



**In this edition of Tech Talk, we wax lyrical about limited-slip differentials, how they work and why so many successful race teams and tuners choose Quaife's ATB offering...**

# Making a **diff**erence



## QUAIFE AS A COMPANY

Before we examine different types of differentials and how they operate, let's take a look at Quaife's rich and colourful history of producing performance parts.

R.T. Quaife Engineering Ltd was founded in 1965 by Rodney Quaife. The business quickly established a name for itself manufacturing motorcycle gear sets, including five-speeds for Triumph and Norton. The company's output was soon being used to achieve victories at Daytona International Speedway and on the legendary Isle of Man TT, but it wasn't until the 1980s that the underlying design for the Quaife ATB differential was first introduced to the world. Maserati adopted the technology (commonly referred to as the 'Ranger' differential) for its Biturbo and second-gen Ghibli. A Quaife differential was also used in Gerhard Berger's Benetton F1 car, an immense track weapon which won the 1986 Mexico Grand Prix.

Today, Quaife is managed and operated from its headquarters in Sevenoaks by Michael and Sharon, Rodney's son and daughter. The firm boasts two manufacturing facilities, one being at the Sevenoaks site, and another in nearby Gillingham. The company's products continue to dominate the motorsport scene, but it's



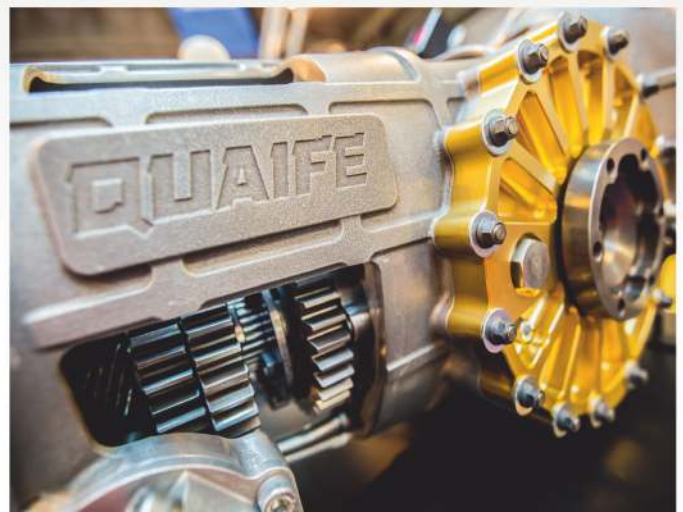
not just differentials Quaife can count on; its gear sets and full transmissions (including synchromesh, dog engagement and sequential systems) are used to great effect worldwide, not least of all in Radical, Ginetta and Caterham cars as OEM equipment. Additionally, Morgan Motor Company takes advantage of the availability of Quaife driveline components (such as its range of steering racks), as do a massive number of professional tuners and DIY modifiers, including those in charge of classic Porsches.

Michael and Sharon's team prides itself on developing and investing in the latest technologies, ensuring the company caters for all types of vehicle, be they a Le Mans-style closed-cockpit racing machine, a Tesla or your favourite petrol-powered fast-road sports car from our friends in Stuttgart!

Many Porsche cars came with the option of a limited-slip differential from the factory (hello to all you M030 owners out there!), but what exactly is a differential, what are the different types of differential and what makes Quaife Engineering's ATB limited-slip differential the pick of the bunch?

We took time out to chat to the British company's talented team in order to find out the answers to each of these questions. After all, Quaife is a firm respected the world over for the development and manufacturing of OEM and race-winning performance gear sets, gearboxes, differentials and driveline componentry, so who better to talk to about transmission technology?!

Read on to discover our findings and to view a list of Quaife's current line of Porsche products (including differentials, steering racks and sequential gearboxes) catering for cars of all ages.





## ESC is inferior and unable to match the effectiveness of a mechanical limited-slip diff

### HOW DOES A DIFFERENTIAL WORK?

When a car travels around a corner, its inside and outside wheels need to travel at different speeds. In essence, a differential allows power to continue to be sent to each driven wheel at the same time as accounting for the discrepancy of speed between each wheel.

When an engine is treated to more power (or when grip reduces), torque from the engine follows the path of least resistance. Typically, this will be the unloaded wheel (or the wheel with the least grip), resulting in useless wheel spin. There are various mechanical solutions available to prevent this from happening. Fluid-filled viscous couplings and torque biasing differentials – like ATB units made by Quaife – are popular manufacturer-adopted bits of kit. The advantage of the helical gear design of ATB differentials is that they never lock and have less negative impact

on turn-in behaviour than viscous or plated diffs. Importantly, the design of a Quaife ATB differential ensures the part won't wear easily.

Car makers looking to cut costs often see equipment like limited-slip differentials as being an expense they can do without, hence the popularity of electronic stability control program systems (usually referred to as ESC or ESP), which are designed to detect the presence of an unloaded wheel getting ready to spin. The idea is to nip the brake and quickly divert torque through the standard open diff. Sometimes branded as 'torque vectoring E-diffs', these systems are seen as cost-effective substitutes for a mechanical limited-slip differential. Ask anyone with experience of both technologies, though, and they'll tell you ESC is inferior and unable to match the effectiveness of a mechanical limited-slip diff.





## WHAT IS AN OPEN DIFFERENTIAL?

Standard (often referred to as 'open') differentials are designed to allow the two wheels on a single axle to spin at different speeds. The majority of vehicles on the road – in other words, cars not fitted with traction-enhancing limited-slip differentials or torque-biasing differentials – feature open diffs. Cheaper for manufacturers of mass-produced vehicles to produce, open diffs are dependable, but aren't ideal for sports cars or drivers who want to modify and maximise the performance of their chosen chariots. For example, if one of your classic

Porsche's driven wheels loses grip and spins, you're experiencing lost power. A torque-biasing limited-slip differential enables this otherwise wasted power to be transferred to the driven wheel at the other side of the car, thereby promoting continued grip.

