

Photo courtesy of Robert Baxter/ OpenTrack.co.uk



MAKING THE FASTEST, FASTER...

Andy Jupp of Partridge Green Motorsport (PGM) reports on the recent development of a paddleshift system for the 620R.

Prior to the COVID-19 lockdown, PGM was approached by a customer who wanted us to fit a paddle shift system to his 620R. He mainly uses the car on trackdays, and openly admitted that he was struggling with the 'heel and toe' technique for down-changes. He was looking to develop the gearshift with paddles so he could keep his hands on the wheel, including adding a throttle "blipper". We fully understood the reasoning, but at the time, none of us appreciated the positive side effect this development would have on the rest of the car.

Although it was PGM who took this project on, we collaborated with SBD, Meteor Motorsport and Northampton Motorsport to create a complete package. From a technical point of view, controlling the engine and gear change system within a single ECU is a superior solution compared to having a standalone gear control unit; it allows a much better correlation for the engine torque reduction whilst the gear shift period is occurring, which results in a flat up-shift change, without using the clutch, which is almost seamless with respect to engine power.

Importantly, this system also needs to be neat and tidy with respect to installation, keeping in mind the price tag of a 620R. We set out to position all the components under the bonnet, reducing the length of pipes and

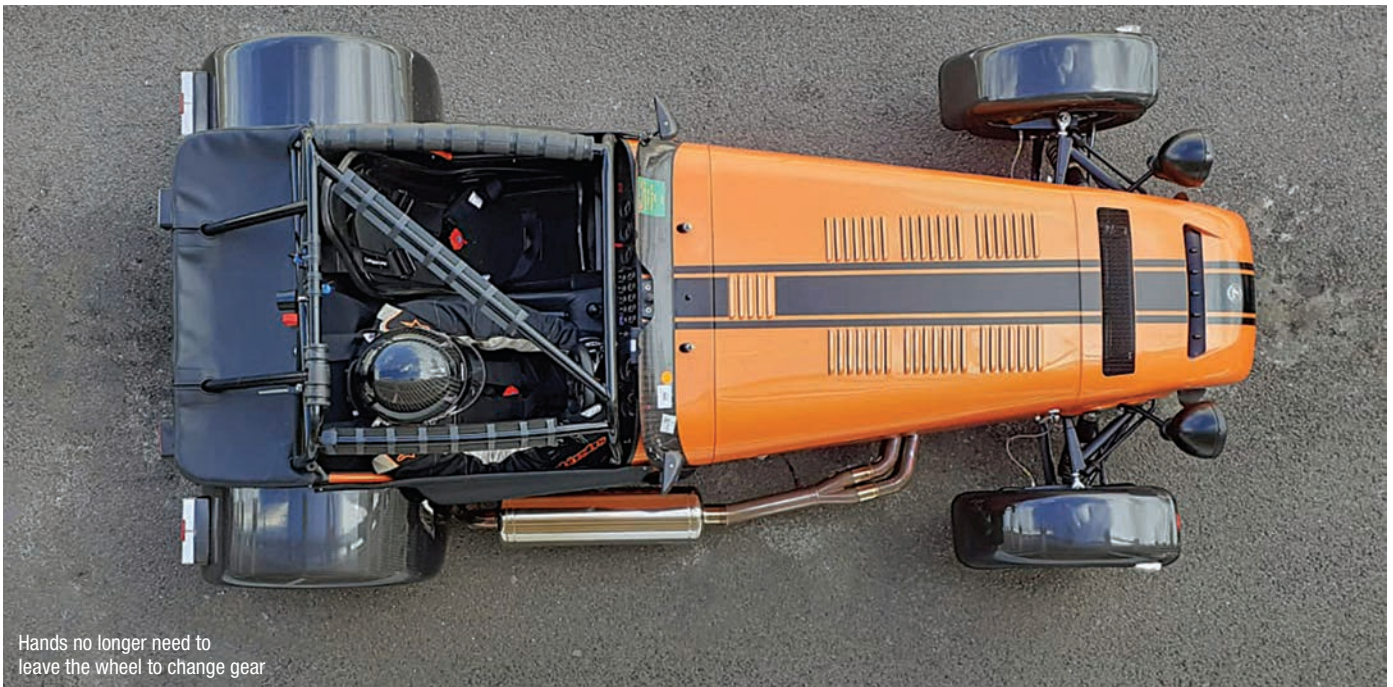
wiring to a minimum. After discussion with the customer, we also opted to retain the original gear lever. It would be possible to remove the lever completely, but leaving it in place provided a backup at any point in the future if needed.

