacers

**15** Each IRD contains three spacers, responsible for setting the preload on the taper bearings on the shafts. They're matched to the casings and should be kept with their donor to prevent incorrect preload settings. Tim fits the spacer to the intermediate shaft.

## Fit the crownwheel

**16** The crownwheel's inner taper bearing is pressed onto the short shaft and lubricated with a liberal dose of gear oil, and the crownwheel gear is given a coat of meshing paste. The crownwheel is offered up to its outer bearing race in the casing.

## Intermediate shaft in

**17** The casing is carefully up-ended so that the crownwheel is at the base, then the intermediate shaft and its bearings are lowered in on top of it. As you will have seen in step 8, the crownwheel fits onto the end of the intermediate shaft.

## Press it together

**18** Tim makes sure the casing is flat on the press table, then gradually applies pressure to the end of the intermediate shaft to push it onto the crownwheel, sandwiching all the bearings together. The spacer takes the guesswork out of preloading.

## Jigging up

**19** Tim has an assortment of braces and jigs made specifically for supporting the IRD in different positions for carrying out different jobs. We need to clamp it securely in a vice, so he attaches a large bracket to the casing with M12 bolts and nuts.

## Intermediate shaft nut

**20** Next, the large nut can be spun onto the end of the intermediate shaft as it protrudes through the crownwheel. It's snugged down by hand, but it'll be fully torqued later. As the shafts have been pressed together, the gear mesh can be set accurately.

## Torque up

**21** The nut on the end of the intermediate shaft must now be torqued up high to 184lb ft. It's important that the IRD is held tightly in the vice and that the other end is held solid with a breaker bar and special cup tool that acts on flats on the shaft.

## Studs and shims

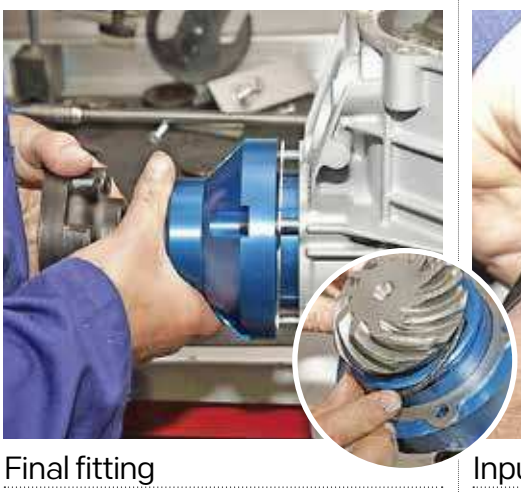
**22** The IRD is turned in the vice, and Tim fits the five studs that will hold the pinion housing to the casing. He also drops on the housing's shim; this sets the crownwheel and pinion mesh, so it's vital to get it right. Tim has a wide variety of these shims.

## Setting the mesh

**23** With the pinion housing on and the crownwheel locked, Tim fits a dial test indicator (DTI) to the jig and winds a bolt through the propshaft flange for the needle to act on. We're after 5 thou here, and achieve it after just two shim changes.

## Install oil cooler

**24** The circular oil cooler disc can go on. The IRD is placed at the correct angle in the press, and a smear of silicone is applied to the outer lip of the cooler. With a special plate, the oil cooler is gradually pressed down until home, and excess sealant is wiped away.



## Final fitting

**25** The pinion housing can now go back on for the last time. The O-ring is lubricated and slotted into its groove in the housing body, then the pinion housing and correct shim are refitted. New nuts are wound onto the studs and torqued down to 18lb ft.

## Input shaft seals

**26** The input shaft itself has a pair of small oil seals that sit in recesses at each end. The seals are seated carefully by hand before being pressed in. Tim takes care not to over-compress and damage the seals by releasing the pressure as soon as they're home.

## Fit the bearings

**27** The shaft is taken back over to the press and supported on the press table under the gear. Each of its two bearings is carefully installed on the shaft, using a long tube acting on the bearing inner to press them on firmly.

## How it fits

**28** The new Quaife diff's end bearing is pressed on in the same manner as the input shaft's. Tim shows how the input shaft and diff sit together in the IRD; the bearing on the end of the input shaft allows for the speed difference between it and the diff.

## Put in the input

**29** With the IRD positioned in the vice, the intermediate shaft can be lowered down into place. Great care is taken to mesh the gears as the shaft goes home; the bearings have already been treated to a healthy dose of fresh oil.

## Check the gears

**30** With the input shaft installed, the gears should mesh nicely and sit almost flush. It's possible to see the input shaft's internal oil seal, and the flats on the end of the intermediate shaft that allow it to be held while torqueing the crownwheel nut.

## Install driveshaft

**31** Next, the driveshaft can be seated in the new diff. It has a splined end with a groove and a spring clip, which locks it in the diff's output. Once lined up, a few taps with a rubber mallet sees it home. Tim checks it's locked in properly by trying to pull it back out.

## Fit the diff

**32** The diff and shaft assembly is the last big component to go into the IRD. The driveshaft is carefully manoeuvred through the oil seal and down the middle of the input shaft, and the diff rests on top of the input shaft bearing.

## End casing on

**33** Tim presses a new oil seal into the end casing, then lowers it onto the built-up IRD. Once satisfied everything is sitting nicely, the end case is removed and a bead of sealant is applied to the mating faces before refitting. Bolts are torqued up to 18lb ft.

## Ready to go!

**34** Here's the finished article, ready to be fitted to the Freelander. The oil drain and filler plugs are fitted with new copper washers, and the oil cooler pipes are kept plugged until the unit is in place to prevent contamination. The new Sovereign heavy duty crownwheel and pinion will easily handle all the abuse the turbocharged K-series can throw at them, and the Quaife ATB diff will help the rally car claw its way through the loosest of stages. **LRO**