This specification is intended to be utilized in conjunction with Series PW & PV data sheets.

RESISTOR SPECIFICATION

RCD Series PW & PV Ceramic-Encased Power Resistors

RESISTORS • CAPACITORS • COILS • DELAY LINES

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RCD Series PW & PV Ceramic Encased Power Resistors

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Performance ratings apply to standard Series PW and PV resistors, unless indicated otherwise. Consult factory for performance ratings of parts with options or are custom-designed to meet specialty requirements.

For additional information not presented in this report, request following Application Guides…

Thermal EMF (Engineering Report #R-32)
Forced Air Convection Across Power Resistors (Engineering Report #R-33)
Thermal Considerations and Temperature Rise of RCD Resistors (Engineering Report #R-35)
Power Derating Factors for Grouping Resistors (Engineering Report #R-36)
Mounting Guidelines for RCD Axial Lead Resistors & Inductors (Engineering Report #R-37)

1.0 SERIES PW/PV PRODUCT HISTORY

RCD's ceramic-encased power resistors were developed in early 1970's to achieve moderate power and performance levels at costs significantly lower than conventional conformal-coated resistors. The PW/PV Series have been constantly improved and expanded over the years to achieve greater stability under various environmental conditions, as well as a wider range of resistance values and design options.

2.0 PRODUCT DESCRIPTION

Designed for low cost power applications, the units are available with a wide range of custom options including non-standard values, non-inductive design, high-pulse and high voltage designs, fusible design, temperature sensitive design, increased power, low thermal emf, etc., are available. Refer to individual data sheets for list of options, dimensions, etc.

PW Series: General Purpose 1W-30W Axial Lead (data sheet #FA040)
PWLL Series: 5W to 25W, Horizontal Mount with Radial Leads (data sheet # FA051)
PWH Series: 10W to 50W, Lug terminals (data sheet # FA051)
PWHM: 10W to 50W, Lug terminals, metal mounting bracket (data sheet # FA051)
PV Series: 2W to 12W Vertical Mount (data sheet # FA053)
PVH Series: 2W to 12W Vertical Mount, 4-Terminal (data sheet # FA053)
PWV Series: 5W to 25W Vertical Mount with bracket (data sheet #FA053)

2.1 Component Weight: Series PW Option A standoffs adds 5%-10% to weight of part

Type	Weight (typ.) g	Type	Weight (typ.) g	Type	Weight (typ.) g	Type	Weight (typ.) g	Type	Weight (typ.) g	Type	Weight (typ.) g	Type	Weight (typ.) g
PW1		PWLL5	6.5	PWH10	11	PWHM10	15	PV2	3.8	PVH2	5	PWV5	8
PW2	2.2	PWLL7	8.3	PWH15	18	PWHM15	24	PV3	5.4	PVH3	6	PWV7	10
PW3	3.7	PWLL10	11	PWH25	36	PWHM25	44	PV5	6.5	PVH5	7	PWV10	14
PW5	5.1	PWLL15	19	PWH40	60	PWHM40	74	PV7	11	PVH7	12	PWV15	22
PW7	7.7	PWLL25	30	PWH50	72	PWHM50	87	PV10	16	PVH10	17	PWV20	27
PW10	10.8							PV10S	16	PVH10S	17	PWV25	29
PW15	18							PV10A	16	PVH10A	17		
PW20	26												
PW22	26												
PW25	28												
PW30	58												

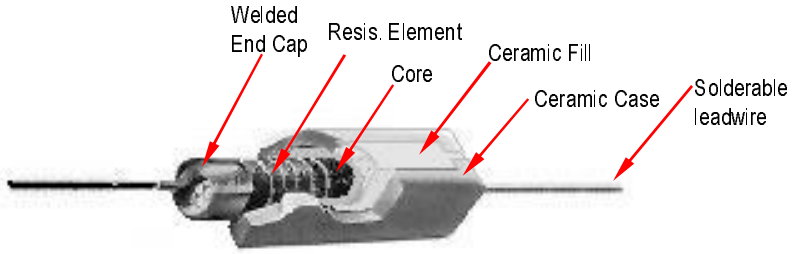
3.0 DESIGN FEATURES

- Low cost and wide choice of packaging options (axial, radial, 2-terminal, 4-terminal, bracket mount, etc.)
- Design objectives are achieved via use of high thermally- conductive ceramic materials and special processing.
- Fireproof construction
- Excellent performance and reliability

