STUBBORN STABILITY CONTROL

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STUBBORN STABILITY CONTROL

VEHICLE: TOYOTA PRIUS 2ZR-FXE HYBRID 2012

This diagnostic article takes you through the process our technical support team use with problematic vehicles. We look at the issues involved and share how we resolved the problem. This an inside look, from the profound to everyday issues automotive workshops encounter.

Problem presented from the workshop to our Technical Support Team:
"Hi AECS, we have a Prius here from another workshop. It has a TRC fault. The complaint is that when cornering fairly hard the brakes apply (ABS). When at speed this can be a bit scary.

The vehicle has had the steering rack removed and a repair done on the rack then refitted. Apparently, the problem has only appeared after the rack repair. Wheel alignment has been checked and rechecked.

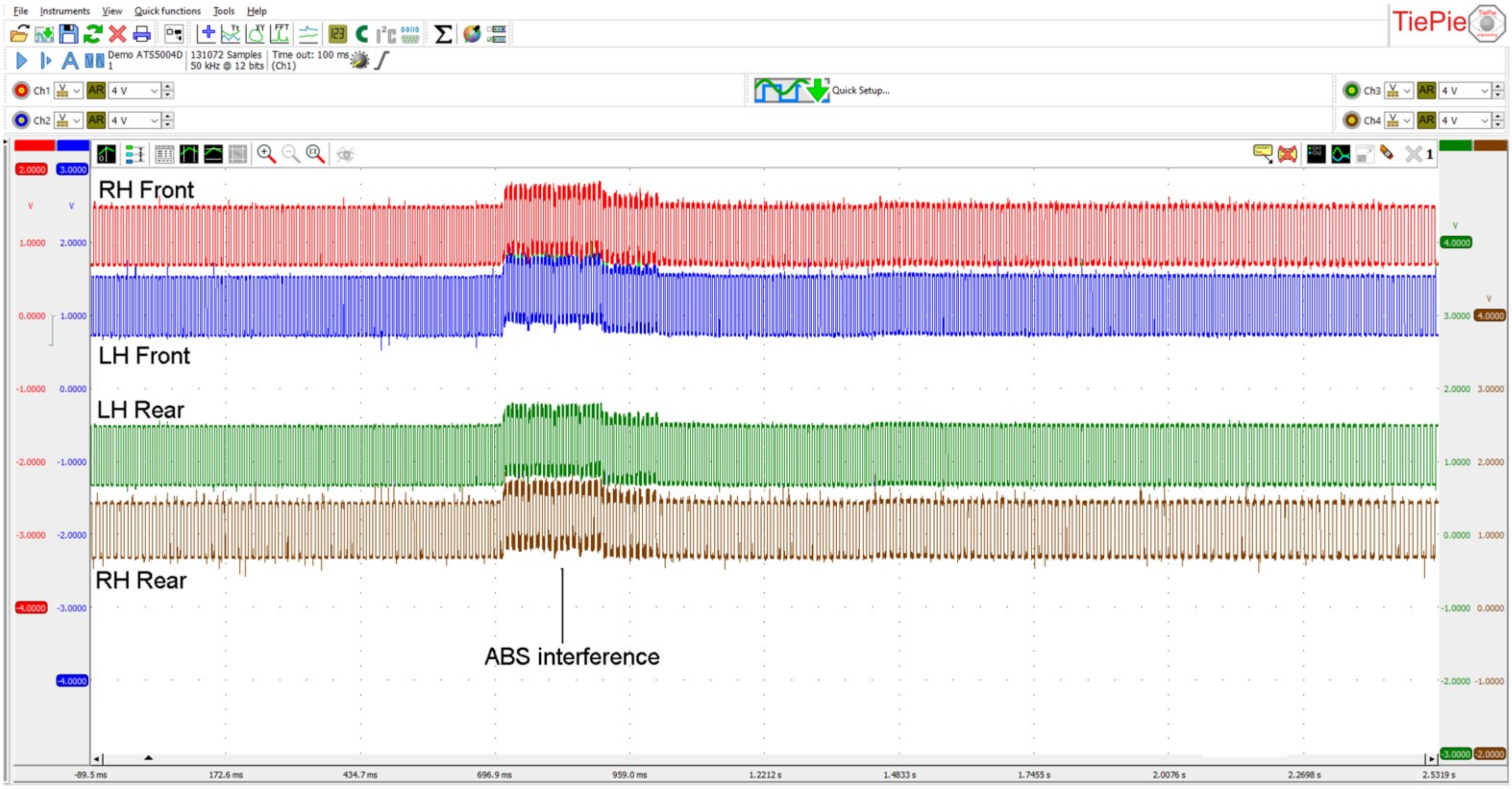
I have checked the front to rear alignment (by eye) then checked steering angle sensor alignment on the scan tool. The other workshop did an SAS (steering angle sensor) re-learn and I also performed one again with our Launch scanner to confirm. This also zero calibrates the two G force and Yaw rate sensors.