It might seem quirky to today's audience, but in 1937, a short film produced by Chevrolet explained how an open differential works. The underlying principles are still relevant today, so fire up YouTube and have a search for *Around the Corner*. Alternatively, visit [bit.ly/quaifecorner](http://bit.ly/quaifecorner)





## WHAT IS A QUAIFE ATB LIMITED-SLIP DIFFERENTIAL?

If you're after serious grip and enhanced performance on the road or at the track, you're the kind of driver who should be investing in a Quaife ATB limited-slip differential. ATB – which stands for Automatic Torque Biasing – diffs have been in continuous production since the 1980s. The ATB product range caters for hundreds of applications, spanning makes and models of car from Alfa Romeo to Volvo! Trusted by Ford for three generations of Focus RS and the new Fiesta ST, BMW for the Mini JCW Challenge, General Motors, Chrysler, Lotus and many other manufacturers as essential OEM equipment for high performance model lines, the parts are renowned worldwide for their effectiveness, quality of construction and reliability.

The ATB unit works by biasing torque to the driven wheel with the most grip. It's a gear-loaded differential,

meaning it's extremely strong and is smooth in operation. When one wheel starts to slip, the helical gears inside the differential begin to rotate with speed proportional to the torque of the wheels. Excess torque is then reduced on the wheel which is slipping at the same time as being increased on the wheel with the most grip. The effect of this activity is that unwanted wheel slip is vastly reduced, resulting in low levels of understeer, more controlled oversteer and improved acceleration.

Due to the design of a Quaife ATB differential, there's no friction, meaning there are no parts susceptible to wear. This makes the product a true 'fit and forget' solution for your Porsche. Besides, you can take comfort from the fact there's a lifetime warranty supplied with each Quaife diff, even if you're using the part for track days or professional motorsport!





**Due to the design of a Quaife ATB limited-slip differential, there's no friction, meaning there are no parts susceptible to wear**

## WHAT IS A PLATED DIFFERENTIAL?

Instead of featuring gears, a plate-type limited-slip differential uses multiple plates within its design. For example, a Tran-X unit features two ramp blocks sandwiching two carrier pins which sit in the radius between the leading and trailing ramp angle. As torque is applied to the differential's input, the pins ride up their respective leading ramps, pushing the blocks apart and increasing the transfer of torque across the axle.

The angle of the ramp determines how quickly the transfer of torque occurs within the differential. An angle of thirty-five degrees allows the blocks

to be pushed apart more readily than a fifty-five degree setting, resulting in a more aggressive differential locking action. The preload setting dictates the contact friction between the plates themselves. The higher the preload, the more rapidly friction increases between the plates, behaviour which creates a more aggressive locking action. Combined with the ramp angles, the preload allows subtle adjustments to the torque transfer characteristics, allowing users to alter the dynamic balance of their car as they see fit.

A plate-type differential's locking

characteristics means it's a product popular with those involved in the tough world of off-road rallying. In this motorsport environment, when the driven wheels regularly lose contact with the ground, or when traction is lost when travelling across loose surfaces, the plated differential allows the continuation of drive.

As you might expect, this type of differential is far harsher in operation than a Quaife ATB differential. Furthermore, plated diffs require regular maintenance and feature parts prone to wear through regular use.



## QUAIFE ENGINEERING AND THE WONDERFUL WORLD OF PORSCHE

Quaife ATB differentials have been helping to propel Porsche pilots to victory on the track for many years, but the company's products are also engineered to enhance the performance of your road car. In fact, as you'll see in forthcoming issues of *Ultimate Porsche*, we're about to fit a Quaife ATB limited-slipper to our project 944 Turbo! That's right, Quaife products aren't just for the latest cars in Porsche's product portfolio; the British firm's offerings cover Porsches dating back almost as old as Quaife itself. The company is always looking to design and develop new Porsche products, so don't hesitate to get in touch with Michael's team if you don't spot what you're looking for in the following list.

### Quaife ATB differentials (£855 plus VAT)

Part no.	Application
QDF5Q	911 with 901 gearbox / 914 ('69-'74)
QDF1Q	911 with 915 gearbox / 924 Turbo
QDF2Q	911 with G50 gearbox / 996 / 930 ('89) / 964 / 968 / 993
QDF4Q	944 ('86 onwards, including Turbo)
QDF10Q	968 Club Sport
QDF6Q	986 Boxster 2.5 ('97-'99)
QDF9Q	993 Tiptronic / 964 Tiptronic
QDF7Q	986 Boxster S 3.2 ('00-'04) / 987 3.2 ('05-'06) / 996 six-speed (open diff replacement)
QDF14Q	996 Turbo / GT2, GT3 ('00-'04)
QDF13Q	997
QDF16Q	Cayman 2.7 / 986, 987 Boxster 2.7 with five-speed
QDF12Q	Cayman S 3.4 / 987 Boxster S 3.4 ('07 onwards)
QDF15Q	Cayman Tiptronic / Cayman S Tiptronic / Boxster 986, 987 Tiptronic

### Transmission (£POA from Parr Motorsport)

Part no.	Application
QBE85G	996, 997 six-speed sequential transaxle gearbox

### 2.5-turn lock-to-lock quick steering racks (£175 plus VAT)

Part no.	Application
QSF3Q001	911 (1974-1989) / 914



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