4.0 CONSTRUCTION AND MANUFACTURING PROCESS

The design and construction of the PW/PV Series results in excellent reliability. Resistance elements are potted into ceramic cases providing a durable fireproof construction. Elements are typically power film on higher resistance values, wirewound construction on lower values, and metal plates on some ulta-low values. Element construction depends on options, e.g. option P parts are always WW or metal elements. If a specific construction is preferred, specify opt. 'WW' for wirewound, opt. 'M' for power film, opt. 68 for metal elements. Terminals are solder coated copper or copperweld (lead-free version available). Parts are marked with resistance value and tolerance as a minimum (custom marking is available).

Typical PW Series Construction



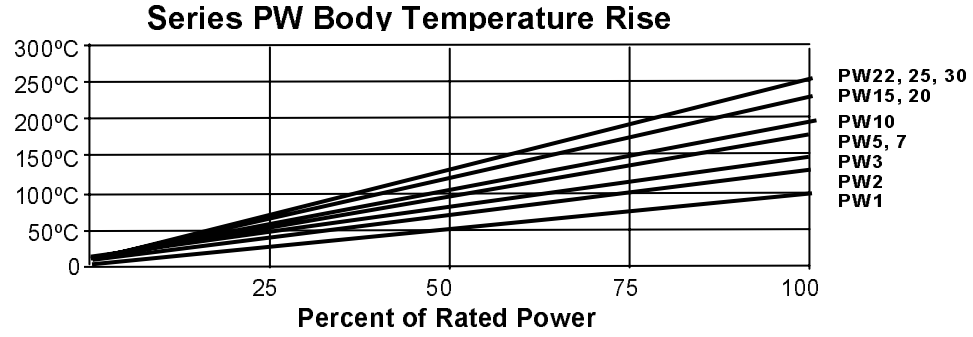
Typical PV Series Construction

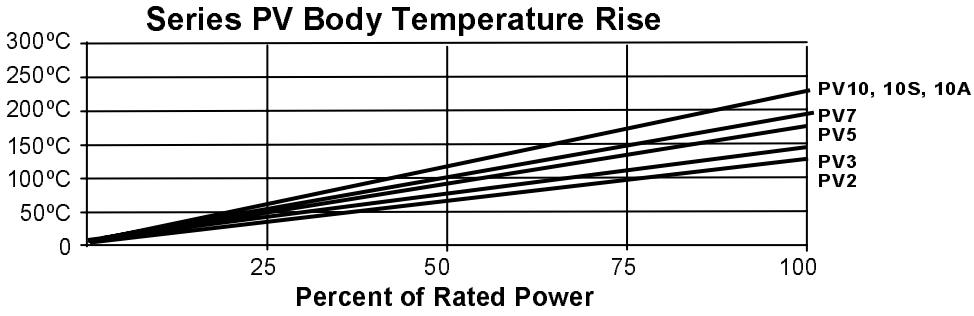
5.0 QUALITY CONTROL

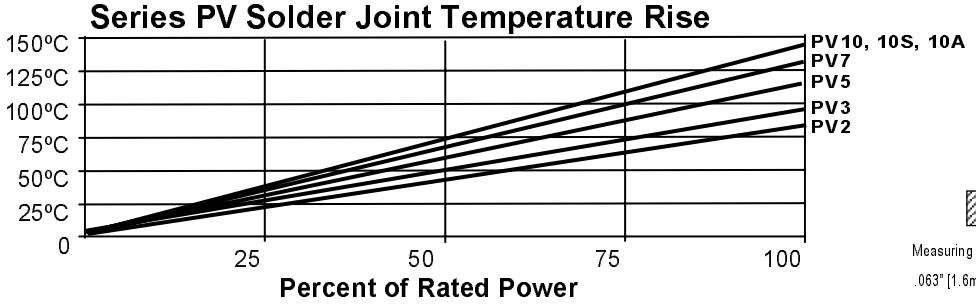
As part of RCD's ABZED program (Absolute Zero Defects), all key stages of production are monitored by Statistical Process Control (SPC), first-piece inspection, and/or a variety of in-process inspection steps to ensure optimum uniformity. Final outgoing inspection typically results in six sigma quality levels. A wide range of military screening tests are available as an option fo high reliability applications.

