VITROHM
a YAGEO company

CRP SERIES

Wirewound resistors are the most common type of resistors used for inrush energy protection.
In order to limit the inrush energy into electronic circuits, design engineers often used 2 or even more resistors in parallel or series, depending on the necessity to limit either the inrush current or the voltage.

But nowadays, in this era of 'miniaturization', space can be a major issue for design engineers in new developments. Following this need, VITROHM developed the CRP Series. Working along with our customers, we have improved the pulse capability of our resistors, not only for standard, but for customized resistors as well.

CRP Series

APPLICATION NOTE

Precision Power Wirewound Resistor

FEATURES

The first and therefore oldest resistor technology is based on the knowledge of the "specific resistance" as a material constant, and also on the possibility to change the constant by modifying the alloy. This principle has remained unchangeable even today. A resistance wire is wound on to a carrier which is provided with suitable connection elements.

The essential electrical characteristics are determined by the winding wire used. However, the contacting method between the resistance wire and external connecting leads is relevant to the suitability and reliability of the component.

The CRP Series had been especially designed to be used as a precision resistor with a pulse handling characteristic.
It is a wirewound resistor with ceramic core plus wire welded terminals onto metal caps.
It is finished with a light grey silicone lacquer; this lacquer has flame retardant characteristics according to UL-94 V-0.

The design engineer not only will be able to reduce the number of components in his circuit, but, in some cases, he or she can choose a resistor with a lower nominal power rating for the same purpose. But of course, this will depend on the characteristics of the application.

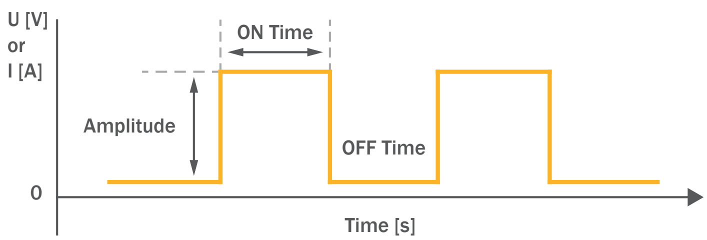
These resistors are often used in electronic circuits where the inrush energy and transients are critical to the circuit.

PULSE PERFORMANCE

The pulse load could be single or continuous in the shape of rectangular, exponential or tooth saw. It could appear at the input of an electronic circuit, resulting of a lightning surge, some transients surrounding of the electronic equipment, or resulting of an inrush current after a switch had been turned to "ON".

In VITROHM's test laboratory, customized pulse shapes and characteristics can be simulated according to customer's request, respectively to relevant standards like the IEC60115-1 clause 4.27 and IEC61000-4-5.

Square pulse shape

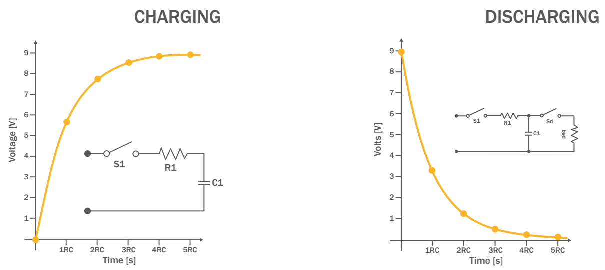


$E = P \times t$

$P = \frac{U^2}{R}$ or $I^2 \times R$

Signs and symbols:
E = Dissipated energy [WS] or [J]
P = Pulse power [W]
t = Pulse time 'ON' [S]
U = Voltage [V]
$U_{AC\ or\ DC}$ = Pulse Voltage [V]
R = Resistor under pulse [Ω]
I = Current pulse [A]

Capacitor charging/discharging



$E = \frac{C \times U^2}{2}$

$P = \frac{U^2}{R}$ or $I^2 \times R$

Signs and symbols:
E = Dissipated energy [WS] or [J]
P = Pulse power [W]
t = Pulse time 'ON' [S]
U = Voltage [V]
U_{AC} = Peak pulse Voltage $[V]_{RMS}$
U_{DC} = Pulse Voltage [V]
R = Resistor under pulse [Ω]
I = Current pulse [A]
C = Capacitance [F]

APPLICATION NOTE

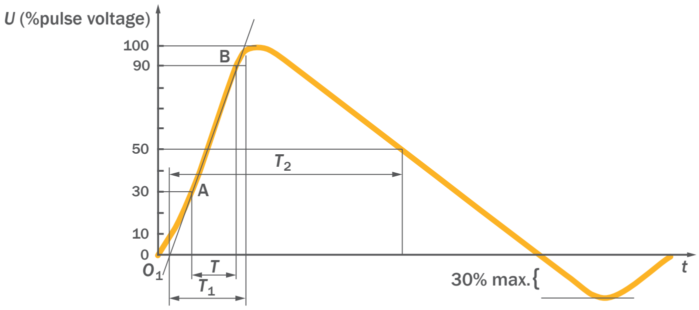
EXPONENTIAL PULSE CURVE

Exponential pulse is related with the standards IEC60115-1 clause 4.27, for single pulse test, and IEC61000-4-5, for surge immunity test, like lightning surge for example, or other transients around.

