Design of dual mode power supply distribution circuit with detection and control functions

Fengge Wang*, Ji Fan, Baohua Wang, Yuyun Zeng, Xiaoming Chen, Ying Lu, and Haiwen Wang
Northwest institute of Mechanical &Electrical Engineering, Xianyang 712099, China

Keywords: The generator, Battery, Mode conversion, Anti-loss detection, Control.

Abstract. Aiming at single mode of Underpan generator power supply, and the feature of being not meet the regular work of system under special working conditions, engine fuel exhaustion, unexpected faults, Design of Dual Mode Power Supply Distribution Circuit With Detection And Control Functions which includes Battery power, power distribution module, anti-diode, generator detection module, underpan on-off control module, Battery anti-loss detection module was proposed. The tests show that the generator power supply mode and battery power supply mode can convert freely, and the Supply Distribution Circuit is stable and reliable.

1 Introduction

Underpan generator Power Supply Distribution circuit because of its simple structure, without additional generator, cost and weight, space required, is widely used in military, civil and industry vehicle power supply and distribution system. It has a good development prospect. In order to work normally under special working conditions, engine fuel exhaustion, unexpected faults and other conditions, this paper proposes a vehicle power supply and distribution circuit with Battery anti-loss detection and underpan generator on-off control functions, the system includes generator power supply mode and battery power supply mode, which can be converted freely without gaps. At the same time, through anti-reaction, filtering, anti-surge and DC/DC processing, meet the needs of different electrical equipment.

2 The design of dual mode power supply distribution circuit

2.1 The circuit structure of dual mode power supply distribution circuit

The system of dual mode Power Supply Distribution circuit includes Underpan generator, Underpan battery, Battery power, power distribution module, generator detection module,
anti-diode, underpan on-off control module, Battery anti-loss detection module. The circuit structure block diagram is shown in figure 1.

2.2 Dual mode power supply distribution circuit

Power supply and distribution system is divided into the generator power supply mode and battery power supply mode, the generator power supply mode: when underpan generator in normal condition, the engine driven generator, battery charge, generator give stable and reliable DC28V voltage to distribution module, which according to the distribution demand of the device through the socket output, transmission to the devices. Battery power supply mode: in the case of special requirements of certain working conditions, exhaustion of generator oil, unexpected faults, the generator stops generating electricity, and the battery group automatically converts as power supply voltage, and transmits it to the distribution module, so as to ensure the normal operation of each device in a short time. The block diagram of dual-mode power supply and distribution is shown in figure 2.

3 Design of modules

3.1 Design of underpan on-off control module
The underpan on-off control module is mainly used to keep the underpan generator and underpan battery connected in the normal working state; disconnect the underpan generator and underpan battery in the idle state to ensure that the underpan battery contains enough power to start the underpan engine.

Underpan on-off control module include normally closed relay and related peripheral components. in the normal working state, the detection result of Generator detection module[2] is low and the relay is in a closed state. in the idle state, the detection result is high and the relay is disconnected.

### 3.2 Design of battery anti-loss detection module

Battery anti-loss detection module mainly detects the voltage of the battery, gives warning and reminder to ensure reasonable use. The module mainly consists of four parts: DC/DC, sampling circuit, comparative amplification and warning reminder. The DC/DC convert 28V to 5V providing power for the amplifier and all branches; The sampling circuit is mainly used to take the voltage of the accumulator in proportion as the positive input of the comparison amplifier; The comparison amplifier mainly amplifies the sampled voltage and fixed voltage, the output results are used as the negative voltage of the led to warn and remind whether the battery is loss [3] [4]. The circuit diagram is shown in figure 3.