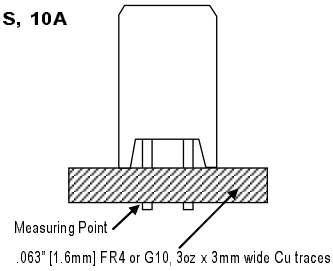
6.0 TEMPERATURE RISE

Power resistors are designed to run hot when subjected to full rated power levels. The temperature rise of low power resistors, particularly smaller models, depends largely on heat conduction through the leads or end terminations, which can vary significantly depending on PCB material and layout (i.e. pad size, trace area, copper thickness, air flow, etc.). It is recommended to evaluate product in actual use conditions to ensure that the proper component and PCB layout is utilized. Refer to charts below for general guideline…









7.0 ELECTRICAL, ENVIRONMENTAL, AND MECHANICAL PERFORMANCE

7.1 Terminal Strength: terminations shall not break when tested per MIL-STD-202 Method 211, pull test. Direct load shall be 5 lbs.

7.2 Solderability: When resistors are tested per ANSI-J-STD-002 Cat.1, the dipped surface of the lead shall be at least 95% covered with new solder coating. On resistors with standoffs, the portion of the lead below the standoff shall meet 95% solderability requiremets.

7.3 Solvent Resistance:
The potting and marking are resistant to industrial solvents and aqueous based cleaners. The speciality high temp/ high-thermal conductivity potting compound utilized on this series is not waterproof and therefore care should be taken to quickly and thoroughly dry parts after water rinse. Do not brush with hard bristles or use jet spray immediately after soaking in solvent.

7.4 Resistance Measurement: When measured at 25°C ±2C, the reading shall be within the specified tolerance of the nominal value. Series PW are measured on the leads at a point 3/8" ±1/16" from end of body. Series PV are measured on the leads at a point 1/16" ±1/32" below the standoffs.

7.5 Temperature Coefficient: Typical TCR for Series PV and PW 2-terminal resistors is 100 -200ppm/°C for values 1ohm and above (available to 10ppm). Series PVH 4-terminal model has TC of 20ppm//°C for values 1ohm and above (available to 5ppm). Consult applicable data sheets as listed in Section 2.0 for addition detail. TC is typically measured at 25°C and 100°C but can be measured at customer-specified temperatures with prior arrangement.

7.6 Overload & Pulse Capability

a) Short Time Overload: PV and PW resistors (in wirewound or power film construction) are capable of overloads 3 times rated power for 5 seconds (not to exceed 1.5 x maximum voltage rating). Increased overlodas are available on custom basis (consult factory).

b) Pulse Capability Option WW Wirewound Construction: Pulse capability is dependent on a variety of factors including construction (wirewound vs. film), resistance value, waveform, repetition rate, environmental conditions, etc. RCD's PW and PV Series offer excellent overload capability, however wirewound construction generally offers better surge capability. It is recommended that pulse-applications of moderate levels utilize wirewound elements (specify opt. WW or XWW for non-inductive wirewound). The chart

below is a general guide for standard PW and PV series, based on single or infrequent pulses, WW construction, inductively wound.

c) Pulse Capability Option M Power Film Construction: film elements generally can not withstand energy levels equivalent to that of wirewound models. If film elements are required in pulse applications, consult RCD engineering for assistance in product selection to ensure the product will satisy the requirements.

d) Standard vs. Option P: Option P resistors are wirewound with special materials and processing to achieve increased surge energy levels. The pulse rating for parts with Opt. P is 50% greater than standard WW ratings, and increased pulse levels up to 3x standard are available on custom basis.

e) Single Pulse Application Note

a) Pulse must not exceed peak power level given in chart for given time duration, and
b) Ambient temperature must be 25ºC or below (if above 25ºC, derate peak wattage/voltage/energy/current levels by .476%/ºC)
c) Peak voltage must not exceed the levels given in chart below (increased voltage design available):

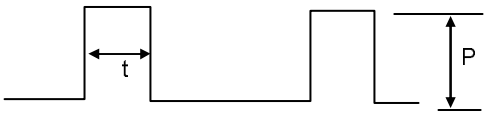
Type	Peak Voltage	Avg. Power @ 25°C
PW1	1000V	1W
PW2	1500V	2W
PW3	2000V	3W
PW5	2000V	5W
PW7	3000V	7W
PW10	4000V	10W
PW15	4000V	15W
PW20	5000V	20W
PW22	5000V	22W
PW25	5000V	25W
PW30	6000V	30W