VITROHM developed the CRP Series according to those two standards, always with the continuous improvement in mind.
The tests are done in VITROHM's tests laboratory, using special equipment to simulate the curve characteristic.
The voltage shown in the "Peak voltage limit" graph is the net voltage across the resistor.
The generator open voltage will be higher due to the generator's internal impedance 12[Ω].

The pulse shape is according to IEC61000-4-5, 1,2/50[μs], described in the graph below, the pulse shape is 10 pulses with a cool down period of 10 up to 20[s].

Peak voltage limit



$$E = \left(\frac{1}{3}\cdot\frac{U^2}{R}\cdot t_1\right) + \left(\left(\frac{U^2\cdot\tau}{-2\cdot R}\right)\cdot e^{-\frac{2\cdot(t_2-t_1)}{\tau}} - 1\right)$$

$$T_1 = 1{,}67\cdot T = 1{,}2[\mu s]^{\pm 30[\%]}$$

$$T_2 = 50\,[\mu s]^{\pm 20[\%]}$$

Signs and symbols:
E = Dissipated energy [WS] or [J]
T_1 = Time to peak voltage [s]
T_2 = Time to 50[%] of peak voltage [s]
U = Voltage [V]
U_{AC} = Peak pulse Voltage $[V]_{RMS}$
R = Resistor under pulse [Ω]
τ = Exponential rate of decay

Calculate 'K' factor

Beside the above mentioned curves, even many years ago VITROHM did develop an easy way to find out what will be the best resistor for customer applications according to pulse characteristic. Using the circuit parameters, it will be easy to calculate the maximum power rating and the time the resistor will be subjected to the inrush energy.
Customer can calculate the so-called 'K' factor using:

$$K = P_{Max}\cdot\sqrt{t}$$

The admissible pulse duration can be calculated by:

$$t_{Max} = \frac{K^2}{P^2}$$

The minimum time between pulses can be calculated by:

$$t_{\min} = P_{Max}\cdot\frac{t}{P_{70}}$$

The equations are the results of many separate experiments and represent the sum of experience.
Several other factors, often application related, cannot be considered in our formula which should give safe operation information rather than exact limiting data. After calculating the provisional results, testing to the specific requirements is recommended.

With this information, using the 'Pulse data for wirewound resistors' table, available in VITROHM website (download file), customer can easily choose the most suitable resistor for their application:

	CRP110	CRP200	CRP300	CRP400	CRP500
Nominal power rating P70 [W]	1,0	1,8	2,7	3,6	4,5
Resistance range	0R1...220R	0R1...470R	0R1...1K8	0R1...1K5	0R1...5K1
Tolerances [%]	1, 2, 5, R ≥ 1R0: 0,5				
Temperature coefficient [10^{-6}*K^{-1}]	$120^{\pm 50}$				
Temperature range [°c]	-55...+350				
Dielectric withstanding voltage [V]	Max. 500				
Maximum continuous working voltage [V]	√(P_70×R)				
Endurance ±[%]	3				
Short time overload ±[%] $U = \sqrt{10\cdot P_{70}\cdot R}$, 5[s]	2				
Surge test ±[%]	2				
Pulse performance	see graphics next page				
K factor	under development	65	90	under development	155

The equations above to calculate the factor K can only be used in case the time between pulses is according to:

$$1\times 10^{-6} \le t_{(sec)} \le 100\times 10^{-3}$$

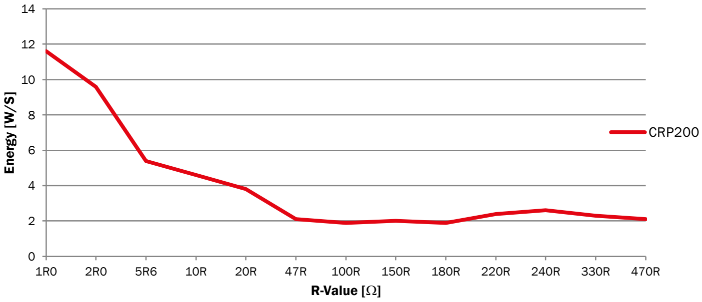
Under the conditions of:

$$P_{Avg}(t) \le P_{70}$$

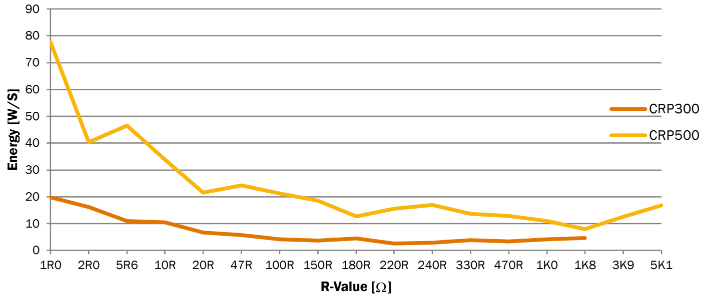
APPLICATION NOTE

PULSE CAPABILITY CURVES

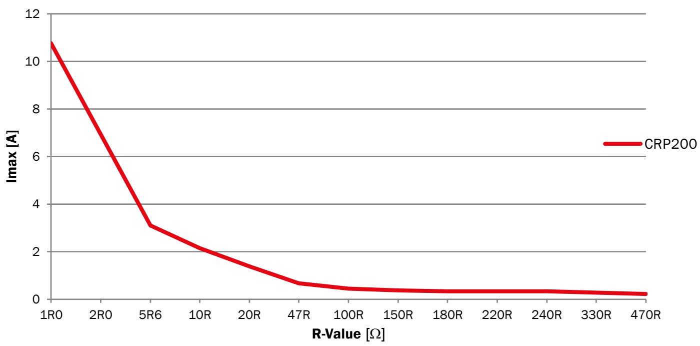
ENERGY CAPABILITY GRAPH (Based on maximum wire temperature)



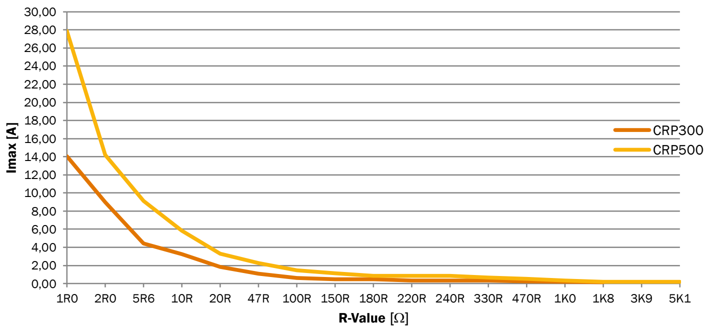
ENERGY CAPABILITY GRAPH (Based on maximum wire temperature)



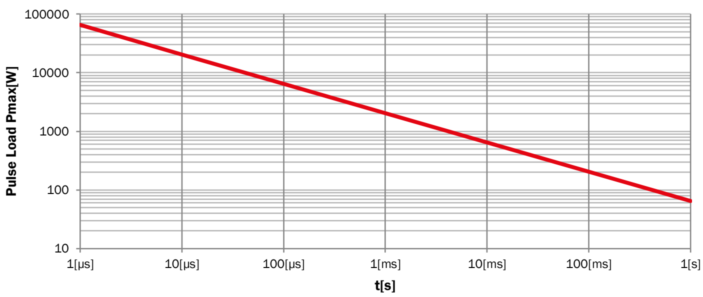
MAXIMUM CURRENT (Based on maximum wire temperature)



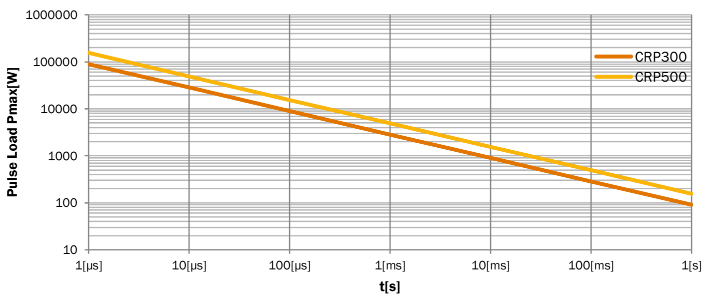
MAXIMUM CURRENT (Based on maximum wire temperature)



