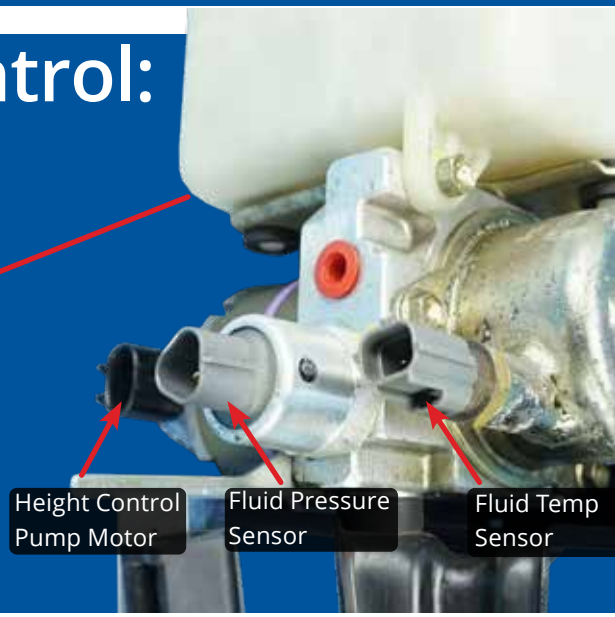
Toyota Active Height Control: Overview and Bleeding



1998 -2007 Toyota Land Cruiser 100 Series
1998 -2007 Lexus LX570
2002 -2007 Lexus LX470

Self-levelling refers to a suspension system that maintains a constant ride height of the vehicle, regardless of load. Toyota has been using their system called Active Height Control (AHC) Suspension since 1998 in the 100 series Land Cruiser and the Lexus LX470 and LX570. This article will give an overview of its operation, common issues, pressure relief and bleeding procedure.

Operation

Citroën was the first to introduce self-levelling suspension using a hydropneumatic system in 1955.

These systems use a combination of pressurised oil and gas to provide a sensitive, dynamic and high-capacity suspension, that offered superior ride quality on a variety of surfaces. Similar systems have been made under licence by many manufacturers. Toyota is one of these.

Hydropneumatic self-levelling suspension uses the combined advantages of hydraulic systems which use incompressible liquids inside a closed system, to transmit pressure and force, and pneumatic systems that use a compressible gas to act as highly efficient spring and shock dampener.

The hydraulic part of the system uses an electrically driven pump to raise and lower the vehicle by varying the volume of fluid in the hydraulic circuit. ***See Diagram #1.*** This fluid also transfers the road forces from the suspension to the pneumatic elements of the system.

These pneumatic elements use nitrogen gas as a spring medium which is approximately six times more flexible than traditional steel springs. The Toyota / Lexus suspension looks like a conventional system as it still has torsion bar springs at the front and coil springs at the rear with what looks like shock absorbers on each corner. However, these springs are lighter than on vehicle variants without AHC suspension, as the nitrogen-filled spheres or globes on the Damping Force Control Actuators on the chassis rails are acting as the springs and shock absorbers.

See Diagram #6 & #7.

Diagram #2
Height Control and Suspension Mode Switches

Diagram #3
Height Indicator Lights

The shock absorbers on each axle mainly act as hydraulic rams to raise and lower the ride height and only have a minimal impact on dampening the suspension bounce.

The spheres consist of hollow metal balls, open at the bottom, with a flexible rubber membrane, fixed at the 'equator' inside, separating the top and bottom halves. The top is filled with nitrogen at high pressure, and the bottom connects to the car's hydraulic fluid circuit. As the suspension goes over bumps the hydraulic fluid in the hydraulic rams at each wheel transfer the force to the spheres which compresses the gas and absorbs the shocks. ***See Diagram #7.***

There are three possible height modes which can be selected by the arrow buttons or switch in the centre console near the gear selector. There is an indicator on the dash to show which mode the vehicle is in.
See Diagram #2 & #3.

High (HI)

This will raise the front of the vehicle 40mm and the rear 50 mm above the normal ride height and is used in bumpy off-road conditions or fording a watercourse. This mode is only available under 30 Km/h, as the vehicle becomes unstable at this height if it corners.

If the 4WD system has been put into "LOW Range" mode, the suspension AHC system will go into "**Extra High**" as it anticipates more extreme driving conditions which will require extra ground clearance.

Extra High is 70 mm above normal.

Normal (N)

The vehicle is at its normal ride height for general driving conditions. There is a Normal 2 mode. However, there is no information available about it.

LOW (LO)

If the driver selects **LOW** this will lower the vehicle 50mm at the front and 40mm at the rear to make it easier to get in and out of, and for ease of unloading. This mode is only available when the vehicle is stationary and normal mode will automatically engage when the vehicle starts to move.

