

高壓厚膜貼片電阻器的應用

Application of High-Voltage Thick Film Chip Resistors

§0 . 摘要 Abstract

随着科技的进步，时代的发展及人们对电子产品小型化要求的不断提升，性能可靠及工艺稳定的厚膜贴片电阻也应电子产品的特性需求呈现着多样化的发展趋势，故本廠根據客戶及市場要求開發一款贴片电阻:高壓厚膜贴片電阻器（HV 系列），此產品：特殊的高壓設計結構、優越的抗靜電特性、高可靠性、耐高電壓，較普通產品可減少安裝面積節約成本。

With the advancement of technology, the development of the times, and the continuous improvement of people's requirements for miniaturization of electronic products, thick film chip resistors with reliable performance and stable technology are also showing a diversified development trend according to the characteristics of electronic products. Therefore, our factory has developed a chip resistor based on customer and market requirements: high-voltage thick film chip resistors (HV series). This product has a special high-voltage design structure, superior anti-static characteristics, high reliability and high voltage resistance, which can reduce installation area and save costs compared to ordinary products.

§1 . HV 系列—高壓厚膜貼片電阻器介紹

Introduction of HV Series——High-Voltage Thick Film Chip Resistors

高壓產品的研究對象是普通產品臨界值以上的電壓。據悉，同樣的膏品系列進行印刷，其電阻在單位長度上的耐壓是一樣的。電阻阻值不變，但電阻體本身尺寸發生變化，類似電路的分壓原理，將改變整個電阻體所能承受的電壓極限。

The research object of high-voltage products is the voltage above the critical value of ordinary products. It is reported that for printing with the same paste series, the withstanding voltage per unit length of the resistor is the same. The resistance value remains unchanged, but the size of the resistor body itself changes, similar to the voltage sharing principle of a circuit, which will change the voltage limit that the entire resistor body can withstand.

高壓厚膜貼片電阻器與普通厚膜貼片電阻器電壓性能的對比，具體如下：

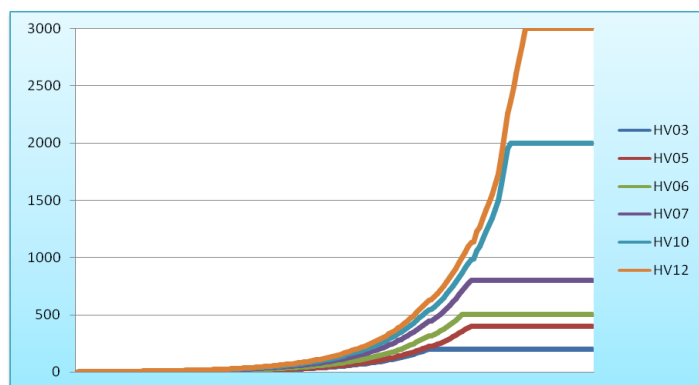
The comparison of voltage performance between high-voltage thick film chip resistors and ordinary thick film chip resistors is as follows:

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對比 Comparison		HV 系列 HV Series		普通厚膜 Ordinary thick film chip resistors	
特殊特性 Special characteristics	尺寸 Dimension	最大工作電壓 Max working voltage	最大過負荷電壓 Max overload voltage	最大工作電壓 Max working voltage	最大過負荷電壓 Max overload voltage
	0603	200V	400V	75V	150V
	0805	400V	800V	150V	300V
	1206	500V	1000V	200V	400V
	1210	800V	1500V	200V	500V
	2010	2000V	3000V	200V	500V
	2512	3000V	4000V	200V	500V
	HV 系列耐高電壓特性最少是普通產品 2 倍 The withstanding voltage of HV series is at least 2 times of that of ordinary products				

HV 系列最大工作電壓曲線如下：

Max working voltage curve of HV series is as below :



說明：以大尺寸為例，普通產品的 2512 最大工作電壓為 200V，對應的臨界阻值是 40K；而 HV12 的最大工作電壓（3000V）對應阻值為 9M1。此時，高阻的 HV 產品優勢就盡顯無疑，相對低阻的高壓則是沒有意義的。

Explanation: Taking large-sized products as an example, the maximum working voltage of ordinary 2512 products is 200V, and the corresponding critical resistance value is 40K; the maximum working voltage of HV12 (3000V) corresponds to a resistance value of 9M1. At this point, the advantages of high resistance HV products are undoubtedly evident, while relatively low resistance high voltage is meaningless.

