§0. Abstract

Our MS resistor, also known as metal foil chip resistor, belongs to the metal resistor series and is mostly used as a current detection chip resistor in the circuit at customer end. Therefore, current resistance is a major indicator to measure the performance of metal foil chip resistors. However, as a resistor, the stability and accuracy of the resistance value are crucial. In working environments at different frequencies, due to the presence of the inductance values of the metal foil resistors, different sizes of inductive reactance will be generated. If it is a high resistance resistor, the influence of inductive reactance on the resistance value of the product can be ignored. However, as a low resistance resistor, the influence of inductive reactance on the measured resistance value is significant. Therefore, the following research is conducted on the changes of resistance values of MS resistors at high frequencies.

§1. The mechanism of the presence of inductive reactance

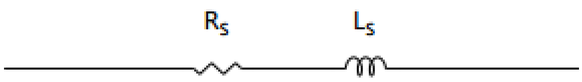


Fig.1: Equivalent circuit of low resistance current detection resistor

The inductance value not only occurs in the surrounding circuit, but also in the linear circuit. Since it is the inductance value, it has the characteristics of inductors, allowing DC to go through while blocking AC. When AC power is applied, inductive reactance is generated. The resistance value reflected in the circuit is the DC impedance of the resistor itself plus inductive reactance. The inductive reactance calculation formula is as follows:

$$XL=2\pi fL$$

XL represents inductive reactance, in ohms, with the symbol Ω; π represents pi; f represents the frequency of the input AC power, in hertz, with the symbol Hz; L represents the inductance value, in Henry, with the symbol H.

§2. Measure the resistance value of MS resistor at different frequencies

Table One: Measured resistance values at different frequencies of MS06 10mΩ

Frequency (Hz)	Resistance value (Ω)									
	1	2	3	4	5	6	7	8	9	10
100	0.25251	0.02971	0.09841	0.37069	0.03465	0.02798	0.08405	0.02639	0.0296	0.02674
1K	0.02434	0.02457	0.02489	0.02449	0.02876	0.02469	0.02442	0.02405	0.02457	0.02432
10K	0.02471	0.02492	0.02528	0.02486	0.02913	0.02506	0.02476	0.02444	0.02493	0.0247
100K	0.02713	0.02732	0.02774	0.02726	0.03157	0.02474	0.02719	0.02686	0.02735	0.02712
1M	0.04739	0.04769	0.04801	0.04756	0.05182	0.04776	0.04738	0.04709	0.04754	0.04741

Table Two: Measured resistance values at different frequencies of MS12 10mΩ

Frequency (Hz)	Resistance value (Ω)									
	1	2	3	4	5	6	7	8	9	10
100	0.02437	0.02487	0.02439	0.02467	0.02527	0.02423	0.02486	0.02487	0.0244	0.02674
1K	0.02454	0.02485	0.02451	0.02507	0.02458	0.02435	0.02459	0.02462	0.02433	0.02476
10K	0.02492	0.02521	0.02486	0.02543	0.02472	0.02472	0.02495	0.02496	0.02468	0.02508
100K	0.02744	0.02773	0.02804	0.02791	0.02742	0.02725	0.02747	0.02747	0.02721	0.02759
1M	0.04826	0.04863	0.04879	0.04872	0.04823	0.04812	0.04826	0.04831	0.04805	0.04842

Table Three: Data analysis

Frequency (Hz)	MS06 10mΩ			MS12 10mΩ		
	Max	Min	Avg	Max	Min	Avg
100	0.37069	0.02639	0.098073	0.02674	0.02423	0.024867
1K	0.02876	0.02405	0.024910	0.02507	0.02433	0.024620
10K	0.02913	0.02444	0.025279	0.02543	0.02468	0.024953
100K	0.03157	0.02474	0.027428	0.02804	0.02721	0.027553
1M	0.05182	0.04709	0.047965	0.04879	0.04805	0.048379

§3. Conclusion

Table One: Line chart of measured resistance values at different frequencies of MS06 10mΩ

