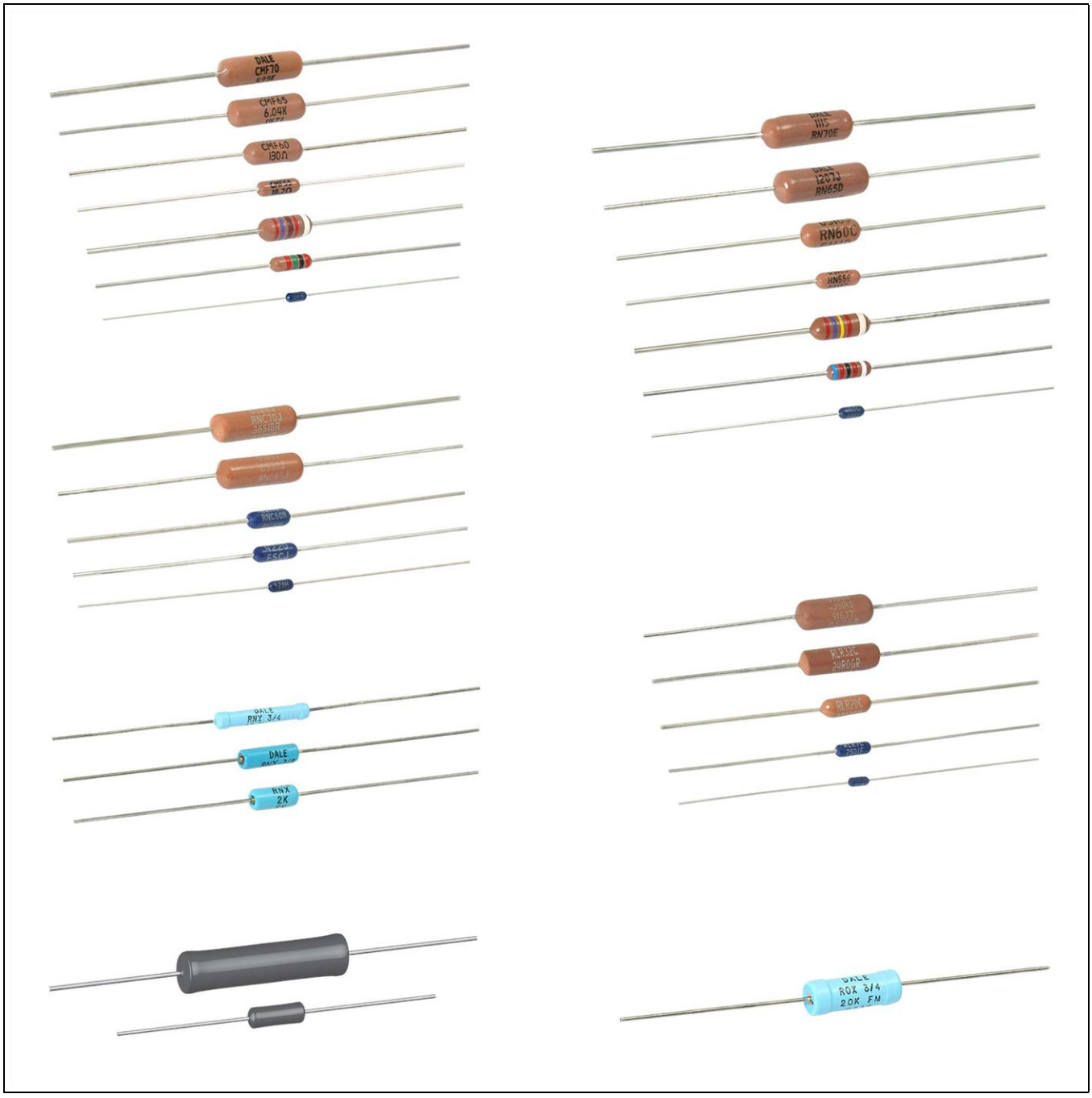
Selection Guide for Conversion of Carbon Composition Resistors



Vishay Dale believes that the information described in this publication is accurate and reliable, and much care has been taken in its preparation. However, no responsibility, financial or otherwise, is accepted for any consequences arising out of the use of this information.

This information is subject to change without notice.

The following cross reference guide is intended to assist in finding Vishay Dale film or wirewound resistor types that are most similar to a particular Allen-Bradley carbon composition type. Direct interchangeability is not implied due to differences in technology; however, electrical characteristics typically will be met or exceeded.