Type	Peak Voltage	Avg. Power at 25°C
PV2	1000V	2W
PV3	1300V	3W
PV5	1500V	5W
PV7	2000V	7W
PV10	3000V	10W
PV10S	3000V	10W
PV10A	3000V	10W

f) Multiple Pulse Application Note

a) Must meet the criteria for a single pulse given above, and
b) Average power must not exceed the levels at 25ºC given in chart above

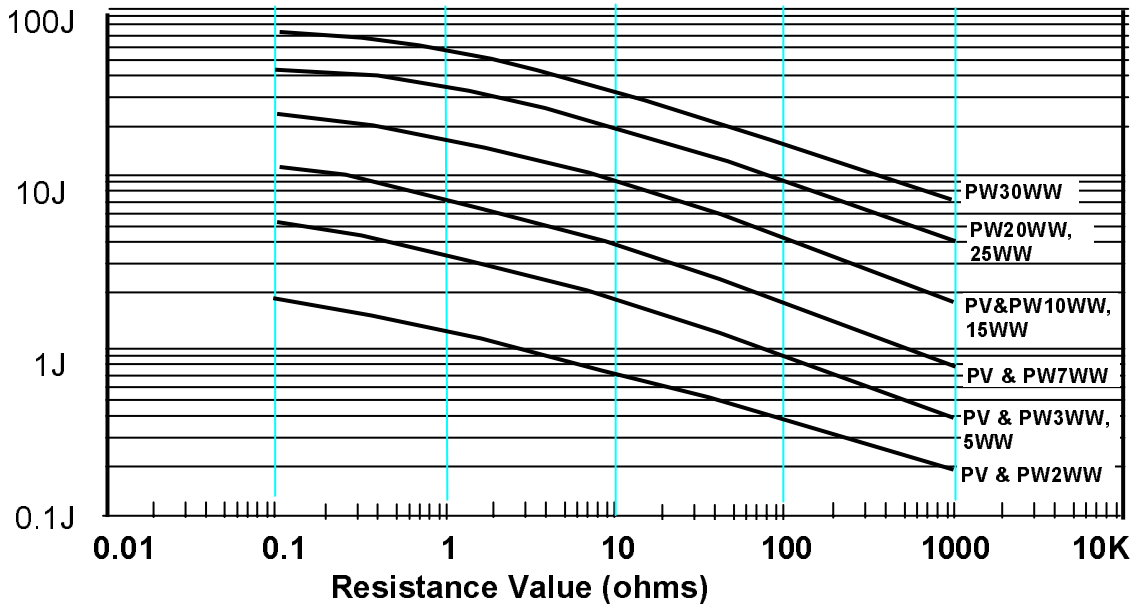
Average Power = Pt/T
P= Peak Power (Watts)
t= Pulse duration (Seconds)
T= Cycle Time



Example: Peak Power (P)= 1000W, pulse duration (t) = 10uS, cyle time = 60Hz (.01667S)... 1000W x .00001S / .01667S = .6 Watts average power.

For improved performance and reliability, a 30% safety factor is recommended (50% if parts are subjected to multiple pulses). Complete RCD's "Surge Questionnaire Form" if standard or Opt.P construction won't suffice so that we can recommend the optimum resistor for your application. Always verify selection by evaluating protoypes under worst-case conditions.

Series PV & PW Opt. WW Wirewound Surge Capability (Joules)



7.7 High Temperature Exposure: When subjected to 200°C for 250 hours, the resistance value shall not shift more than 4% + 0.005Ω and marking shall remain legible.

7.8 Voltage Rating and Voltage Coefficient:

a. Maximum Voltage Rating: PW and PV Series resistors have a DC or AC_{RMS} voltage rating equivalent to $(PxR)^{1/2}$, not to exceed maximum voltage levels listed in respective data sheets. Increased voltage levels are available.

b. Voltage Coefficient: The voltage coefficient (amount that the resistance value temporarily changes with applied voltage) is very low on wirewound models (especially option P) and typically varies inversely to body size, i.e. larger parts generally have lower VC. VC is measured at 10% rated voltage and 100% rated voltage. Typical VC is <5ppm on WW models, and 5 - 20ppm on film models.