In basic form, the gear system works by using a small compressor to charge up an accumulator. The output of this stored air cylinder is controlled by a micro switch on a steering wheel paddle. This operates a solenoid valve to allow air pressure to an actuator that is bolted to the gearbox gear change rocker.

Central to the 620R system is an MBE 9A9 ECU controller. This is an upgrade to the original MBE ECU that the car is fitted with as standard. The first task consisted of wiring the new ECU into the existing Caterham loom. This was achieved using a conversion harness, enabling the original ECU plug and vehicle harness to be retained, including providing additional sensor and gear control connections in the process. This is where the first development became apparent as the original Caterham fuel pump control seemed to be lacking feedback from a fuel pressure



Micro switches trigger an actuator bolted to the gearbox



Hands no longer need to leave the wheel to change gear

sensor. On further investigation, the fuel system on a 620R regulates fuel pressure by changing the pump output. We fitted a fuel pressure sensor allowing closed loop control of the fuel pump pressure.

Next we fitted a wide band lambda sensor to make use of the closed loop control the new ECU provides for lambda control. This serves dual purposes — aiding engine mapping and ensuring that emissions are still within the MOT limits as this car is road legal.

Next, we moved on to the steering wheel paddle arrangement. This car already had an upgrade to the original quick release steering boss with a Rapfix unit fitted. In consultation with our customer, we opted to add a terminal ring to the boss to provide connections to the steering wheel that disconnect when the quick release is used. Caterham offer an alternative boss with a connector in the centre that would achieve the same connection features. Mounting the paddles to the boss required the next area of development to ensure they were ergonomically comfortable. We created a 3D model of a spacer to sit behind the steering wheel, allowing the paddle and neutral switch to be mounted. We then printed a few versions of this until we were happy with the end product, tested while sitting in the car with race gloves on. With this setup fitted, we additionally printed a quick release boss cover to keep the wiring tidy and protected from ingress of dust and water.

Once the hardware of the system was mounted and wired correctly, we moved on to the software side of the installation. Initially, we set up all the gear change voltages and a few other parameters for controlling the compressor / accumulator. For example, the accumulator has a pressure threshold which will trigger the compressor to start or stop running. However, this is also dependent

upon battery voltage, so when you turn on the ignition power, the compressor will not run if the battery voltage is low. This occurs even if the accumulator pressure is low and ensures that if you have a low battery, the compressor will not add a further load while you are cranking. Once the car is running and the alternator is charging, the compressor will then start up.

The calibration of a starting map and some of the sensors was not correct initially. With the aid of SBD and some remote laptop control, we managed to get the car running to check everything was working correctly in preparation for the rolling road session at Northampton Motorsport.

Northampton Motorsport spent time perfecting the map to ensure that the fuel pump control and lambda were stable throughout the rev / load range. At this point, we discovered the improvement in performance compared to a standard 620R. The peak power gain was about 45bhp and the peak torque gain was about 40lb/ft. However, although the headline figures are impressive, the graph shows a substantial gain throughout the whole rev range, suggesting a very usable

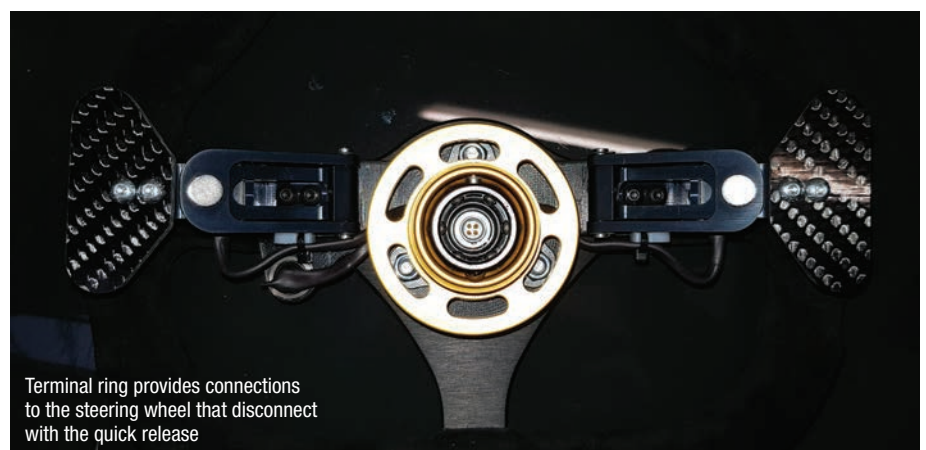
performance advantage. Northampton Motorsport additionally collaborated with SBD to develop the torque reduction system and perfect the gear change strategy. They tested the flat up shifts and the throttle blipper down shifts on the rollers to ensure everything worked correctly.

