Application of Anti-Surge Thick Film Chip Resistors

§0．Abstract

With the advancement of technology and the continuous increase in the variety of new electronic products, the demand for pulse resistance for various types of chip resistors is also increasing. There are single pulse waves, multiple pulse waves, and continuously changing pulse waveforms. In order to make it easier for customers to make reasonable choices about the pulse resistance performance of our products, this data is compiled to facilitate customer selection.

§1．Introduction of Anti-Surge Resistors

In electronic design, surges mainly refer to the strong pulses generated at the moment when the power supply (mainly referring to the power supply) is just turned on. Due to the possibility of the linearity of the circuit itself being higher than the pulses of the power supply itself; or due to the interference of internal or external sharp pulses on the power supply or other parts of the circuit, it is called a surge. It is likely to cause the circuit to burn out at the moment of the surge, such as PN junction capacitor breakdown, resistor burnout and so on.

Therefore, in order to meet surge characteristics, our company has designed two products: AS (Anti-Surge Thick Film Chip Resistor) and PS (High Precision Anti-Surge Thick Film Chip Resistor). The differences between the two products are as follows:

Difference	AS	PS
Dimension	AS02 AS03 AS05 AS06 AS07 AS10 AS12	PS02 PS03 PS05 PS06PS07 PS10 PS12
Tolerance	Mainly ±10% ±20%, ±5% is specially provided	Product tolerance is high (±1% ±5%)
Special characteristics	High power (AS05、AS06、AS10)	Power is comparatively lower (AS05、AS06、AS10)
Pulse indicator	Single pulse indicator is high	Single pulse indicator is comparatively lower
Process	No resistance adjustment (no laser) is conducted	Resistance adjustment (laser)

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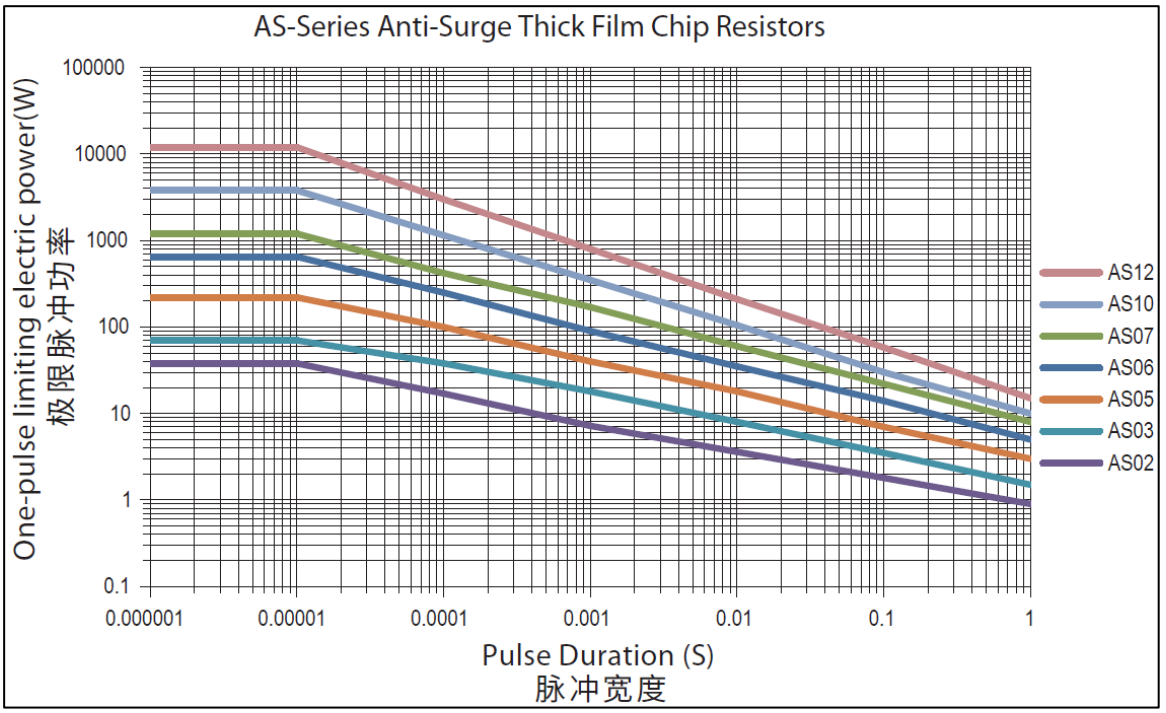
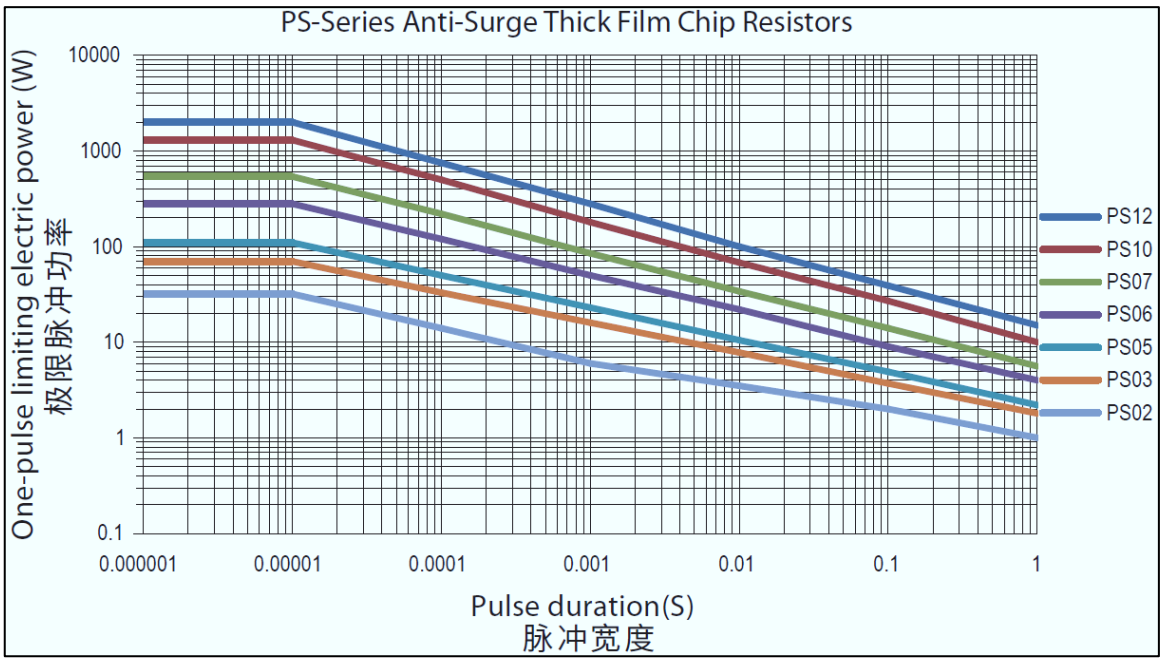
AS single pulse power curve is as follows：



