Low ESL Current Sensing Chip Resistor Technology

＜Introduction＞

Current sensing low resistance chip resistors, introduced originally as an over-current protection device in power source circuits, have expanded their application range and have become indispensable components for power management of mobile devices and for high frequency circuits. It is also used to adjust current to control motor speed and solenoids.

Meanwhile, the movement toward higher functionality of electronics devices, represented by personal computers, is only accelerating and so is signal processing speed. For designers, it is a challenge to control noise caused by the high frequency signal processing.

Susumu offers a wide range of current sensing low resistance chip resistors. In this article, we will focus on one of them, the RL series, which was the industry's very first long-side terminal current sensing chip resistor. This particular resistor series has been very popular due to its high power capability and low inductance at lower resistive range which helps control the noise of high frequency and high speed applications of electronics devices.

＜Functionality and required characteristics＞

In order to measure the current in a circuit, such as the power management circuit, the current sensing low resistance chip resistors are placed in the circuit and the voltage over the resistor is measured. The required characteristics are tight tolerance, small TCR, high power and small size, which are all currently materialized by low resistance chip resistors. Here, we describe another important character, low inductance (ESL).

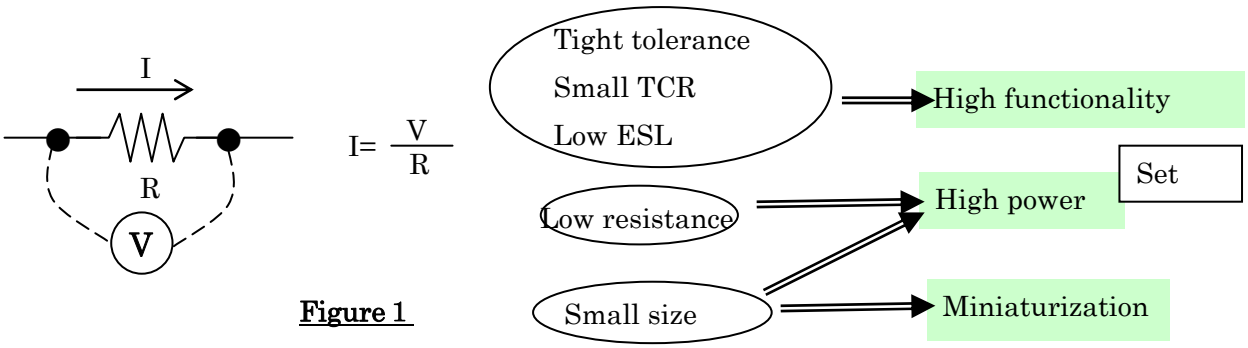


Figure 1

＜Low ESL current sensing low resistant chip resistor＞

1． Theoretical discussion and measurement results

（1）The inductance of conductor (non-coil) is provided by the following equation. The inductance increases with permeability of the material and length of the conductor and decreases with the width of the conductor.

$$L = 0.002h\ (2.303\log_{10}4h/d - 1 + \mu/4)$$

h : conductor length, d : conductor width, μ : permeability

Therefore, when the material is fixed, low ESL can be obtained by shortening the conductor length and widening the conductor width.

（２）Sususmu’s low ESL long-side terminal low resistance chip resistor

Susumu’s long-side terminal type resistor realizes low ESL with shorter length and wider width of the resistive element by using its longer side as the terminal. The comparison of ESL among Susumu’s low resistance chip resistors is shown in Figure 2. As expected, the long-side terminal type with shorter and wider conductor demonstrates 1/3 of ESL of the regular short-side terminal type.

