



UNDERSTANDING
CLUTCH
SYSTEMS

 Clutch Industries

WHAT IS A CLUTCH?

INTERNAL COMBUSTION ENGINE.

A common theme in most things automotive is the internal combustion engine. Pistons move up and down and work together to spin the crankshaft.

The spinning of the crank shaft delivers the **torque** to the driving wheels. Torque originally meant “to twist” and is now defined as a force that tends to cause rotation.

There’s no surprise that the engine torque (the rotation or spinning of the crank) is the force that rotates the wheels, but if an engine were connected directly to the wheels, they would turn all the time. Drivers couldn’t sit at idle, wait at lights or change gears comfortably.

Drivers need to be able to connect and disconnect the spinning motion of the crankshaft without turning off the engine, and that’s where the clutch comes in.

WHAT IS A CLUTCH?

The clutch is a coupling that sits between the engine and gearbox. Its purpose is to **connect and disconnect** the engine’s torque to the gearbox and driving wheels.

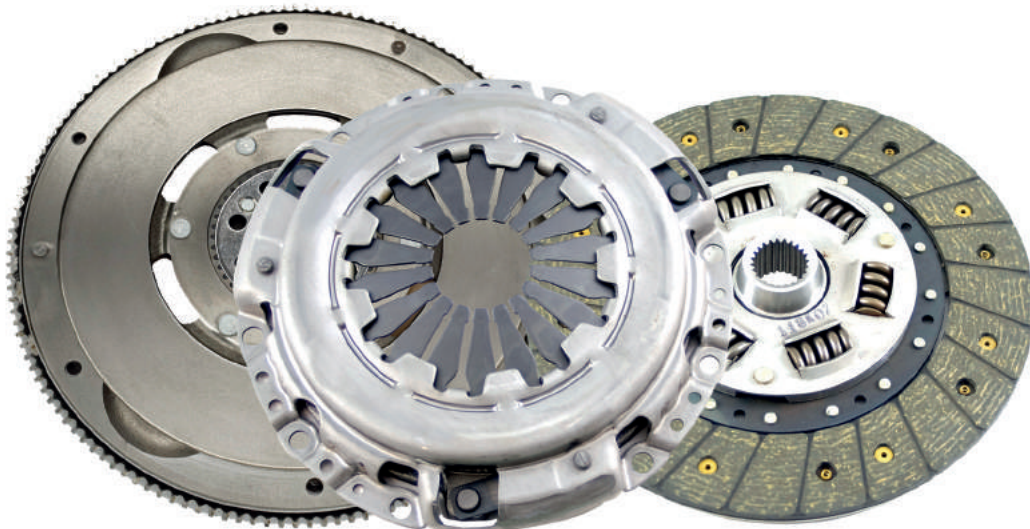
WHY IS IT CALLED A CLUTCH?

To clutch something is to grasp something tightly - **grab hold of it**.

A good way to look at it is that a clutch is a way of grabbing hold of the torque of the engine (and letting go of it as well).

WHAT’S THE PRINCIPLE?

A clutch is just like a vice. You have two sides to the vice that are designed to clamp down onto something, in this case a clutch plate. When the vice is tightened the disc is held, when the vice is loosened, the clutch plate is not held.



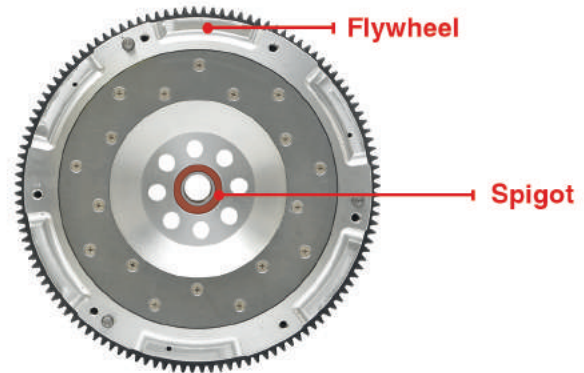
COMPONENTS OF A CLUTCH

1. FLYWHEEL

The flywheel is one side of the vice. It is a big metal disc that bolts directly to the crankshaft. Its role is to:

- Provide a flat clamping surface for the clutch plate to match up to.
- Keep momentum, it's a heavy mass that keeps turning the crank.
- Take heat away from the clutch plate.

