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Godzilla Tamed

Electronic handling modification of an R32 Nissan Skyline GT-R

by Julian Edgar
Photos by David Bryant and Julian Edgar

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This article was first published in December 1998. At the time the idea that the handling of the Skyline GTR was not perfect was seen as absurd: according to many, this story was simply indicative of my hopeless driving ability. But in the years since, the use of aftermarket torque split controllers on GTRs has become common - and of course, Nissan themselves improved the logic of the four wheel drive systems on subsequent GTR models by dramatically decreasing the silly amounts of power oversteer available on the R32 GTR...

The car that you see here is a 1991 R32 Nissan Skyline GT-R, capable in standard form of mid 13 second quarter miles and a top speed near 250 km/h. It's owned (well, leased anyway!) by AutoSpeed editor, Julian Edgar. After initial extreme disappointment with the handling, he's made some unique electronic modifications. These have utterly transformed the car...

After owning a turbo 4WD Subaru Liberty (Legacy) RS for four years, I'd decided that I wanted a Skyline GT-R. The famous winner of the Australian Bathurst Touring Car races (until it was banned!), the Skyline is the car that every person into turbo four wheel drive cars simply lusts after. Not only has it great grunt, but also the brakes and handling to match.

And it's the topic of handling that needs some dwelling on. I remembered once doing a GT-R story for an American magazine. The conversation with the car's owner had gone something like this:

"What's she like around corners?" I'd asked.

The owner had shaken his head. "It's just fantastic - it never even moves. Once I went into a corner way too fast and the torque gauge on the dash flicked for a moment - that was it. It's just incredible..."

I've always been a bloke who prefers a good handling car to one that is fast but can't go around corners. So to have both blistering straight line speed **and** what many regard as one of the all-time best handlers in the one package.....wow!

Buying

Skyline GT-Rs in Australia fall into two categories - the 100-odd R32 model cars that were imported by Nissan Australia in 1991, and the R32 and R33 models privately imported direct from Japan. The latter R32's are a lot cheaper, but at the time I was looking, had some major problems. Problems like having been burned, crashed or pranged in Japan to the point where the Japanese owner would rather get rid of it than persevere with repairs....

This put me off the imports and so I turned my attention to the Australian-delivered cars. I fully expected to have to travel widely in Australia to find the car, but in the end I located it in my home city of just a million people, Adelaide. Even better, the car was effectively brand new, having only 3500km on the clock. I twisted the arm of the bank leasing officer, dropped my house payments to the minimum, and leased the car. Some car purchases require no financial sacrifices at all...this sure as hell wasn't one of them!

The Handling

Obviously how you regard the handling of a car depends very much on what you are used to. And if I'd been pedalling around a pedestrian car, I'm sure I would have thought that the GT-R handled very well. But I hadn't been. My Liberty RS had been shod with super-sticky track-use A008-RS Yokohamas, and the car's standard all wheel drive made wheelspin impossible - even with a modified 280-odd horsepower. The Liberty had a slight understeering characteristic, but the ability to put power down (even before the apex) and then just haul-arse out of the corner was mind-boggling.

Even while I had been test driving the GT-R I had been surprised by the amount of power oversteer that was present, but I had put that down to the odd wheels and tyres that the previous owner had fitted. I assumed that decent tyres would fix the car (I mean, this **was** a GT-R!) and asked that different tyres and the original rims be re-fitted before I took delivery. However, even with the new tyres (Kuhmo Ecstas) and standard 16x8 rims, the GTR power oversteered - no matter what I did when cornering.

If you went in hard, the car would understeer a smidgin before the rear end came out in a big slide when you applied power after the apex. The understeer felt about right - it happened at much higher limits than the Subaru - but all you could do about the oversteer was to accelerate less quickly! If you wanted to stay on your side of the road, you soon ran out of opposite lock: you could literally have the car sideways in the lane. It looked great (bystanders used to actually point and clap!) but you were going nowhere pretty fast. And if you made a mistake, it was diabolical.

