RCL Long Side Termination Thick Film Chip Resistors

Product Overview

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Introduction

Purpose

- Overview of the Vishay RCL Long Side Termination Thick Film Chip Resistor Series

Objectives

- Discuss features
- Present construction
- Compare power rating to standard thick film chip resistors
- Discuss benefits of RCL long side termination design for thermal cycling
- Show potential applications

Welcome to the Vishay RCL Long Side Termination Thick Film Chip Resistor Series product overview.
This presentation will provide an overview of the RCL thick film chip resistor series.
Features and Construction of the product series will be discussed and comparisons of performance with standard geometry thick film chip resistors will be made. Additionally we will discuss potential applications in which RCL series parts can be used.

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Main Features of the RCL series

- Package sizes: 0406, 0612, 1020, 1218, 1225
- Enhanced power dissipation: 0.25W to 2W
- 2 to 4 times the power ratings of standard thick film resistors with same chip size
- Termination on long side of chip for stronger solder joint
- **Enhanced thermal cycling performance**
- Resistance range: 1Ω to 2.2MΩ
- Tolerance & TCR: ±1% & ±100ppm/°C or ±5% & ±200ppm/°C
- Jumpers with enhanced maximum current ($I_{max.}$) up to 12A also available
- Sulfur Resistant version also available (RCA-LS e3 series)
- AEC-Q200 qualified
- RoHS compliant

The Vishay RCL series is a long side termination thick film chip resistor series available in sizes: 0406, 0612, 1020, 1218, & 1225. Compared to standard thick film chip resistors, RCL series parts have higher power dissipation capabilities, 2 to 4 times the power dissipation of standard thick film chip resistors with similar chip size. The 1225 case size is rated for 2W. For reasons that will be discussed later, RCL series parts are an excellent choice for application with extreme thermal cycling requirements. RCL series parts are available with tolerance ±5% or ±1%. Many industries, including automotive, demand AEC-Q200 qualified resistors and Vishay's RCL series meets this standard. The series is offered with a resistance range from 1 ohm to 2.2Mohms. Additionally, Jumper versions of RCL series parts are available with maximum current capability up to 12A for the 1225 case size. For operation in harsh environments, the sulfur resistant version known as the RCA-LS e3 series is available.

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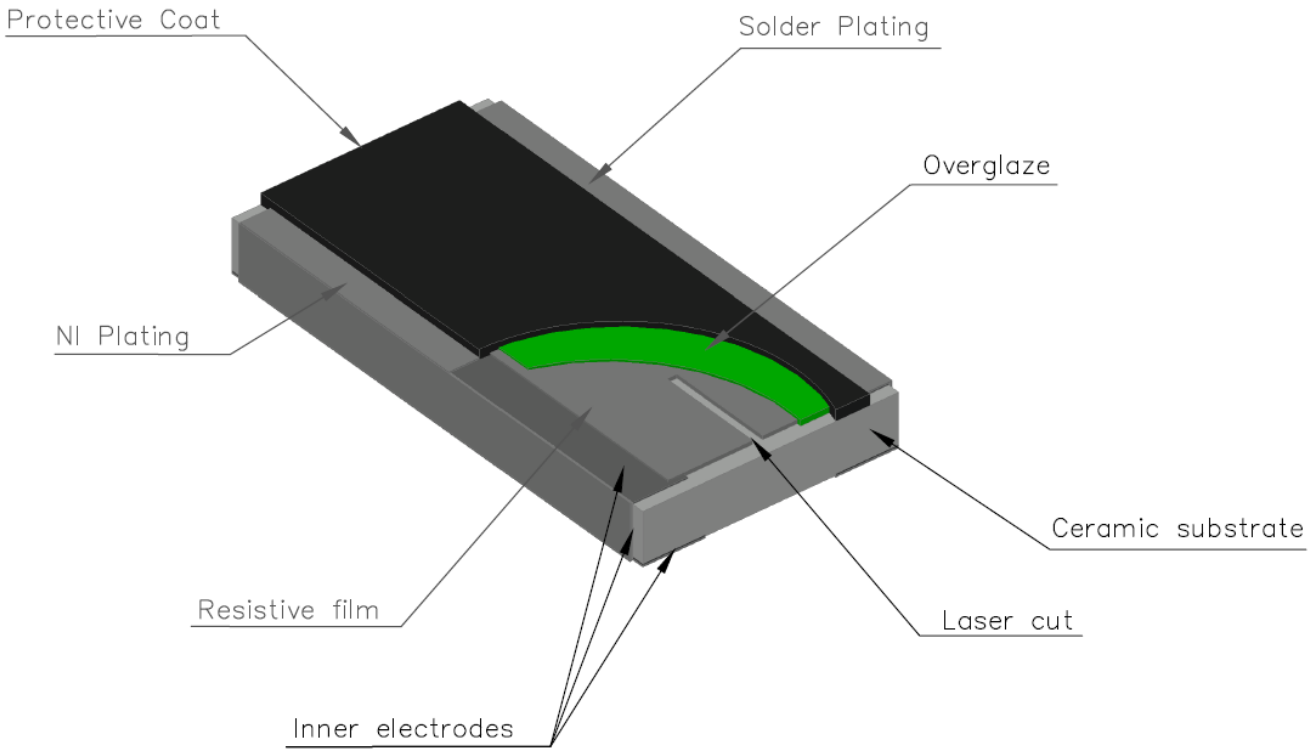
Construction of the RCL series