Because the flywheel is bolted directly to the crank, the flywheel will always spin at the same rate as the crank shaft of the engine. (Around the outside of the flywheel you will find a ring gear. Although it is part of the flywheel, ring gears have nothing to do with the clutch itself. They work with the starter motor).



2. GEARBOX INPUT SHAFT

A small but very strong shaft. At one end is a locating pin that sits in the centre of the flywheel/crank. A spigot bearing sits in the centre of the flywheel, on the locating pin of the shaft. Because the input shaft is not bolted to the crank, it does not turn with the crank, it just uses it as a locating point.

The opposite end of the shaft is connected to the gearbox. Along the shaft you'll find gear teeth, called the spline, these match the centre hole of the clutch plate.

The gearbox input shaft's purpose is to:

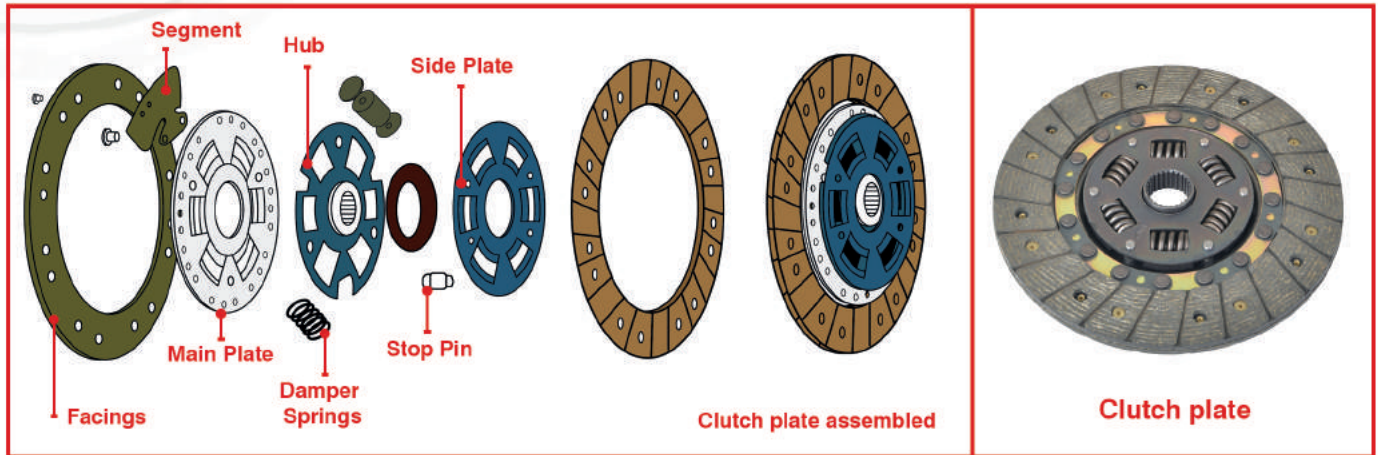
- Line up the gearbox with the centre of the crank shaft, keeping the rest of the drive train straight and true to the crank.
- Give the clutch plate something to locate onto and position itself.



COMPONENTS OF A CLUTCH

3. CLUTCH PLATE

The clutch plate is a disc that slides over the gearbox input shaft. The spline or teeth at the centre of the clutch plate match the teeth of the gearbox input shaft. When the clutch plate slides over the shaft, the matching spline teeth mean the clutch plate is keyed or locked into the gearbox input shaft, and is positioned flat to the flywheel.