It seemed to me that the four wheel drive system was simply too slow to come into action. You see, unlike most four wheel drive hi-po cars, the GT-R is rear wheel drive most of the time. It is only when rear wheelspin occurs, you use a very large throttle opening, or (so I then thought) the G-sensor detects enough lateral acceleration, that the front wheels are powered. So, I figured, maybe you needed to keep the power on harder and later to make the front wheels start to work? I drove the car harder and harder, holding the oversteer slides with armfuls of opposite lock and getting used to viewing the road literally through the side glass. About this time most passengers started developing a strong urge to get out..... So perhaps it was still the tyres? I couldn't afford to buy another set of expensive tyres, but managed to source some slightly worn Yokohama AVS donuts. The car handled just the same.

I talked to many experts and other GT-R owners after that, concerned that there was something very seriously wrong with my car. Much to my amazement, most of the other GT-R owners had never driven their cars hard enough to slide them anyway! They were strictly pose-and-straight-line-go merchants. Other owners were totally shocked at what I told them. Mostly, it appeared that they were shocked

because someone dared to criticise their favourite toy..... The experts just told me that I obviously couldn't drive, and to fit bigger rear tyres.

I took one GT-R driver for a ride (he refused to drive the car himself because he said that it would be impossible to safely slide it in urban conditions) and the car oversteered around every corner as usual. You know, boot it in second gear while heading through a "Turn Left at Any Time With Care", swing on the opposite lock as the tail came out and then hold it down the road. Flamboyant, slow and dangerous. "It's handling exactly as I would expect a GT-R to handle" the other GT-R owner said from the passenger seat. "You just need to feed the power in gradually as you are exiting corners. There is a lot of power there, you know." After the modified Subaru this was simply a bullshit statement - my old modified Subaru went just as hard as the standard GT-R **and** you could tromp it out of every corner without understeer **or** oversteer!

You can imagine my utter disappointment. The twin turbo engine was superb, the seats, steering and brakes wonderful - but the car handled like a solid rear axle RWD Falcon. I was so disappointed that I seriously considering selling it. Remember, this was the car that truth be known I really couldn't afford anyway. Perhaps I **would** have sold it, but the next development in the story put the car off the road for a while. What happened? I bumped it into a tree - purely driver error, nothing to do with the handling. And only the second time I had ever left the road in many years of very hard driving. During the time that the car was being repaired I made a decision - I was going to modify the four wheel drive control system to bring on four wheel drive much earlier and stronger. After that - we'll I'd see.

Where to Start?

The Japanese manufacturers Blitz, Field and HKS produce torque split controllers for the GT-R. I managed to source a Japanese magazine review of one of the controllers and get the article translated. The translation showed that the device plugged into the centrally-mounted G-sensor and that it certainly altered the handling characteristics! I figured that it must change the output of the G-sensor, perhaps increasing it so that the four wheel drive ECU thought that the car was cornering harder than it really was. Wouldn't this direct more torque to the front wheels?

Armed with a multimeter and an assistant, I measured the output of the G-sensor in all sorts of driving conditions. I soon found that there isn't just one G-sensor - there are three! Two measure longitudinal acceleration (ie acceleration and braking) and the other measures lateral acceleration (ie cornering). All three sensors have a 0-5 volt output signal. When there is no acceleration, the sensors all have about 2.5 volts output. The harder the car is accelerating, the higher the voltage output from the longitudinal G-sensors. When decelerating, the sensor voltage drops to below 2.5. With the lateral G-sensor, the voltage decreases below 2.5 on right turns and increases above 2.5 volts on left turns.

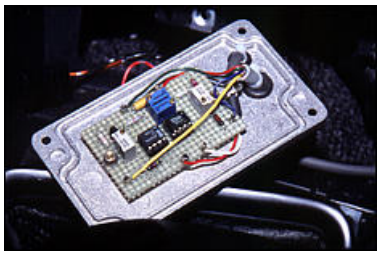
My electronics skills are near to zero so I called on some experts to design an amplifier. This device would boost the output swings of the lateral accelerometer, while at the same time leaving the 2.5 volts 'stationary' output untouched. The amplifier was designed and fitted to the lateral sensor output, but sadly there was absolutely no difference in the car's behaviour. The standard dash-mounted torque split gauge also behaved as standard. Another amplifier design was developed (this time designed and built by my Father), and it was duly fitted. Weeks of experimentation followed. The amp was working - when it was connected to the longitudinal sensors I could boost straight-line acceleration torque going to the front wheels, but with only limited benefits when cornering. But when it was connected to the lateral accelerometer, little changed. Did the lateral accelerometer even work? I wondered.