NOTE: The vehicle will automatically self-level in relation to the loads placed on the vehicle. However, if the loads exceed predetermined weights, this function will not operate (see owner's manual for weight specifications).

The AHC system will **NOT** operate if;

- The engine is not running
- AHC OFF button has been pressed
- Any door is open (side or rear)

Components

Height Control Pump and Motor

Usually mounted under the bonnet but can also be mounted in the right-hand rear of the luggage compartment on some models. This unit generates hydraulic pressure that is used to raise the vehicle. It does this via an electrically driven gear pump.

This unit incorporates a reservoir tank for the hydraulic fluid, a return valve, pressure sensor and fluid temperature sensor. It also has a pump attenuator full of nitrogen to smooth out the pump pulsations. ***See Diagram #1 & #12.***

Height Control Accumulator

This is a chamber with a free piston. On one side is nitrogen at 5.9 MPa / 856 psi, and on the other is hydraulic fluid.

The accumulator stores hydraulic pressure, so when the vehicle height is being raised, the accumulator discharges the stored fluid to accelerate the raising speed. ***See Diagram #4.***

Height Control Valve Assembly

The amount of fluid to be sent through the height control valve into the shock absorbers for each of the wheels is regulated in accordance with the manual switch operation and driving conditions, therefore, the vehicle height can be controlled within 5 levels: (Low, Normal 2, Normal, High and Extra-High). ***See Diagram #5.***

The height control valve is comprised of four levelling valves, two gate valves and an accumulator valve.

The levelling valves control the fluid between the pump and the gas chambers (globes) located at each wheel.

The gate valves control the fluid between the left and right levelling valves to balance the fluid pressure for the left and right gas chambers.

The accumulator valve controls the fluid passage between the accumulator and the pump.

Front and Rear Damping Force Control Actuators

These units incorporate the gas-filled spheres or globes which act as the spring, a relief gas chamber which restricts pressure increases in the hydraulic system and a 16 position stepper motor controlled actuator to switch the damping force to control the spring rate based on signals from the ECU. The damping force can be selected via the comfort or sport settings on the console. ***See Diagram #2 & #6.***

Height Control Sensors

Mounted on both sides of the front suspension and on the RH rear of the rear suspension. These are Hall IC type sensors which allow the ECU to know at what height the vehicle is so it can be adjusted for vehicle load and speed.
See Diagram #8 & #9.

Diagram #6
Damping Force Control Actuator

Service Tip

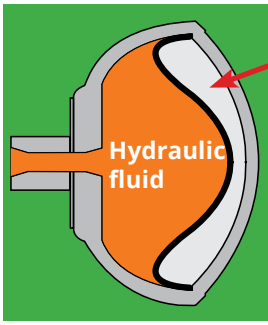
Before raising the vehicle on a 2-post hoist or using a floor jack, ensure that the engine is OFF. If you need the ignition ON while the vehicle is raised with the wheels hanging, ensure that the height control switch is OFF. Then bridge out the OPA (Full-time 4WD maintenance support) and CG (Chassis Ground) terminals in the DLC3, which is Toyota speak for terminal 11 and 4 in the OBDII diagnostic link under the dashboard and not the one under the bonnet. This will stop the suspension control ECU from operating.
See Diagram #10.

Sphere Trouble

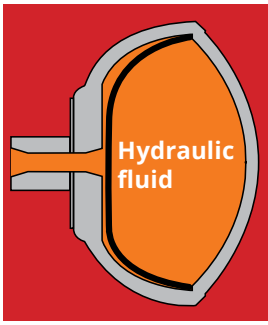
It is not uncommon for the spheres on the Damping Force Control Actuators to start to leak on older vehicles with high mileage (approximately 160,000 km). The spheres will slowly leak gas internally, and fluid will enter the gas side of the spheres reducing the volume of gas and their ability to act as a spring. When the gas is all gone, and there is only fluid in both sides of the sphere, it will be rigid as you can't compress a liquid. ***See Diagram #7.***

Over time the suspension will slowly start to feel harder with every little

Diagram #7
Actuator Sphere



When in good condition, the gas sealed by the diaphragm acts as a spring and the force is transferred by the hydraulic fluid.



When the diaphragm leaks it will allow the gas out and fluid will fill the sphere making the suspension solid.

WARNING: Release Hydraulic System Pressure

This system is under high pressure, you should release this pressure before opening the system or replacing any components. If you open the system without using the following procedure the vehicles height may drop suddenly or high-pressure fluid may cause injury.