§2 . HV 系列—高壓厚膜貼片電阻器結構介紹

HV Series—Introduction of the Structure of High-Voltage Thick Film Chip Resistors

2.1 設計原理 Design principle:

高壓產品的研究對象是普通產品臨界值以上的電壓。據悉，同樣的膏品系列進行印刷，其電阻在單位長度上的耐壓是一樣的。電阻阻值不變，但電阻體本身尺寸發生變化，類似電路的分壓原理，將改變整個電阻體所能承受的電壓極限。

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The research object of high-voltage products is the voltage above the critical value of ordinary products. It is reported that for printing with the same paste series, the withstanding voltage per unit length of the resistor is the same. The resistance value remains unchanged, but the size of the resistor body itself changes, similar to the voltage sharing principle of a circuit, which will change the voltage limit that the entire resistor body can withstand.

我司通過增加電阻導電帶的長度來達到提高電壓的目的。因此，HV 產品的 R 設計圖形有所不同：

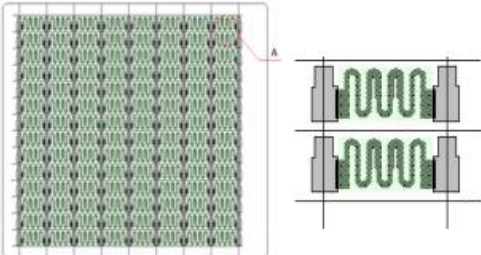
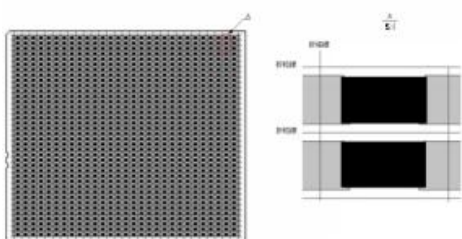
Our company aims to increase the voltage by increasing the length of the resistive conductive tape. Therefore, the R design graphics of HV products are different:

Ω 型 Ω shape HV03、HV05、HV06

蛇型 Snake-shape HV07、HV10、HV12

2.2 印刷(以 HV12 為例) Printing (Take HV12 as an example)

2.2.1 圖形變更 Graphic change

圖形變更 Graphic change	HV 系列 HV Series	普通厚膜 Ordinary Thick Film Chip Resistors
C1、R 圖形 C1、R graphics	<p>例如 Example : HV12</p>  <p>高壓產品 HV12 印刷 C1 是階梯型；R 則採用蛇型。R 尺寸更大，但橫截面積小 C1 printing of high voltage product HV12 is stepped type while R printing is snake-shape. R has a larger size but a smaller cross-sectional area.</p>	<p>例如 Example : 2512</p>  <p>普通產品的 2512 印刷 C1 和 R 都採用的是矩形。R 尺寸偏小 C1 and R printing of the ordinary product 2512 are all rectangles. R size is too small.</p>
小結 Summary	<p>小結：HV 較普通產品的印刷尺寸略大，但總體的橫截面積變小。 Summary: HV product has a larger printing area than that of an ordinary product but a smaller cross-sectional area on the whole.</p>	

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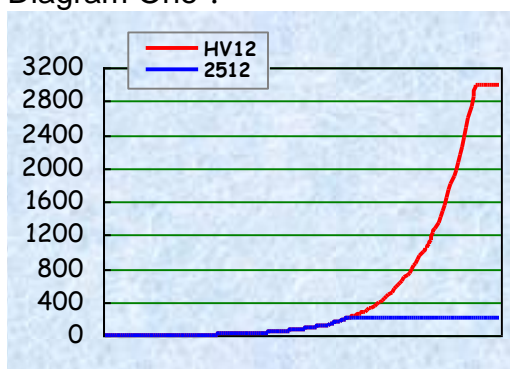
2.2.2 設計注意點 Design notes

易知，HV12 的工作電壓和短時間過負荷電壓較普通電阻的提升空間最大，倍數最高。具體見以下圖示：

It is obvious that the working voltage and short-term overload voltage of HV12 have the greatest potential for improvement compared to ordinary resistors, with the highest multiple.