We have another Prius here in the workshop that drives normally and have swapped the wheels. Made no difference. I have recorded all wheel speed sensors (these are proximity sensors), the square wave pattern looks ok to me.

I have spoken with Herbert and will post some scan tool recordings to view. We suspected the previous workshop had swapped front wheel speed sensors from the good car judging by the way the wire retaining clips have been forcibly removed and not refitted. Can you please give us some direction (pardon the pun)?

Measure

Let us first have a look at the recording that the diagnostician recorded with his old, trusty ATS 5004D oscilloscope and posted on the AECS tech support forum.



ATS scope recording made while cornering when the stability control function of the ABS changed the car's direction unintended.

The first thing that springs to mind in this recording is that there is an earth problem in the ABS unit. All signals' voltage lifts up when the ABS pump motor and valves are powered up. However, the sensors used are current proxy switches. The signals produced by these sensors are not measured by voltage, the current through the sensor is measured by the ABS processor, the change in voltage does therefore has virtually no effect on the signal. In the AECS Modern Anti-Theft Systems (EMS1-5) training course we deal with these sensors in great detail, knowledge equals reduced costly & unnecessary repairs.

The best way to analyse these sensors is to measure the current however, that requires in this case 4 current clamps and current amplifiers under the car, this is not very practical.

In this instance, the signal voltages are stable and high enough to use the voltage signal for analyses. On some cars is the alternator ripple is larger than the voltage changes on the signal wire.

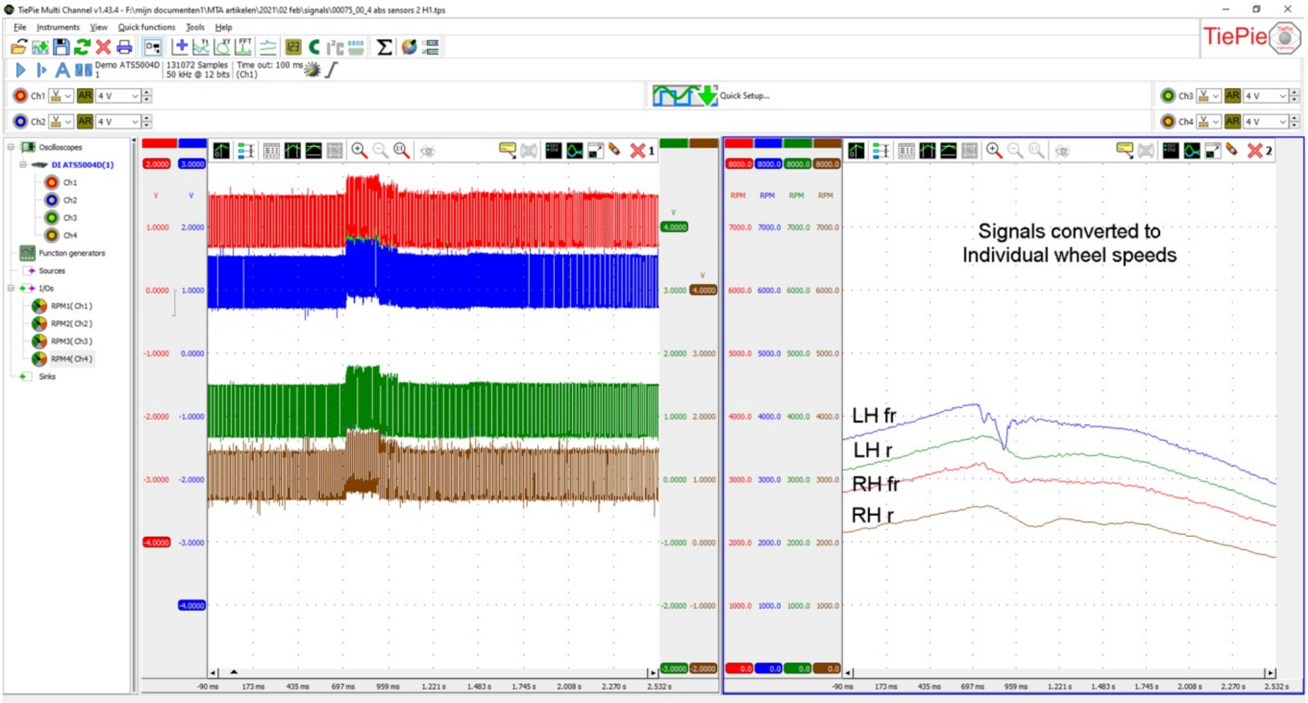
So lets play!