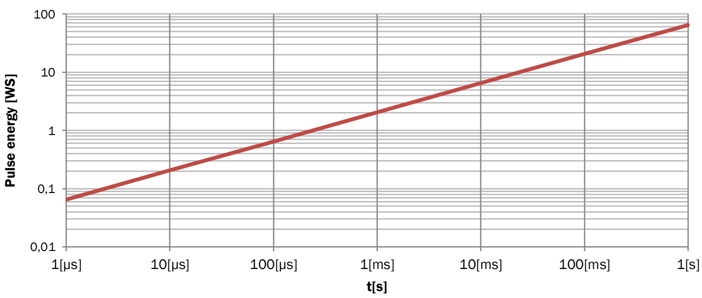
POWER CURVE FOR CRP200



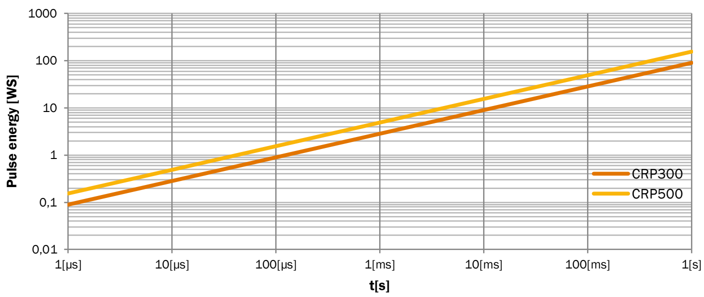
POWER CURVE FOR CRP300 AND CRP500



PULSE ENERGY FOR CRP200



PULSE ENERGY FOR CRP300 AND CRP500

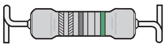


APPLICATION NOTE

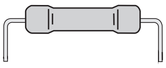
LEAD CONFIGURATIONS

The CRP is also available in a diferent pre-forming, as shown below. Other configurations are available upon request.

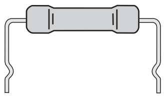
Z-Form



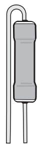
Axial



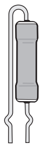
Axial Kink



Radial



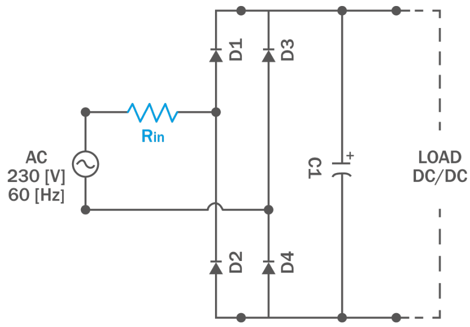
Radial Kink



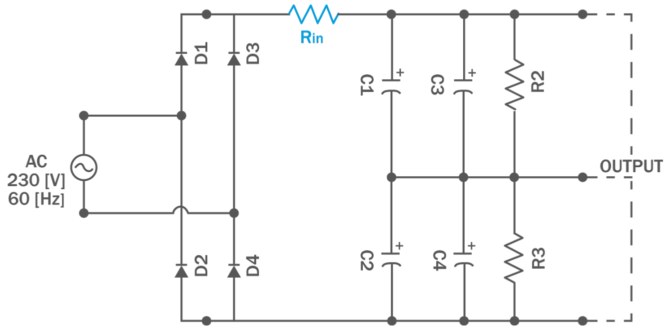
APPLICATIONS OF CRP-SERIES

The most commonly applications of the CRP Series are:

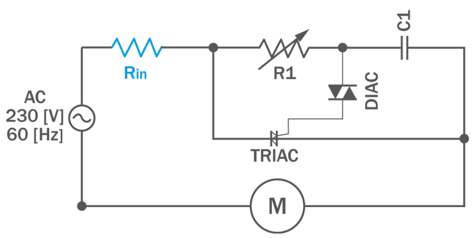
Power supplies



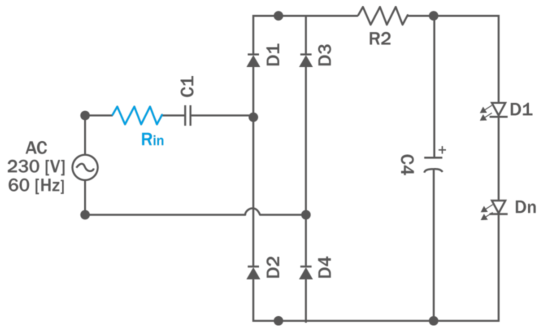
Battery chargers



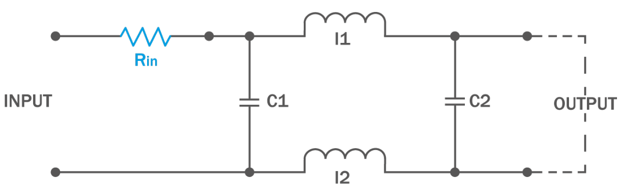
Fans



Energy saving lamps or LED



EMI Filters



More applications:

- Electronic energy meter
- Presence detectors
- Surge protection

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