This specification is intended to be utilized in conjunction with Series BLU data sheet.

RESISTOR SPECIFICATION

RCD Series BLU Precision Chip Resistors

RESISTORS • CAPACITORS • COILS • DELAY LINES

RCD Components Inc. 520 E.Industrial Pk Dr, Manchester, NH, USA 03109
Tel:603-669-0054 Fax:603-669-5455

RCD BLU SERIES METAL FILM RESISTORS

Table of Contents

1.0 SERIES BLU PRODUCT HISTORY

RCD's BLU Series was first introduced in 1986 as a surface mount replacement for RCD’s precision axial-lead metal film resistors. At the time, the SM industry was still developing and RCD’s “BLU-Chip” series offered design engineers a level of precision previously unavailable at a reasonable price. The series became synonymous with top notch performance and has been improved and expanded over the years to enable improved accuracy, tighter TC’s, wider range of sizes and resistance values, RoHS compliant, and most recently an increased voltage design (Option ‘H’). RCD continues to offer the widest range of sizes, values, tolerances, and TC’s in the industry from micro-mini 0201 to 2512 sizes..

2.0 PRODUCT DESCRIPTION

- Series BLU are the lowest cost precision chip resistors available

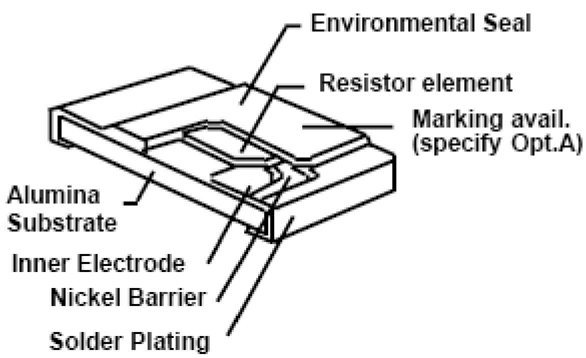
- RCD is the only company that offers a wide range of custom options on precision chip resistors including non-standard values, increased voltage or pulse capability, military screening, custom marking, tin-lead (SnPb) termination option, etc.)

3.0 DESIGN FEATURES

- Tight tolerance and TC
- Low temperature rise resulting from use of highest grade ceramic substrates
- Low noise and high mechanical strength
- Improved temperature stability over competitive models (available to 5ppm)
- Resistance to moisture, solvents, abrasion, and temperature extremes
- Flame retardant materials
- Miniature sizes
- Excellent high frequency performance
- Increased power and voltage designs available

4.0 CONSTRUCTION AND MANUFACTURING PROCESS

The rugged design and construction of the BLU Series results in excellent reliability. In the first phase of production, the ceramic substrates are deposited with inner electrodes, typically followed by Nickel Chromium thin-film via magnetron sputtering process (Nickel alloy, Tantalum Oxide, and Ruthenium Oxide also utilized depending on value, tolerance, TC, surge, and environmental requirements). The deposition and trim process is custom tailored to meet specific resistance and TC levels. Once the substrates have undergone the metalization and stabilization, matte-tin plated nickel barrier terminations and a protective insulation seal over the resistive film is applied. Product is automatically tested to ensure zero defects.



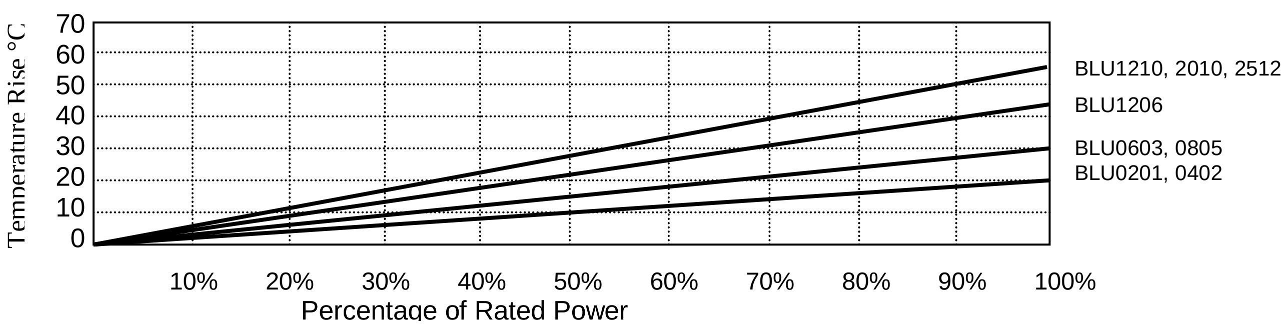
To ensure utmost reliability, care should be taken to avoid potential sources of ionic contamination.