1. **Set the vehicle to its lowest height.**
2. **Turn the ignition off.**
3. **Support all axles with safety stands.**
4. **Connect a hose to the height control accumulator bleed screw and place the other end in a container. *See Diagram #4***
5. **Open the bleed screw slowly.**
6. **When the fluid pressure has dropped and oil stops flowing, close the bleed screw.**

Diagram #8
AHC Front Sensors

bump and ripple in the road being noticeable. If they fail completely the suspension will become more rigid, and there is a possibility that this lack of dampening may damage other parts of the suspension or mounting points.

It is possible to replace the spheres separately from the Damping Force Control Actuator units. However, you should shop around for the best solution, as there are after market and even reconditioned units available. Do your homework if you are not using genuine parts.

NOTE: The hexagon on the spheres is 36mm. However, you might have to grind down your spanner to about 8-9mm thick make it fit in the gap.

Sensor Trouble

If the owners of the vehicle go off-road, they might damage the height sensors for the system. You should check them for damage to their linkages and wiring harnesses. ***See Diagram #8 & #9.***

Pump Trouble

If the system is not working and the pump is not running, many technicians start replacing parts, starting with the pump. Before you go down this path, there are some items to check.

With a compatible scan tool check for fault codes and repair as required, then clear the system. If you cannot clear the codes, try this manual method.

Diagram #9
AHC Rear Sensor

Diagram #10
OBDII diagnostic link

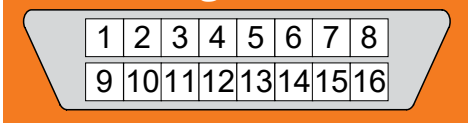


Diagram #11
Under Bonnet Diagnostic Link

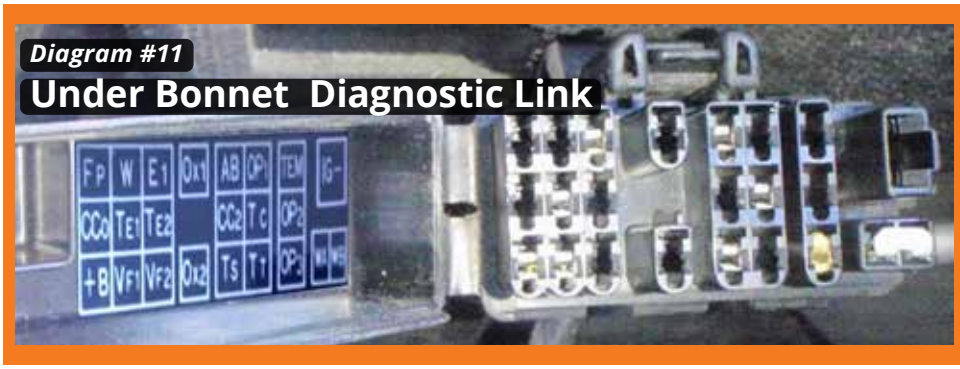
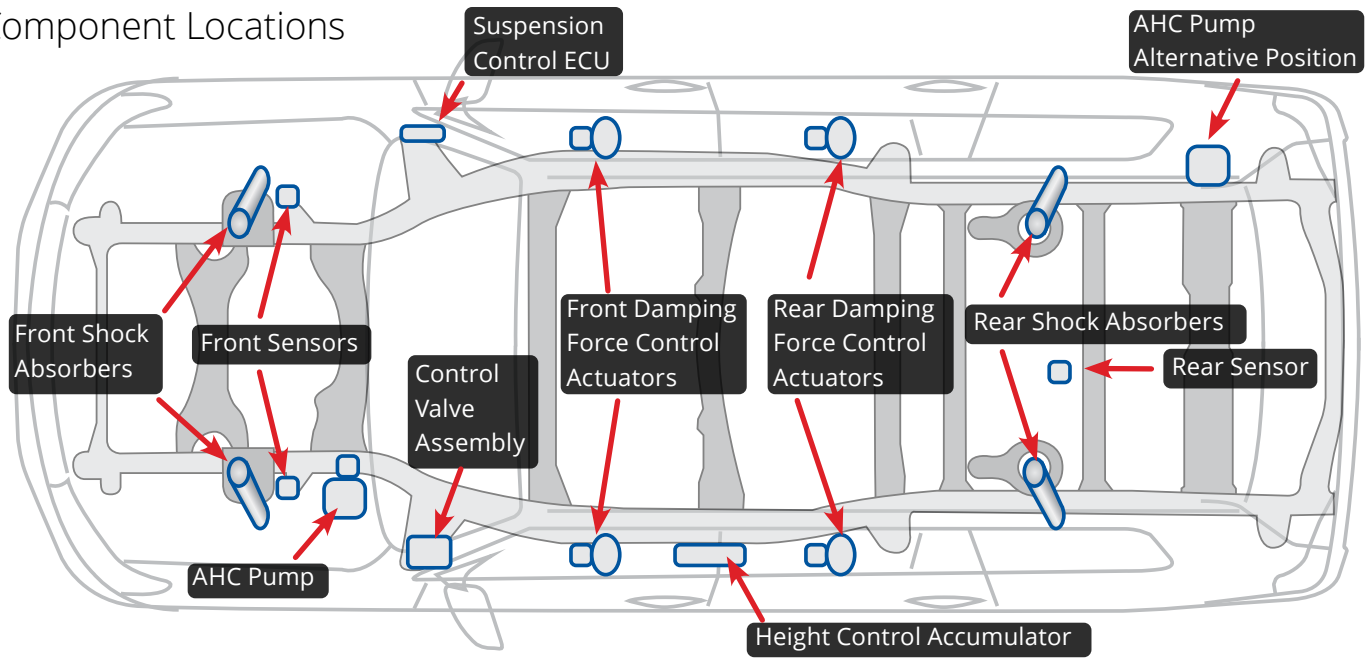