Please refer to the following diagrams for details:

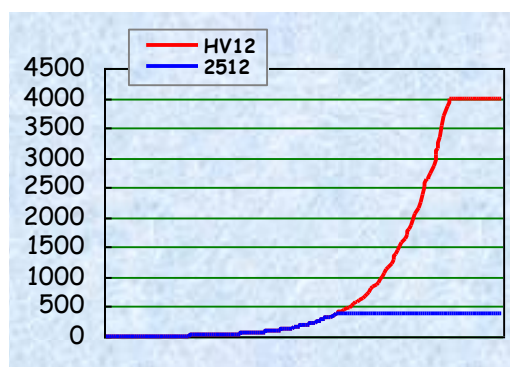
Diagram One :



工作電壓——高壓產品是普通產品的 15 倍。

Working voltage——HV product' s working voltage is 15 times of that of ordinary product

Diagram Two :



短時間過負荷電壓——高壓產品是普通產品 10 倍。

Short-time overload voltage——HV product' s short-time overload voltage is 10 times of that of ordinary product

故設計時需考慮印刷工藝對高壓性能的影響。主要是指打火花現象。當兩點之間距離過近，在導電介質（如空氣）中通過較高的電壓，可能會將兩點間的介質擊穿，從而出現火花。因此，設計時需盡可能做到：

Therefore, when designing, it is necessary to consider the impact of printing technology on high-voltage performance. Mainly refers to the phenomenon of sparking. When the distance between two points is too close, a higher voltage passing through a conductive medium (such as air) may cause the medium between the two points to break down, resulting in sparks. Therefore, it is necessary to achieve the following as much as possible during design:

拉大電極和電阻體的距離

Increase the distance between the electrode and the resistor body

由於 R 圖形的變化，需要修改 C1 的圖形與之相匹配。C1 階梯狀的設計，使得電極和電阻體之間的有效距離拉開。如圖示 L：

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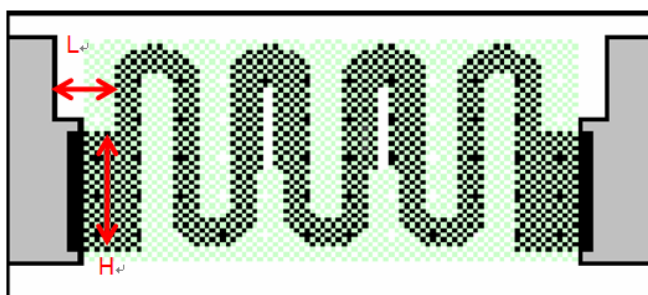
As R shape changes, it is necessary to modify the shape of C1 to match it. The C1 stepped design allows for an effective distance between the electrode and the resistor body. As shown in Figure L:

抬高電極與電阻體的搭接

Lift the overlap between the electrode and the resistor body

相比其他規格的 HV 產品，HV12 的導電帶更長，其蛇形蜿蜒更多，為使保證一定的散熱量，將 R 與 C1 的重迭處抬高，同時加大散熱帶的寬度，做好“補強”動作。如圖示 H：

Compared to specifications of other HV products, HV12 has a longer conductive strip with more snake twists. To ensure a certain amount of heat dissipation, the overlap of R and C1 is raised, and the width of the heat dissipation strip is increased. As shown in Figure H:



2.3 鐳射(以 HV12 為例) Laser (taking HV12 as an example)

根據電阻的決定式 According to the formula of resistance :
$$R = \rho \frac{L}{S}$$

電阻阻值與其長度成正比，當電阻體的導電帶加長后，為保證得到相同的阻值，現場印刷時必須選擇 R 膏系列中阻值較低的膏品。

The resistance value is proportional to its length. When the conductive strip of the resistor body is extended, in order to ensure the same resistance value, the paste with the lower resistance value in the R paste series must be selected for on-site printing.

HV 產品的鐳射和普通產品一樣，都是通過激光切割工藝修整電阻阻值。兩種產品鐳射切割的工藝參數除：
A 切割能量 0.5~5W；B 切線乾淨、無殘渣。

之外，其他控制標準略有差異。詳見下頁表格：

The laser of HV products, like ordinary products, is processed through laser trimming technology to adjust the resistance value. The process parameters for laser trimming of two products have to be A cutting energy of 0.5-5W and B trimming line is clean without residues. Besides, there are slight differences in other control standards. Details are as follows:

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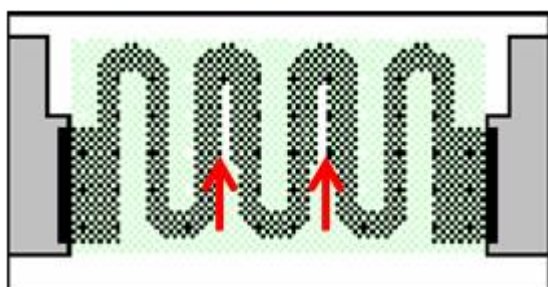
	HV12	普通 2512 Ordinary 2512	備註 Remarks
切割初值 Trimming initial value	0~-18%	0~-25%	
切線長度 Length of trimming line	70%以內 Within 70%	50%以內 Within 50%	切線占電阻寬度的比例 Ratio of trimming line to resistor width
切割方式 Trimming method	單刀切 Single trimming	L 型切 L-shape trimming	
切割位置 Trimming position	1/2 處	2/5 處	切線起刀在導電帶寬度的位置 The start position of trimming line is at the width of conductive strip