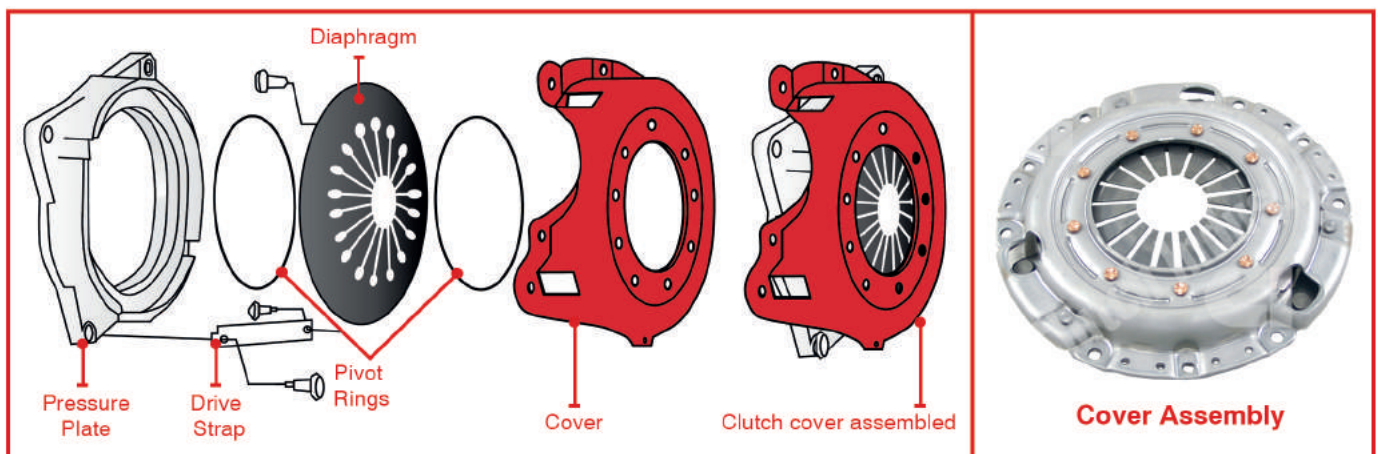


Around the outside of the clutch plate, on both sides, there is a hoop of friction material. The friction material riveted to the disc is designed to grip the flywheel. Because of the interlocking spline, the clutch plate and gearbox input shaft will then turn together.

'When things rub together friction comes into play. In some cases you don't want friction, so a lubricant is used. In other cases you want the friction and use materials to maximise it to achieve grip. Examples of friction material include brake pads, tyres and the material on clutch plates.'

4. COVER ASSEMBLY

The cover assembly bolts to the flywheel and **OVER** the clutch plate. The purpose of the cover assembly is to carry the matching surface (a heavy metal casting) for the flywheel, and a spring loaded system that pushes the casting towards the flywheel. Together the cover assembly and flywheel work just like a vice and work together to clamp down onto the friction material of the clutch plate. When the cover is bolted to the flywheel, its default position is clamped. The vice is tightly clamped onto the clutch plate.



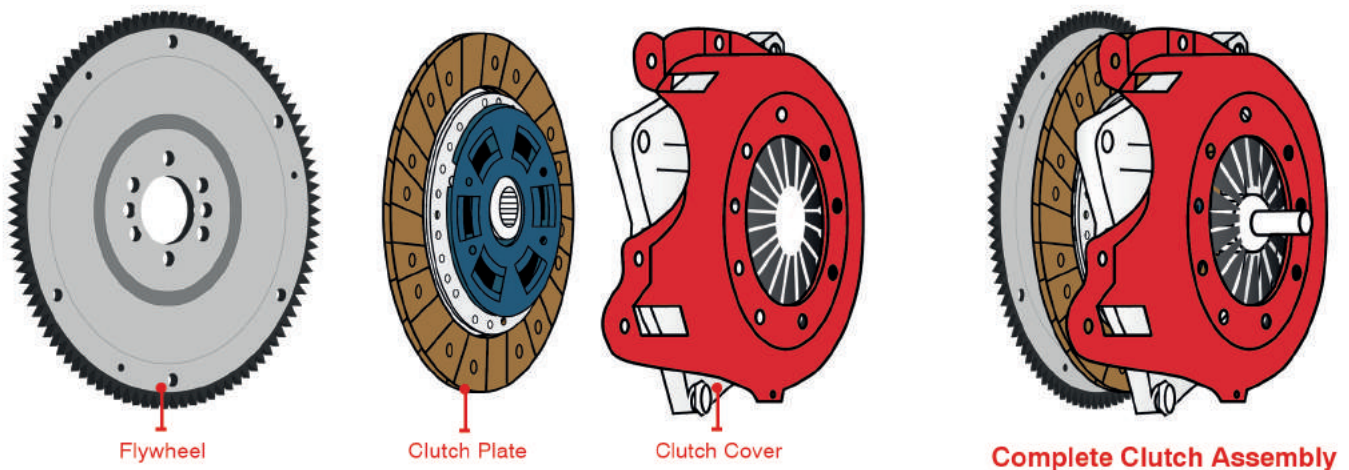
COMPONENTS OF A CLUTCH

5. ACTUATION SYSTEM

To disconnect the clutch, or let go of the torque, you have an actuation system which starts at the pedal and ends at the clutch cover assembly. The Thrust Bearing in a 3 piece clutch kit is one component of the actuation system.