The ATS scope has software that will allow you to perform unique tricks (maths) with the signals, all to make life easy for the diagnostician! Diagnostics does not have to be complex, just looking at 'wiggly lines' is what every scope can offer you, it's knowing how this translates into what the vehicle is actually doing.

Let's play with the signal and make it real, are you ready for a brief journey?

- Step1

First, we must transform the pulses into a speed signal (analogue). So that for example when the wheel speed increases the line rises. This conversion can be done after the recording has been made or while you are recording, this 10 year old function is unique to the ATS Scope.

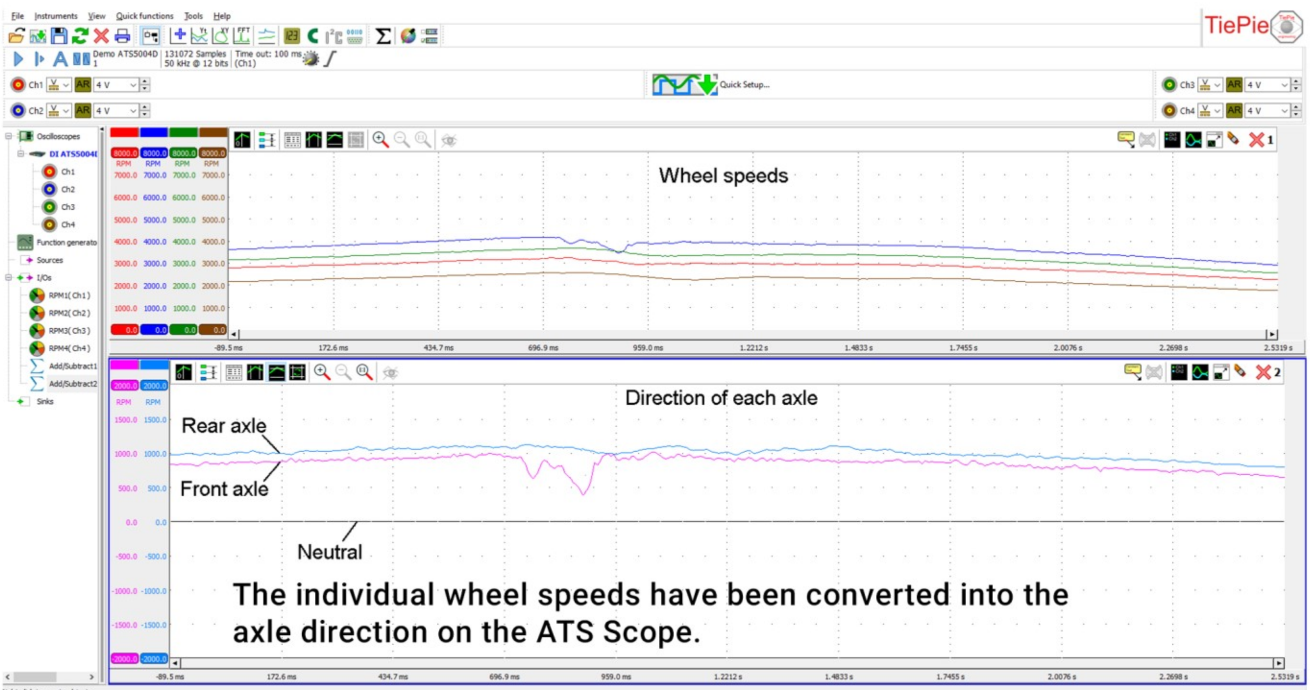


The signals of the 4 wheel speed sensors have been converted into 4 individual wheel speed traces.

This makes more sense already! In the above speed recording, it is clearly visible that the LH front wheel is being braked during cornering. It is also visible that the car is cornering to the right as the wheel speeds on the left are greater than the RH wheel speeds. Let's play with this some more.

