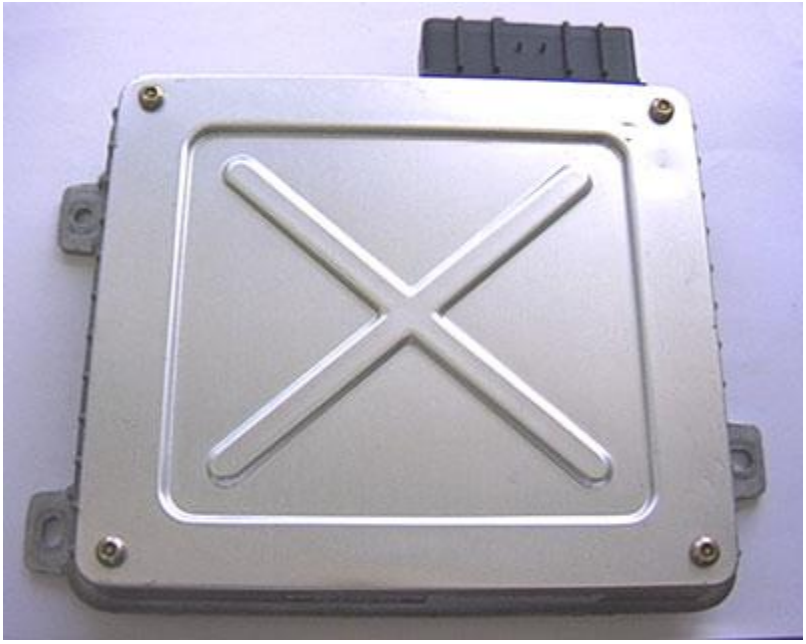
LUCAS ACE - System Overview

The Active Corner Enhancement system manufactured by Rover Group Lucas appears to have been produced specifically for the Land Rover Discovery series II to address the poor cornering association of the Discovery series one. Constantly monitoring very sensitive G sensors mounted at high and low points on the vehicle, the system can detect roll forces and counter them using the output of a hydraulic pump via valves and powerful actuators mounted on both axles to resist the roll forces thus reducing cornering roll. The system is a vast improvement to the vehicles handling allowing much sharper cornering than without, and anyone used to driving with it needs to be careful should it stop working, or due to the fact that it was an optional extra, they borrow a non ACE equipped vehicle, and forget to slow down more than usual at corners. The system has very fast response requirements and as such there is much emphasis on ensuring that the system works properly and fast enough. New ECU's have to pass a number of response tests successfully before the system is commissioned to try and ensure this. There is also sensor calibration and sophisticated bleeding procedures.
Interestingly or amusingly, the ECU is housed in an identical case to the MEMS 1.9 engine management with a blanking plug fitted where the vacuum tube inlet is, no doubt a cost saving measure.

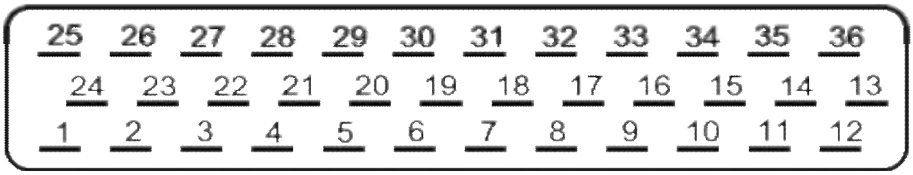


LUCAS ACE - Known Fitments

Vehicle makes models and variants known or believed to be using this vehicle system, required diagnostic lead and degree of known compatibility.

Vehicle make	Vehicle Model	Vehicle Variant	Diagnostic Lead	Compatibility Level
Land Rover	Discovery II	When Fitted	Blue OBD lead	Verified
Land Rover	Discovery II	When Fitted	Green OBD lead	Verified

LUCAS ACE - Pin Outs

	
1 - 4	Not Used
5	Road speed - input
6	ACE relay
7 - 8 - 9	Not Used
10	Diagnostic line
11	Ignition on - input
12	Lower lateral accelerometer power supply
13	Not Used
14	Reverse switch
15	Lower lateral accelerometer - input
16	Pressure transducer - input
17	Upper lateral accelerometer - input
18	Upper lateral accelerometer power supply
19	Engine speed - input
20	Ground
21	Pressure transducer ground
22	Direction control valve 2 - input
23	Direction control valve 1 - input
24	Power supply for DCV 1 and 2
25	Pressure control valve input
26	Not used
27	Power supply for PCV
28	Main supply
29 - 30 - 31	Not Used
32	Ground
33	Lower lateral accelerometer ground
34	Upper lateral accelerometer ground
35	Not Used
36	Warning lamp