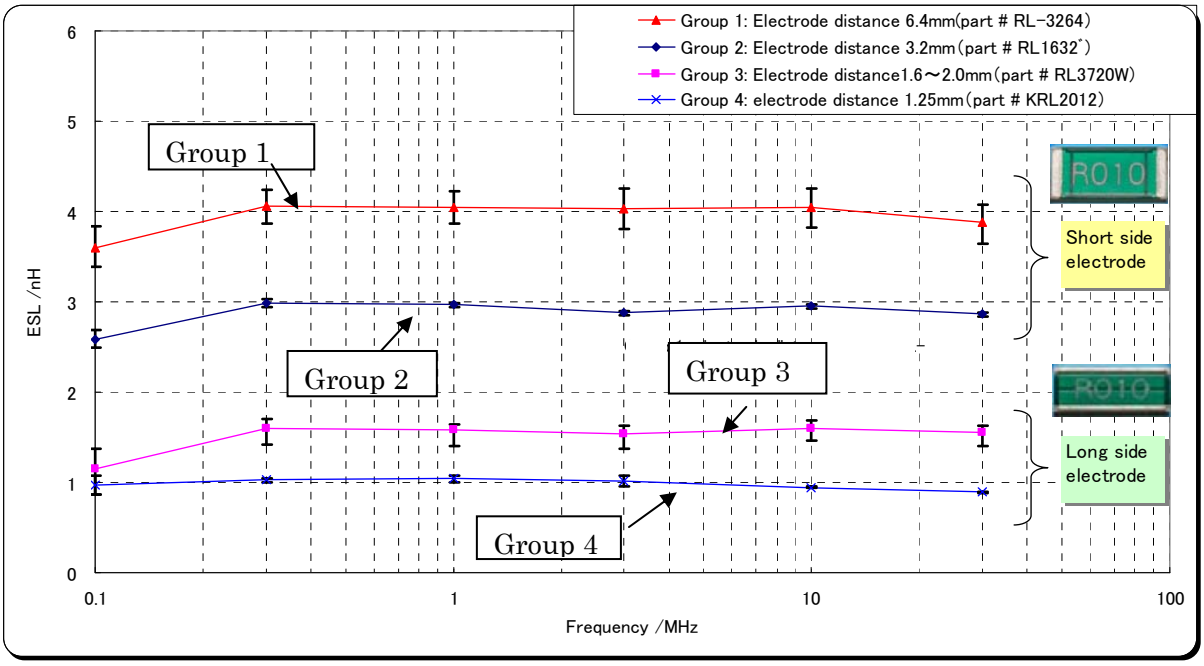


Figure 2 ESL comparison: long side terminal vs. short-side terminal

Measurement instrumentation: 4285A PRECISION LCR METER

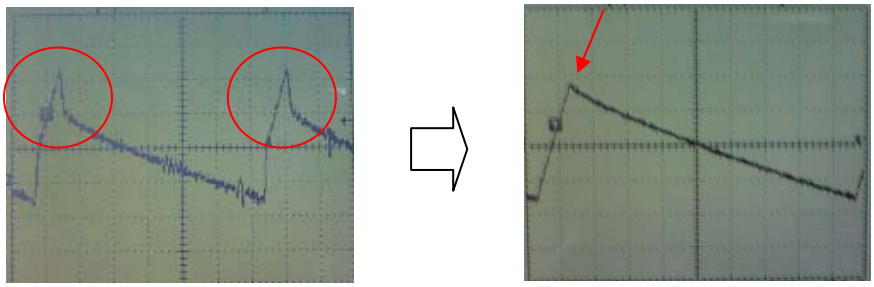
２． Effect of low ESL

（１）Reduction of noise by low ESL

For example, laptop computers require precise power management and the DC/DC converters’ switching frequency can be as high as several hundred kHz. If the ESL of the current sensing resistor is large, the transition switching pulses contain noise that affects the accuracy of the control. However, if ESL is small, such noise will become insignificant.

（２）Actual measurement example

Reduced noise



Picture 1 with short side terminal

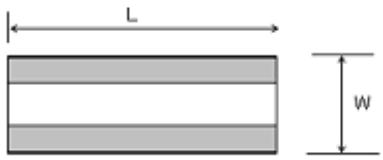
Picture2 with long side terminal

Figure 3

Picture 1 shows the shape of the waves using a short-side terminal resistor with the switching noise. Picture 2 shows the same waves when using a long-side terminal resistor, RL3720W, demonstrating a clear reduction of the switching noise. Using such low ESL current sensing resistors, the designer can avoid employing additional noise reduction circuits.

3. Summary

Susumu's long-side terminal low resistance chip resistors were developed for the purpose of increasing heat dissipation realizing 1W for 3.7mm×2.0mm (RL3720W) and also for the smaller PRL1632 (1.6mm×3.2mm). Due to this high power capability, these chip resistors have been very popular. In addition, new demand has been developing because of their low ESL due to the trend in electronics for high functionality and high speed/frequency. The table below shows summary specification data of Susumu's long-side terminal current sensing low resistance chip resistors, the RL, and the PRL series, as well as the latest low TCR KRL series.



Summary of long side electrode resistors

Series #		RL3720	RL3720W	RL7520W	PRL1220	PRL1632	PRL3264	KRL2012	KRL3216	KRL6432
Size(mm)	L	3.7	3.7	7.5	2.0	3.2	6.4	2.0	3.2	6.4
	W	2.0	2.0	2.0	1.25	1.6	3.2	1.25	1.6	3.2
Rated Power(W)		0.5	1.0	2.0	0.66	1.0	2.0	0.66	1.0	2.0
R value range(Ω)		0.01～2.2	0.001～1.0	0.001～0.47	0.007～0.1	0.005～0.1	0.003～0.1	0.001～0.027	0.001～0.036	0.001～0.050
Tolerance(%)		±1%,±2%			±1%,±2%,±5%			±1%,±2%,±5%		
TCR(ppm/℃)		0～+100,200,350,420,800			±50,±100, 0～200,350			±50,±100,±150		
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