The construction of RCL series parts is similar to that of standard thick film chip resistors in many regards, but there is a difference which impacts performance in a number of ways. We'll start with what the product types have in common. Both standard thick film and RCL series parts are built upon a ceramic substrate chip. At the ends of the chip there is what is known as wrap-around termination, with inner electrodes, covered by a nickel barrier, and with a solder plating. Upon the ceramic chip substrate, making an electrical connection between the part terminals is a thick film Ruthenium Oxide resistive element. This resistive element is trimmed to achieve the desired final resistance value. Above the thick film resistive element is an overglaze layer and a protective top coat.

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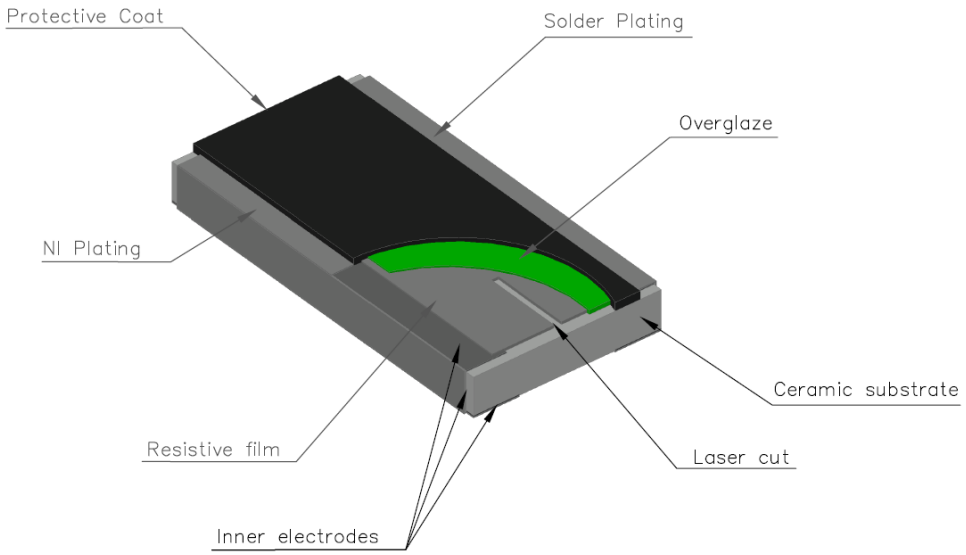
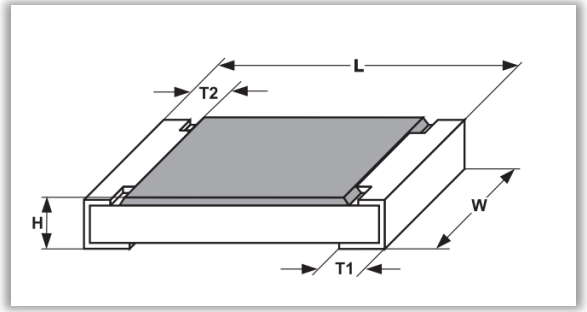
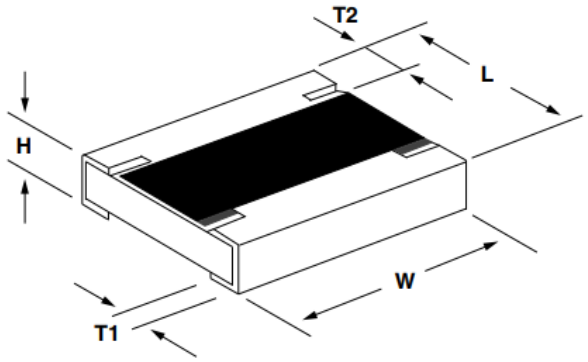
Construction of the RCL series





