Study on the problem of unlocking P block of car

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Abstract: In view of the market problem that the P gear of a certain model cannot be unlocked, through a detailed fault tree analysis of various influencing factors, the control mechanism and transmission control software are optimized to improve the vehicle shift performance and provide a reference for solving similar problems in the later stage.

1. Introduction

Automatic car P block cannot unlock is one of the common problems in the current car market, different cars have different solutions. This article is mainly aimed at a kind of automatic SUV in actual use process, operating mechanism P block cannot unlock problems, main show is: when drivers drive from P cover on D P can't hang out, instrument light transmission, autohold trouble light, TCU fault code P1760, electrical breakdown is still up and down again, must begin immediately after broken battery electric back to normal.

2. Analysis

Through the contact and communication with the market customers, according to the feedback from the market, the faulty vehicles are reported with the fault code P1760 (the position signal of the shift handle is inconsistent with the logic of taking the reverse signal of the position of the shift handle), and the gear is locked. The analysis of P1760 fault code indicates that the logic of TCU lasts for 50ms, and the logical GEARLEVPOS and GEARLEVPOSINV signals cannot be read from CAN. The specific logic is shown in Figure 1.

Fig. 1 Fault logic diagram
As shown in the figure above, according to the fault logic of P1760, FTA tool was used to analyze relevant factors and check Fig. 2 one by one, and the cause of the problem was finally determined. The control mechanism was referred to as SLC and the transmission control unit TCU. 

Fig. 2 Fault tree analysis

2.1 The shift drawing card is broken
Some customers' faulty vehicles were disassembled and inspected, and the gear shifting and wire drawing assembly was in good condition, as shown in Figure 3. Meanwhile, if the wire drawing card was broken, the specific fault phenomenon should be permanent gear lock, and it could not be recovered after restarting, so this reason can be eliminated.

2.2 Loose connector
Disassembly and inspection were carried out for some customers' faulty vehicles. The connectors were not loose, and the faulty parts were returned to the supplier for testing. The gear shifting mechanism functioned normally, and the connectors' pins had no wrong connection, short circuit and other problems, as shown in Figure 4. Therefore, the loose connector is not the cause of the fault.

Fig. 3 Assembling state diagram of shifter drawing
Fig. 4 Connector photo
2.3 TCU fault handling mechanism
Unable to read logically correct GEARLEVPOS and GEARLEVPOSINV signals from CAN for 50ms of TCU. The fault tolerance time is too short, and the restart time after the SLC internal program is abnormal is at least 85ms, according to this logic, the fault will not be able to recover, it is suggested to lengthen the fault tolerance time.

2.4 Abnormal braking signal
Read the vehicle history fault code, there is no abnormal fault of the brake signal, repeatedly step on the brake pedal, it can be confirmed that the fault vehicle brake signal function is normal. The signal test is shown in Figure 6.

2.5 Start the check
At the moment of startup, the power voltage of the vehicle decreases and the SLC chip restarts. According to the standard, the SLC was subjected to the transient disturbance rejection test of the power line to simulate the condition of power supply voltage reduction. The experimental picture is shown in Figure 5.

![Fig. 5 Immunity test](image)

As can be seen by the above, in the process of test, the power supply voltage down to 2 ms after 5 v, SLC chip to restart, restart time of 200 ms, TCU for 200 ms cannot receive to block a signal sent by a SLC, gearbox trouble light light, fault code P1760, at the same time TCU gear might be forwarded to the gateway signals as invalid, the ESC receives the TCU forwarding invalid block is light Autohold, steep slope, slow down trouble light. Therefore, the power supply voltage of the vehicle decreased at the moment of startup, and the restart of SLC chip was the main cause of the fault.

2.6 Inspection of SLC body tacking points
The dashboard frame of the market breakdown vehicle should be in the state of electrophoresis, and there is no defective lapping caused by rust phenomenon.

2.7 SLC insurance screening
A. Plugging and unplugging KL30 insurance, simulating insurance transient break: BUSOFF occurs on CAN bus, and the gateway cannot receive and send messages normally, which is inconsistent with the fault phenomenon of the customer's car and is not the cause of the fault.