Diagram #12
Component Locations



1. Ignition off
2. Bridge terminal Tc and E1 in the diagnostic link under the bonnet on the firewall ***See Diagram #11***
3. Ignition on, then push brake pedal 9 times in less than 3 seconds
4. Ignition off
5. Remove the bridging wire

There are some circuits which might not present with a trouble code which could impact the AHC. The system will not work if one of the doors are open, so check that all door light switches are OK. Check the circuit for the AHC Off switch and the AHC lights on the dash are working correctly.

Shock Absorber Replacement

Over time the shock absorbers can start to leak, and there are some things to be aware of when replacing them. There is a hydraulic line which is mounted on the top of the shock absorber and is held in place by a bracket with two bolts, then below this is the nut, washer and rubber mount for the shock absorber.

If you are going to replace the shock absorbers, remember to release the pressure in the system. Then it is recommended to start with the RH rear one first, as it is the hardest one to access. So, it is best to tackle it while your patience is at maximum.
See Diagram #13

Diagram #13
RH Rear Shock Absorber

There is very little room to remove hydraulic line bracket and the shocker nut, but it can be done.

Bleeding procedure

Use the following steps if any of the components have been replaced or you suspect that there is air in the system.

WARNING: The vehicle's height can drop during this procedure. Don't place yourself in a position to be crushed. The bleed nipples can be accessed from the sides of the vehicle with the wheels on the ground or a 4-post hoist.

WARNING: Don't get clever and try this with the engine running and open the bleed nipples. You will then be dealing with a high-pressure jet of expensive fluid.

NOTE: Use only the manufacturers recommended fluid otherwise you might damage the system
See Diagram #14

1. Place the vehicle on a level surface.
2. Inspect the AHC fluid level and ensure that it is in between the "MIN" and "MAX" marks on the reservoir. ***See Diagram #1***
3. Start the engine
4. With the vehicle unloaded, adjust the vehicle height to the "N" position with the vehicle height control switch on the dash.
See Diagram #3
5. When the height of the vehicle is in the "N" position and the pump stops running, turn the engine off.
6. Connect a bleeder bottle to the LH, or the RH front Damping Force Control Actuator bleed nipple.
See Diagram #6
7. Open the bleed nipple and allow the fluid to flow out until there are no bubbles of air present.
WARNING: The vehicle's height can drop during this procedure.
8. Repeat the above steps for the opposite front Damping Force Control Actuators
9. Connect a bleeder bottle to the LH, or the RH rear Damping Force Control Actuator bleed nipples.

Diagram #14
AHC Fluid

Only use fluid recommended by the manufacturer.

10. Open the bleed nipple and allow the fluid to flow out until there are no bubbles of air present.
WARNING: The vehicle's height can drop during this procedure.
11. Tighten all bleed nipples to **8.3 Nm.**
12. Start the engine and allow the vehicle to pressurise the system and to adjust its height.
13. Repeat the above steps until there is no more air in the system.

The MotorTech HaynesPro service schedule for the Landcruiser 100 series indicates that the AHC fluid should be changed every 100,000 km, and reports from the trade are that after a fluid change, the system seems to give a smoother ride.

Many in the trade are converting the AHC suspension back to a conventional system if something expensive fails. This will require new shocks and springs, and it is recommended to do your research on how to do this correctly.

As this article is only a brief overview of the AHC system, and if your customer wants this system repaired, call VACC's Technical Advisory service for more detailed diagnostic and repair procedures.

Thanks to Mark at Chadstone Motors for access to his shop for the photos in this article.
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