5.0 QUALITY CONTROL

As part of RCD's ABZED program (ABsolute ZEro Defects), all key stages of production are monitored via Statistical Process Control (SPC) to ensure optimum uniformity. Product is 100% tested enabling RCD to achieve SIX SIGMA (3ppm) quality levels. In addition, RCD performs an outgoing inspection on packaging, labeling, and taping quality to ensure 100% compliance. Refer to Section 8 “Reliability/Failure Rate” for additional information.

6.0 TYPICAL TEMPERATURE RISE

The temperature rise of chip resistors, particularly smaller models, depends largely on heat conduction through the 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 proper component and PCB layout.



7.0 TYPICAL ELECTRICAL, ENVIRONMENTAL, AND MECHANICAL PERFORMANCE

Note: a sampling of test data on 3 sizes follows, additional data is available. A full gamut of individualized test programs is also available (contact Sales@rcdcomponents.com for a quotation). Specifications and test data throughout section 7 are based on chips with 0.1% or tighter tolerance and 25ppm or tighter TCR (consult factory for performance outside of this range).

Characteristic	Test Conditions	Test Results				Specification
		Value	Max.	Min.	Avg.	
TEMPERATURE CYCLE/ THERMAL SHOCK	MIL-STD-202 Method 107, -55°C to +125°C, 5 cycles	0201 100Ω 0603 10KΩ 2512 100KΩ	0.039% 0.024% 0.023%	-0.012% 0.003% -0.008%	0.011% 0.014% 0.012%	ΔR ±0.25%
HIGH TEMPERATURE	MIL-PRF-55342 p. 4.7.6, 100 hrs at 125°C	0201 100Ω 0603 10KΩ 2512 100KΩ	0.075% 0.069% 0.080%	0.026% 0.030% 0.004%	0.044% 0.058% 0.056%	ΔR ±0.25%
VIBRATION	10 to 55Hz 3 directions, 6 hours total	0201 100Ω 0603 10KΩ 2512 100KΩ	0.009% 0.007% 0.008%	-0.008% -0.004% 0.001%	0.003% 0.003% 0,004%	ΔR ±0.2% without damage
RESISTANCE TO SOLDERING HEAT	MIL-PRF-55342 par. 4.7.7, 260 °C for 10 sec	0201 100Ω 0603 10KΩ 2512 100KΩ	0.059% 0.012% 0.005%	-0.014% -0.041% -0.040%	0.016% -0.022% -0.026%	ΔR ±0.1%
SOLDERABILITY	Solder Dip at 230°C ±5°C for 3 sec. ±1 sec. ANSI-J-STD-	0201 100Ω 0603 10KΩ 2512 100KΩ	>95% >95% >95%	>95% >95% >95%	>95% >95% >95%	Minimum 95% coverage
SHORT TIME OVERLOAD	MIL-PRF-55342 p.4.7.5, 2.5 times rated voltage, 5 seconds (NTE max	0201 100Ω 0603 10KΩ 2512 100KΩ	0.022% 0.016% 0.031%	-0.019% -0.012% -0.018%	0.002% 0.008% 0.011%	ΔR ±0.25%
MOISTURE RESISTANCE	MIL-STD-202, Method 103, 95% RH, 1000 hrs	0201 100Ω 0603 10KΩ 2512 100KΩ	0.073% 0.055% 0.068%	0.002% 0.001% 0.008%	0.047% 0.033% 0.032%	ΔR ±0.25%
STD LOAD LIFE (MIL-PRF-55342 Equivalent W & V Ratings)	MIL-STD-202, Method 108, 1000 hrs, MIL-PRF-55342 p.4.8.11.1, 70°C	0201 100Ω 0603 10KΩ 2512 100KΩ	0.065% 0.023% 0.028%	-0.059% -0.016% -0.010%	0.016% 0.009% 0.017%	ΔR ±0.25%
OPT. H LOAD LIFE (Opt.H = Increased W & V, 0201= 1/20W 25V; 0402= 1/16W 50V; 1206=1/3W 200V	MIL-STD-202, Method 108, 1000 hrs, MIL-PRF-55342 p.4.8.11.1, 70°C	0201 10KΩ 0603 10KΩ 1206 100KΩ	0.176% 0.162% 0.206%	-0.118% -0.063% -0.107%	0.144% 0.112% 0.126%	ΔR ±0.5%