CROSS-REFERENCE FOR COMMERCIAL MODELS

CHARACTERISTICS BY WATTAGE	ALLEN BRADLEY (CARBON COMP)	GENERAL APPLICATIONS		SNUBBER	EXTENDED RANGE
1/8 Watt					
Model	**BB ± 5 %**	**CMF-50**		**RS-1/4**	**RNX-1/4**
Body Length	0.145"	0.150"		0.250"	0.290"
Body Diameter	0.062"	0.065"		0.085"	0.140"
Lead Diameter	0.015"	0.016"		0.020"	0.025"
Resistance Range (Ω)	2.7 to 100M	10 to 22M		0.1 to 3.4K	1K to 100M
Maximum Operating Voltage	150 V	200 V			750 V
1/4 Watt					
Model	**CB ± 5 %**	**CMF-55**		**RS-1/4**	**RNX-1/4**
Body Length	0.250"	0.240"		0.250"	0.290"
Body Diameter	0.090"	0.090"		0.085"	0.140"
Lead Diameter	0.025"	0.025"		0.020"	0.025"
Resistance Range (Ω)	2.7 to 100M	1 to 50M		0.1 to 3.4K	1K to 100M
Maximum Operating Voltage	250 V	250 V			750 V
1/2 Watt					
Model	**EB ± 5 %**	**CMF-20**		**RS-1/2**	**RNX-3/8**
Body Length	0.375"	0.375"		0.312"	0.420"
Body Diameter	0.140"	0.145"		0.085"	0.140"
Lead Diameter	0.033"	0.032"		0.020"	0.025"
Resistance Range (Ω)	1 to 100M	1 to 10M		0.1 to 4.9K	1K to 1G
Maximum Operating Voltage	350 V	500 V			1.5 kV
1 Watt					
Model	**GB ± 5 %**	**CMF-65**	**CMF-65-146**	**RS-2B**	**RNX-3/4**
Body Length	0.562"	0.562"	0.562"	0.560"	0.790"
Body Diameter	0.225"	0.180"	0.215"	0.187"	0.140"
Lead Diameter	0.041"	0.025"	0.025"	0.032"	0.025"
Resistance Range (Ω)	1 to 100M	1 to 22M	1 to 15M	0.1 to 24.5K	1K to 1G
Maximum Operating Voltage	500 V	500 V	500 V		3 kV
2 Watt					
Model	**HB ± 5 %**	**CMF-70**	**CMF-70-146**	**RS-2C**	**ROX-3/4**
Body Length	0.688"	0.562"	0.562"	0.500"	0.800"
Body Diameter	0.312"	0.180"	0.230"	0.218"	0.310"
Lead Diameter	0.045"	0.032"	0.032"	0.040"	0.032"
Resistance Range (Ω)	10 to 100M	1 to 22M	1 to 15M	0.1 to 32.3K	1K to 1G
Maximum Operating Voltage	500 V/750 V	500 V	500 V		5 kV

The following cross reference guide is intended to assist in finding Vishay Dale film resistor types that are most similar to a particular Allen-Bradley carbon composition type. Direct interchangeability is not implied due to differences in technology; however, electrical characteristics typically will be met or exceeded.

Military types are also listed for reference: MIL-R-11 (RC), MIL-PRF-22684 (RL) and MIL-R-10509 (RN)

CROSS-REFERENCE FOR BASIC MILITARY MODELS

CHARACTERISTICS BY WATTAGE	ALLEN BRADLEY (CARBON COMP)	SUGGESTED VISHAY DALE MODELS (FILM RESISTOR TYPES)	
1/8 Watt			
Model	**RC05 ± 5 %**	**RN50**	
Body Length	0.145"	0.150"	
Body Diameter	0.062"	0.065"	
Lead Diameter	0.015"	0.016"	
Resistance Range (Ω)	2.7 to 100M	10 to 22M	
Maximum Operating Voltage	150 V	200 V	
1/4 Watt			
Model	**RC07 ± 5 %**	**RN55**	**RL07**
Body Length	0.250"	0.240"	0.240"
Body Diameter	0.090"	0.090"	0.090"
Lead Diameter	0.025"	0.025"	0.025"
Resistance Range (Ω)	2.7 to 100M	1 to 50M	1 to 5M
Maximum Operating Voltage	250 V	200 V	250 V
1/2 Watt			
Model	**RC20 ± 5 %**	**RN60**	**RL20**
Body Length	0.375"	0.344"	0.375"
Body Diameter	0.140"	0.145"	0.145"
Lead Diameter	0.033"	0.025"	0.032"
Resistance Range (Ω)	1 to 100M	1 to 10M	1 to 10M
Maximum Operating Voltage	350 V	300 V	350 V
1 Watt			
Model	**RC32 ± 5 %**	**RN70**	
Body Length	0.562"	0.562"	
Body Diameter	0.225"	0.180"	
Lead Diameter	0.041"	0.032"	
Resistance Range (Ω)	1 to 100M	1 to 22M	
Maximum Operating Voltage	500 V	500 V	
2 Watt			
Model	**RC42 ± 5 %**		
Body Length	0.688"		
Body Diameter	0.312"	**(SEE COMMERCIAL OFFERINGS)**	
Lead Diameter	0.045"		
Resistance Range (Ω)	10 to 100M		
Maximum Operating Voltage	500 V/750 V		