- Step2

In this step we convert the individual wheel speeds into axle direction:



The individual wheel speeds have been converted into the axle direction on the ATS Scope.

Okay now, this is what should make sense to any (automotive) technician's mind, 'in which direction are the individual axles going'. The rear axle is logically always turning a tighter corner, so its direction (the blue line) is further away from being straight ahead (the black Neutral line).
The front axle is turning less tight (closer to neutral), and guess what the stability function of the ABS tries to achieve??

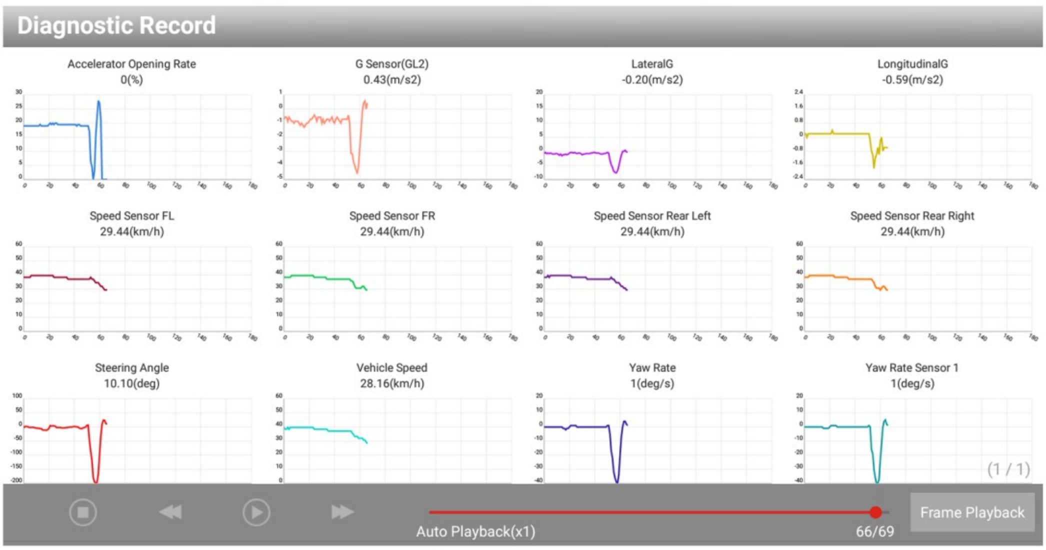
In my mind, it is clear that the stability control judges that the front axle is turning too tight into the right-hand corner based on the front wheel speeds, and it doesn't like it, so it pulls the brakes on the left front wheel. How would you make such a reaction visible with any other tool?