Standard thick film geometry (above), for comparison.



The major difference in design which allows for enhanced power dissipation performance and thermal cycling performance is the geometry of the parts. While typical standard thick film chip resistors have the wraparound terminations on the short sides of the component (shown here in the Top Right), RCL series resistors are designed with the terminations on the long sides of the component (shown here on the Left). This configuration is known as “long side termination” or “wide terminal”. It is also sometimes referred to as “reverse geometry”.

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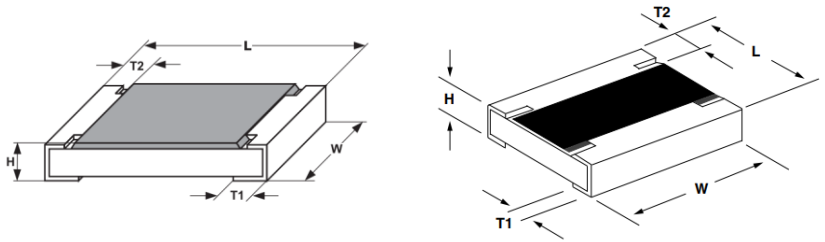
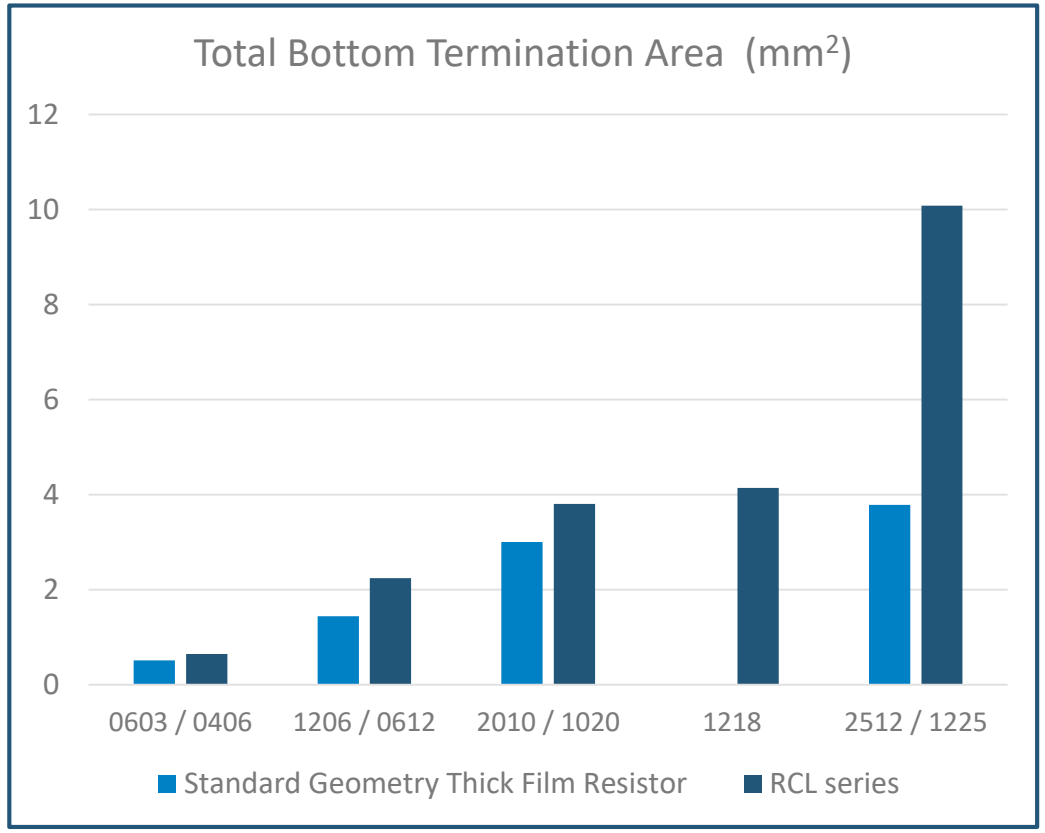
Terminal Area Ratio / Solder Joint Strength