Putting your foot on to the clutch pedal is the same as winding back one side of the vice. When you push onto the pedal, it works a series of connected parts which end with a push onto the spring loaded part of the cover assembly. The spring load is taken off and because the clutch plate is no longer clamped to the flywheel, it stops spinning at the same rate as the crank. It means you have disconnected drive.

Remember the locating pin of the gearbox input shaft is just a locating pin. It will sit in the flywheel, but is not bolted to it so it won't spin at the same rate.



THE IDEA IN PRACTISE

The simplest way is to think of two sides.

One side is the vice that is the flywheel and cover assembly. They are both connected to the crank shaft. They turn together, carrying the engine torque, and work together to clamp onto the clutch plate.

The other side is the assembly that is the clutch plate and gearbox input shaft. Being keyed together, the clutch plate and gearbox input shaft will always turn together.

When the flywheel and cover assembly clamp onto the clutch plate:

- The friction material grabs.
- The clutch plate and gearbox input shaft start spinning at the same speed as the flywheel.
- The torque (turning motion of the engine crank) is now being delivered to the gearbox via the clutch plate and input shaft, therefore the wheels are turning.

When the clutch pedal is pushed, the actuation system works on the spring loaded part of the cover assembly. It winds back the vice and there is no clamp on the clutch plate, it stops turning and torque is disconnected.

UPGRADES

An OE vehicle comes fitted with a standard clutch. The largest category of clutch sold is standard replacement kits but we're not all standard drivers. If an engine is modified from standard to improve performance or if the vehicle is under a higher strain than normal (carrying or towing heavy weight) an upgraded clutch might be needed.

CLAMP LOAD

Increasing the clamp load on the cover assembly is a common way to get more torque capacity from your clutch system. It involves increasing the load exerted by the diaphragm to clamp the clutch disc between the pressure plate and the flywheel. The amount of clamp increase is limited as this can make the clutch pedal feel heavy and put strain on the clutch actuation system (hydraulics or cable ect.).



FRICTION MATERIAL

Changing the friction material on a clutch disc can increase the torque capacity and can improve the heat properties. Common clutch disc materials are;

Organic – Most commonly used on OE applications this material is great for drivability but is not suited for high performance applications due to poor torque capacity when hot.

Aramid – Generally a mixture of organic and aramid this compound has the drivability of standard organic material with much higher torque capacity and better heat resistance. Found in 4Terrain Ultimate this material is perfectly suited to 4WD applications where higher performance is needed without any compromise to drivability.

Cerametallic/Ceramic - Suited to high performance or race applications this material can handle a high level of heat while also giving a massive increase in torque capacity. Unfortunately, the drivability is significantly decreased as the material gives a more aggressive engagement than organic material. This material can be found in the Mantic performance range.

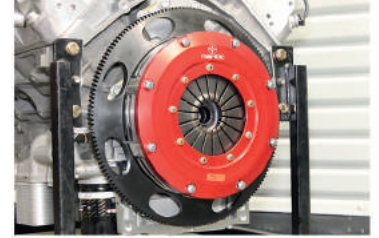


INCREASING SURFACE AREA

Increasing the size or the surface area of a clutch increases the torque capacity of the system, however unlike brakes you're generally not able to simply install a larger clutch. There are two methods that are used by performance clutch manufactures to increase the surface area;

MULTIPLE PLATES

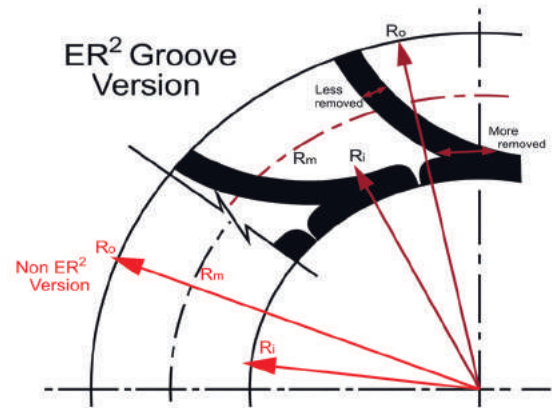
Installing twin or triple plates in most cases can be done without modifying the bellhousing and can double or triple the torque capacity without having a detriment to the drivability. The Mantic Track series has a range of twin and triple plate kits which feature several different plate options to suit various applications from street to track.