7.9 Moisture Resistance: When tested at 90%-100% relative humidity for 240 hours, the resistance shift shall not exceed 5% + .005 ohm. Customized construction with internal moisture seal is available for applications involving high humidity and/or harsh environments.

7.10 Load Life: Series PW & PV resistors have an indefinite life expectancy, i.e. there is no expected "burn-out" period when used within published guidelines. Stability level is within 5% % (+.005Ω) when subjected to full rated power at 25°C (cycled 1½ hours on, ½ hour off) for 1000 hours. Tightened stability levels are available via extra preconditioning.

7.11 Vibration: Under harsh conditions of shock or vibration, all leaded resistors should be mounted so that the body is restrained from movement, as specified by Mil-PRF-39007 par.6.5. If clamps are utilized to hold the resistor body in place, the performance of the resistor could be enhanced or retarded depending on the thermal conductivity of the material. Under normal vibration conditions, all sizes may be supported by their leads only. For improved vibration resistance, keep lead lengths as short as practical. When subjected to Vibration per MIL-STD-202 Method 201 (6 hours), the resistance value shall not shift more than 1% +.005Ω (resistors shall be mounted per Mil-R-26 par 4.6.15 (A). Specialty design is available for high vibration applications.

7.12 Dielectric Withstanding Voltage: When tested per MIL-STD-202 M.311 using V-block mounting, there shall be no evidence of flashover, mechanical damage, arcing, or insulation breakdown. Dielectric rating is 1000VAC for 60 seconds (increased voltage levels available).

7.13 Insulation Resistance: Insulation resistance shall be 10 MegΩ Minimum when tested per method 302 of MIL-STD-202 test condition A, and prepared per MIL-R-26 Par.4.6.8.1(A) and 4.6.8.1(G)

7.14 Noise: Noise levels are generally lowest on wirewound models (especially option P) and on lower values of film resistors. Typical noise levels are -35dB on values up to 1K ohm, -20 dB on values up to 10Kohm, and -10dB on values up to 100Kohm. Specialty design is available for applications which require lowest noise and distortion charateristics (such as audio circuits).

7.15 Operating Temperature Range: -55°C to +220 (ratings up to 275°C available)

7.16 Power/ Voltage/Current Derating: Derate 0.513%/°C when ambient temperature exceeds 25°C (to zero at 220°C).

7.17 Flame Retardancy: Series PW & PV resistors are flame retardent in accordance with UL94-V0.

7.18 Shelf Life: Typical shelf life stability is 0.05% $\triangle R$/year

7.19 Inductance: The inductance of RCD's PW and PV Series is primarily value and size dependent, typically in the range of 0.5 to 10uH for lower values and smaller sizes, 10 uH to 50uH for higher values and larger sizes. External factors such as length of leads, layout of the circuit, stray capacitance, etc., may have an impact. Low inductance design is available (specify option 'X'). Maximum inductance for Option X models (measured at 500KHz) is as follows (models with inductance levels as low as 20nH are available)...

Opt. X Inductance	Values ≤50 ohm	Values >50 ohm
≤5W	0.2uH Max	0.37uH Max
7W-25W	0.3uH Max	0.6uH Max
30W-50W	1uH Max	2.0uH Max

7.20 Potting Compound Characteristics: Potting compound shall fill the case typically within 1/16" from top of case. Slight anomalies, shade variation, and shrinkage are normal and expected. As detailed in U.S. military specification MIL-R-49465... Due to the nature of this design, if the units are potted in a ceramic "boat" a natural shrinkage of the potting may occur prior to or following some tests. This will not be considered a defect as long as it does not impair the electrical or environmental characteristics. The internal circuitry shall not be exposed. Cracks in the boat itself are not allowed."

7.21 Fusing Characteristics: For fusible version, specify option FF ("PW5FF", PV3FF", etc). Option FF parts are designed to fuse within10 seconds at 10x rated wattage and within 45 seconds at 20x rated wattage (not to exceed 200x rated power or 1.5x rated continuous working voltage). Applicable to values 1 ohm to 1K (consult factory for values outside this range). Surge ratings don't apply to Option FF construction.