PS single pulse power curve is as follows：



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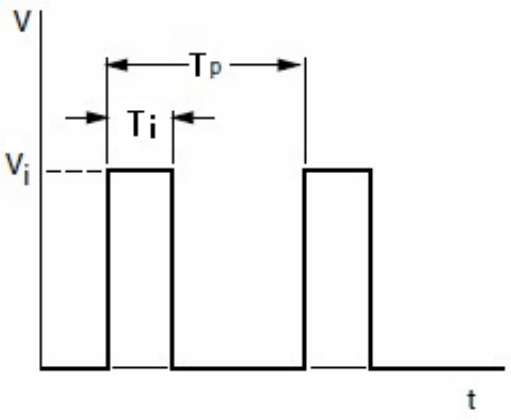
§2．Pulse wave principle calculation

2.1 Derivation and calculation method of pulse power

Item	Calculation formula	Unit
Demand resistance value (R)	R	Ω
Rated power (Po)	Po	W
Rated voltage (Vo)	V=√(Po*R)	V
Rated current (Io)	Io=√(Po/R)	A
Pulse duration (Ti)	Ti	S
Stop time (T)	T=Tp-Ti	S
Peak current (I)	I=Vi/R	A
Peak voltage (Vi)	Vi= √(P*R)	V
Peak power (P)	P	W
Joule integral value Q	Q=I^2*R*Ti	A^2*S
Average power (P)	P= (I^2*R*Ti)/Pulse period Tp	W
Power load rate	P / Po	%



Vi: Peak voltage

Ti: Pulse duration

Tp: Pulse period

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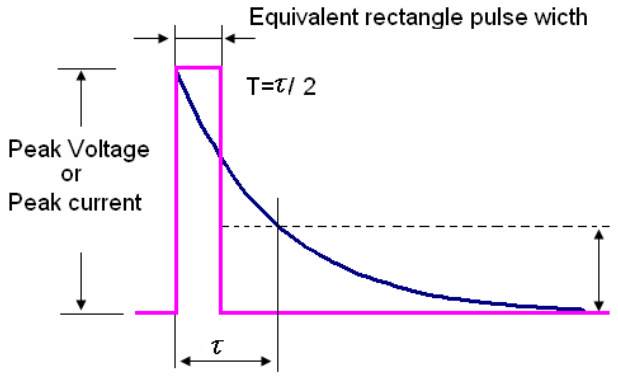
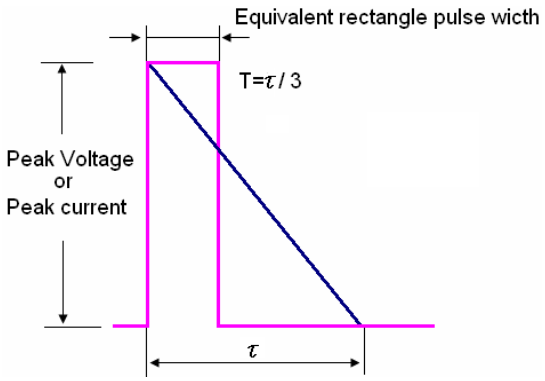
2.2 The equivalent relationship between four common waveforms and square waves

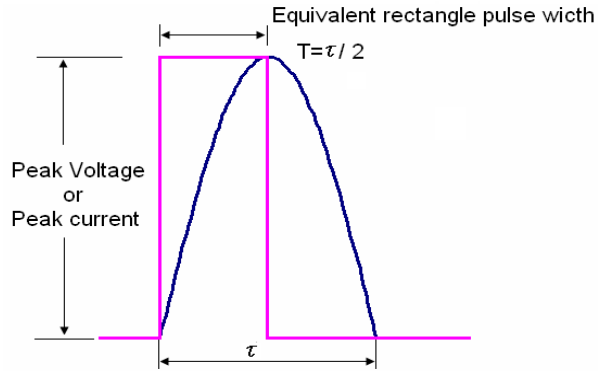
a. Discharge waveform



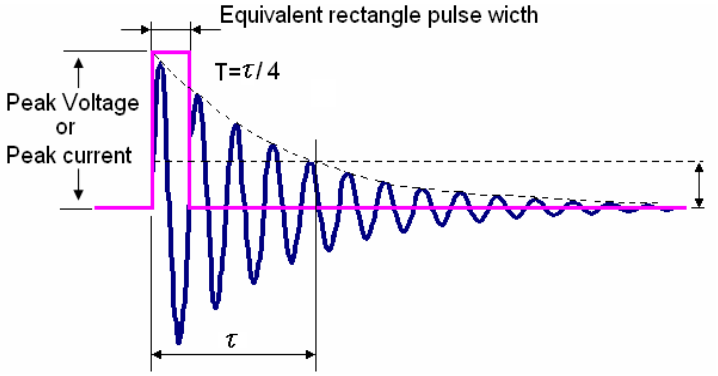
b. Triangular waveform



c. Sinusoidal waveform



d. Oscillation attenuation waveform



2.3 Selection principle of pulse power resistor

a. The maximum pulse power of the user should be lower than the limit power given by the pulse curve ;