Why?
What condition do you need to have before the stability control intervenes like it does in the above recording? An oversteer situation will most certainly create the situation, think about a vehicle with a lot of weight in the back, and that weight wanting to push the rear end out of the right-hand corner. Braking the left-hand front wheel makes the car pivot around that front-wheel getting the car back under control again.

Well, incorrect loading was certainly not the case in this Prius.

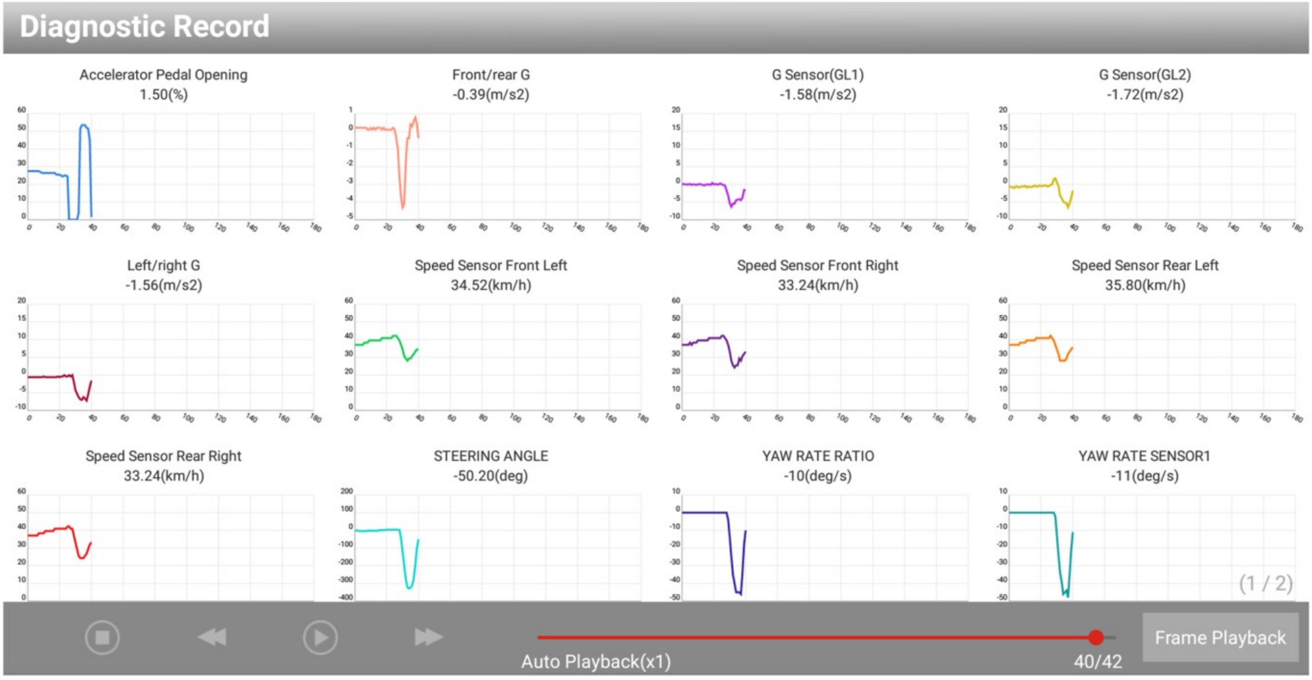
Think further, how about for example:
- Steering angle sensor, damaged, incorrectly calibrated.
- Yaw rate sensor, loose on its mounting, so that the wiring harness swings the yaw rate sensor further than it should, in the corner.
- G force sensor, the sensor fitted on an angle, so that the sideways G force after (zero) calibration, does not read high enough as it is a progressive sensor.
- Tires, softer tyres, deforming more on the outside of the corner than they should.
- Alignment, rear axle response which tilts the car further than what it should, creating an excessive G force reading or yaw rate response.
- Have the ABS module brake pipes been fitted correctly, they may have been removed during the rack repair?