On return of the car back to PGM, we took it for its first MOT test. It passed an emissions test with ease, giving us further confidence in the mapping undertaken by Northampton Motorsport.

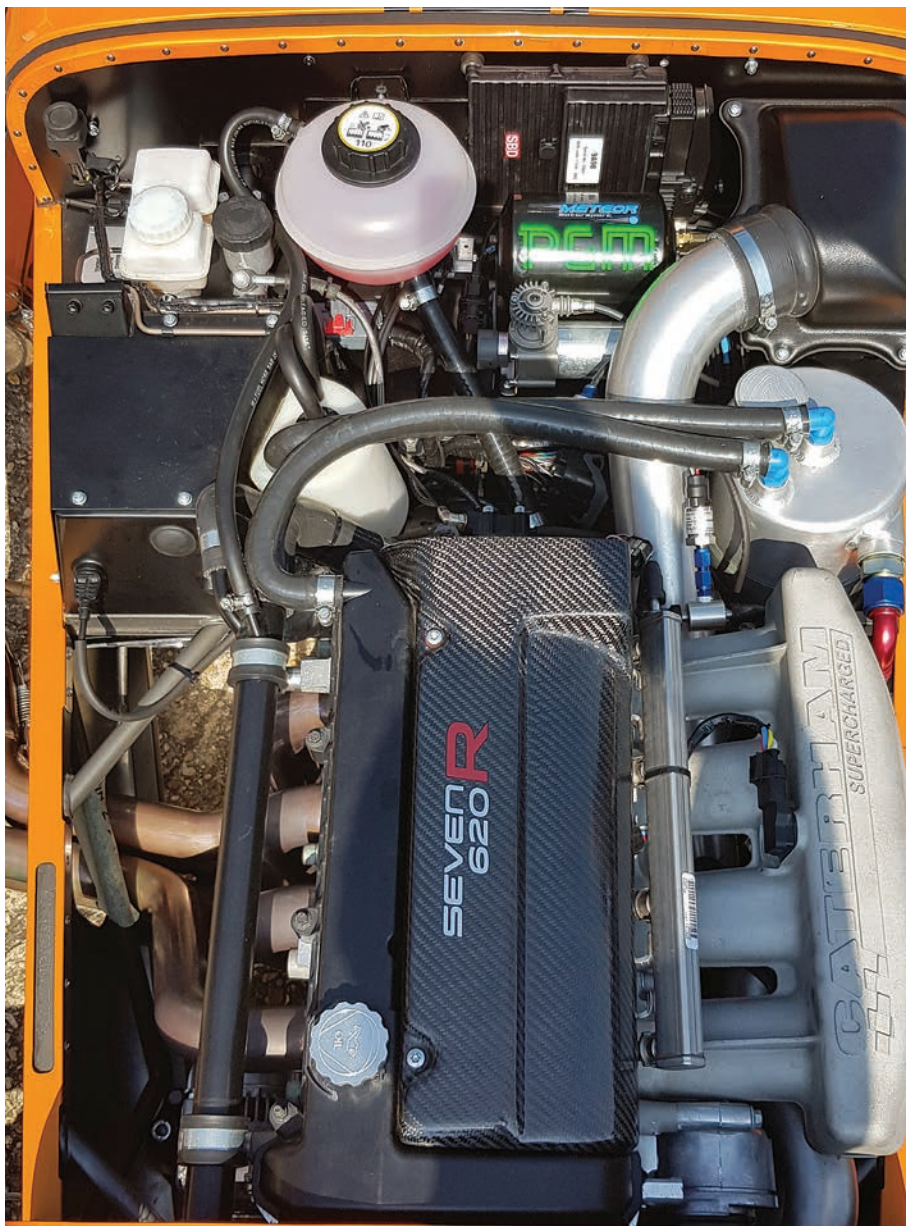
Finally, with the project complete and COVID-19 lockdown being lifted, we returned the car to our customer who had booked to test the new system at Castle Combe...