The following cross reference guide is intended to assist in finding Vishay Dale film or wirewound resistor types that are most similar to a particular Allen-Bradley carbon composition type. Direct interchangeability is not implied due to differences in technology; however, electrical characteristics typically will be met or exceeded.

Military types are also listed for reference: MIL-R-39008 (RCR), MIL-PRF-39017 (RLR) and MIL-PRF-39007 (RWR)

CROSS-REFERENCE FOR ESTABLISHED RELIABILITY MODELS

CHARACTERISTICS BY WATTAGE	ALLEN BRADLEY (CARBON COMP)	GENERAL APPLICATIONS	SNUBBER
1/8 Watt			
Model	**RCR05 ± 5 %**	**RLR05**	**RWR81S**
Body Length	0.145"	0.150"	0.250"
Body Diameter	0.062"	0.066"	0.085"
Lead Diameter	0.015"	0.016"	0.020"
Resistance Range (Ω)	2.7 to 100M	4.7 to 1M (DSCC drawing 98020: 1.1M to 22M)	0.1 to 1K
Maximum Operating Voltage	150 V	200 V	
1/4 Watt			
Model	**RCR07 ± 5 %**	**RLR07**	**RWR81S**
Body Length	0.250"	0.250"	0.250"
Body Diameter	0.090"	0.090"	0.085"
Lead Diameter	0.025"	0.025"	0.020"
Resistance Range (Ω)	2.7 to 100M	1 to 10M (DSCC drawing 99011: 11M to 22M)	0.1 to 1K
Maximum Operating Voltage	250 V	250 V	
1/2 Watt			
Model	**RCR20 ± 5 %**	**RLR20**	**RWR82S**
Body Length	0.375"	0.375"	0.312"
Body Diameter	0.140"	0.138"	0.085"
Lead Diameter	0.033"	0.032"	0.020"
Resistance Range (Ω)	1 to 100M	4.3 to 3.01M (DSCC drawing 98021: 3.3M to 22M)	0.1 to 1.3K
Maximum Operating Voltage	350 V	350 V	
1 Watt			
Model	**RCR32 ± 5 %**	**RLR32**	**RWR89S**
Body Length	0.562"	0.562"	0.560"
Body Diameter	0.225"	0.190"	0.187"
Lead Diameter	0.041"	0.032"	0.032"
Resistance Range (Ω)	1 to 100M	1 to 2.7M (DSCC drawing 98022: 3M to 22M)	0.1 to 4.12K
Maximum Operating Voltage	500 V	500 V	
2 Watt			
Model	**RCR42 ± 5 %**	**(non-E-EREL part) DSCC drawing 97004**	**RWR89S**
Body Length	0.688"	0.562"	0.560"
Body Diameter	0.312"	0.230"	0.187"
Lead Diameter	0.045"	0.032"	0.032"
Resistance Range (Ω)	10 to 100M	10 to 22M	0.1 to 4.12K
Maximum Operating Voltage	500 V/750 V	500 V	

COMPARISON OF RLR AND RCR SPECIFICATIONS

GENERAL CHARACTERISTICS

MODEL	RLR	RCR
MIL SPECIFICATION	**MIL-PRF-39017**	**MIL-R-39008**
Type Element	Film element on insulating form	Carbon composition (hot molded solid core or material applied as a thin coating on insulation form)
Available Tolerances	± 1 % in 96 values per decade ± 2 % in 24 values per decade	± 5 % and ± 10 % in 24 values per decade
Mil-Spec Test Criteria for Failure Rate Determination (+70 °C)	100 % rated power for 10 000 h permissible change in resistance ± 4 %	50 % rated power for 10 000 h permissible change in resistance ± 15 %
Resistance Temperature Characteristics (Maximum TCR)	± 100 ppm/°C (350 ppm/°C, above 10M) Equivalent to: **-55 °C / ± 150 °C** Below 10M = ± 0.8 % / ± 1.25 % Above 10M = ± 2.8 % / ± 4.375 %	**-55 °C / ± 105 °C** 1K and under: ± 6.5 % / ± 5 % 1.1K to 10K: ± 10 % / ± 6 % 11K to 100K: ± 13 % / ± 7.5 % 110K to 1M: ± 15 % / ± 10 % 1.1M to 10M: ± 20 % / ± 15 % 11M and above: ± 25 % / ± 15 %

