An Electronic Control Air Suspension System for Commercial Vehicles

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Abstract. At present, the developed countries will air suspension applications in medium and heavy trucks and trailers on the penetration rate of more than 90%. In contrast, due to the influence of commercial vehicle production technology, the utilization rate of air suspension in commercial vehicles is relatively low. The proportion of air suspension used in heavy trucks and trailers is only 5% - 10%. With the rapid development of China's economy, people's demand for cars is also getting higher and higher, not only a means of transport, but also on the ride comfort, ride comfort requirements are also getting higher and higher. Foreign advanced electronic control air suspension is also becoming more and more popular, which will inevitably lead to the domestic market demand for electrically controlled air suspension. The author of this article during the Ruian Ruili group Beijing Great Automotive Components Company Limited, the electronically controlled air suspension hardware localization, has made some achievements and some suggestions.

1. Composition of Electronically Controlled Air Suspension System

- **Pressure limiting valve:** installed in lifting pipeline to limit the maximum pressure during lifting and falling of the second bridge.
- **Height Sensor:** Installed on the right side of a bridge bridge bridge, connected to the frame by connecting rods, through the perception of the load of a bridge, the pressure of the second bridge bearing airbag is regulated by ECU.
- **EACS solenoid valve:** The function conversion of lifting and descending of the second bridge is realized by external switch control.
- **Pneumatic Protection Valve:** Installed between solenoid valve and the second bridge bearing airbag pipeline. When the second bridge is in the lifting state, the part will keep the compressed air in the bearing airbag at 50kPa, which is used to protect the bearing airbag from damage.
- **ECU:** Vehicle speed signal, pressure signal of sensor and position information of sensor are input into ECU. According to the current information of vehicle, the program is used to determine and filter the relevant information whether to charge and deflate the carrying airbag and control the inflatable pressure proportionally.
- **Pressure sensor:** The pressure sensor collects the pressure of the airbag and sends it to the ECU. The ECU determines whether to fill or deflate according to the position of the altitude sensor. That is
to say, the angle position of the pendulum rod of the altitude sensor is linear with the pressure in the airbag.

Fig. 1. Functional schematic for commercial vehicle electronic control air suspension system

2. **Description of structure and operating principle**

1) Heavy load (second bridge down): (Initial state) The compressed air of the vehicle reaches one port of solenoid valve through the pressure limit valve (0.8MPa). At this time, 25 ports of solenoid valve have no air pressure output. The height sensor installed in a bridge automatically adjusts the position angle of the pendulum rod of the height sensor by connecting the height sensor with the frame according to the load of the vehicle, so that the height sensor outputs the corresponding pulse signal. After the pulse signal is transmitted to the ECU, the ECU passes the control command to the connection end of the ECAS solenoid valve according to this information, and the load-bearing and speed signals of the current vehicle. Sub61.4 (common end), 61.3 and 61.2 input rated voltage to control the internal piston to control the pressure of the bearing airbag. The pressure sensor transmits the pressure information to the ECU in real time, that is, the pressure of the bearing airbag is regulated by the ECAS solenoid valve controlled by the ECU.

2) No-load (second bridge lifting): When the vehicle is no-load, it is necessary to switch the state of the second bridge. Through manual control switch, the rated voltage is applied to the terminal 62.3 and 62.4 of the solenoid valve (in conjunction with 2 lines). The solenoid valve works. Through the control of the internal piston, on the one hand, the 24 ports of the solenoid valve and 32 ports of the exhaust port are opened, and the compressed air carrying the airbag passes through the air. Pressure protection valve and solenoid valve discharged into the atmosphere from 32 ports of solenoid valve. Finally, the compressed air in the balloon was reduced to 50 kPa due to the pressure protection valve. On the other hand, open the channel of the solenoid valve inlet and outlet 25, can made compressed air from the lifting pipeline can enter the lifting airbag through one port, and the lifting airbag can be inflated to lift the second bridge.
3) When restoring to heavy load (second bridge down): when heavy load, the second bridge needs to be lowered. It can be controlled by manual control switch. The terminal 62.1 and 62.4 of solenoid valve (in conjunction with 2 lines) are connected to rated voltage. The solenoid valve works. Through the control of internal piston, on the one hand, 24 ports of solenoid valve and 32 ports of exhaust port are closed, and the compressed air from the bearing pipeline is freed from height. Sensors send signals to ECU, according to this information, and the current vehicle load and speed signals, ECU will control the command through the ECAS solenoid valve wiring terminal 61.4 (common end), 61.3 and 61.2 input rated voltage, control the internal piston, flow through the pneumatic protection valve to inflate or exhaust the bearing airbag, that is, the pressure of the bearing airbag is regulated by the ECAS solenoid valve. On the other hand, the channel of solenoid valve 1 and 25 ports is closed, the channel of solenoid valve 25 and exhaust port 32 is opened, and the compressed air of airbag is discharged to the atmosphere through 32 ports of solenoid valve.

4) The function of the second bridge in the lifting state (automatic drop and lifting) to prevent the increase of load: ECU needs two power supply, one constant power supply and one key power supply. Auto-drop function: ECU delayed power-off control when key power is cut off. When power failure occurs, ECU detects whether there is air in the bearing airbag to determine whether the pontoon is in a down state or not. If not, it issues an order to automatically lower the pontoon. Automatic lifting function: After the key is plugged in, ECU will automatically detect whether the load is loaded or not according to the position of the height sensor. If it is loaded, it will maintain the status quo. If it is no-load, it will automatically lift the floating bridge.

5) The current scheme is isobaric control, which means that a solenoid valve controls the charging and discharging process of lifting and supporting airbags. Because the filling and discharging of lifting and supporting airbags are opposite actions, that is, one is filling and discharging, the supporting airbags can be fine-tuned separately by adding solenoid valves.

6) The program only carries on the static adjustment, does not carry on the dynamic adjustment. In order to avoid driving, when the axle load moves forward and changes, the control effect will not be ideal. For example, in the early braking stage, the deceleration is small, and the altitude sensor changes...
can not be perceived, while in an emergency situation, one foot is trampled to death. At this time, if the height adjustment, will lead to the release of the brake, the height has been adjusted too high and to deflate. The control logic of the ECAS system is as follows (for reference). When the vehicle is in dynamic state, ECAS does not adjust, the main reason is to avoid the influences of height adjustment on braking.

7) Lifting is not allowed when the load exceeds the specified value. When the ECU detects that the load exceeds the specified value, it is impossible to press the lifting bridge switch at this time. Switch and ECU are connected to realize this function.

3. Conclusion
The ECU of this system can input the speed signal and the pressure signal of the sensor into the ECU. According to the current driving information of the vehicle, the program is used to determine and filter whether the relevant information is used to fill and deflate the carrying airbag. In this way, the ineffective adjustment of braking and bumping pavement can be filtered out without adjustment, and the safety and comfort will be greatly improved. The control is more precise, and the pressure of the airbag can be fine-tuned according to the load. This system can reduce the consumption of compressed air, reduce the fuel consumption of the whole vehicle, and achieve the purpose of saving energy. Some invalid information can be filtered out, and the service life of the valve will be longer. Vehicles with air suspension have less impact on the road surface, reduce the friction between tires and road surface, and prolong the service life of tires. At present, there is no such mature product in China. We are the first company in China to develop products, enter the market and win profits. It has had a great impact on the price of WABCO and other foreign manufacturers.

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