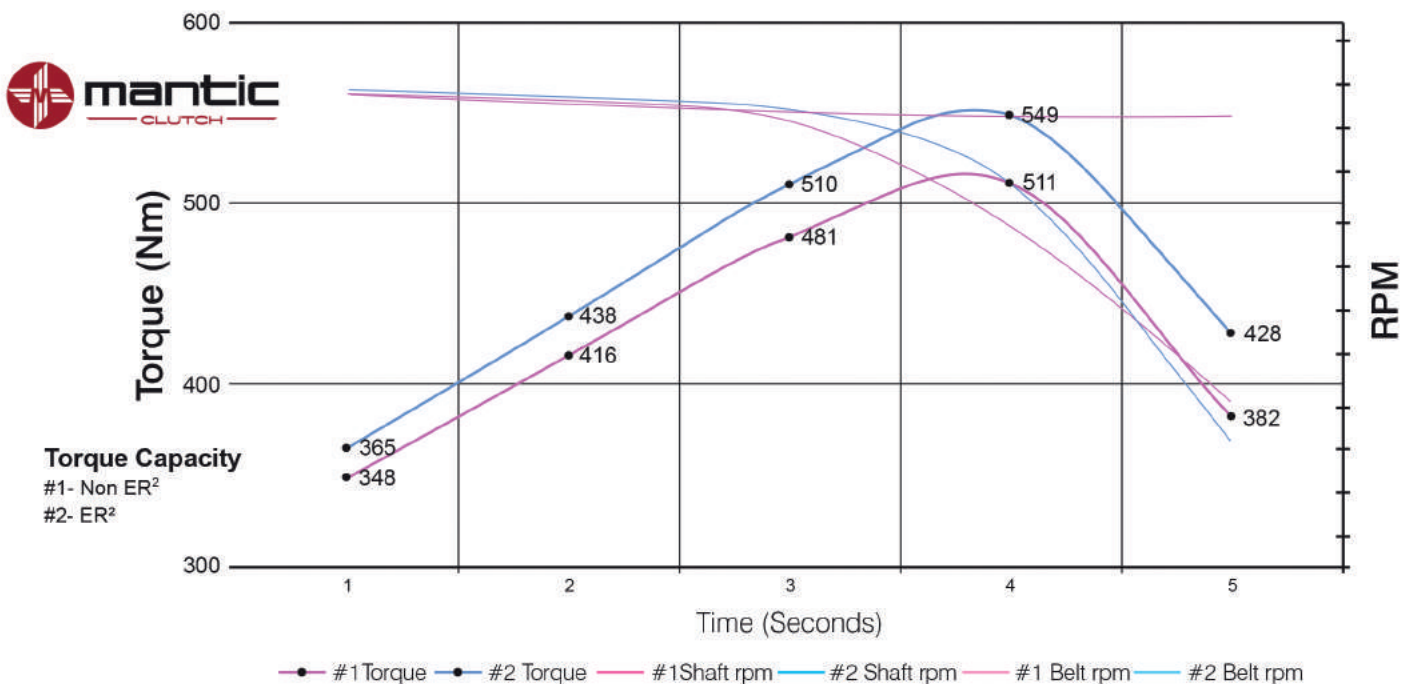
ER² GROOVE

This groove is a patented system that has been specifically designed to increase the Mean Effective Radius of the pressure plate and assist in heat removal. The increase in the Mean Effective Radius of the cover assembly gives a significant increase in torque capacity.

By adding the groove to the pressure plate, the inside radius of the friction face has effectively been increased. The first 5/16 inches (7.9375mm) of the pressure plate has all but been removed and added to this, there is progressively less material removed as the radius increases. The net effect of this is to move the effective inside radius further out.