A lot to check, let's start somewhere…easy things first:
The ABS pipes are correctly fitted. With the scan tool, the diagnostician checked if there were any odd signals on the G force and yaw rate sensors.



Launch Scan Tool recording of the badly behaving car.

At frame 58 the steering wheel is turned to a -196º angle, at that speed a yaw rate of 40 deg/sec seems normal to the naked eye. Also, the lateral G force of -6.86 m/s2 (69% of G) seems normal, close to letting the tyres slip in that corner but again, it's possible.



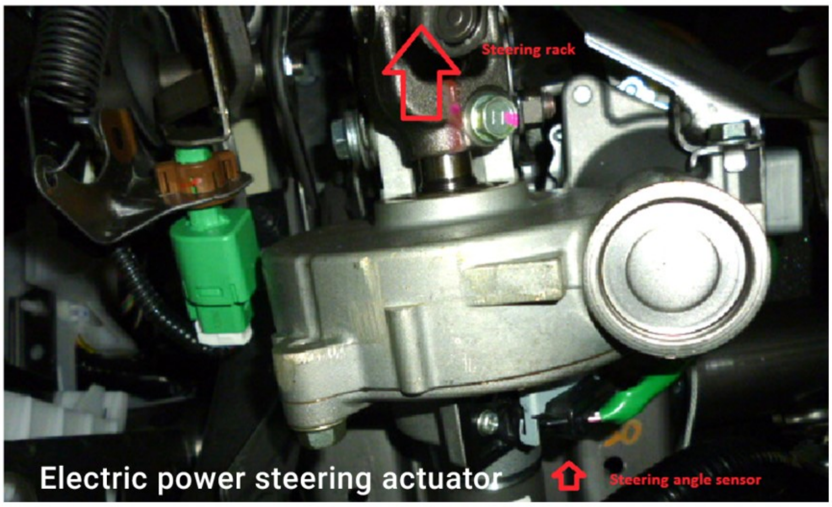
Launch Scantool recording of the good car.

At frame 35 the steering angle is -324.5º at that time the yaw rate is 45 deg/sec. The lateral G force is -5.15 m/s2 (52% of G) again close to letting the tyres slip in that corner.

Could the different readings be perhaps as a result of the different vehicle speeds? The yaw rate and lateral G force are certainly vehicle speed-related. On the bad car the speed of the Front left wheel is 37.1km/h on the good car 40.9km/h just before the steering wheel has been turned. Hmm... we are not sure now, lets go back to the beginning before we go much deeper.

Rack repair

What was actually done to the rack, as that is when all problems started.
I asked the diagnostician if it perhaps was possible that by fitting the rack the steering angle sensor was damaged as a result of the very different steering angle in both Launch scanner recordings. Together with his picture, he told me that that would have been very hard to do.



The diagnostician also came back to me with that the job done on the rack was a pretty standard job as the old rack was full of water. We asked the diagnostician to exactly measure the number of turns from neutral to full lock.

Full lock
On the bad car, it took only 1.2 turns from centre to full lock, to a max steering angle reading of 490 degrees on the scan tool. On the good car, it took 1.8 turns to a max reading of 605 degrees !! ….
Even before he called us back with the values, he swapped the rack from the good car into the bad car, which fixed the issue!!

Apparently, the rack was rebuilt with parts from another model Toyota. Parts that look almost identical. The rebuilt rack had a different gear ratio than what it should have had, upsetting the relationship between the steering angle (sensor) and the actual corner the car took (yaw rate, wheel speeds and lateral G force readings).

Steering rack Prius on the workshop floor.

Conclusion
I can honestly say that I would have never found this issue if it was not for the readings from the good car, and even then we still would not have expected the ratio in the rack to be incorrect. Quite simply the ratio must not be changed!? There is always a first I suppose.

One thing is for sure, the AECS tools and AECS technical support made it possible for this diagnostician to bring this job to a conclusion, unlike the 2 preceding garages.
Also, what did you think about the trick with the scope where we looked at the direction of each axle? That made it real to us, and the beauty of the ATS scope is, it is EASY to do!

