Research and implementation of key technologies for vehicle chassis output power detection

Hongyu Zhang

School of Automotive and Marine Engineering, Dalian Vocational Technical College, Liaoning Dalian, 116035, China

Abstract: Automobile chassis output power is one of the important evaluation indexes in automobile power performance testing. It is the direct embodiment of engine power transmission performance and fuel efficiency. Its performance has a direct impact on automobile transportation efficiency, stability and safety of vehicle operation and automobile exhaust emission pollution. Strengthening the research on the key technologies of vehicle chassis output power detection and developing a set of efficient, safe and accurate vehicle chassis output power measurement and control system will play a positive role in improving China's vehicle chassis output power detection technology, saving social energy and strengthening environmental protection. The actual calibration and test of the developed vehicle chassis output power detection and control system are carried out in this paper. The test results show that the system runs stably and reliably, and the detection and control accuracy and sampling real-time meet the requirements of relevant national detection standards and practical engineering applications.

1. Introduction

The rapid growth of car ownership not only saves people's travel time, but also speeds up the efficiency of goods circulation, greatly facilitates people's life and improves people's quality of life. As a modern means of carrying passengers or transportation, the transportation capacity of automobile is very important [1]. The level of automobile transportation capacity largely depends on the dynamic performance of automobile. Vehicle power performance refers to the average driving speed that can be achieved when driving on a good and straight road [2]. The detection methods of vehicle dynamic performance are divided into road and indoor. The main items of road inspection include maximum speed, minimum stable speed, acceleration performance, maximum climbing gradient and traction performance; Indoor testing mainly measures the output power of automobile chassis, maximum speed, acceleration capacity and engine output power. The output power of automobile chassis, that is, the output power of automobile driving wheels, is an important diagnostic parameter used to characterize the overall technical status of automobile transmission system. Whether the technical condition of the transmission system is good or not is directly related to the driving and handling safety and stability of the whole vehicle, and also affects the power transmission performance and fuel efficiency of the engine [3].

2. Theoretical research on vehicle chassis output power and vehicle testing

2.1. Introduction to chassis dynamometer

Automobile chassis dynamometer is an important automobile indoor testing equipment. It can complete the detection of automobile chassis output power without disassembling the whole automobile [4]. When the vehicle chassis dynamometer is used for the test, it can control the test conditions and minimize the impact of the surrounding environment. At the same time, it can also simulate the vehicle road driving resistance through the power absorption loading device, so as to control the vehicle driving condition. Therefore, it can carry out complex cycle test and be widely used. The vehicle indoor bench test is not affected by the objective conditions such as climate and

driving technology, but only by the test accuracy of the chassis dynamometer and its control system. The test conditions are easy to control. Therefore, the vehicle testing institutions use the chassis dynamometer to detect the chassis output power.

Chassis dynamometer is mainly divided into single drum type and double drum type. The single drum dynamometer is shown in Figure 1. The larger the diameter of the drum, the closer the wheel tends to roll on the flat road. However, increasing the diameter of the drum will significantly increase the manufacturing and installation cost of the dynamometer. The drum diameter of the general single drum dynamometer is between 1500mm and 2500mm. Because the test accuracy table of single drum dynamometer is high, but its requirements for the placement and positioning of the tested vehicle are relatively strict, and the alignment of drum and wheel is very difficult, so single drum dynamometer is mainly used in automobile manufacturing and scientific research institutions. The double drum dynamometer is shown in Figure 2. Its drum diameter is much smaller than that of the single drum chassis dynamometer, generally between 180mm and 500mm. The radius of curvature of the drum should not be too small in order to ensure that the contact between the tire and the drum is the same as the compression on the road. The double drum chassis dynamometer has low requirements for the placement of the test vehicle, convenient installation and use, and low cost. Therefore, it is suitable for vehicle inspection and warranty enterprises to carry out technical condition inspection and fault diagnosis [5].
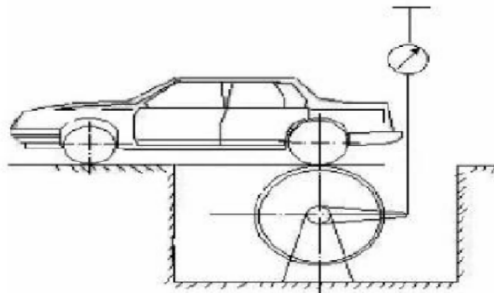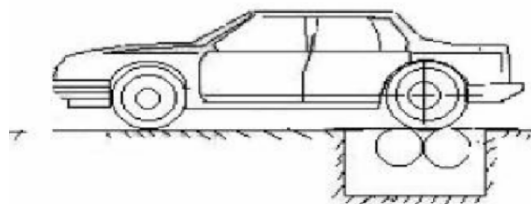
Fig.1 Single rotating drum dynamometer

Fig.2 Double drum dynamometer

Double drum chassis dynamometer is generally composed of frame, drum device, lifting device, dynamometer, speed measuring device, control and indication device and auxiliary device [6].