The Mean Effective Radius of the clutch is directly proportional to the torque capacity of the system. Therefore as the Mean Effective radius increases so does the Torque Capacity of the clutch. This system can be found in both the Mantic and 4Terrain performance clutch range.



PASSENGER PERFORMANCE UPGRADE OPTION

STAGE STREET



Mantic Stage 1 and Stage 2 clutch kit Cover Assemblies feature the Patented* ER² Groove Design, which is a unique groove pattern CNC machined on the friction face of the pressure plate. This groove has been specifically designed to increase the Mean Effective Radius of the pressure plate and assist in heat removal. The increase in the Mean Effective Radius of the cover assembly gives a significant increase in torque capacity.

STAGE 1 / ER² ORGANIC

Features an upgraded cover assembly with organic disc and ER² grooved Spheroidal Graphite (SG) iron pressure plate. Providing up to a 40% torque capacity increase over OE while not compromising drivability.

STAGE 2 / ER² DUAL FRICTION OC

Features an upgraded cover assembly with OC (combined organic / cerametallic) disc and ER² grooved SG iron pressure plate. This system gives up to an 80% increase in torque capacity while still having excellent drivability.

STAGE SPORT

STAGE 3 / SPRUNG CENTRE CUSHIONED CERAMETALLIC

Features an upgraded cover assembly with sprung cushioned cerametallic disc and SG iron pressure plate. Giving up to a 100% torque capacity increase, this system is designed for track as well as street use.

STAGE 4 / SPRUNG CENTRE UNDAMPENED CERAMETALLIC

Features an upgraded cover assembly with sprung undampened cerametallic disc and SG iron pressure plate. Giving up to a 100% torque capacity increase, this system is designed for track use.

STAGE 5 / RIGID CENTRE UNDAMPENED CERAMETALLIC

Features an upgraded cover assembly with rigid centre undampened cerametallic disc and SG iron pressure plate. Giving up to a 100% torque capacity increase, this system is aggressive and is only for track use.



* Torque capacity increase is only a guide based on a peak torque capacity figure which is dependent on your vehicle.

STREET TWIN / TRIPLE DISC KIT

The Mantic Street 9000 series is a 9" (230mm) diameter multiple application clutch system.

Available in twin and triple disc configurations with various disc options to suit street and track use.

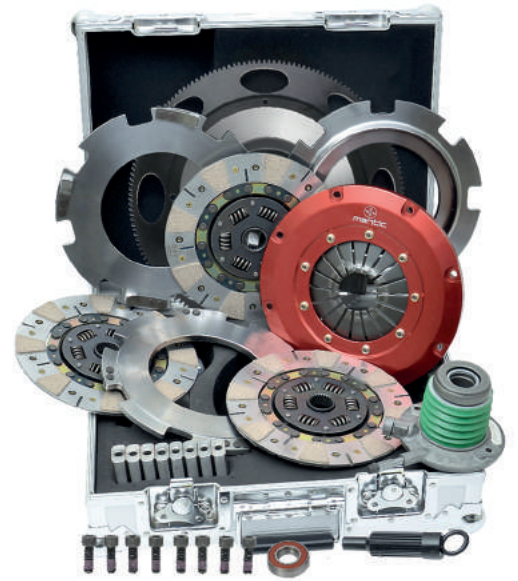
STREET / ORGANIC

The organic plate option provides outstanding levels of torque capacity, with low pedal effort (light pedal) which is designed to be driven everyday. The twin configuration holds up to 1,230Nm of peak torque while the triple holds up to 1,845Nm of peak torque.

STREET / SPRUNG CENTRE CUSHIONED CERAMETALLIC

The sprung centre cushioned segmented cerametallic clutch disc offers a level of performance above organic discs, while still being able to be used for street as well as track applications.

The twin configuration holds up to 2,050Nm of peak torque while the triple holds up to 3,075Nm of peak torque.



SPORT TWIN / TRIPLE DISC KIT

SPORT / RIGID CENTRE CUSHIONED CERAMETALLIC

The rigid centre cushioned cerametallic disc allows for a harder driving style while also providing some dampening. Designed for track applications that still require some compromise for driveability.