7.1 Solvent Resistance

When resistors are tested as specified in MIL-STD-202 Method 215, there shall be no mechanical damage and the markings shall remain legible.

7.2 Resistance Measurement

When measured at 25°C ±2°C, and <60% RH, the reading must be within the specified tolerance of the nominal value.

7.3 Temperature Coefficient

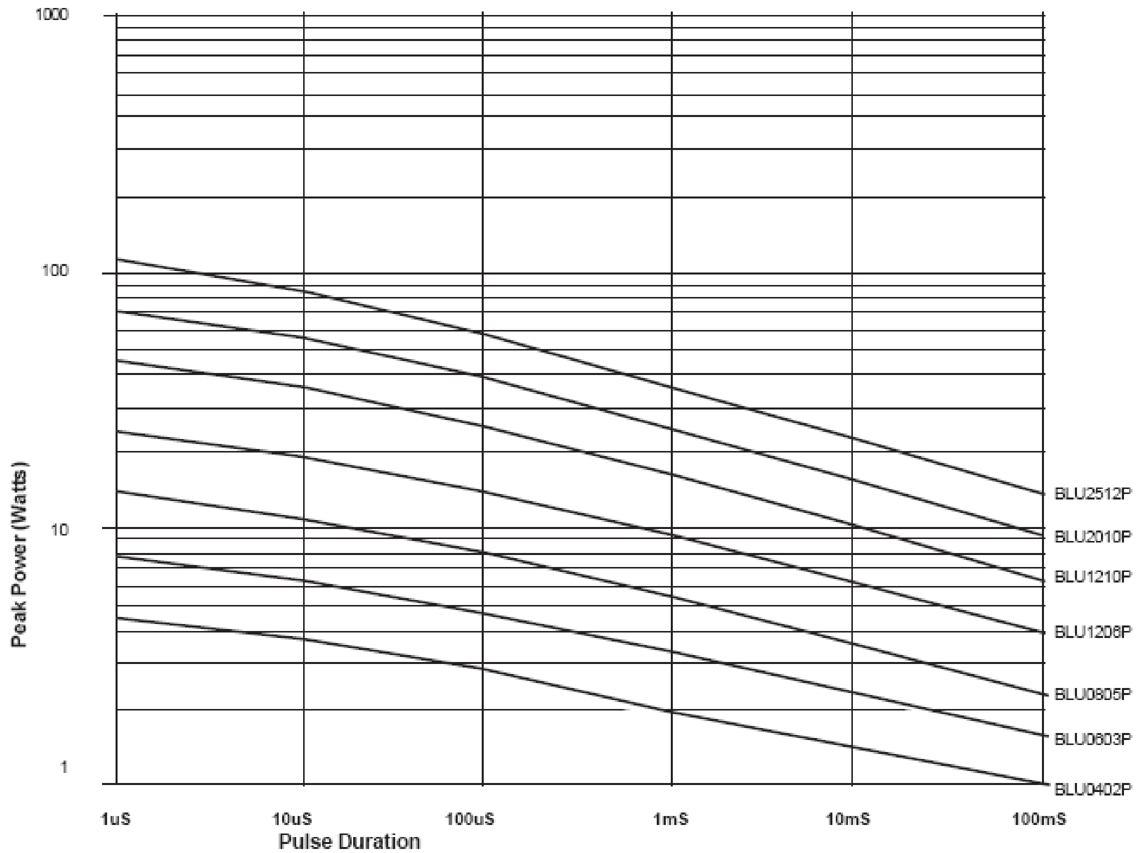
When measured at 25◦C and +125◦C (referenced to 25°C), the must be within the specified nominal value