Chip size	Total Bottom Termination Area for Standard Thick Film Resistor with short side termination (mm^2)	Total Bottom Termination Area for RCL series with long side termination (mm^2)
0603 / 0406	0.51	0.64
1206 / 0612	1.44	2.24
2010 / 1020	3	3.8
2512 / 1225	3.78	10.08



By placing the terminations of the part on the long side of the component, a number of benefits are achieved.
The area of the termination compared to the chip size is greatly increased for some chip sizes. For example, a standard geometry 2512 size chip resistor may have bottom termination are of approximately 3.78mm^2, while the RCL1225 has bottom termination area of approximately 10.08mm^2 (over 2.5 times as much). This creates a more robust solder joint after assembly. Additionally, the larger termination area helps to reduce the thermal resistance from the resistive element of the part to the circuit trace of the printed circuit board, thereby increasing the maximum power that the component can dissipate, or allowing for a component with shorter distance between terminals to be chosen while retaining the necessary specified maximum power dissipation.

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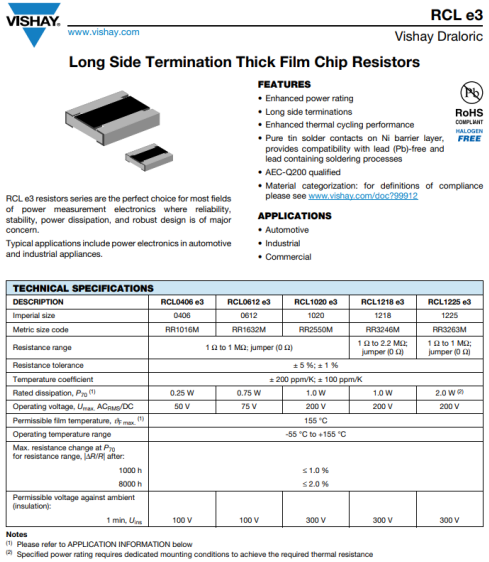
Enhanced Power Rating



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RCL e3
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Long Side Termination Thick Film Chip Resistors

FEATURES
- Enhanced power rating
- Long side terminations
- Enhanced thermal cycling performance
- Pure tin solder contacts on Ni barrier layer, provides compatibility with lead (Pb)-free and lead containing soldering processes
- AEC-Q200 qualified
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT HALOGEN FREE

RCL e3 resistors series are the perfect choice for most fields of power measurement electronics where reliability, stability, power dissipation, and robust design is of major concern.

Typical applications include power electronics in automotive and industrial appliances.