B. Plug and unplug KL15 insurance to simulate insurance instantaneous break
TCU reported the communication interruption fault with SLC, but there was no indication on the instrument, which was inconsistent with the fault phenomenon of the customer's car and was not the cause of the fault (as shown in Figure 7).
By analyzing these problems, and finally confirm the cause of the problem is: the vehicle starting instant battery voltage is too low, operation internal chip to restart, restart time of 200 ms, and TCU within 50 ms cannot receive the operating mechanism of block a signal will be quoted P1760 fault code correctly, at the same time to the CAN bus signal invalid block, the ESC to recognize the invalid block signal after autohold fault lights, tests are picked out.

3. Formulate measures
According to the cause analysis of the problem, the final implementation plan (see Table 1 for details) is as follows:

Optimization of TCU fault handling mechanism: TCU cannot receive the correct gear signal of the control mechanism within 50ms, that is, the transmission fault light is lit, and the fault tolerance time is too short. The fault code reporting time of P1760 was increased to 100ms by TCU software version upgrade.

Table 1 Schema list

| parts     | Schemes                                      | Measures                                      |
|-----------|----------------------------------------------|-----------------------------------------------|
| Hardware  | Peripheral capacitance of LDO module increased | Capacitance: increased from 10uF to 220uF     |
|           | Optimization of RESET circuit (adding capacitance and pull-up resistance) | Increase 100NF capacitance and 10K pull-up resistor suspended Reset pin |
|           | Power chip Reset pin suspended               |                                               |
|           | Increase the capacitance of the lampboard circuit. | Increase the capacitance by 100N |
|           | Replace the varistor with a TVS tube         | Change varistor to TVS tube                   |
| Software  | Disable the GearLeverr (block error signal) set 1 policy | The SLC only records the DTC internally, and the GearLeverr signal is always kept at 0 |
|           | The lower limit of voltage failure is changed to 6.5V | The voltage limit of 8.5V was changed to 6.5V |
|           | SLC power initialization time changed to 70ms | Reset time changed from 190ms to 70ms         |

4. Test Verification
For the control mechanism SLC circuit board hardware optimization and software upgrade, according
to the rectification plan, the reset voltage and restart time of the control mechanism were tested. The test plan is shown in Table 2.

| Table 2 Test protocol |
|-----------------------|
| Part name.            | Automatic shift motherboard PCBA |
| Drawing no.           | 6025303                            |
| Part quantity         | 1                                   |
| Part Production Level | Experimental / other test          |
| The Test type         | PCBA low voltage/power on reset    |
| Test the Comment      | A7 version                          |

Equipment and used: programmable power supply, oscilloscope

Test method:
1. The power supply voltage BAT is slowly adjusted to a certain voltage, and the oscillator stops vibration. The time between reaching the voltage and the oscillator stops is measured.
2. Supply voltage drops to OV, measure the time between the drop position and the oscillator stop.
3. BAT rises sharply from OV to 12V and measures the time between this position and the start of packet transmission.

According to the above requirements, the test results show that: the time from the restart of the chip to the normal message sending :85ms; The chip was reset 174ms after voltage drop to 3.72V.

5. Conclusion
The problem that P block cannot be removed is a major fault point for customers to complain about at present, especially in the condition of emergency vehicles. This time, through the rectification of the problem that cannot be removed by the project P, the problem has been successfully solved and the goal has been achieved through months of fault cause investigation and multi-scheme verification. At the same time, the project team members have accumulated experience in such system problems.

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Reference
[1] Jia-rui Chen. Vehicle Structure [M], Version 4. Beijing: People's Communications Press, 2002:46 -- 75.
[2] Kang Zhanquan, Design of Automotive Engineering Manual [K], Beijing: People's Communications Press, 2001.5
[3] Xu huadong. Study on Automobile Fault Diagnosis ExPert System Based on Fault Tree Analysis[D]. Hefei:Hefei University of Technology.2002.
[4] Zhang Jun, Zhang Weizhong, Li Hongling. Optimization Design of Transmission Parameters Based on Fault Tree Analysis[J]. 2020,23(3):40-46.
[5] WEI Xuanping, BIAN Shutan. Theory and Applicaiton of Fault Tree Analysis[J]. Computer science and technology. 2004,6:43-46.