Jim Harrison reports his thoughts on the upgrade...

Having collected my car from PGM by trailer, I had not driven it with the paddle shift system until the Lotus Seven Club track day at Castle Combe. When I told Andy I was going to Castle Combe for the upgraded car's first outing, I detected a bit of a groan that I had chosen a circuit with no runoff, and I suspected he was secretly expecting to see it back for repairs.



Terminal ring provides connections to the steering wheel that disconnect with the quick release



Neat and tidy under-bonnet installation

Anyway, following the two initial sighting laps and the pace car pulling in, I continued on track for my first session of the day. Once I had got everything up to temperature, my first impression was that the car was much easier to drive and that the throttle response was noticeably sharper. It was so easy just pulling the left paddle for the downshifts while braking for the corners. After using the clutch to get the car moving initially, my left foot is now not required. I found it much easier to concentrate on my modulation of the brake pressure with my right foot, without having to heel and toe. I have to admit that I had never owned a car with paddle shift prior to this, so it was all a bit of a learning experience. The up shifts were also much smoother, and the acceleration feels even more relentless as the power builds towards the rev limit. If you keep your right foot planted, the gear change is smooth and fast with almost no noticeable loss of acceleration. On the cooling-down laps when driving

more slowly, the shift system continued to work smoothly, but at very slow speeds it downshifts with a bit of a clonk, so I reverted to dipping the clutch on these occasions.

As the day progressed and conditions appeared to be drying out, I bolted on my ZZR dry tyres. This of course immediately caused the heavens to open with a heavy shower, so I sat out the following session. By the end of the day I had got more familiar with the car and was able to push it a bit harder. It was simply a pleasure to drive as I could keep my hands on the wheel all the time.

At the end of the day, I noted that I had only used one full tank and a 20 litre can of fuel; previously, the car would have used a further 20 litres for this sort of event. I always thought that it had been running very rich previously.

The following week, I had the car out for the next track day at a very sunny Goodwood. I had only driven this car once previously at Goodwood, but it certainly felt much faster than before and was now pulling over 140mph

down the Lavant Straight. After a small-run in with the noise police, I had to short shift in a few places which was a bit of a shame, but it gave me the chance to enjoy listening to the engine note during the shifts and to marvel at how smooth everything was. This outing also confirmed the fuel consumption improvement I had noticed at Castle Combe. It's a bit ironic really, as I work in the oil industry and I'm trying to get the oil price back up! The next project that PGM are working on is a solution to reduce noise further as track day limits are becoming ever-stricter. They have a new side and rear system that looks promising, but because of lockdown, it has not been verified on track yet.

The second car to receive this conversion belongs to Terry Stubbington. This is his view of the kit on first use.

I previously owned a Caterham CSR 260 which I used almost exclusively on track and which has undergone a few upgrades over the years. However, on a trackday last year, I had the chance to try a friend's 620R and it opened my eyes to a step up in performance. I mulled over purchasing a 620R of my own, and discussed with Andy some of the upgrade options he had already completed for Jim Harrison. The opportunity to buy a second-hand SV 620R came up and given my history with the CSR, I preferred that chassis size so decided to go ahead with the purchase.

Before I even took it on track, I also committed to a list of upgrades including the addition of the paddle shift system. I must say a big thank you to the guys at PGM for a superb professional installation as in my opinion, the finished article looks factory-fitted. Upon collecting my car, I had a trackday booked at Goodwood the following week. The car was an absolute joy to drive on the first outing, with super-smooth up shifts and a down shift with auto blip — what's not to like?

So — what else does PGM have in the pipeline for 620R and 620S owners?

Working in collaboration with Mark Weatherby and Igor Fedor, who have documented the cooling system modifications they have made to their cars on BlatChat, PGM now offer an evolution of this kit to aid the overcooling problems that some owners experience. *Lowflying* will be covering this subject in a future edition. Additionally, PGM also offer an ECU and mapping upgrade that incorporates the testing and development gained from the paddle shift system to improve torque, power and fuel economy as a standalone kit. As touched on previously, another development is larger, re-packable side and rear silencers to adhere to lower trackday limits. As part of the exhaust system redesign, the pipe that occasionally touches the ground just in front of the rear wheel has been altered to provide greater ground clearance. **LF**