b. The average power of the user should be lower than 75% of the rated power ;

c. When the environmental temperature of the user's product exceeds 70 ℃, power attenuation should be performed according to the derating curve;

d. The maximum pulse voltage of the user should meet the limit voltage requirements provided by our company ;

e. The actual pulse duration of the user should be read based on the principle of taking the greater one ;

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f. When the user pulse period Tp>Isec, take Tp=Isec；

g. When user pulse TP/Ti>2 times, take 200 for calculation

2.4 Calculation example of application of anti-surge thick film chip resistors

a. Case one:

Customer inquiry: spec.1206, 100K 5%, working temperature between 80 ℃ and 90 ℃, continuous waveform Tp=3ms, Ti=100us; Whether it can withstand the application conditions shown in the attached figure

Figure One：

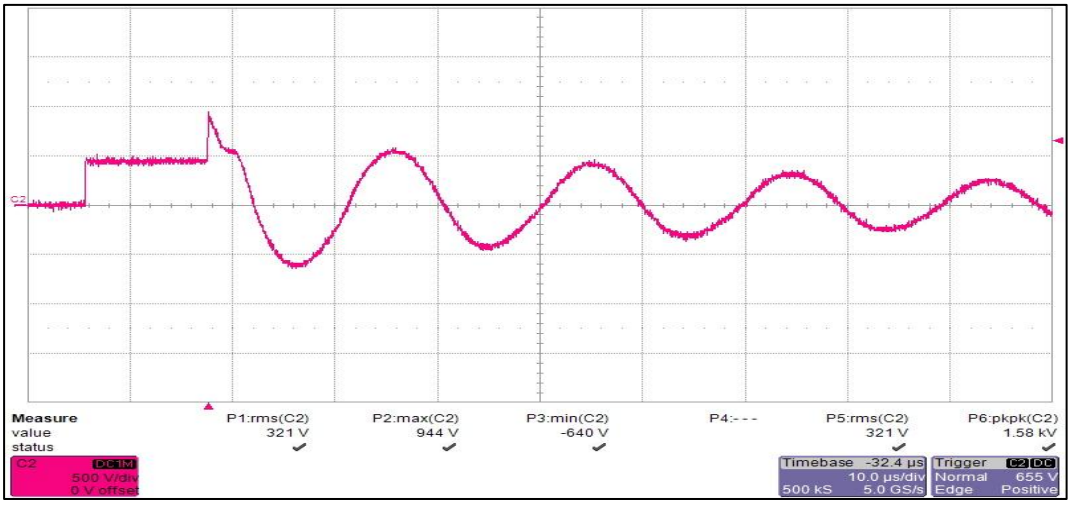

Figure Two：

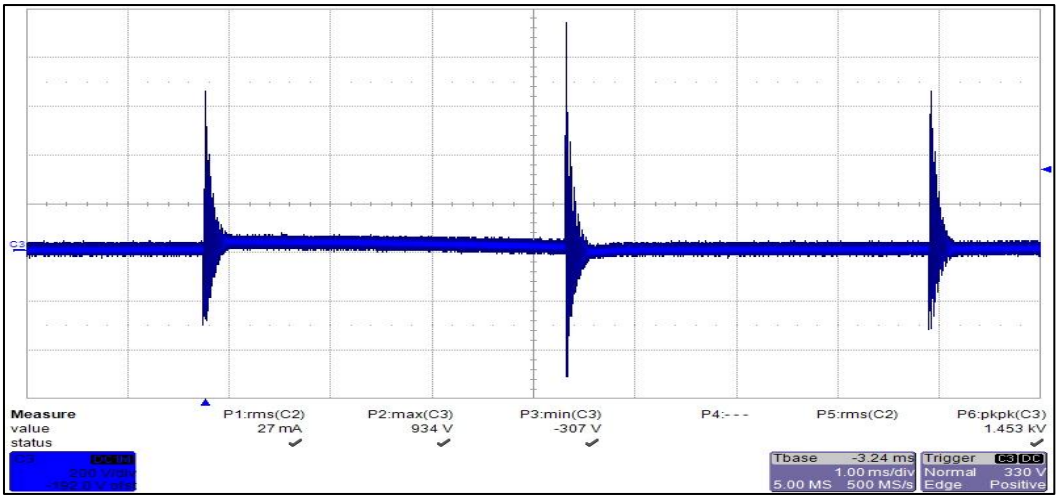

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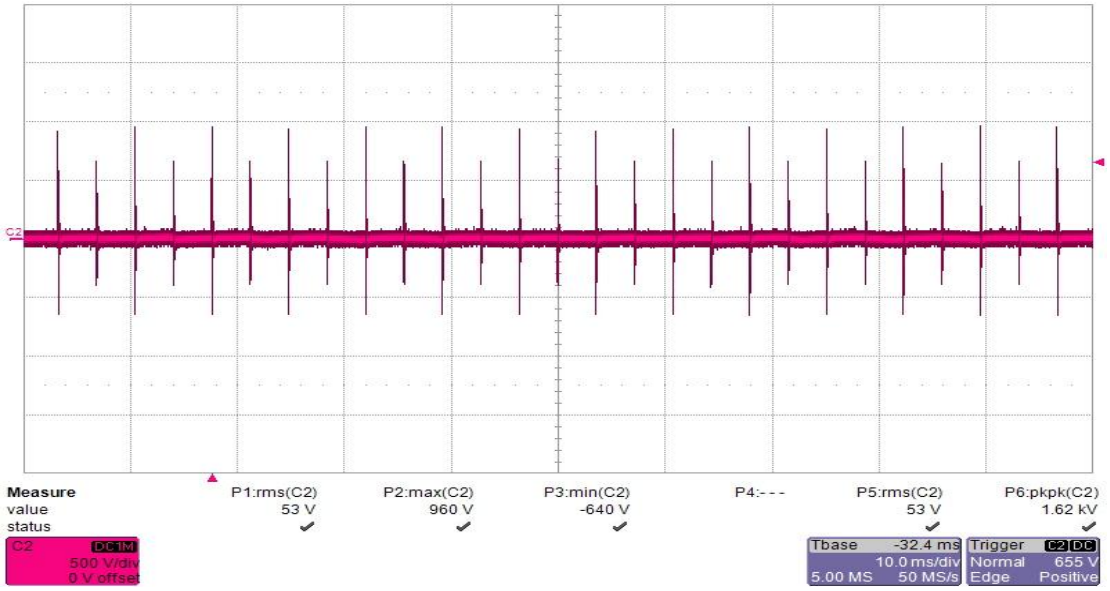
Figure Three：



Derivation and calculation of pulse load rate：

項目	計算公式	單位
需求阻值(R)	100000	Ω
額定功率(Po)	0.45	W
額定電壓(Vo)	223.61	V
額定電流(Io)	0.00224	A
脈沖寬度(Ti)	0.0001	S
停止時間(T)	0.0029	S
峰值電流(I)	0.01	A
峰值電壓(Vi)	10	W
峰值功率(P)	0.0000000025	A^2*S
焦爾積分值 Q	0.083333	W
平均功率(P)	18.51	%
功率負荷率	P / Po	%

Conclusion: UR’ s AS06 products can meet customer’ s requirements.

Remarks:

a. Max peak power≦Curve limit power;

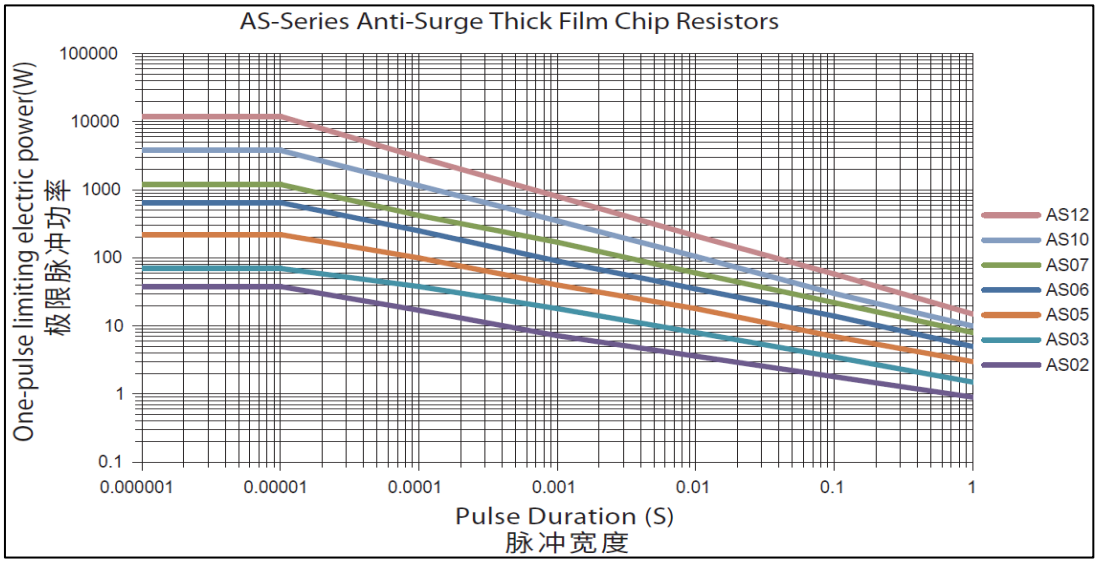
b. Avg. power≦75% of rated power;

c. The ambient temperature needs to be attenuated according to the power curve;

d. Power attenuates to 76.5% at 90 ℃.