ENVIRONMENTAL TEST (STABILITY)

MODEL	RLR	RCR
MIL SPECIFICATION	**MIL-PRF-39017**	**MIL-R-39008**
Life (+70 %)	2000 h at 100 % rated power: ± 2 %	1000 h at 100 % rated power: ± 6 % average or ± 10 % for individual resistor 1000 h at 50 % rated power: ± 8 %
Power Conditioning (100 % Test)	± 0.5 %	(Test not required)
Thermal Shock	± 0.25 %	± 4 %
Dielectric Strength	± 0.25 %	No ΔR required
High Temperature Exposure (+150 °C for 2000 h)	± 2 %	(Test not required)
Low Temperature Operation	± 0.25 %	± 3 %
Moisture Resistance	± 1 %	± 10 % average or ± 15 % for individual resistor
Short Time Overload	± 0.5 %	± 2.5 %
Terminal Strength	± 0.25 %	± 1 %
Resistance to Solder Heat	± 0.25 %	± 3 %
Shock and vibration	± 0.5 %	± 2 %

ADVANTAGES AND DISADVANTAGES

STYLE: CARBON COMPOSITION		STYLE: METAL FILM	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
• Wide resistance range	• Highest TCR	• Better stability at full power	• Limited resistance range (in some styles)
• Good stability at 1/2 rate power	• Poor moisture resistance	• Better operating temperature (150 °C to 175 °C)	
• Good pulse handling capability	• Poor shelf life (15 %)	• Excellent shelf life (0.1 %)	
• Good frequency characteristics	• High noise level	• Good frequency characteristics	
	• High voltage coefficient (0.02 % to ± 0.5 %)	• Good voltage coefficient (0.001 %/V)	
	• Becoming obsolete	• Best TC of R	
	• Very high A.S.P.	• Off the shelf availability	

Note

- Each board application has unique design parameters. You may wish to request samples, to insure compatibility with your specific application, for prototype or qualification builds.