7.4 Pulse Capability

When subjected to 2.5 times the DC voltage rating (but not to exceed the specified "maximum overload voltage") for 5 seconds, the resistance value shall not shift more than 0.25%, and no arcing, charring, or other physical damage.

For shorter term pulses utilize following chart as guide.

PULSE WITHSTAND CHART (increased pulse levels avail.)



Pulse capability is dependent on resistance value, waveform, repetition rate, current, etc. Chart is intended as a "general guideline" only, to assist customers in their evaluation process. The chart depicts rated pulse capability for Opt. P pulse resistant version, single pulse, with peak voltage levels not exceeding 150V for 0402 & 0603 size, 300V for 0805, 400V for 1206 & 1210, 450V for 2010 & 2512. Max pulse power for standard parts (w/o Opt.P) is 50% less, and max pulse voltage is 50V less. For improved performance and reliability, a 30% pulse derating factor is recommended (50% for frequent pulses, high values, etc). Consult RCD for application assistance. Applications involving surges should always be verified by evaluating prototypes under worst-case conditions plus a suitable safety factor to compensate for manufacturing variation, etc. Option P products are available over a limited range of values, tolerances and TC's as compared to standard BLU Series. If Option P design isn't available in the required desired characteristic then customers should consider utilizing a standard part in a suitably larger chip size. Note: increased pulse levels up to approximately 50% above Option P rating are available on custom basis.

Disclaimer: This information is offered solely for user consideration and verification, and is not, in part or total, to be construed as consituting a warranty or representation for which RCD Components Inc., or its officers and employees, assume legal responsibility.

7.5 Dielectric Withstanding Voltage

When tested per MIL-STD-202 M.311, there shall be no evidence of flashover, mechanical damage, arcing, or insulation breakdown. Dielectric rating through the ceramic substrate is as follows...

50V BLU0201, 100V BLU0402 & BLU0603; 250V all larger sizes (increased ratings available)

7.6 Insulation Resistance

Insulation resistance shall be 1,000 Megohm Minimum, when tested per method 302A of MIL-STD-202.

7.7 Voltage Coefficient

2-20 ppm/volt typical. The voltage coefficient typically varies inversely to body size, i.e. larger parts generally have lower (better) VC. VC is measured at 10% rated voltage and 100% rated voltage. Customers with applications sensitive to VC should evaluate prototypes.

7.8 Noise

Typical levels are given for BLU1206 0.1% 25ppm. The current noise level is a function of construction, resistance value, body size, and operating frequency. The noise level typically varies inversely with body size, i.e. larger parts generally have lower noise levels. Higher values exhibit higher noise levels. Looser tolerances and TC's generally exhibit higher noise levels. Customers with applications sensitive to noise should evaluate prototypes.

10R to 1K	-35 dB
10KΩ	-30 dB
100KΩ	-25 dB
1MΩ	-20 dB

7.9 Operating Temperature Range

-55°C to +155°C (wider range available on custom basis)

7.10 Power/ Voltage/Current Derating

Derate 1.1765%/°C when ambient temperature exceeds 70°C

7.11 Flame Retardancy

Series BLU are flame retardant in accordance with UL-94-V0.