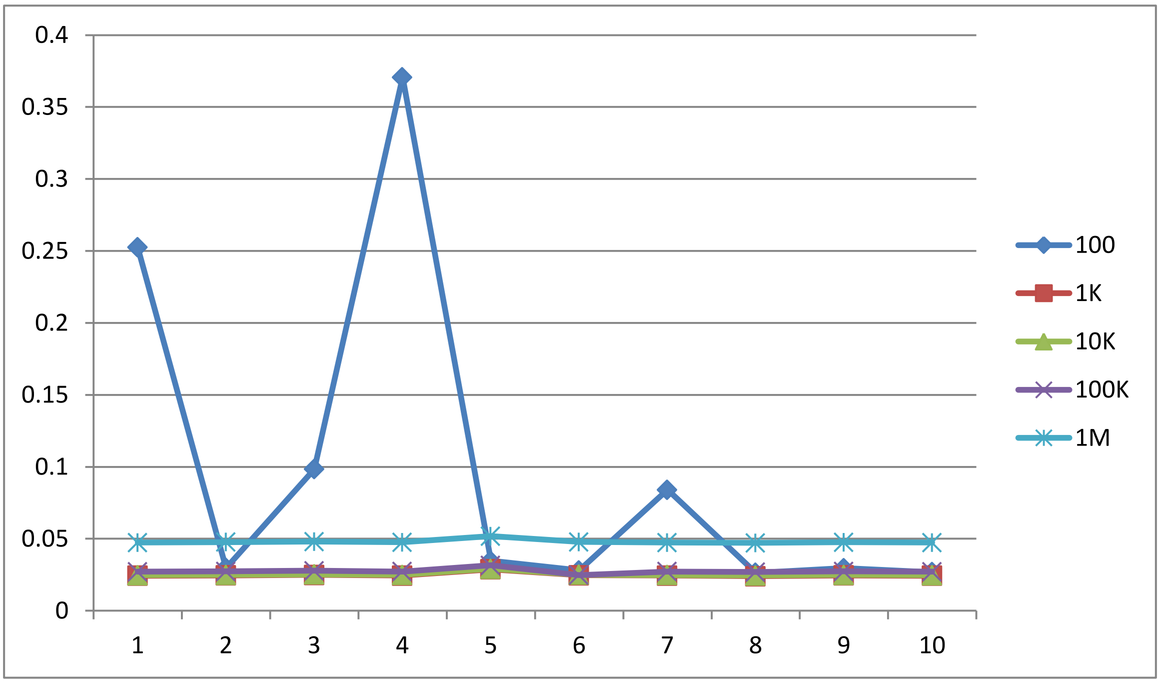
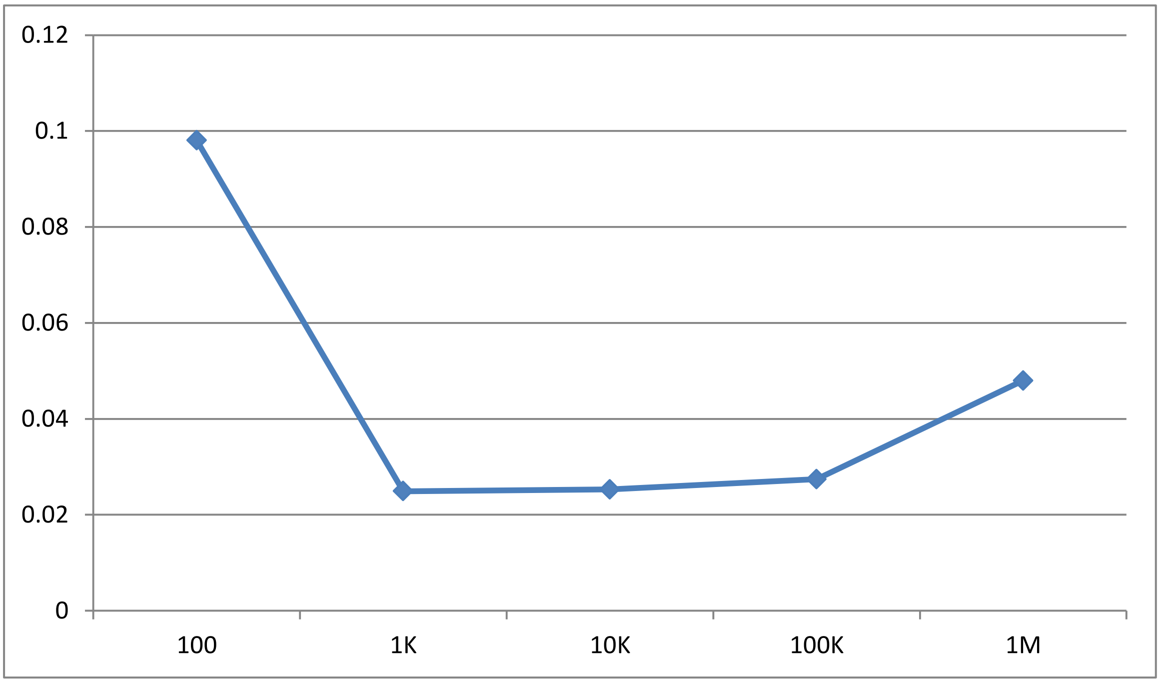