Stunning

The first breakthrough came when I took the unlikely step of rotating the G-sensor package through 90°. This meant that the lateral G-sensor became the longitudinal, and the longitudinal became the lateral. Sounds terrible, doesn't it! This was done because I realised that the longitudinal sensors had a very powerful influence on the torque split - something that the lateral sensor didn't appear to have.

Turning the G-sensor package through 90° made a stunning difference to the handling. Instead of being a car where every slow corner exit required a gentle foot and/or opposite lock, now full throttle could be used with near-impunity. For the first time it simply felt like a **proper** four wheel drive car..... But there proved to be some negatives. Firstly, in tight corners taken with a high entrance speed, the car could now understeer excessively. Also, the confused torque split computer allowed some wheelspin high in the rev range in first gear. Still, the handling was so much better than standard that I stuck with this mod for some time. Then it rained. The predictability and stability that the car had in the dry was immediately gone. Not that it was as bad as I'd found it in standard form, but it just didn't feel quite right and straightline wheelspin was even more pronounced.

By this stage two more important things had happened: I'd had a chat to a bloke who had been involved in the Bathurst race GT-R's, and my tame electronic guru (thanks Dad!) had developed the third version of the G-sensor adjustable amplifier. This was being used to slightly reduce the output of what (with the G-sensor rotated) was now the lateral sensor.



The ex-Bathurst race team man said something that immediately caught my attention. "The computer **reduces** the front torque split the harder you corner. So if you remove the influence of the lateral G-sensor, the car will go into four wheel drive earlier". Gulp! I'd always figured that the computer would **increase** the front torque split as you cornered harder. That's why I'd initially tried to amplify the signal - I should have been trying to reduce it all along! "One way to do this is to feed a constant 2.5 volt signal to the computer input for the lateral G-sensor" he continued. "Course, it understeers like a pig then" he added.

Even Better

I raced out to the car and effectively returned it to standard, but for feeding a constant 2.5 volt input lateral signal to the computer. He was right - with this mod the car did understeer excessively. But that was in the dry. In **wet** conditions this modification made the car just ballistic - unbelievably good, with so much traction and cornering prowess that it was uncanny. The difference was so immense that in the wet conditions I found myself ABS'ing up to roundabouts, so good was the car's grip in every other situation.

Okay - if holding the lateral G-sensor input fixed at 2.5 volts gave too much front wheel drive in the dry but was perfect in the wet, why not use the amplifier to vary the lateral G-sensor signal from 1:1 (ie signal unchanged from the standard voltage swings) right through to 0:1 (ie signal fixed at 2.5 volts input)? In other words, be able to change the influence of the lateral G-sensor all the way from factory standard to none! That way I'd be able to dial up any cornering torque split from huge oversteer right through to heaps of FWD for wet conditions.

And that's just what the final configuration is like. A knob on the dash allows variable selection across the whole range. The knob is calibrated from 0-10, with 0 being standard and 10 being for full wet weather. Generally I'm around '7' in dry conditions, with '6' being used in really tight low speed corners when I want the tail to come out a bit to turn the car in. When the road gets wet '8' or '9' is selected, and when it's streaming with water I'm a '10' man!

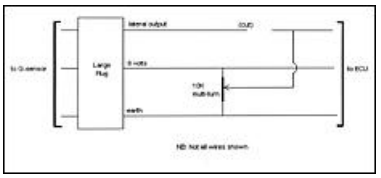
Set up in this way the handling is absolutely fantastic. It's hard to believe, but the electronic mods have made more difference to the handling of the GT-R than any other suspension modifications I have ever made to a car. And that includes the changing on previous cars of wheels, tyres, sway bars, springs, dampers, bushes - the lot. The difference simply cannot be overstated. And I might add that now the cat's out of the bag, a number of GT-R owners who had previously told me how wonderfully their cars handled have modified their torque split control system...