![Battery loss prevention detection circuit](image)

**Fig. 3.** Battery loss prevention detection circuit.

\[
V_\text{+} = V\text{battery} \cdot \frac{R_2}{R_1+R_2} \quad (1)
\]

\[
V_- = 5 \cdot \frac{R_5}{R_4+R_5} \quad (2)
\]

\[
\text{if} \quad V_\text{+} = V_- \quad \Rightarrow \quad V\text{battery} \cdot \frac{R_2}{R_1+R_2} = 5 \cdot \frac{R_5}{R_4+R_5} \quad (3)
\]
put “R1=80k, R2=20k” values into formula (3) get 

\[ V_{\text{battery}} = 25 - \frac{R_5}{R_4} \]  \hspace{1cm} (4)

\[ \frac{R_5}{R_4} = \frac{V_{\text{battery}}}{25-V_{\text{battery}}} \]  \hspace{1cm} (5)

According to the temperature, battery life, determine the loss voltage of the battery, and then the value of R5 / R4. The loss voltage of the battery and the value of R5 / R4 is shown in table 1.

<table>
<thead>
<tr>
<th>V_{\text{battery}} loss</th>
<th>\frac{R_5}{R_4}</th>
<th>V_{\text{battery}} loss</th>
<th>\frac{R_5}{R_4}</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>24</td>
<td>21.5</td>
<td>6.1</td>
</tr>
<tr>
<td>23.5</td>
<td>16</td>
<td>21</td>
<td>5.3</td>
</tr>
<tr>
<td>23</td>
<td>11.5</td>
<td>20.5</td>
<td>4.6</td>
</tr>
<tr>
<td>22.5</td>
<td>9</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>22</td>
<td>7.3</td>
<td>19.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

3.3 Design of power distribution module

The distribution module mainly distributes voltage to each electrical equipment as required, includes anti-reaction device, filter surge suppressor, relay, DC/DC power conversion and related peripheral devices. Circuit diagram of distribution module is shown in figure 4.

Fig. 4. Circuit diagram of distribution module.

4 Summary

In this paper, a dual-mode power supply and distribution circuit with detection and control functions is designed. The application circuit is shown in figure 5. At present, this power supply and distribution circuit has been applied in multiple vehicle-mounted systems, which can be freely converted. Underpan on-off control module for the underpan engine ignition start provides a strong guarantee; The battery anti-loss detection module can detect the state of the battery power supply at any time, and the loss voltage value can be reasonably set according to the actual situation[5][6]. The test and application show that the power supply and distribution system is stable, reliable, dual-mode and has detection and control functions, which can meet the power supply and distribution requirements of various vehicle systems.
According to the temperature, battery life, determine the loss voltage of the battery, and then the value of $R_5 / R_4$. The loss voltage of the battery and the value of $R_5 / R_4$ is shown in Table 1.

### Table 1. V_battery loss and Value of $R_5/R_4$

<table>
<thead>
<tr>
<th>V_battery loss</th>
<th>R_5</th>
<th>R_4</th>
<th>R_5 / R_4</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>24</td>
<td>21.5</td>
<td>6.1</td>
</tr>
<tr>
<td>23.5</td>
<td>16</td>
<td>21</td>
<td>5.3</td>
</tr>
<tr>
<td>23</td>
<td>11.5</td>
<td>20.5</td>
<td>4.6</td>
</tr>
<tr>
<td>22.5</td>
<td>9</td>
<td>20</td>
<td>4.0</td>
</tr>
<tr>
<td>22</td>
<td>7.3</td>
<td>19.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

#### Design of power distribution module

The distribution module mainly distributes voltage to each electrical equipment as required, includes anti-reaction device, filter surge suppressor, relay, DC/DC power conversion and related peripheral devices. Circuit diagram of distribution module is shown in figure 4.

### Fig. 4. Circuit diagram of distribution module.

#### 4. Summary

In this paper, a dual-mode power supply and distribution circuit with detection and control functions is designed. The application circuit is shown in figure 5. At present, this power supply and distribution circuit has been applied in multiple vehicle-mounted systems, which can be freely converted. Underpan on-off control module for the underpan engine ignition start provides a strong guarantee; the battery anti-loss detection module can detect the state of the battery power supply at any time, and the loss voltage value can be reasonably set according to the actual situation [5][6]. The test and application show that the power supply and distribution system is stable, reliable, dual-mode and has detection and control functions, which can meet the power supply and distribution requirements of various vehicle systems.

### References