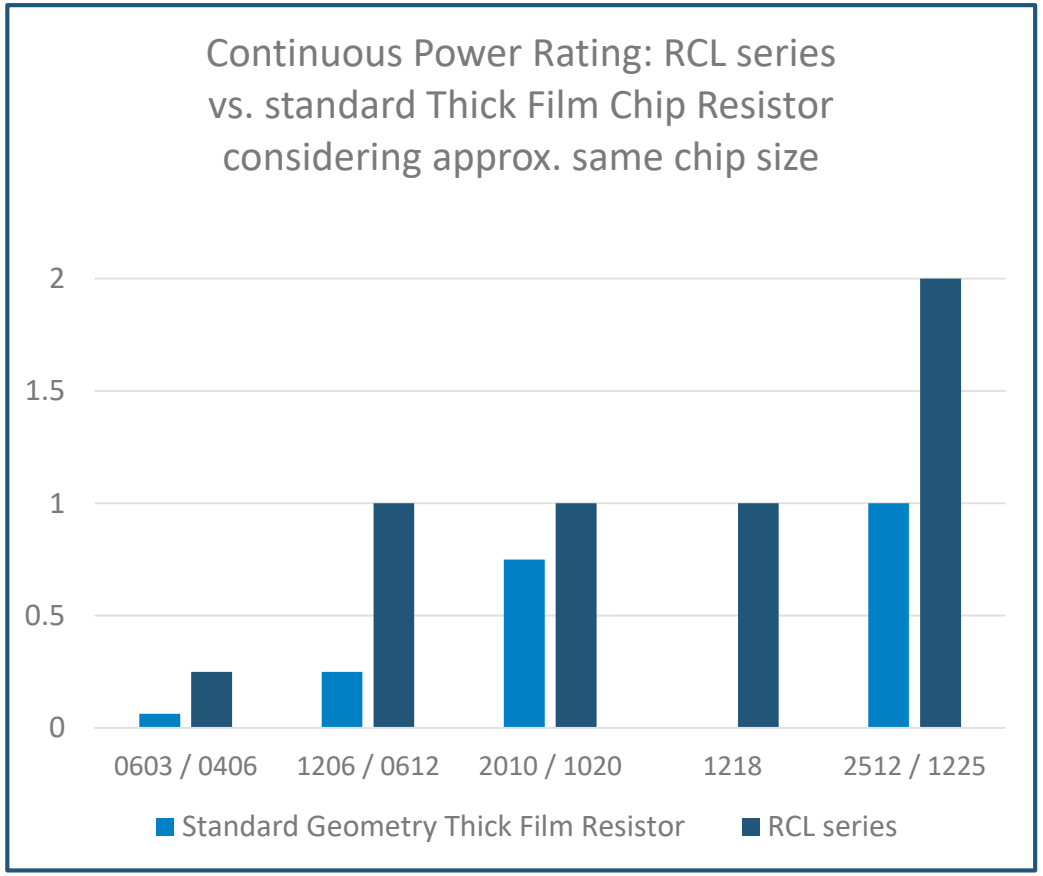
APPLICATIONS
- Automotive
- Industrial
- Commercial

TECHNICAL SPECIFICATIONS

DESCRIPTION	RCL0406 e3	RCL0612 e3	RCL1020 e3	RCL1218 e3	RCL1225 e3
Imperial size	0406	0612	1020	1218	1225
Metric size code	RR1016M	RR1632M	RR2550M	RR3246M	RR3263M
Resistance range	1 Ω to 1 MΩ; jumper (0 Ω)			1 Ω to 2.2 MΩ; jumper (0 Ω)	1 Ω to 1 MΩ; jumper (0 Ω)
Resistance tolerance	± 5 %; ± 1 %				
Temperature coefficient	± 200 ppm/K; ± 100 ppm/K				
Rated dissipation, P_{70} (1)	0.25 W	0.75 W	1.0 W	1.0 W	2.0 W (2)
Operating voltage, $U_{max.}$ AC$_{RMS}$/DC	50 V	75 V	200 V	200 V	200 V
Permissible film temperature, $\vartheta_{f\,max.}$ (1)	155 °C				
Operating temperature range	-55 °C to +155 °C				
Max. resistance change at P_{70} for resistance range, $\lvert\Delta R/R\rvert$ after: 1000 h	≤ 1.0 %				
Max. resistance change at P_{70} for resistance range, $\lvert\Delta R/R\rvert$ after: 8000 h	≤ 2.0 %				
Permissible voltage against ambient (insulation): 1 min, U_{ins}	100 V	100 V	300 V	300 V	300 V