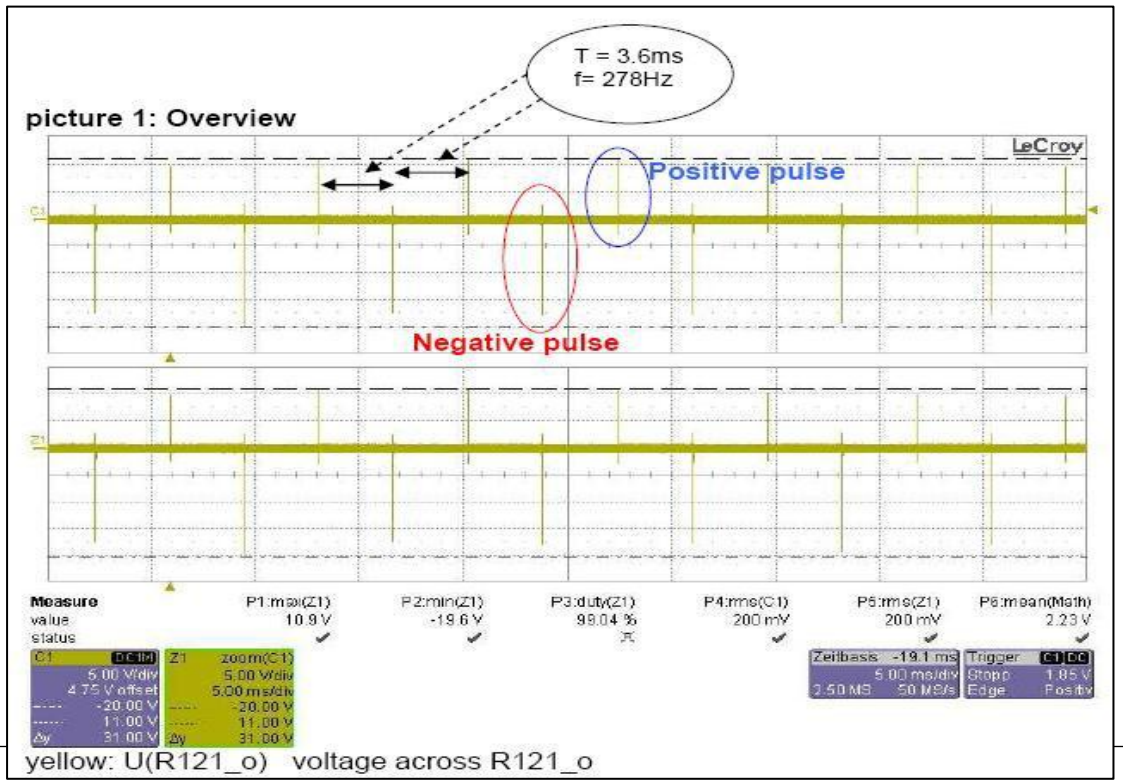
Application of Anti-Surge Thick Film Chip Resistors

Remarks：AS06 single pulse curve standard



b. Case Two：

Customer inquiry: Can our PS06 1/2W 39R products meet the following waveform requirements?
Waveform 1: Normal Mode in normal working condition.



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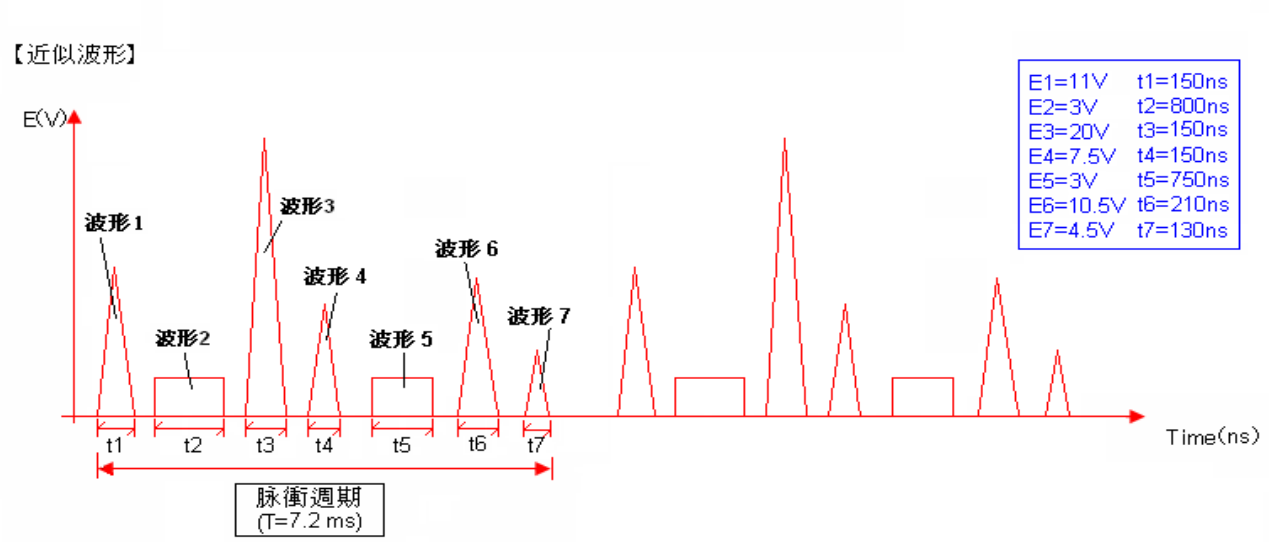


Derivation and calculation of pulse load rate：

項目	數值	單位
需求阻值(R)	39	Ω
額定功率(Po)	0.38	W
額定電壓(Vo)	3.86	V
額定電流(Io)	0.09901	A
脈沖寬度(Ti)	t1 t2 t3 t4 t5 t6 t7	S
停止時間(T)	0.0072	S
峰值電流(I)	0.512820513	A
峰值電壓(Vi)	20	V
峰值功率(P)	10.25641026	W
焦爾積分值 Q	0.0000000337985	A^2*S
平均功率(P)	0.0021662	A
功率負荷率	2.19	%

Conclusion: UR’ s PS06 products can meet customer’ s requirements

Remarks:

1. Max peak power≦Curve limit power;

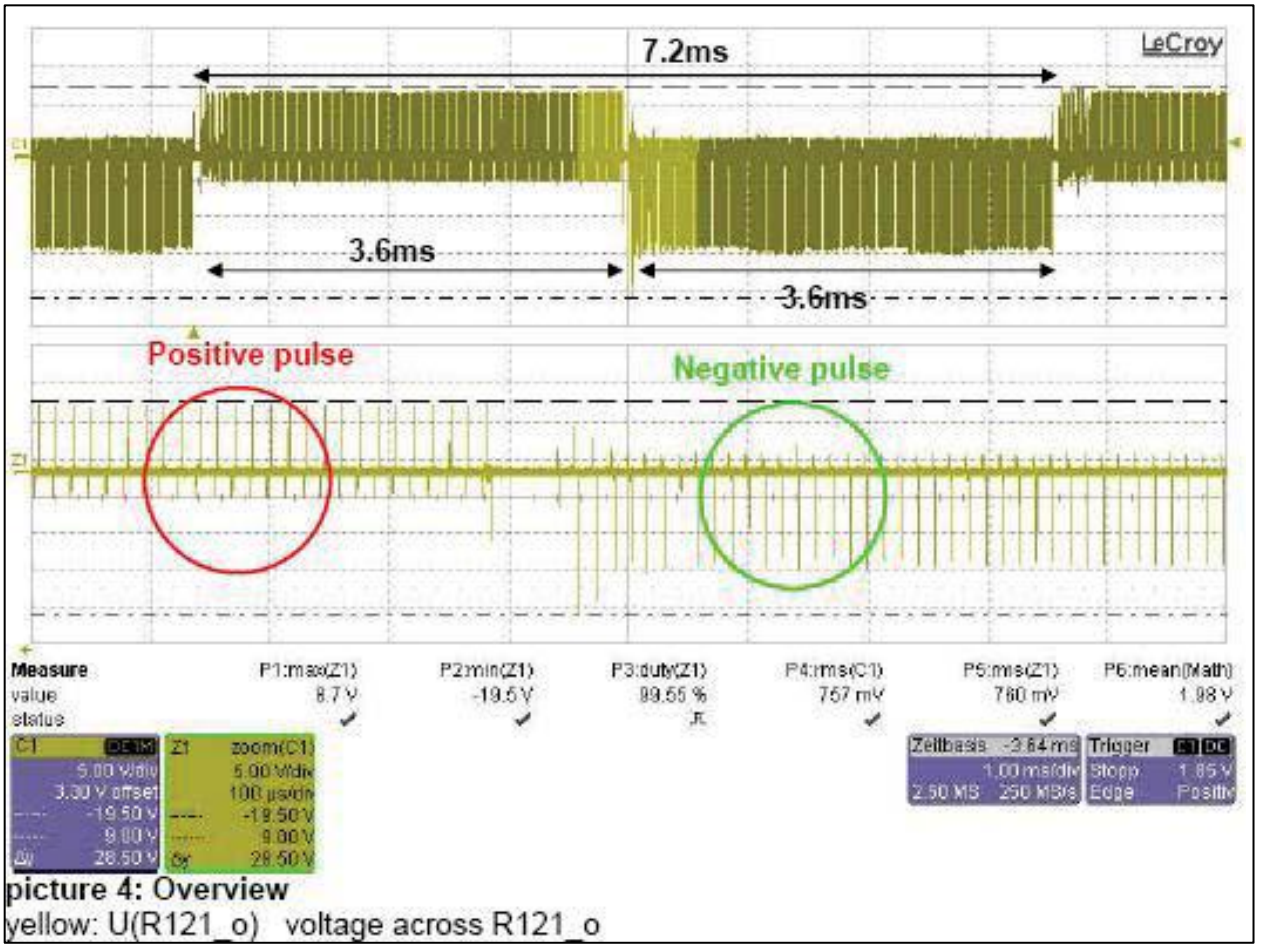
2. Avg. current≦50% of rated current;

3. The ambient temperature needs to be attenuated according to the power curve;

4. Power attenuates to 76.5% at 90 ℃.

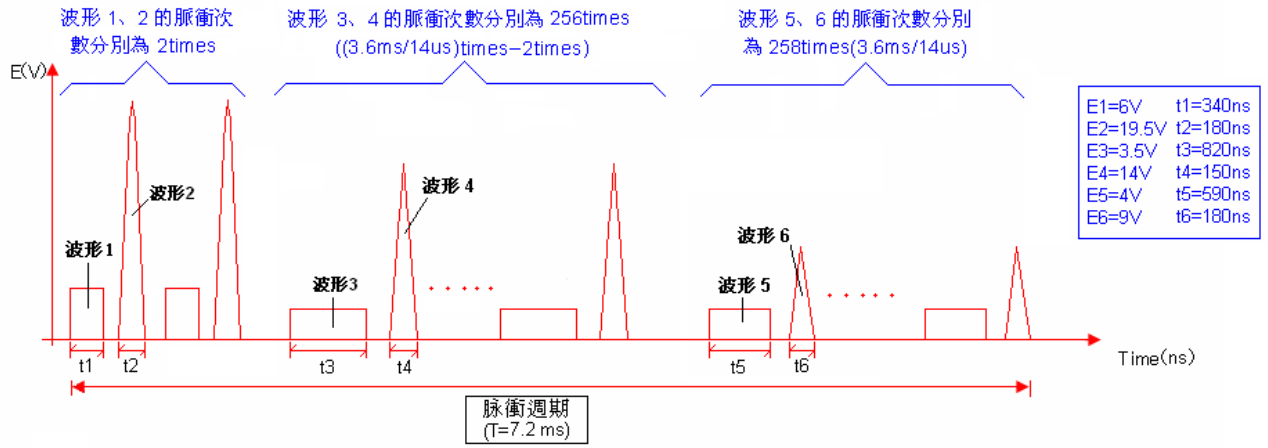
Application of Anti-Surge Thick Film Chip Resistors