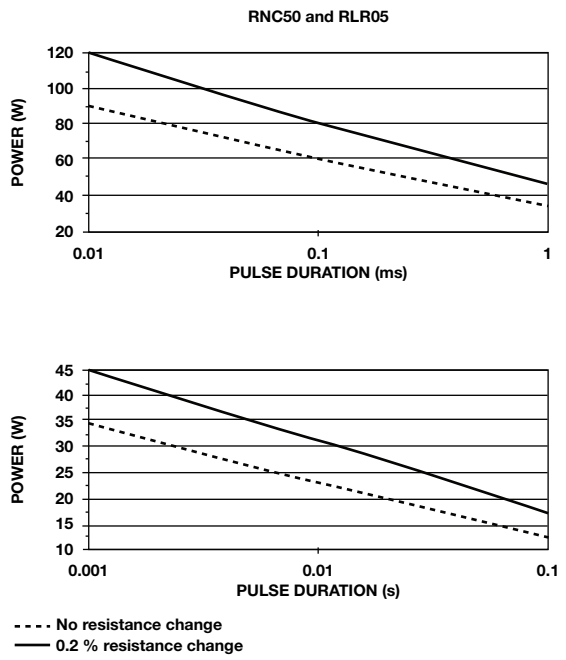
VISHAY DALE NICHROME FILM RESISTORS IN PULSED POWER APPLICATIONS

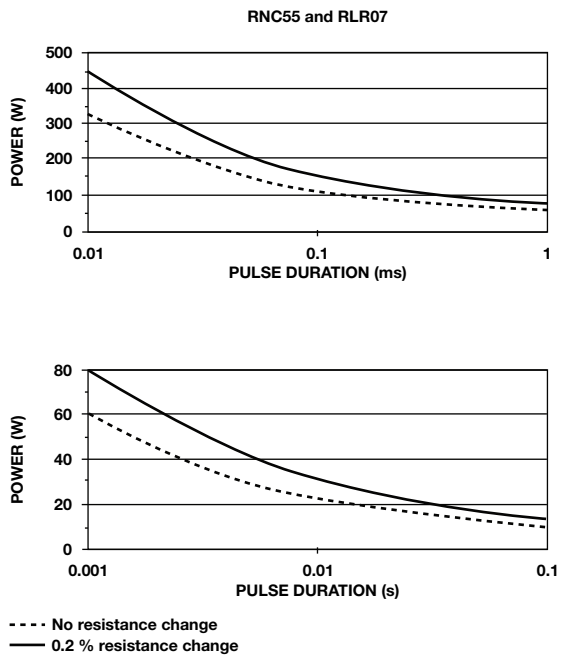
The various military specifications which provide the framework for the construction and testing of established reliability film resistors supply detailed requirements for the performance of these components in a wide range of operating environments. They do not, however, provide much guidance in the area of pulsed power applications. It has become very evident from the numerous questions we receive that film resistors are subjected to a wide variety of electrical pulses which are of short duration and relatively high amplitude. To answer these questions, the Vishay Dale Resistor Division has performed extensive testing to develop guidelines for the use of ERL and ERC resistors in short duration current pulse applications. The ERL and ERC product lines are a Vishay Dale equivalent to the RLR and RNC styles respectively.

All recommendations presented here shall apply to only the Vishay Dale ERC and ERL styles and are not applicable to any other RLR and RNC products. Numerous factors influence the response of any single resistor to a given pulsed overload so these guidelines are based on the most conservative analysis of test results from thousands of individual units.

Single Square Pulse: The following graphs depict the maximum recommended instantaneous power amplitudes for Vishay Dale RLR05, RNC50, RLR07 and RNC55 products for a single square wave form pulse. Each graph provides the maximum power a resistor will withstand without any resistance change, and a maximum power when allowing a 0.2 % resistance change for the single applied pulse.

MAXIMUM PULSE AMPLITUDE



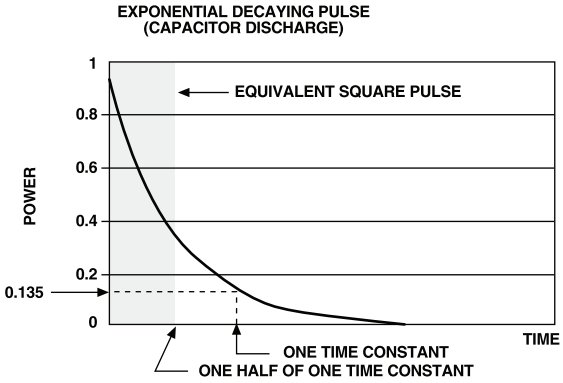


VISHAY DALE NICHROME FILM RESISTORS IN PULSED POWER APPLICATIONS

Repetitive Pulses: Any change induced by a single overload pulse can be expected to have similar cumulative effects with successive pulses. For this reason, Vishay Dale recommends that any application with repetitive pulses limit the pulse power to a value which results in no resistance change. Additionally, it is necessary to verify that the average power during any five second period of operation does not exceed the power rating of the component.

Capacitor Discharge: In the case where the pulse exhibits an exponential decay typical of the discharge of a capacitor, the suitability of a resistor can be determined by calculating an equivalent square wave pulse. For determining a resistor's tolerance to a short duration exponentially decaying power overload, a square wave with an amplitude equal to the initial voltage of that pulse and with a duration equal to one-half of the time constant of the decaying pulse will be of equivalent energy and may be substituted. The time constant is the time required for the voltage across the capacitor to have decreased to 36.8 % of its value at the moment the discharge began. Because the power is proportional to the square of the voltage, the power will have decayed to 13.5 % of its original value in the same time. The graph at the right depicts the power output of a discharging capacitor and an equivalent square pulse.

The time constant of a capacitive discharge can be calculated by multiplying the capacitance in Farads by the resistive load in Ohms through which to capacitor is discharged.



One half of this value will provide the proper duration for the equivalent pulse.

Equivalent pulse duration = $0.5 \times \text{Resistive } (\Omega) \times \text{Capacitance (F)}$

Maximum Voltage Constraints: In addition to the previous limitations which are imposed by the properties of the resistive film, the characteristics of the dielectric materials insulating the resistive elements must also be recognized. For all four Vishay Dale styles mentioned above, the potential across the component cannot exceed 3000 V without the risk of a dielectric failure in the insulating coating.

Additional Information: While the recommendations presented here are very broad, it is likely that there are applications which do not fit the ones we have provided. If you need additional information or have any questions on this subject, please use the email contact on the bottom of this datasheet.