

Analysis of the Application of Wide Electrode Thick Film Chip Resistors in Automobiles

§0 . Abstract

Chip resistors have now become one of the most commonly used components in electronic circuits. However, due to the structure, layering, and terminal electrode detachment of the chip resistor body, any operation that may cause bending deformation during the assembly and use of the device may lead to resistor cracking. In response to these adverse phenomena, our company has developed a wide electrode product. The electrode size of this product is wider than that of ordinary ones, and it has characteristics such as good solderability, high bending strength, and good reliability.

§1 . Introduction of Wide Electrode Thick Film Chip Resistors

WR series products have the same small size of ordinary products which can save space. The research object of wide electrode resistor is to change the electrode length (L) and electrode width (W) of ordinary products into the electrode width W 'and electrode length L', respectively. The purpose of printing long size of electrode on the same size of resistor is to reduce the effect of mechanical stress after temperature changes, i.e. the thermal dissipation capacity of the resistor length is enhanced.

The comparison of power performance between wide electrode thick film chip resistors and ordinary thick film chip resistors is as follows:

Spec.		Power		Resistance value range
Special characteristics	Size	WR Series	Ordinary thick film	
	0508	1/3W	1/8W	10R~1M
	0612	1/2W	1/4W	
	1020	1W	3/4W	
	1218	1W	/	
	1225	2W	1W	
	WR series wide electrode resistors have superior characteristics compared to ordinary ones			

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§2 . Introduction of the Structure of Wide Electrode Chip Resistors

2.1 Design Principle

WR series products have the same small size of ordinary products which can save space. The research object of wide electrode resistors is to change the electrode length and electrode width of ordinary products into the electrode width and electrode length, respectively. The purpose of printing long size of electrode on the same size of resistor is to reduce the effect of mechanical stress after temperature changes, i.e. the thermal dissipation capacity of the resistor length is enhanced.

Our company improves the product's solderability and pulse resistance by increasing the length of electrode. Therefore, the electrode design dimension of wide electrode chip resistors is different:

WR series resistors	L : 2.00 ± 0.15 mm	W : 0.40 ± 0.20 mm
Ordinary thick film chip resistors	L : 0.40 ± 0.20 mm	W : 2.00 ± 0.15 mm

2.2 Printing process

2.2.1 Take marking 104 as an example:

Pattern change	WR (reinforced) series	Ordinary thick film chip resistors
Thickness of top electrode	 <p>The size of the top electrode printed on the wide electrode product with marking 104 is bigger.</p>	 <p>The electrode pattern of ordinary thick film product is like a mountain, and the size of the top electrode is relatively small</p>
Summary	<p>With bigger top electrode pattern, WR (reinforced) series resistors have better solderability than ordinary thick film chip resistors.</p>	

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§3 . Electrode strength of Wide Electrode Chip Resistors

3.1 Terminal bending resistance

- a. Test standard basis JIS-C-5201 4.33
- b. Test quantity 5mm 60S 20 pcs

Take WR06 (reinforced product) as an example of wide electrode chip resistor and 1206 as an example of ordinary thick film chip resistors:

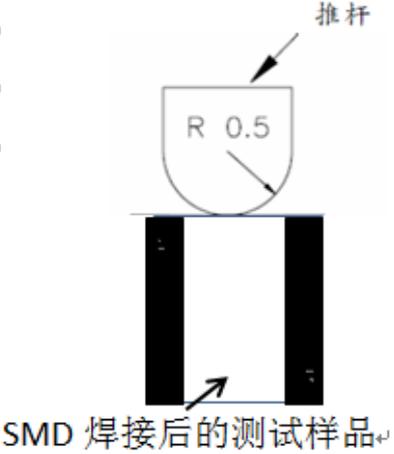
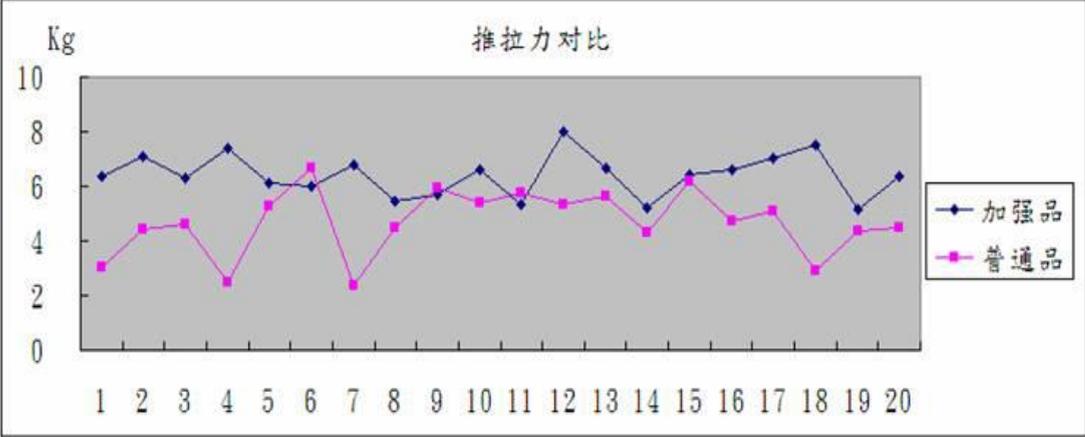
Test item	Bending test machine	Bending test board																																																															
Terminal bending																																																																	
Test result	 <table border="1"> <caption>抗弯折变形力对比 (Deformation Comparison)</caption> <thead> <tr> <th>Sample No.</th> <th>Reinforced Product (mm)</th> <th>Ordinary Product (mm)</th> </tr> </thead> <tbody> <tr><td>1</td><td>9.0</td><td>7.0</td></tr> <tr><td>2</td><td>8.0</td><td>6.0</td></tr> <tr><td>3</td><td>9.0</td><td>7.0</td></tr> <tr><td>4</td><td>9.0</td><td>7.0</td></tr> <tr><td>5</td><td>11.0</td><td>8.0</td></tr> <tr><td>6</td><td>10.0</td><td>6.0</td></tr> <tr><td>7</td><td>11.0</td><td>8.0</td></tr> <tr><td>8</td><td>10.0</td><td>6.0</td></tr> <tr><td>9</td><td>10.0</td><td>6.0</td></tr> <tr><td>10</td><td>11.0</td><td>6.0</td></tr> <tr><td>11</td><td>11.0</td><td>8.0</td></tr> <tr><td>12</td><td>9.0</td><td>7.0</td></tr> <tr><td>13</td><td>9.0</td><td>6.0</td></tr> <tr><td>14</td><td>10.0</td><td>6.0</td></tr> <tr><td>15</td><td>9.0</td><td>8.0</td></tr> <tr><td>16</td><td>8.0</td><td>7.0</td></tr> <tr><td>17</td><td>9.0</td><td>6.0</td></tr> <tr><td>18</td><td>9.0</td><td>7.0</td></tr> <tr><td>19</td><td>9.0</td><td>6.0</td></tr> <tr><td>20</td><td>9.0</td><td>8.0</td></tr> </tbody> </table>		Sample No.	Reinforced Product (mm)	Ordinary Product (mm)	1	9.0	7.0	2	8.0	6.0	3	9.0	7.0	4	9.0	7.0	5	11.0	8.0	6	10.0	6.0	7	11.0	8.0	8	10.0	6.0	9	10.0	6.0	10	11.0	6.0	11	11.0	8.0	12	9.0	7.0	13	9.0	6.0	14	10.0	6.0	15	9.0	8.0	16	8.0	7.0	17	9.0	6.0	18	9.0	7.0	19	9.0	6.0	20	9.0	8.0
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3.1.2 Terminal push