7.12 Shelf Life

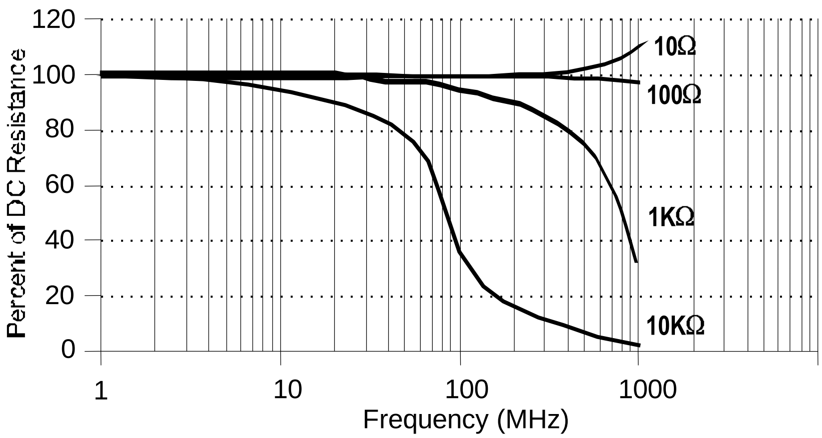
Typical shelf life stability is better than 0.01% △R/year

7.13 Reactance and High Frequency Performance

The reactance of RCD's BLU Series is primarily capacitive, typically 0.05 to 0.2pF. Lower values may be inductive at high frequencies. External factors such layout of the circuit, stray capacitance, etc., may have a significant impact. Typical high frequency performance is given in the following chart. Information is supplied as a starting point for customer further evaluation.

RCD Series BLU Precision Film Resistors

Series BLU0805 High Frequency Performance



8. RELIABILITY / FAILURE RATE (RELEVANT SPECIFICATIONS: MIL-HDBK-217, MIL-R-55342)

Reliability is affected by the applied voltage and operating conditions. When this product is to be used where moderate to high reliability is required, it is recommended that the maximum voltage/wattage/current be limited to 50% or less of the rated levels. When using alternating current, the peak voltage should be limited to the maximum working voltage. RCD offers military screening and burn-in options for improved reliability. Reliability levels are based on mounting, operating power levels and conditions within mil-specifications.

TYPICAL FAILURE RATE LEVELS OF RCD's RESISTORS

General failure rate levels for typical-use environments are estimated below for various resistor technologies. Failure rates of resistors that typically operate at higher temperatures and stress levels (such as wirewound, high voltage, power film, etc), typically exhibit higher failure levels. The failure rate level depends greatly on the application, temperature, derating factor, etc.

Carbon Comp	Thick Film	Metal Film	Metal Oxide	Carbon Film	Network	High Voltage	Wirewound
.5 ~ 6 FIT	.5 ~ 6 FIT	1 ~ 10 FIT	2 ~ 15 FIT	1 ~ 20 FIT	2 ~ 30 FIT	10 ~ 50 FIT	8 ~ 100 FIT

FAILURE RATE DETERMINATION

For resistors, the failure rate is generally specified in failures per million hours. Another common method is to specify % failures per 1000 hours of testing. For example a failure rate of 0.1% per 1000 hours when tested under load life conditions means 0.1% of parts fail each 1000 hours of testing. Other measures utilized in reliability analysis are FIT (Failure In Time), MTTF (Mean Time To Failure), and MTBF (Mean Time Between Failure). 1 FIT = 1 failure per billion hours. FIT = FR x 1000 (if FR=1 per 10^6 hours this equates to 1000 FITS). The MTTF is the reciprocal of the failure rate, MTTF = 1/FR (if FR= 0.1 per10^6 hours then MTTF= $10x10^6$ hours). 100 FIT = .01% per 1000 hours = 0.1 failures per million hours = 100 failures per billion hours = 10 million hour MTTF. Note: MTBF differs from MTTF by including the length of time required to replace or repair failing units in the end product. Since the repair time is generally insignificant, MTTF is essentially equal to MTBF, and therefore used interchangeably.

The failure rate of resistors is related to 5 major factors...

- Ambient Temperature
- Power Dissipation
- Resistance Value
- Quality Factor
- Environmental Factor

1. **Ambient Temperature**: higher temperature levels result in increased stress on the resistance element and subsequently an increase to the failure rate.