Roller device is the basic component of chassis dynamometer, which generally adopts steel hollow structure. Its structure and performance directly affect the test accuracy of chassis dynamometer. The diameter and surface condition of the drum are the main structural parameters affecting the performance of the chassis dynamometer.

In order to truly detect the performance of the vehicle, the chassis dynamometer must be able to simulate the resistance of the vehicle on the road and provide additional resistance to the vehicle to compensate for this part of the resistance difference. The device providing this part of the resistance is called the loading device, Also called power absorption device

The measuring device includes speed measuring device and force measuring device. Due to the real-time measurement, the measuring device is required to be reliable, accurate, stable reading and quickly adapt to the changes of measured values.

Measurement and control system is the abbreviation of computer automatic measurement and

control system. It is a new technology developed from the combination and comprehensive development of automatic control, computer, microelectronics and communication technology. Including process control system, data acquisition and processing system, automatic measurement system, etc., which are widely used in national defense, scientific research and other fields [7].

2.2. Test condition and evaluation index of automobile chassis output power

According to the standard requirements of GB / T 18276 bench test methods and evaluation indexes for vehicle power performance, the test condition of vehicle chassis output power adopts the working condition of vehicle rated torque and rated power. That is, the working condition composed of the full load of the engine and the speed of the direct gear corresponding to the rated torque speed and rated power speed (when there is no direct gear, it refers to the gear with the transmission ratio closest to 1).

Under the condition of vehicle rated torque and rated power detection, the percentage of corrected drive wheel output power and corresponding total engine output power is used as the limit of drive wheel output power.

$$\eta_{VM} = P_{VMO} / P_M \qquad (1)$$

$$\eta_{VP} = P_{VPO} / P_e \qquad (2)$$

Where: η_{VM} —Percentage of corrected driving wheel output power and rated torque power under rated torque condition,%;

η_{VP} —Percentage of corrected driving wheel output power and rated power under rated power condition,%;

P_{VMO} —Corrected driving wheel output power of vehicle under rated torque condition, kW;

P_{VPO} —Corrected driving wheel output power of the vehicle under rated power condition, kW;

P_M —Rated torque power, kW;

P_e —Rated power, kw

When $\eta_{VM} \geq \eta_{Ma}$ or $\eta_{VP} \geq \eta_{Pa}$, It indicates that the output power of automobile chassis is qualified. among η_{Ma} It is the allowable value for correcting the percentage of driving wheel output power and rated torque power under rated torque condition; η_{Pa} It is the allowable value of the percentage of corrected drive wheel output power and rated power under rated power condition.
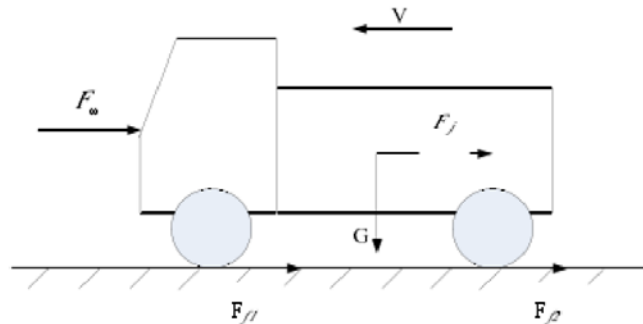

Fig. 3 Schematic diagram of vehicle resistance [8]

2.3. Analysis of vehicle running resistance

When driving on a horizontal road, the vehicle must overcome air resistance, rolling resistance and acceleration resistance. In addition, when driving on a ramp, it must overcome the component force generated by gravity along the ramp, that is, slope resistance. Under any driving conditions, rolling resistance and air resistance exist, while slope resistance and acceleration resistance only

exist under certain driving conditions. The driving resistance of the vehicle when driving on a horizontal road is shown in Figure 3.

2.4. Testing principle of automobile chassis output power bench

The chassis dynamometer has high requirements for the detection accuracy of drum speed. The change of eddy current machine braking current and vehicle throttle opening will lead to the instantaneous decrease or increase of its speed. The control system requires timely feedback, and the feedback response time is very short. Therefore, a high-accuracy speed sensor must be used. Generally, the dynamometer uses high accuracy (not less than 1000p / R) Photoelectric encoder as speed sensor [9].

When the automobile driving wheel drives the main drum to rotate, the drum drives the speed sensor installed on the central shaft of the drum to rotate synchronously, and the photoelectric encoder generates pulse signal PC [10]. After computer calculation, the instantaneous speed of the automobile is displayed. At the same time, in the chassis dynamometer control mode, this speed signal will be provided as feedback to the torque controller to determine the corresponding eddy current feedback value through PID algorithm. The vehicle speed V is calculated according to equation (3):

$$V = \frac{C_P}{N \bullet T} \bullet \pi \bullet d \tag{3}$$

Where:
CP - number of pulses in time interval T, PCs;
N - number of pulses in one cycle of photoelectric encoder, PCs;
T - counting interval of computer, s;
D - drum diameter of chassis dynamometer, M.