Notes
(1) Please refer to APPLICATION INFORMATION below
(2) Specified power rating requires dedicated mounting conditions to achieve the required thermal resistance

Chip size (standard geometry / reverse geometry)	P_{70} (W) for Standard Thick Film Resistor with short side termination	P_{70} (W) for RCL series with long side termination
0603 / 0406	0.063	0.25
1206 / 0612	0.25	1
2010 / 1020	0.75	1
2512 / 1225	1	2



Let's compare continuous power dissipation ratings of RCL series parts with those of standard thick film resistors which have approximately the same chip size in further detail. As shown in the table and chart above, RCL series parts are specified to withstand continuous power dissipation of two or more times that allowed for standard thick film chip resistors of the same or similar size. For example, while a standard geometry 1206 size thick film chip resistor may only dissipate 0.25W, the RCL0612, which is the same size *except* that is has terminations on the long sides of the part, can handle up to 1W (4 times as much). With power rating 1W, the RCL0612 size is capable of replacing larger standard 1210, 2010, or 2512 size resistors. And while a standard geometry 2512 size thick film chip resistor may dissipate 1W, the RCL1225 can dissipate up to 2W. This is possible because of the larger terminations that long side terminations parts have, as previously described.

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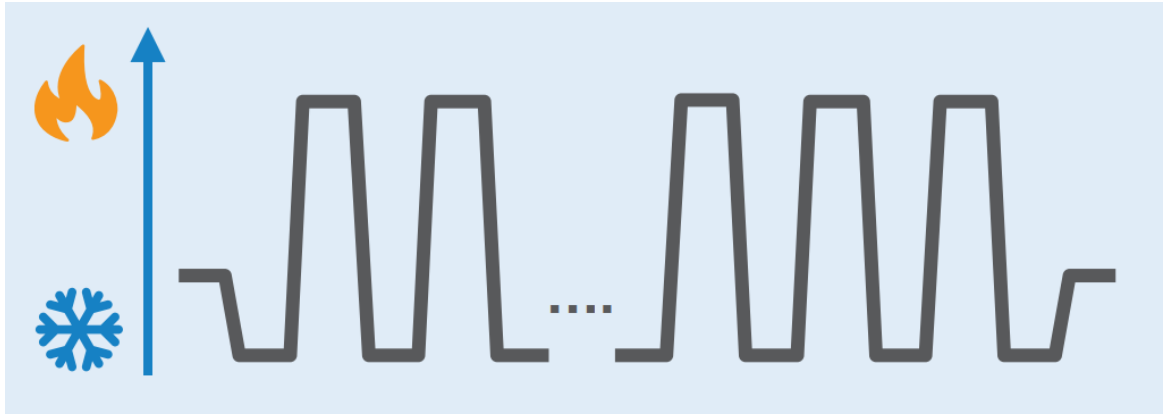
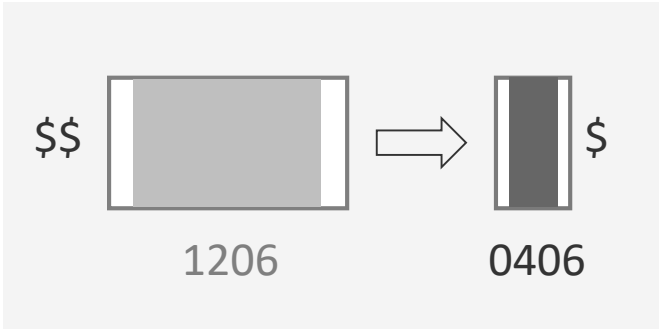
Improving thermal Cycling Performance