LUCAS ACE - Diagnostic Capabilities Read Fault Codes/Clear Fault Codes

This function reads the fault code memory. The system can self detect up to 45 different problems with itself and associated sensors, storing the respective code if it detects any malfunction or reading outside of pre defined acceptable limits. Not all stored faults may cause the fault warning lamp to illuminate. Some faults, even if stored in the ECU memory, are masked and therefore the Test Book is not showing them. We decided to show all faults stored in the ECU. The masked faults are preceded by "MASKED FAULT" text.
There is also the option to Clear Faults

LUCAS ACE - Diagnostic Capabilities (Inputs)

- Engine speed (rpm): A pulse train generated by either the Bosch Engine management or the TD5 engine management ECU's.
- Road speed (km/h): Used in roll compensation and off-road algorithms, this is vehicle speed dependent.
- Battery voltage (v): This is the current battery voltage which supplies the ACE ECU.
- Directional control valve 1/amps: The ACE ECU controls the DCV's by varying a 200 Hz pulse width modulated signal supplied to it. The higher the mark space ratio of this signal gets the more current is consumed by the DCV's. This value therefore shows how much the valve is being opened by.
- Directional control valve 2/amps: The ACE ECU controls the DCV's by varying a 200 Hz pulse width modulated signal, the higher the mark space ratio of this signal gets the more current is consumed by the DCV's. This value therefore shows how much the valve is being opened by.
- Pressure control valve/amps: The ACE ECU controls the Pressure Control Valve by varying a 200 Hz pulse width modulated signal which is supplied to it. The higher the mark space ratio of this signal gets the more current is consumed by the PCV. This value therefore shows how much the valve is being opened by.
- Pressure Sensor (bar): This is the pressure in bars derived from the pressure transducer which is mounted on the front face of the hydraulic valve block on the right hand chassis rail.
- Residual pressure (bar): It may be noticed that when the PCV is closed i.e. drawing no current, that the actual pressure reading is not zero Bar. This pressure offset is known as the residual pressure and it is critical to the 'on centre' feel of the vehicle and initial roll when cornering. Ideally the residual pressure should be zero; however in practice it can vary between typically 3Bar and 6Bar. These variations are caused by component tolerance, valve design and temperature effects on the viscosity of the oil. The higher the residual pressure the larger the dead-band around centre or straight line driving. If the system requests pressure less than the residual pressure the system is switched into

the 'locked bars' state. Residual pressure is measured by the ACE ECU every 12 seconds when the direction valves are closed and there is no lateral acceleration and the engine speed is above 550rpm. The residual pressure value should drop nearly 50% within the first 2 minutes of starting the engine from cold. As the ambient temperatures decrease, the initial value of residual pressure will increase.

- System pressure (bar): This is an internally calculated value is used to filter pressure sensor outputs for the pressure controller and determines residual pressure and pressure sensor offset. Residual pressure is measured every 12 seconds when the direction valves are closed and there is no lateral acceleration and the engine speed is above 550rpm.
- Upper lateral accelerometer/gravities: A capacitive acceleration sensor located on a bracket in the roof lining above the rear view mirror. It is driven by a 5.0Vdc supply from the ACE ECU on pin 18 of C0647 on a yellow / red wire. The buffered output is 0.25 - 4.75Vdc which returns to the ACE ECU on pin 17 of C0647 on an orange / blue wire. The sensor can measure ± 1.14g. It is fed with earth from pin 34 of C0647 on a yellow / green wire. Its input is used for 'head toss' correction and fault detection in conjunction with the lower accelerometer. With the vehicle on level ground with all the doors closed, both accelerometers should read ± 0.01g after calibration. After normal usage, the difference between the upper and lower accelerometers could be as much as ± 0.15g.
- Lower lateral accelerometer/gravities: A capacitive acceleration sensor located on a bracket attached to inner sill panel under RH front floor. It is driven by a 5.0Vdc supply from the ACE ECU on pin 12 of C0647 on a yellow / black wire. The buffered output is 0.25 -4.75Vdc which returns to the ACE ECU on pin 15 of C0647 on an orange / grey wire. The sensor can measure ± 1.14g. It is fed with earth from pin 34 of C0647 on a yellow / green wire. While two independent accelerometers are used, this is the primary sensor used to measure acceleration on the vehicle. The sensor's outputs are fed to separate A/D inputs of the ACE ECU's main microprocessor. With the vehicle on level ground with all the doors closed, both accelerometers should read ± 0.01g after calibration. After normal usage, the difference between the upper and lower accelerometers could be as much as ± 0.15g.
- Ignition switch: Used to wake up the ACE ECU and provide shutdown signal at power off. The ECU stays powered up for 30 seconds after ignition is turned off.
- Reverse switch: Used to change the ACE system functionality. This is supplied via switch S210 in an automatic vehicle or switch S103 in a manual vehicle.
- Main relay: This is the current status of the ACE systems main relay; this is controlled by the ACE ECU and can be tested with an output function provided in the 'OUTPUTS' section. When an ACE ECU is new as shown in the settings section, the ACE ECU will not energies this relay until the ECU has passed all response tests and been self calibrated, however to do this the system needs the power provided by this relay.
- Warning lamp: This shows the current status of the ACE systems warning lamp, which is located in the instrument pack.