3. Research on vehicle chassis output power detection hardware system

The hardware part of the vehicle chassis output power detection and control system mainly includes the sensing, output and conditioning circuits of various analog and digital signals. Based on the in-depth study of PCI bus protocol, the design and implementation process of PCI data acquisition card integrating various signal measurement and control are described in detail. PCI bus defines two connectors suitable for 5V and 3.3V environment, and expansion boards of 5V, 3.3V and general purpose. 5V expansion board and general expansion board can be used for 5V connector, and 3.3V expansion board and general expansion board can be used for 3.3V connector. However, 5V and 3.3V power supply exist in all three expansion boards. The positioning keys on the connector and expansion card are used to prevent the board from inserting the wrong connector. The connector type and board type are shown in Figure 4.
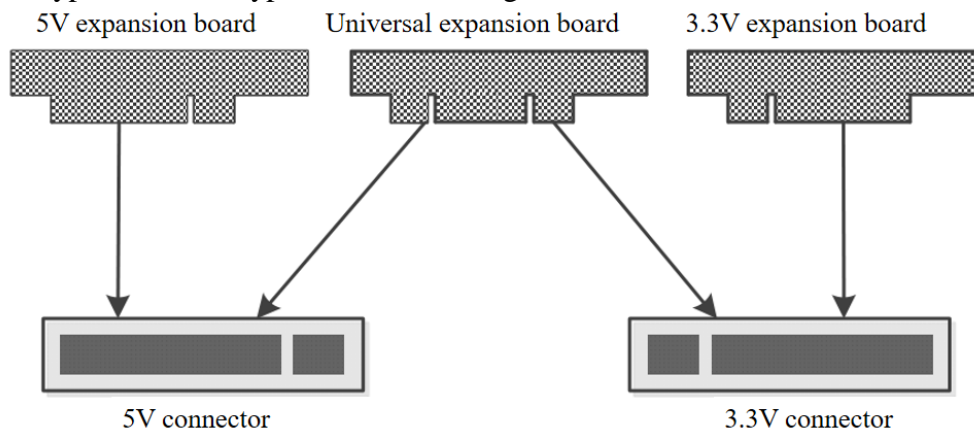

Figure 4 Connector type and board type

PCI local bus standard adopts the multiplexing mode of data and address bus, supports up to 66

MHz bus clock, allows up to 64 bit data parallel transmission, supports linear burst transmission and multi bus structure, and its maximum peak transmission speed can reach 528mb / s. PCI bus uses bridging technology to maintain the compatibility with traditional bus standards such as MAC, VESA, EISA and SIA, so that high-performance PCI bus coexists with traditional bus standards, especially SIA bus.

After the chassis output power detection station receives the vehicle inspection application information, the system automatically enters the detection preparation state. At this time, the system prompts the conductor to drive the vehicle to be tested into the chassis dynamometer by controlling the LED display screen. After the vehicle drives into the chassis dynamometer, the photoelectric switch sensors on both sides of the chassis dynamometer judge whether the vehicle is in place. If it is in place, the vehicle blocks the photoelectric switch, and the system will detect it. After the system detects that the vehicle is in place, the system controls the lifting device of the chassis dynamometer to descend, and the system will automatically conduct the chassis output power detection interface. The vehicle chassis power detection and control system is a system with complex control, multiple functions, high real-time and accuracy requirements [11]. According to the automobile chassis power detection standard, the system should be able to set system parameters, measure and dispatch in real time. In terms of control, it should also quickly and accurately detect the vehicle in place, the lifting of console frame, and control the excitation current of eddy current machine. At the same time, the system prompts the driver to accelerate the vehicle to the dynamometer through the LED display screen. The system measures the driving force and speed of the vehicle through the pull-up pressure sensor and speed sensor of the chassis dynamometer. The software records the driving force and speed data and writes them into the detection result database at the same time. After the test, the system controls the lifting device of the chassis dynamometer to rise, and the vehicle drives away from the dynamometer.

4. Conclusions

This paper analyzes the whole vehicle chassis output power detection system from two aspects of application background and technical background, puts forward the overall structure of the chassis output power detection system developed in this paper, and then describes the implementation process of the system in detail from three aspects of hardware, software and control strategy, The detection theory and method of automobile chassis output power are studied. On this basis, the overall scheme of the whole vehicle measurement and control system of chassis output power developed in this paper is given, including system function requirements analysis, performance requirements, overall structure and workflow of software and hardware, etc.

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