RCL series long side termination resistors can be used to improve reliability of a circuit board that will be exposed to thermal cycles. After a high number of temperature cycles, physical forces due to mismatches of the coefficients of thermal expansion (CTE) can cause solder joint fatigue. Minimizing the distance between terminals for each component is a key to mitigating temperature cycling issues as doing so will reduce the significance of differences in the coefficients of thermal expansion between the components and the PCB. The reasons RCL long side termination components excel against thermal cycling requirements are threefold: 1) Larger terminations create a more robust solder joint, 2) Long side termination reduces distance between terminations as a matter of geometry, and 3) Enhanced power ratings achieved with lower thermal resistivity of larger terminations allows for smaller sized components to be used, further reducing the distance between terminals. For example, a standard 1206 size resistor can be replaced with a RCL0406 long side termination part, retaining power rating 0.25W of the original 1206 size part, but improving thermal cycling performance to that of a standard 0402 size resistor.

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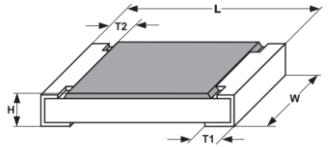
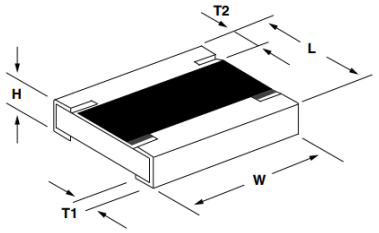
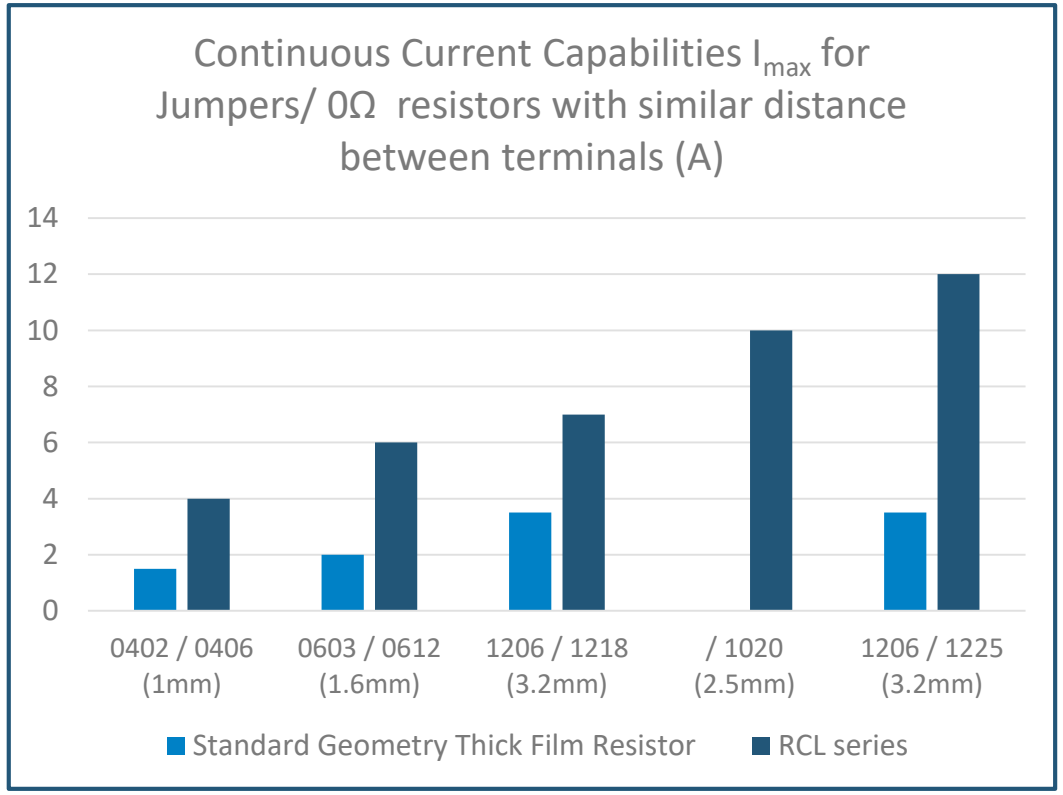
High Current Capability RCL Jumpers