a. Test standard basis JIS-C-5201 4.32

b. Test quantity 20pcs

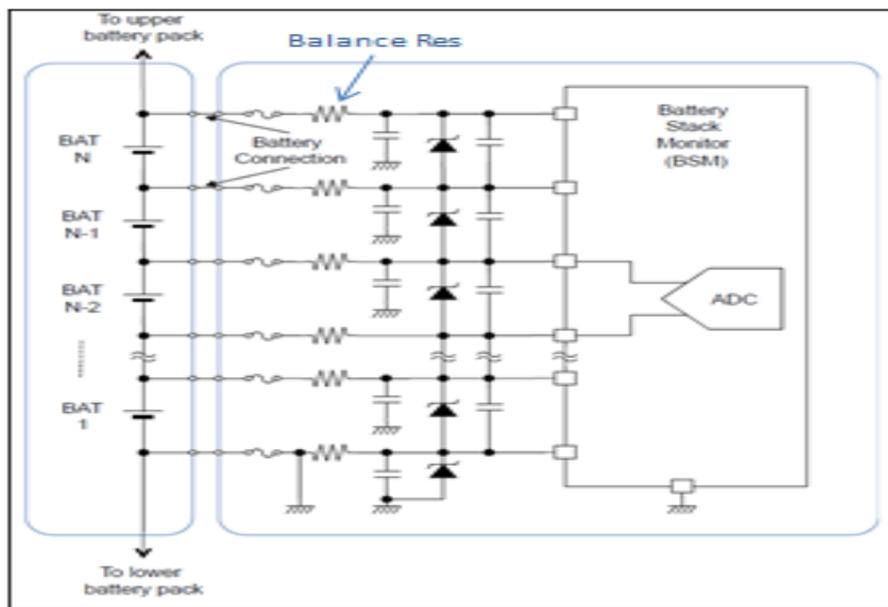
Test item	Test product after soldering																																																															
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Test result	 <table border="1"> <caption>推拉力对比 (Kg)</caption> <thead> <tr> <th>Sample No.</th> <th>加强品 (Kg)</th> <th>普通品 (Kg)</th> </tr> </thead> <tbody> <tr><td>1</td><td>6.5</td><td>3.2</td></tr> <tr><td>2</td><td>7.2</td><td>4.5</td></tr> <tr><td>3</td><td>6.5</td><td>4.8</td></tr> <tr><td>4</td><td>7.5</td><td>2.5</td></tr> <tr><td>5</td><td>6.2</td><td>5.5</td></tr> <tr><td>6</td><td>6.0</td><td>6.8</td></tr> <tr><td>7</td><td>7.0</td><td>2.5</td></tr> <tr><td>8</td><td>5.5</td><td>4.5</td></tr> <tr><td>9</td><td>5.8</td><td>6.0</td></tr> <tr><td>10</td><td>6.8</td><td>5.5</td></tr> <tr><td>11</td><td>5.5</td><td>5.8</td></tr> <tr><td>12</td><td>8.0</td><td>5.5</td></tr> <tr><td>13</td><td>6.8</td><td>5.8</td></tr> <tr><td>14</td><td>5.2</td><td>4.5</td></tr> <tr><td>15</td><td>6.5</td><td>6.5</td></tr> <tr><td>16</td><td>6.8</td><td>4.8</td></tr> <tr><td>17</td><td>7.2</td><td>5.2</td></tr> <tr><td>18</td><td>7.5</td><td>3.2</td></tr> <tr><td>19</td><td>5.2</td><td>4.5</td></tr> <tr><td>20</td><td>6.5</td><td>4.5</td></tr> </tbody> </table>	Sample No.	加强品 (Kg)	普通品 (Kg)	1	6.5	3.2	2	7.2	4.5	3	6.5	4.8	4	7.5	2.5	5	6.2	5.5	6	6.0	6.8	7	7.0	2.5	8	5.5	4.5	9	5.8	6.0	10	6.8	5.5	11	5.5	5.8	12	8.0	5.5	13	6.8	5.8	14	5.2	4.5	15	6.5	6.5	16	6.8	4.8	17	7.2	5.2	18	7.5	3.2	19	5.2	4.5	20	6.5	4.5
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Conclusion	WR (reinforced) series products have greater bending resistance and better reliability																																																															