Waveform 2：Startup/Short circuit



picture 4: Overview
yellow: U(R121_o) voltage across R121_o

【近似波形】



Application of Anti-Surge Thick Film Chip Resistors

Derivation and calculation of pulse load rate：

項目	數值	單位
需求阻值(R)	39	Ω
額定功率(Po)	0.20	W
額定電壓(Vo)	2.83	V
額定電流(Io)	0.07266	A
脈沖寬度(Ti)	t1 t2 t3 t4 t5 t6	S
停止時間(T)	0.0072	S
峰值電流(I)	0.5	A
峰值電壓(Vi)	19.5	V
峰值功率(P)	9.75	W
焦爾積分值 Q	0.00000587185	A^2*S
平均功率(P)	0.02855758	A
功率負荷率	39.30	%

Conclusion: UR’ s PS06 products can meet customer’ s requirements

Remarks:

1. Max peak power≦Curve limit power;
2. Avg. current≦50% of rated current;
3. The ambient temperature needs to be attenuated according to the power curve;
4. Power attenuates to 61.1% at 120 ℃.

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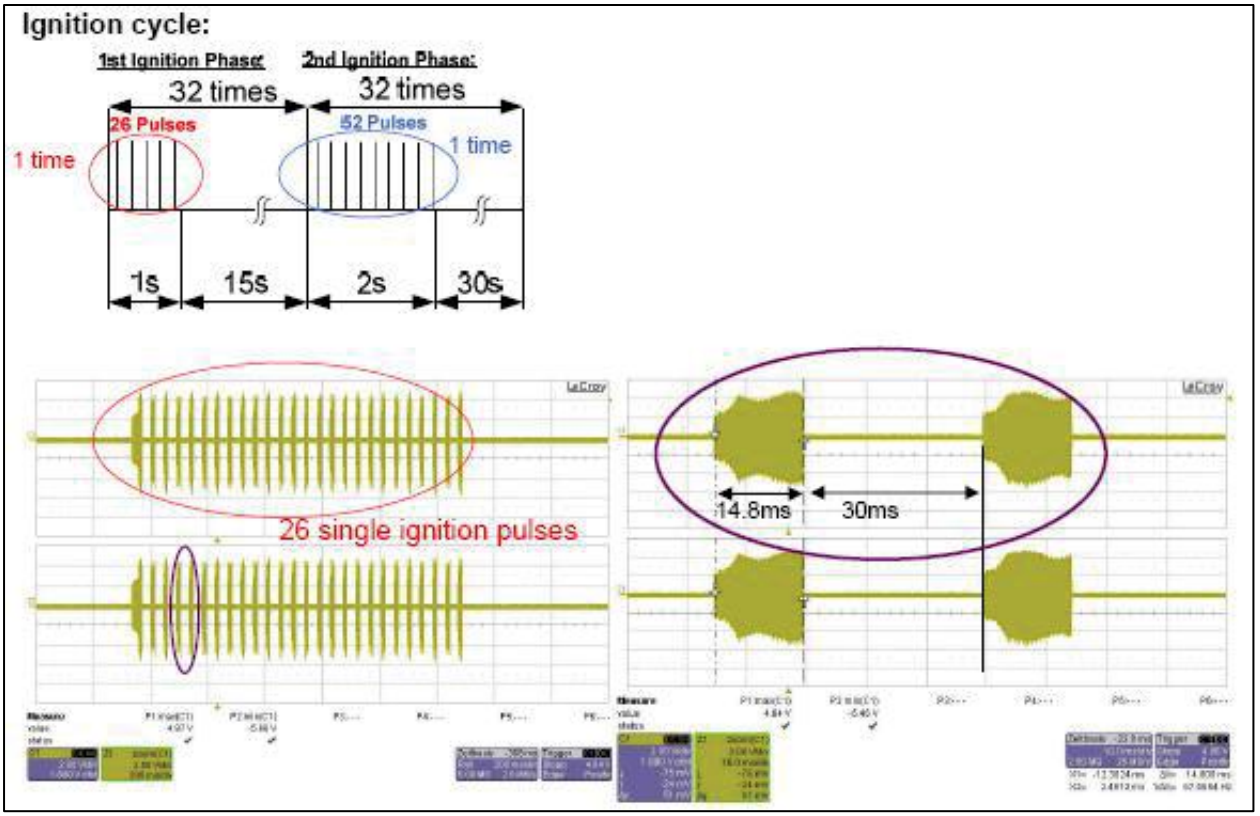
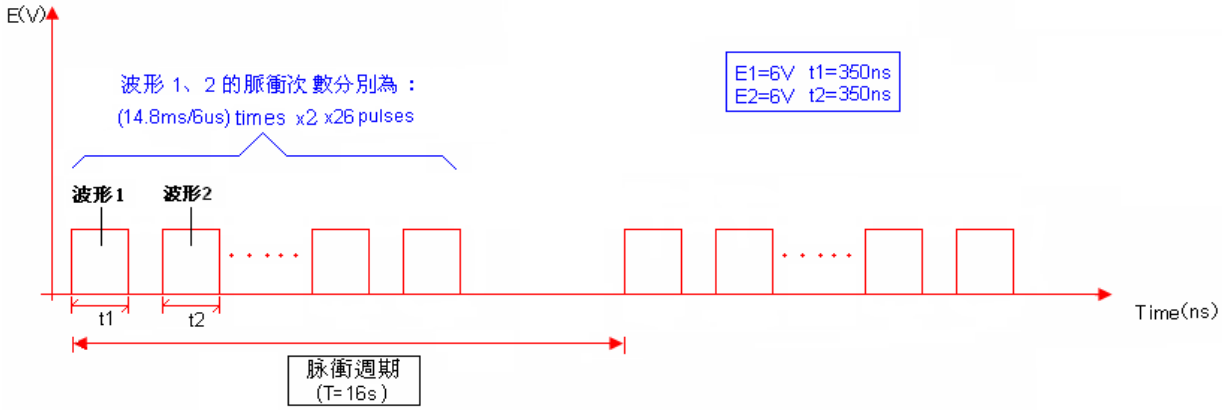
Waveform 3：Ignition cycle