Table Two: Line chart of average measured resistance values at different frequencies of MS06 10mΩ



Conclusion 1: The measurements of MS06 10mΩ are stable when measured at frequencies between 1KHz and 1MHz. Resistance values measured at this frequency range are basically the same, ranging from 24m Ω to 31m Ω. When at 1MHz, the resistance values measured are ranging from 47mΩ to 51m Ω, with an average increase of 22mΩ compared to that measured at frequencies between 1KHz and 1MHz; When at 100Hz , the difference in measured resistance values among resistors is significant, with a difference of 344.3m Ω (maximum-minimum).

Table Three: Line chart of measured resistance values at different frequencies of MS12 10mΩ

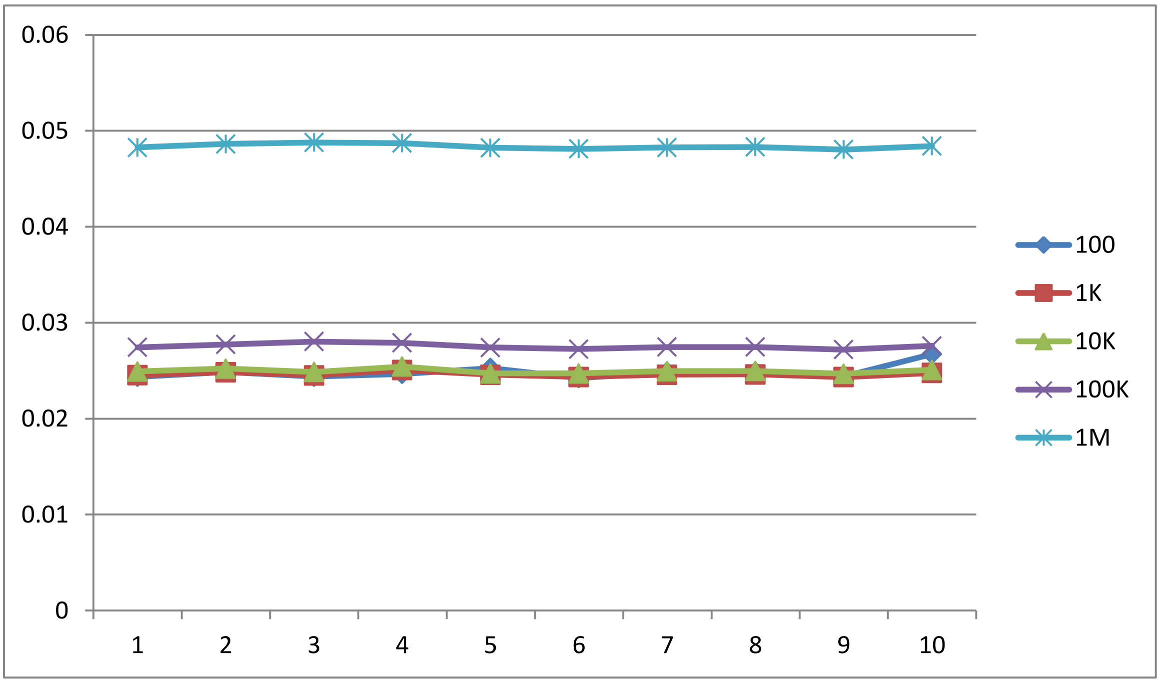
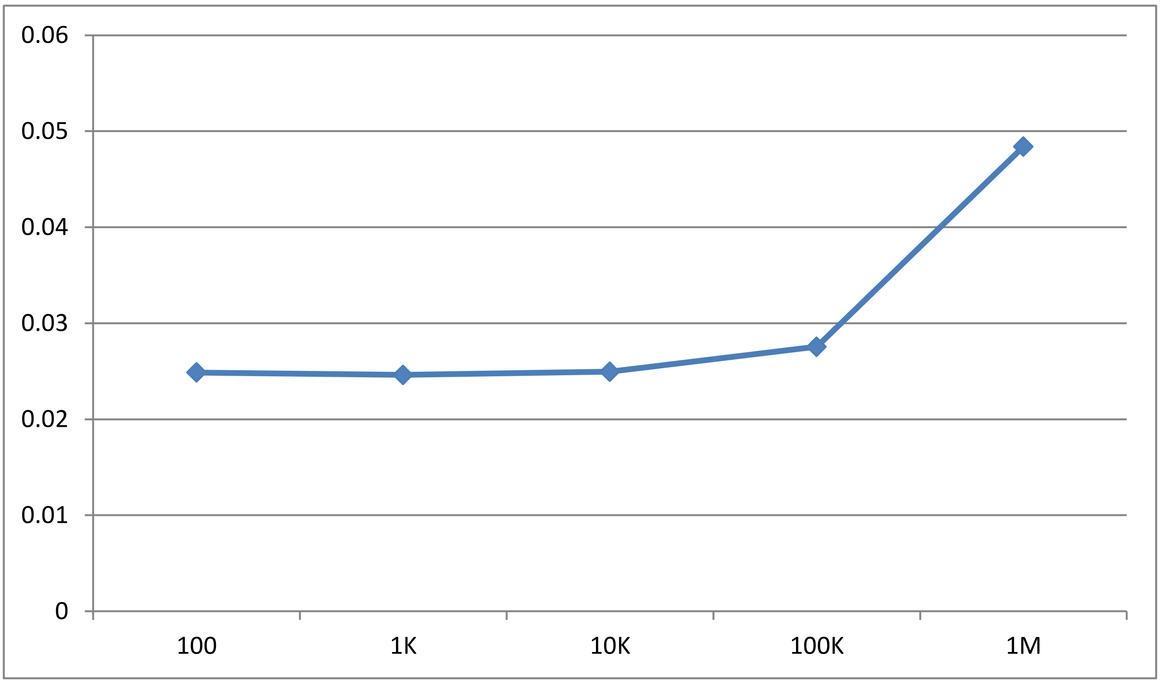
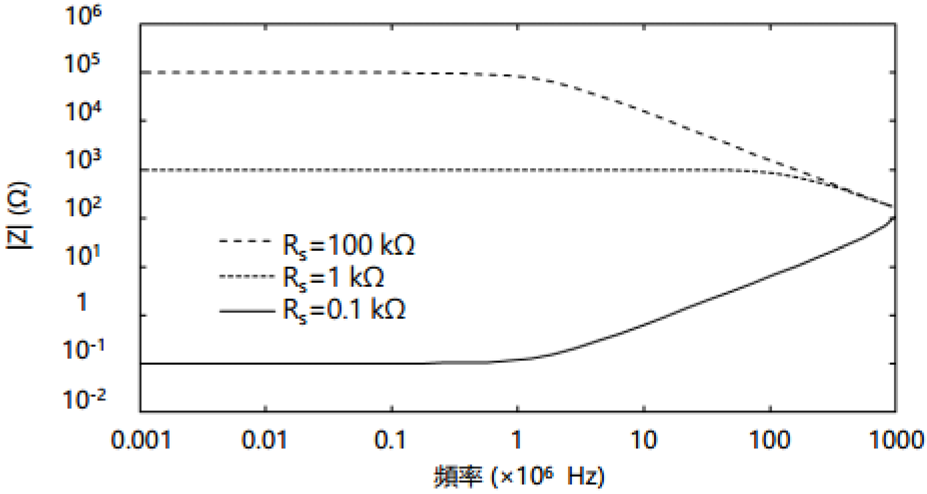


Table Four: Line chart of average measured resistance values at different frequencies of MS12 10mΩ



Conclusion 2: The measurements of MS12 10mΩ are very stable at frequencies between 100Hz and 1M, and the resistance values measured at frequencies between 100Hz and 10KHz are basically the same, ranging from 24mΩ to 27mΩ; When at 100KHz, the resistance values measured are between 27mΩ and 28mΩ, with an average increase of 1mΩ compared to that measured at frequencies between 100Hz and 10KHz; When at 1MHz, the resistance values measured are between 48mΩ and 49mΩ, with an average increase of 23.5mΩ compared to that measured at frequencies between 100Hz and 10KHz.

§4. Compared with KOA



Our company actually tested the resistance values of MS06 10mΩ and MS12 10mΩ at different high current frequencies. The trend of the resistance measurement line chart is the same as that of KOA, but the difference lies in the different inflection points of the trend chart. Our company's product test inflection point is at 100KHz, and the inflection point of KOA equivalent circuit simulation test is at 1MHz.