The twin configuration holds up to 2,050Nm of peak torque while the triple holds up to 3,075Nm of peak torque.

SPORT / RIGID CENTRE UNDAMPENED CERAMETALLIC

The rigid centre undampened cerametallic disc is the most aggressive level in the Mantic 9000 range. Designed for pure performance, the engagement is sudden, limiting the chance of slippage. It is recommended for track use only.

The twin configuration holds up to 2,050Nm of peak torque while the triple holds up to 3,075Nm of peak torque.



* Torque figure quoted is a peak torque capacity, we recommend applying a 1.5 safety factor when selecting the correct system for your application.

4T Ultimate with Patented* ER² Groove Design has many features which give the range unique advantages over other products in the market.

The cover assembly incorporates a premium corrosion resistant surface finish, which exhibits excellent resistance to oxidation over a prolonged period. In addition, the clutch pressure plate incorporates 4T Ultimate's exclusive ER2 design technology.

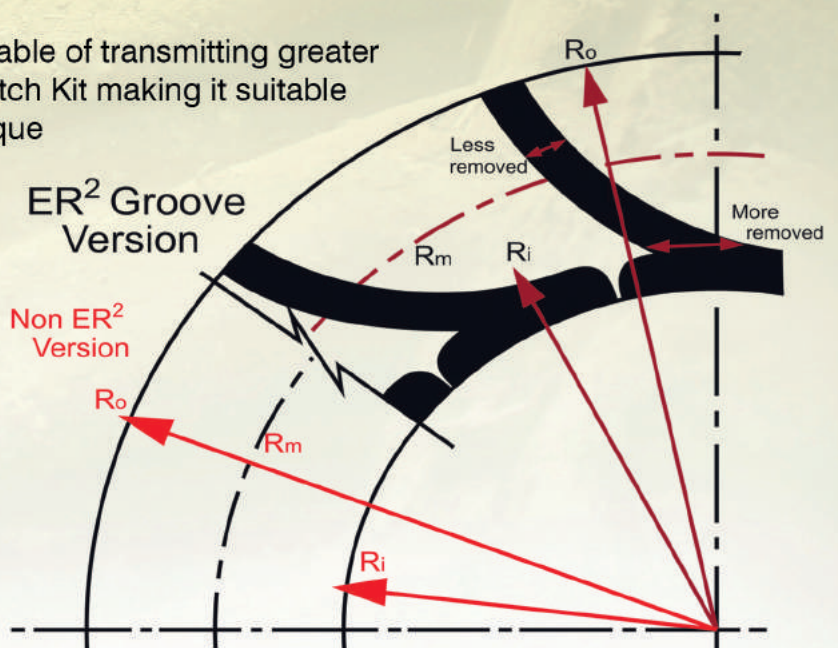
The cover assembly's pressure plate is manufactured from Spheroidal Graphite casting material and has a yield strength some 300% higher than standard castings. The material's microstructure also improves heat dispersion. The cover assembly incorporates greater clamp load than a standard cover assembly. This translates to more torque capacity.

The kit's clutch disc has a unique flywheel side friction material. The Aramid friction material exhibits 50% less wear than a conventional clutch disc's friction material. This material also reduces the effects of clutch fade. Fade is the decline in the clutch system's ability to transmit torque as operating temperatures increase. This material also reduces the effect of fade which reduces the ability of the clutch to transmit torque as the temperatures increase.

The Patented* pressure plate with ER² grooves are precision machined with CAD/CAM technology. The design enhances the performance in 2 ways. Firstly, it increases the torque capacity of the cover assembly and secondly it assists with cooling which in-turn enables the friction material to operate at lower temperatures and therefore at a higher coefficient of friction. Again, this enhances the torque capacity of the clutch.

These features in combination with the previously mentioned microstructure of spheroidal graphite casting and ER2 Technology allows the clutch kit to dissipate heat far more effectively, allowing the clutch to run cooler for longer.

It also means that the clutch system is capable of transmitting greater than 60% more torque than a standard Clutch Kit making it suitable for demanding conditions. This overall Torque Capacity increase has been achieved by higher Clamp Loads, increased Mean Effective Radius of the pressure plate, better cooling and higher coefficient of friction materials on the clutch disc.





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