Approximate waveform：



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Derivation and calculation of pulse load rate：

項目	數值	單位
需求阻值(R)	39	Ω
額定功率(Po)	0.38	W
額定電壓(Vo)	3.86	V
額定電流(Io)	0.09901	A
脈沖寬度(Ti)	t1 t2	S
停止時間(T)	16	S
峰值電流(I)	0.153846154	A
峰值電壓(Vi)	6	V
峰值功率(P)	0.923076923	W
焦爾積分值 Q	0.002125415	A^2*S
平均功率(P)	0.01152556	A
功率負荷率	11.64	%

Conclusion: UR's PS06 products can meet customer' s requirements

Remarks:

1. Max peak power≦Curve limit power;
2. Avg. current≦50% of rated current;
3. The ambient temperature needs to be attenuated according to the power curve;
4. Power attenuates to 76.5% at 90℃.

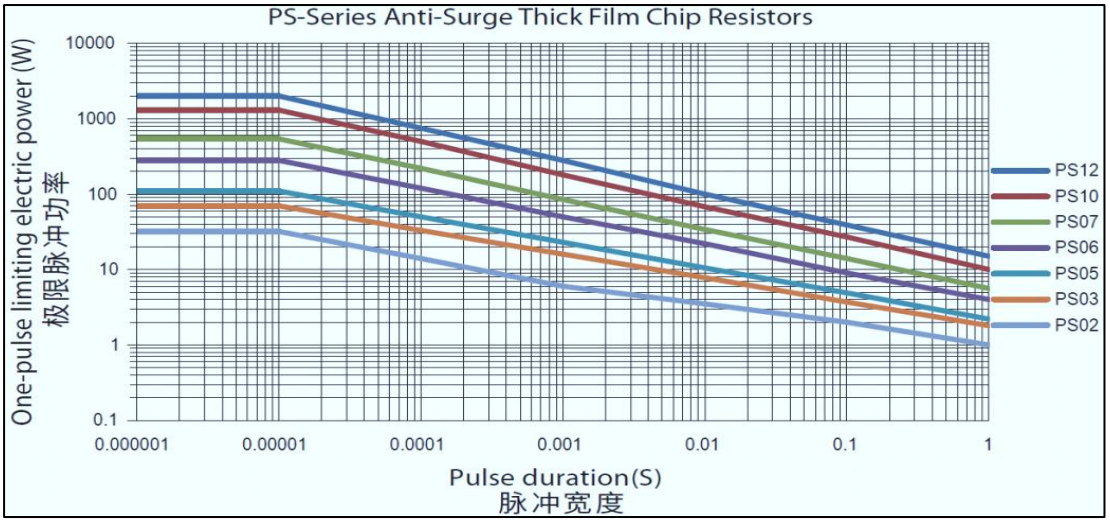
Application of Anti-Surge Thick Film Chip Resistors

Summary table of pulse load rate calculation

項目	數值			單位
	正常工作型	啟動型	點火型	
需求阻值(R)	39	39	39	Ω
額定功率(Po)	0.38	0.20	0.38	W
額定電壓(Vo)	3.86	2.83	3.86	V
額定電流(Io)	0.09901	0.07266	0.09901	A
脈沖寬度(Ti)	t1 t2 t3 t4 t5 t6 t7	t1 t2 t3 t4 t5 t6	t1 t2	S
停止時間(T)	0.0072	0.0072	16	S
峰值電流(I)	0.512820513	0.5	0.153846154	A
峰值電壓(Vi)	20	19.5	6	V
峰值功率(P)	10.25641026	9.75	0.923076923	W
焦爾積分值 Q	0.0000000337985	0.00000587185	0.002125415	A^2*S
平均功率(P)	0.0021662	0.02855758	0.01152556	A
功率負荷率	2.19	39.30	11.64	%

Conclusion：UR's PS06 0.5W 39R products can meet customer's requirements

Remarks：PS06 single pulse curve standard



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§3．Application of anti-surge thick film chip resistors

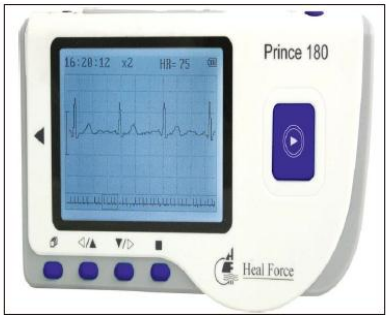
- Metering (Testing/Measurement)
- Diagnostic Equipment
- Medical Devices
- Industrial Controls
- Plasma
- LCD Video Monitors LCD

GPS

Automobile

Wireless telephone

CT



Electrocardiograph

Glucose meter

Frequency converter

Frequency converter

PLC

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§4. Summary

In electronic design, surges mainly refer to the strong pulses generated at the moment when the power supply (mainly referring to the power supply) is just turned on. Due to the possibility of the linearity of the circuit itself being higher than the pulses of the power supply itself; or due to the interference of internal or external sharp pulses on the power supply or other parts of the circuit, it is called a surge, which may cause the circuit to burn out at the moment of the surge. Anti-surge resistors have superior anti-surge voltage characteristics, and are used in AC/DC or pulse circuits and high voltage equipment, with high reliability resistance performance and can withstand high voltage impacts in the circuit.