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§4 . Application of Wide Electrode Thick Film Chip Resistors in Automobiles

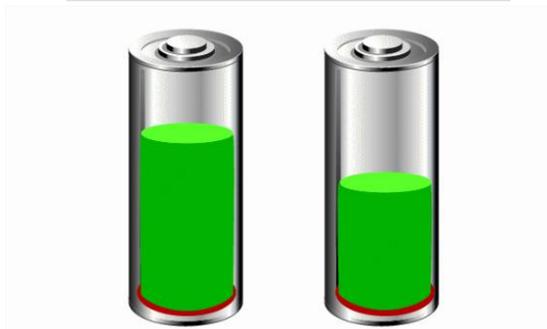
4.1 Take automotive battery as an example

In the earliest schemes, MELF resistors were usually used as equalizer resistors. The voltage of a ternary lithium battery is 3.65V and the circuit is usually connected in series with a fuse, a resistor, and a ceramic capacitor. The commonly used resistance values are 33R, 36R, 39R, 47R, 51R, and the wide electrode resistor sizes (power) are 0612 (1W or 0.75W) and 1020 (1W), respectively; Due to procurement channels and other reasons, more and more wide electrode thick film chip resistors are being used now; The circuit schematic diagram is shown in the following figure:

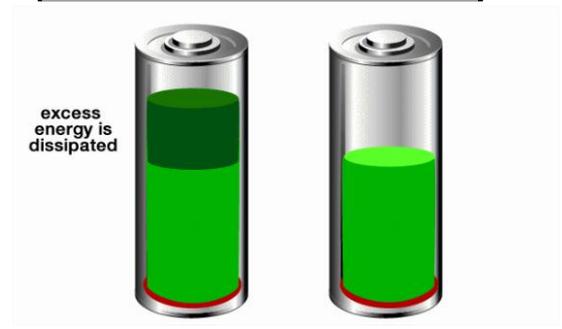


During the use of automotive batteries, there may be inconsistent battery levels, resulting in batteries with high battery capacity not being able to fully discharge; batteries with low battery capacity cannot be fully charged. The WR series resistors can dissipate excess power onto other resistor to achieve battery balance, thereby regaining the ability to fully charge the battery and achieve full charging.

Automotive batteries cannot be fully charged



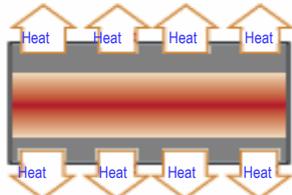
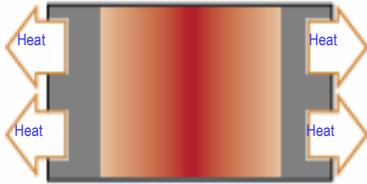
Automotive batteries can be fully charged



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4.2 Characteristics of Wide Electrode Thick Film Chip Resistors in Automobiles

The WR series resistors have a bigger electrode pattern than that of ordinary thick film chip resistors which can save space. Besides, their high rated power characteristic of thermal dissipation is stronger than that of ordinary resistors.

Characteristic	WR series	Ordinary thick film chip resistors
Degree of electrode heat dissipation	 <p>Enhanced heat dissipation capacity on electrodes</p>	
Summary	The WR series resistors have stronger high rated power characteristic of thermal dissipation than that of ordinary resistors.	

In addition to the above applications, wide electrodes resistors are widely used in automotive engine control units, circuit boards and dashboards.

Application examples:

a. Automotive Engine Control



b. PCB



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C. Dashboard**§5 . Summary**

Compared to ordinary products, the biggest feature of the WR series resistors is their enhanced thermal dissipation capacity of the resistor length. Our company changes the electrode length and electrode width of ordinary products with the same size to the electrode width W' and electrode length L' of wide electrode chip resistors. Changing the electrode size of the resistor body i.e. increasing the electrode size, and printing lengthened electrode on the vehicle can reduce the impact of mechanical stress after temperature changes, i.e. enhance the thermal dissipation capacity of the resistor length.