2. **Power Dissipation**: The general rule of thumb towards achieving high reliability is to derate parts by 50% (i.e. in actual use the parts should only dissipate half of their rated wattage). The higher the wattage dissipated, the higher the temperature rise and stress level on the resistance element. The "base" failure rate is considered to be the failure rate attributable to ambient temperature and power dissipation.

3. **Resistance Value**: In many types of resistors, particularly wirewound and thin-film models, higher resistance values are more susceptible to stress, weak welds, etc., and therefore exhibit increased failure rate levels. Non-Inductively wound parts generally exhibit higher failure rates since they're wound with finer wire sizes.

4. **Quality Factor**: Parts that are manufactured according to one Military specification may have a different failure rate than those manufactured per a different Mil-spec or a commercial spec. This is due to different processing controls and conditions as well as varying amounts of testing and burn-in. RCD's standard commercial-grade failure rate can be improved by specifying Mil-style screening (available as an option on most product families).

5. **Environmental Factor**: the failure rate of components is highly dependent on how the part is used. For instance, if a part is utilized in a piece of test equipment that is located in an office, hospital, or laboratory with controlled temperature and humidity, the failure rate will be much less than parts utilized in unsheltered Naval applications, helicopters, and cannon launchers.

Estimated failure rate (FR) based on actual use conditions may be determined using the formula...

FR = B x R x Q x E

B = Base failure rate
R = Resistance factor
Q = Quality factor
E = Environmental factor

B: Base Failure Rate (10^6 hours), RCD Series BLU

Ambient Temp (□C)	B @ 10% rated wattage*	B @ 30% rated wattage*	B @ 50% rated wattage*	B @ 70% rated wattage*	B @ 90% rated wattage*
20	.00067	.00084	.001	.0013	.0016
40	.000781	.00098	.0012	.0016	.0019
70	.001	.0018	.0017	.0021	.0027

* or percent of rated voltage when resistance exceeds critical value

R: Resistance Factor

<100KΩ	100K – 1M	>1M – 10M
1.0	1.1	1.6

Q: Quality Factor: Multiply base rate by 5 for standard parts, multiply by 1 for option ER parts (option "ER" is Mil-spec burn-in)