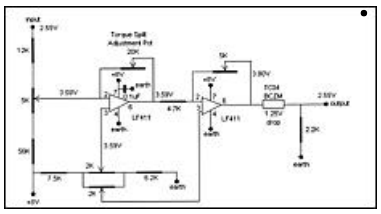
Tech Summary:

Skyline GT-R R32 Torque Controller Modifications

- Some R32 GT-R Skylines have pronounced power oversteer. The degree of oversteer varies from car to car. If the driver has driven only rear wheel drive cars previously they are less likely to recognise a problem. The oversteer is at its greatest in wet conditions.
- Modification to the electronic torque split control system can make a **massive** difference to the degree of power oversteer or understeer.
- There are several ways in which the system can be modified. Quite different results can be achieved by the different modifications.
- Simplest is to rotate the G-sensor module through 90°. The G-sensor is the gold coloured box located under the centre console, in the very middle of the car. Rotate it by 90° and fix it in its new position. **Advantages:** results in a far higher degree of front wheel drive torque split in cornering conditions; is the easiest of all modifications. **Disadvantages:** results in some wheelspin in straight-line acceleration at high revs; power understeer can occur; in wet conditions the car is still a little unpredictable. **Summary:** Gives an easier car to drive but isn't the ultimate mod.
- With the G-sensor orientated as factory, disable the output of the lateral (cornering) G-sensor. This G-sensor input actually reduces the front wheel torque split as cornering loads increase. Cutting the wire results in a fault condition and the disabling of the four wheel drive and ABS systems. Instead, 2.5 volts needs to be constantly fed to this ECU input. This can be achieved by using a voltage divider (pot) as shown here. The pot should be carefully adjusted until 2.5 volts

output occurs when it is connected up. **Advantages:** very large amount of front torque split in cornering; simple mod; superb in wet conditions; excellent straight-line traction. **Disadvantages:** excessive power understeer in dry conditions. **Summary:** great "wet weather over-ride" if switched in and out appropriately.





With the G-sensor orientated as factory, use an amplifier circuit that allows variation of the magnitude of output swing of the lateral G-sensor. This involves feeding the output of the lateral G-sensor into the amp and then the output of the amp into the ECU input. A dash-mounted potentiometer allows adjustment of the gain. As shown, the circuit allows a gain of 1 times (ie factory output signal retained) right through to 0 times (ie output stays at 2.5 volts irrespective of input voltage swings). **Advantages:** best of all worlds - with knob adjustment, excellent dry road handling, excellent wet weather handling, excellent straight-line traction. **Disadvantages:** requires extensive knowledge of electronics to build and calibrate amp. Figure 2 shows a suggested amp circuit. Note that the designer of this amplifier has stated "This circuit cannot be employed as the basis of replication with randomly chosen LF411 ICs because the voltages shown are optimum for the particular op amps used." Also note that the designer is not interested in producing any more amplifiers. **Summary:** just superb!

G-sensor Pin-Outs With G-sensor in Standard Orientation

Note: initial colour code refers to wiring on the sensor side of plugs; after semi-colon refers to colour code on the ECU side of plugs.

Large Plug

Yellow; blue/green longitudinal sensor output (2.5 volts at rest)

Blue; blue/yellow lateral sensor output (2.5 volts at rest)

Red; white/blue regulated supply (8 volts)

Black; orange/blue earth

Brown; black braided earth

Small Plug

White; red longitudinal sensor output (2.5 volts at rest)

Red; white regulated supply (8 volts)

Black; black earth

Brown; black braided earth

All three G-sensors have a 2.5 volt output at rest. Under acceleration conditions, the voltage swings at least as high as 4 volts or at least as low as 1 volt (depending on the direction of acceleration).

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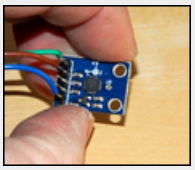

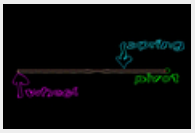

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