LUCAS ACE - Diagnostic Capabilities (Outputs)

This is a choice of outputs that can be tested. The outputs would be pulsed.

- Main relay (Force ON):
- Main relay (Force OFF):
- Warning lamp: This function flashes the Active Cornering Enhancement Systems warning lamp, which is located in the instrument pack. This confirms that it is under the proper control of the ACE ECU.
- Direction control valve 1: This function activates Direction Control valve 1, which in conjunction with Direction Control Valve 2, affects the direction torque which is applied to the vehicle to counter cornering forces. With either DCV1 or DCV2 on, which is the default state, the anti roll bars are locked which makes the vehicle suspension stiff. With only DCV1 on, the torque is applied to lean the vehicle to the right and with only DCV2 on, the vehicle leans to the left. If both DCV1 and DCV2 are on, the Anti Roll bars become floppy and soft allowing the vehicle to roll freely. The output can be tested only with the engine running.
  WARNING: The vehicle may suddenly jerk violently from side to side during this test and so it is vitally important to ensure sufficient clear space around the vehicle.
- Direction control valve 2: This function activates Direction Control valve 2, which in conjunction with Direction Control Valve 1, affects the direction torque which is applied to the vehicle to counter cornering forces. (See details in DCV1). The output can be tested only with the engine running.
  WARNING: The vehicle may suddenly jerk violently from side to side during this test and so it is vitally important to ensure sufficient clear space around the vehicle.

LUCAS ACE - Diagnostic Capabilities (UTILITY)

- Calib. Accelerometer 1: This function allows you to calibrate the accelerometer used by the ACE to manage the process of cornering enhancement.
- Calib. Accelerometer 2: This function allows you to calibrate the accelerometer used by the ACE to manage the process of cornering enhancement.
- Set Calibrated: This function sets the Calibrated flag. This flag is only an indication and it doesn't have any effect on the system.
- Ace System Bleeding: During ACE system maintenance or repair, hydraulic fluid may be lost from the system and air introduced. If air is present in the primary circuit (pump, attenuator and PCV) the system will self bleed shortly after starting the engine. The unwanted air will escape when it reaches the reservoir. When air is in the secondary circuit (actuators and associated pipe work) it is necessary to perform the System Bleed procedure using this function. Both actuators are designed to allow oil and air to flow

freely through them when the piston is in the fully extended position. In this position, the air will be forced out and allowed to escape to the reservoir. Using the following procedure, it is possible to bleed the front and then the rear secondary circuits with the front secondary circuit being bled first, but it is critically important that both the front and rear actuators are bled independently.

1. The vehicle has to be parked on a 4 post ramp with the handbrake on and in park or neutral.
2. Verify that the oil reservoir is to the maximum level and that the pump is active and it generates fluid's turbulence on the reservoir.
3. Turn off the engine, raise the car at working height and perform OIL BLEEDING STEP 1.
4. Disconnect both stabilizer links on the front axle only. Do not disconnect the stabilizer links on the rear axles. Free the nut that holds the silent block at the end of the roll bar.
5. Push the stabilizer link on the torsion bar side end up and pull the stabilizer link on the actuator side down simultaneously to bring the actuator to its maximum extension; make sure that no pipes or hoses become stretched.
6. For added safety, lower the vehicle to ground height.
7. Stop the STEP 1 function if it is not yet terminated. Turn on the engine and perform the OIL BLEEDING STEP 2 (it will take about 10 minutes) and keep the reservoir topped if the oil decreases its level. Once the function is terminated turn off the engine
8. Perform OIL BLEEDING STEP 1 and raise the car at working height and reconnect the links of the front axels. Stop the STEP 1 function if it is not yet terminated.
9. Disconnect both stabilizer links on the rear axle only. Free the nut that holds the silent block at the end of the roll bar.
10. For added safety, lower the vehicle to ground height again.
11. Turn on the engine and perform the OIL BLEEDING STEP 2 (it will take about 10 minutes) and keep the reservoir topped if the oil decreases its level. Once the function is terminated turn off the engine
12. Raise the car at working height and reconnect the links of the front axels. Perform OIL BLEEDING STEP 3 for a few seconds.
13. Lower the car and check the level of the oil again.