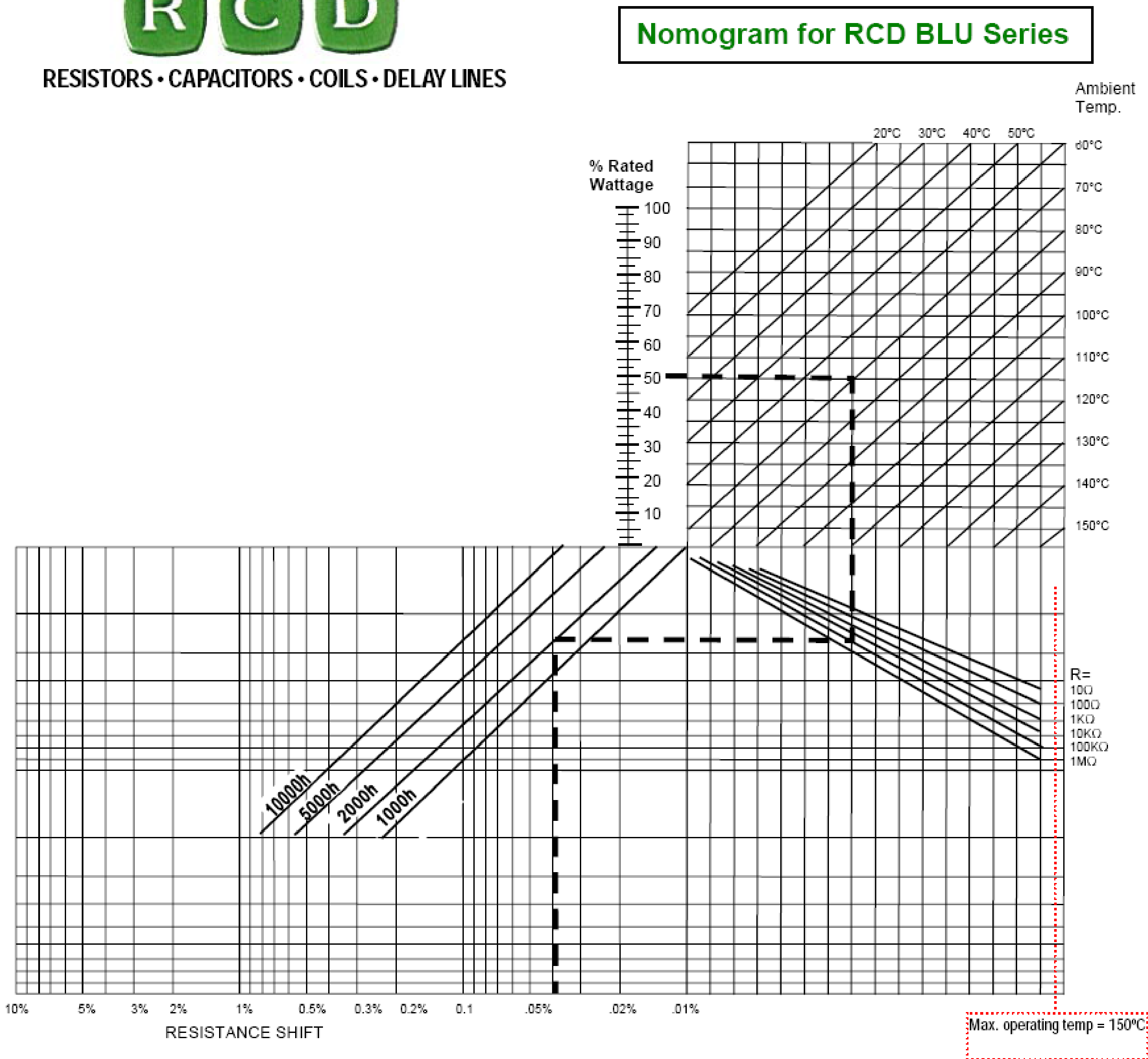
E: Environmental Factor

Multiplier	Description
1	Temp. and humidity controlled (office, medical, etc)
2	Semi-controlled fixed environment (warehouses, etc)
4	Airplanes, commercial jets (multiply x 2 for fighter jets)
10	Mobile ground environment (automotive, handheld, etc)
16	Naval use, unsheltered (sonar, etc)
23	Helicopters

EXAMPLE: Type BLU2512 100 ohm to be utilized at 0.5W (50% rated power) at 40°C in office environment...
FR= BxRxQxE B= .0012, R= 1, Q=5, E= 1
Failure Rate = .0012x1x5x1 = .006 failures/10^6 hours = 6 FIT
MTTF= 1÷FR = 166 million hours

9. LONG TERM STABILITY NOMOGRAM

RESISTORS • CAPACITORS • COILS • DELAY LINES



Long Term Stability Nomogram

The above nomogram has been developed to enable users to determine the approximate percentage change in resistance that occurs under various combinations of wattage, temperature, and time.

Example: What is the estimated stability of RCD type **BLU1206** 100KΩ operated at 0.125W (50% of rated power) at 70°C for 2000 hours? Select the starting point at 50%, then follow horizontal line until it intersects the desired ambient temperature (70°C in this example). Follow vertical line down to intersect with 100KΩ. Follow horizontal line to intersect with 2,000 hour line. Stability ≈ .04%.

Note: all parts are to be utilized within rated power and voltage levels. When resistance value exceeds the critical resistance, the above chart is based on percentage of Maximum Working Voltage instead of wattage. Chart is intended as general guideline only, to assist customers in the pre-selection process. Information is approximate and can vary depending on various factors (such as PCB material, PCB layout, etc.). Customers to verify selection prior to use. Info is subject to change without notice.

RCD Components Inc., 520 E. Industrial Pk Dr, Manchester, NH, USA 03109
Tel: 603-669-0054 Fax: 603-669-5455 E-mail: sales@rcdcomponents.com *www.rcdcomponents.com*