注：HV12 切線長度不大於 2.1mm，蛇形拐角的“A”值切割則不小於 0.3mm。

Note: Trimming line of HV12 is no longer than 2.1mm and the length of "A" value of the snake-shape corner trimming is no less than 0.3mm

對比 HV12 和普通產品的切割圖例：

Comparison of trimming patterns between HV12 and ordinary products:



§3 . HV 系列—高壓厚膜貼片電阻器的應用

HV series—application of high-voltage thick film chip resistors

➤高壓電源及高壓取樣電路

High voltage power supply and high voltage sampling circuit

➤靜電漏放回路

Electrostatic leakage return circuit

高壓厚膜貼片電阻器的應用

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►LCD 背光電路

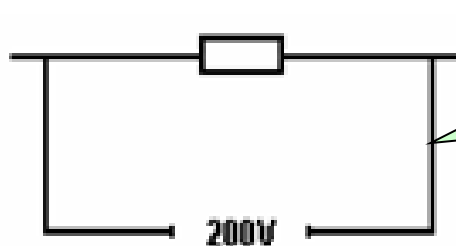
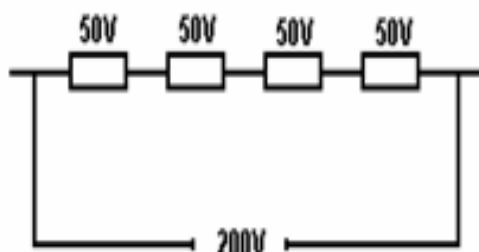
LCD backlight circuit

►照相機的閃光電路

The Flash Circuit of Cameras

►LED 燈控制線路

LED light control circuit

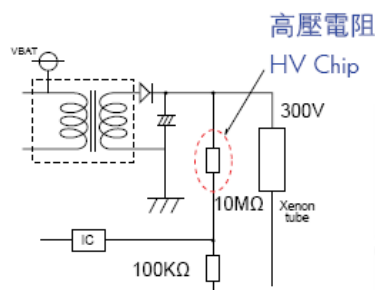


可減少安裝空間
Can reduce
installation space

應用舉例 Application examples :

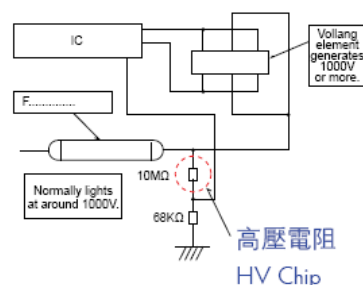
a. 於照相機閃光電路

In camera flash circuit



b. 用於顯示器背光燈的轉換電路

Conversion circuit for display backlight



§ 4. 總結 Summary

HV 高壓系列產品，相較普通產品的最大特色就是可以承受更大的工作電壓和短時間過負荷電壓。由於受時間的限制，一般試驗驗證從短時間的過負荷電壓開始。

The biggest feature of the HV high-voltage series products compared to ordinary products is



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that they can withstand larger working voltages and short-term overload voltages. Due to time constraints, the general test verification starts with a short-time overload voltage.

我司通過改變尺寸圖形和鐳射切割方式，增加電阻的導電帶，來增強電阻的耐壓性能。

Our company enhances the withstanding voltage performance by changing the size pattern and laser cutting method, and adding conductive strips of the resistor.

R 印刷圖形的改變需要配套的 C1 尺寸變化，為解決高壓散熱及穩定性問題，HV12 需進行兩次的 C1 印刷，並增大散熱帶寬度。為保證高壓產品更好的絕緣性，G1 要求完全覆蓋住 R 層（普通產品 G1 只蓋住 R 的有效面積）。此外，HV 產品針對的是高阻段，低阻的高壓是沒有意義的。

The change in R printing patterns requires a corresponding C1 size change. To solve the problems of high voltage heat dissipation and stability, HV12 product needs to undergo two C1 printing operations and increase the width of the heat dissipation strip. To ensure better insulation of high-voltage products, G1 layer has to complete cover of the R layer (ordinary product G1 only covers the effective area of R). In addition, HV products are targeted at high resistance sections, and low resistance high voltage is meaningless.