I hope to see you in one of our training seminars soon, or else have a play with our online academy. In the AECS tool training section ($18/month) of our academy, you will find in the scope section how to set up the scope for the axle direction in a simple sequence.

Herbert Leijen
Director, AECS Ltd

AUSCAN 3 + 3YRS OF UPDATES

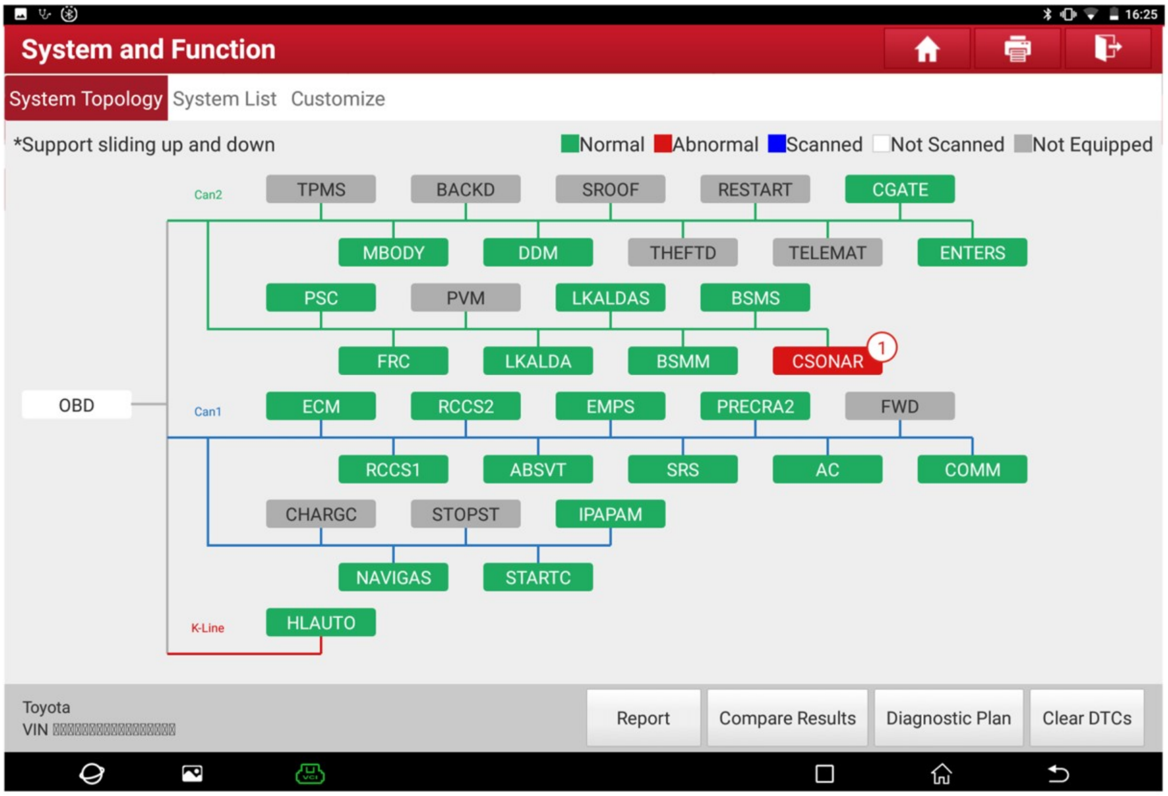
With our new freight costs that may go up 500%, the price of the AUSCAN 3 will get a price increase soon. With the latest shipment coming we'll still do it for the old price (you will need to pre-order with deposit) and we'll include 3yrs of updates (instead of 2) .

Pre-order with $500 deposit from our new website with this link only.

New development in Eurotab II software

The Eurotab 2 can scan each communication network individually to see if there is communication. The Topology map will show instantly if there are faults and if so in which network. The topology map doubles as a menu from which you can access each ECU individually.

Below is a screen shot from the Eurotab II, showing the new Topology map.