Distance from one terminal end to the other (mm)	I_{max} (A) for Standard Geometry Jumper with short side termination	I_{max} (A) for RCL series Jumper with long side termination
1mm	1.5A (0402 size)	4A (0406 size)
1.55mm / 1.6mm	2A (0603 size)	6A (0612 size)
3.2mm	3.5A (1206 size)	7A (1218 size)
2.5mm	-	10A (1020 size)
3.2mm	3.5A (1206 size)	12A (1225 size)



Zero-ohm resistors, also known as “Jumpers”, are often used to make connections between printed circuit board traces, when an unconnected trace is between them. Depending on the width of the trace that must be crossed, the jumper component used will have a necessary length between terminals. Another factor to consider when choosing a jumper is the continuous and surge current requirements for the circuit traces that are to be connected via the “jumper”. If a standard geometry chip jumper will not meet the current requirement then RCL series long side terminal jumpers may be a solution. As shown here in the table (on the left) and chart (on the right), RCL series jumpers offer vastly increased current capabilities while minimizing distance between the end terminals. The 0612 size RCL jumper withstands 6A continuously versus 2A that the 0603 size standard geometry jumper withstands (3 times as much) even though distance between the part terminals remains similar. As another example, the 1225 size RCL jumper withstands 12A continuously versus the much lower value of 3.5A that the 1206 size standard geometry jumper withstands (over 3 times as much), again, with similar distance between end terminals.

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Applications

Any application where…

- High continuous power dissipation is needed from thick film chip resistors
- Reduced chip resistor size is desired
- **Thermal cycling** is expected
- High current jumper is needed

ALTERNATIVE ENERGY

- Solar Inverter
- Micro-inverter

AMS

- Land Mobile Radio
- Navigation System

AUTOMOTIVE

- RGB Lighting Module
- Wiper Systems
- Transmission control unit
- Gasoline ECU Module
- Overhead Console
- Diesel ECM
- Door panel
- Ambient Light Assembly

COMPUTER

- Server
- Routers
- Chargers
- Outdoor Antenna Dish (TRIA)

INDUSTRIAL

- DC-DC Converter
- Power Supply
- LED Controller
- Audio amplifier
- Battery charger

RCL long side termination resistors are recommended in any application where thermal cycling is expected, when reducing the size of components is desired, or when a chip jumper with higher current capability is needed. As the series is AEC-Q200 qualified, it is suitable for automotive applications such as Wiper Systems and Transmission Control Units; in addition to many other industry wide applications such as Solar Inverters, Navigation Systems, Computer Servers, Chargers, and Power Supplies.

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Summary

- Great option for improved reliability against thermal cycling
- Long side termination thick film chip resistor
- Power rating up to 2W with 1225 case size
- 2 to 4 times the power rating compared to standard thick film resistors with similar chip size
- Available in size 0406 to 1225, value 1Ω to 2.2MΩ, and as a jumper (0Ω)
- Jumpers with maximum current ($I_{max.}$) up to 12A
- AEC-Q200 qualified
- RoHS compliant

That concludes this Product Overview focused on Vishay's RCL series. The design of Vishay's RCL series allows for the parts to have power ratings that are 2 to 4 times that of standard thick film resistors of similar size. Don't forget that RCL Jumpers with current rating up to 12A are also available. RCL series parts are popular for applications requiring AEC-Q200 qualified resistors, especially when thermal cycling is expected.

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