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Get it now before the freight price-hike. The new AUSCAN 3 with 3 years of updates (normally 2 years) save $1100. $500 deposit to secure you Auscan 3!

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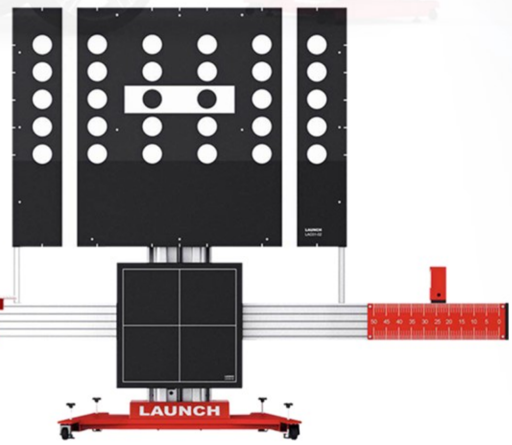
ADAS PRO functions as a multi-calibration tool for vehicle ADAS camera & radar systems.

Easy to calibrate, with instructions from the scan tool. Modular structure and accessories enable you to configure the tool to the best way to suit your workshop.

PRICE FROM: $9,485.00 + GST



AUSCAN 3
Auscan 3 makes its competition high-end scan tools look low-end in comparison. Auscan 3 is roomy, with larger internal storage for 125+ brands, and an increase in memory and processing power.

AUSCAN 3 has a huge ability. Includes special functions such as:
- Immobilizer/key coding
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AECS TRAINING

Location	Course Name	Course ID	Date	Time
June				
Hastings	online EV Diagnostics & Maintenance: Part 1	EV21 Webinar	1 Jun	1:00 PM - 2:00 PM
Palmerston North	Hybrid/EV Safety	HVS1-1 (c)	2 Jun	1:00 PM - 4:00 PM
Ohakea	Comprehensive Scope Training - Level 1	ATS 1-1 (c)	3 Jun - 4 Jun	9:00 AM - 5:00 PM
Hastings	Online EV customer initiation	EV11 Webinar	8 Jun	8:00 AM - 11:00 AM
Auckland	Hybrid/EV Diagnostics	EMS 1-4 (c)	14 Jun - 15 Jun	9:00 AM - 5:00 PM
Auckland	Diesel Electronic Diagnostics	DED	16 Jun - 17 Jun	9:00 AM - 5:00 PM
Christchurch	Air-Conditioning Systems	ECAC 1-1 (c)	21 Jun - 22 Jun	9:00 AM - 5:00 PM
Christchurch	Diesel Electronic Diagnostics	DED (c)	23 Jun - 24 Jun	9:00 AM - 5:00 PM
Palmerston North	Automotive Electronic Diagnostics	AED (c)	30 Jun - 2 Jul	9:00 AM - 5:00 PM
July				
Tauranga	Air-Conditioning Systems	ECAC 1-1	6 Jul - 7 Jul	9:00 AM - 5:00 PM
Hamilton	Air-Conditioning Systems	ECAC 1-1 (c)	13 Jul - 14 Jul	9:00 AM - 5:00 PM
Hamilton	Diesel Electronic Diagnostics	DED (c)	15 Jul - 16 Jul	9:00 AM - 5:00 PM
Rotorua	Diesel Exhaust after treatment one day	DMS14-P20 (c)	17 Jul	9:00 AM - 5:00 PM
Wellington	EV Battery Diagnostics & Repair	EV3-1	22 Jul - 23 Jul	9:00 AM - 5:00 PM
Wellington	Diesel Exhaust after treatment one day	DMS14-P20 (c)	24 Jul	9:00 AM - 5:00 PM
Hastings	Hybrid/EV Safety	HVS1-1 (c)	30 Jul	9:00 AM - 12:00 PM
August				
Christchurch	Automotive Electronic Diagnostics	AED (c)	3 Aug - 4 Aug	9:00 AM - 5:00 PM
Christchurch	CAN databus	CAN 1 (c)	5 Aug	9:00 AM - 12:00 PM