This specification is intended to be utilized in conjunction with Series FLP data sheet.
http://www.rcdcomponents.com/rcd/rcdpdf/flp-fa088.pdf

RESISTOR SPECIFICATION

RCD Series FLP
Temperature Sensitive Chip Resistors

RESISTORS • CAPACITORS • COILS • DELAY LINES

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RCD FLP SERIES TEMPERATURE SENSITIVE CHIP RESISTORS

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1.0 SERIES FLP PRODUCT HISTORY

RCD's FLP Series was first introduced in 1996 as a surface mount version of RCD’s Series LP axial-lead temperature sensitive film resistors. The series has been expanded over the years to include improved accuracy levels and a wider selection of TC’s and resistance values.

2.0 PRODUCT DESCRIPTION

- Series FLP are linear PTC (Positive Temperature Coefficient) film chip resistors and are available with TC’s from +3000ppm/°C to +5000ppm (+0.3%/°C to +0.5%/°C).

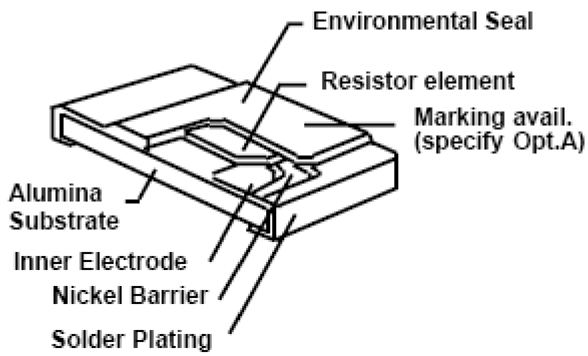
- RCD offers a wide range of customized versions including non-standard temperature coefficients, resistance values, increased voltage, military screening, custom marking, specialty termination platings, etc.

3.0 DESIGN FEATURES

- PTC from +3000ppm to +5000ppm/°C
- Excellent stability and linearity
- Low noise
- Fast response time
- Wide operating temperature range -65°C to +150°C
- Suitable for both reflow and flow soldering

4.0 CONSTRUCTION AND MANUFACTURING PROCESS

The rugged design and construction of the FLP Series results in excellent reliability. In the first phase of production, the ceramic substrates are deposited with inner electrodes, typically followed by Nickel Alloy film (other alloys are utilized depending on TCR-Temperature Coefficient of Resistance requirements). The deposition and trim process is custom tailored to meet specific resistance and TC levels. Once the substrates have undergone the metallization 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. Tin-Lead termination finish is available for military applications.



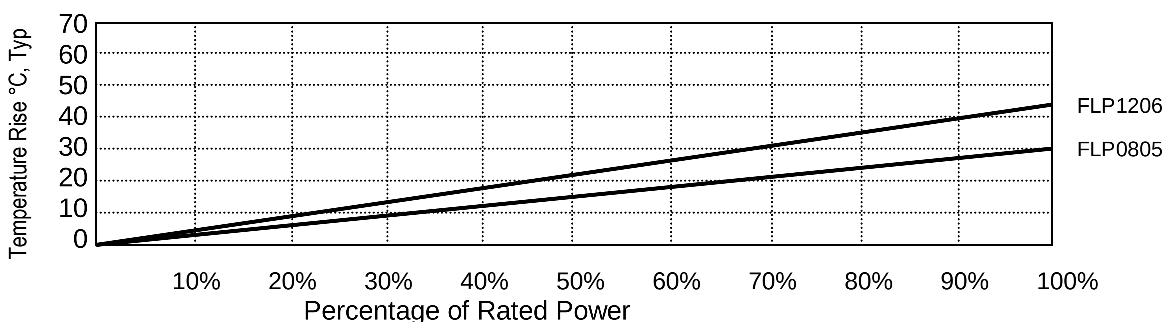
To ensure utmost reliability, care should be taken to avoid potential sources of ionic contamination.

5.0 QUALITY CONTROL

As part of RCD's ABZED program (ABsolute ZEro Defects), 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 visual and electrical inspection ensures excellent quality levels. A wide range of military screening tests are available as an option for high-reliability and critical-use applications.

6.0 TEMPERATURE RISE

The typical 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 TEST RESULTS

Characteristic	**Test Conditions**	**Test Results** (10pcs each)				**Specification**
		Size, Value, TC	**Max.**	**Min.**	**Avg.**	
HIGH TEMPERATURE	100 hrs at 125°C	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	0.37% 0.29%	0.02% 0.03%	0.152% 0.089%	± (2% + 0.05Ω)
TEMPERATURE COEFFICIENT	+25 -->+65°C	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	3304ppm 4988ppm	3246ppm 4876ppm	3273ppm 4917ppm	+3300ppm ±5% +5000ppm ±5%
TEMPERATURE CYCLING/THERMAL SHOCK	-55→+85°C, 5 cycles	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	0.16% 0.18%	-0.06% -0.02%	0.068% 0.079%	± (2% + 0.05Ω)
VIBRATION	10 to 55Hz 3 directions, 6 hours total	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	0.13% 0.05%	-0.01% 0.000%	0.031% 0.019%	± (0.5% +.05Ω)
SHOCK	MIL-STD-810E, Method 516.4, Proced. IV, 26 shocks	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	0.12% 0.08%	-0.01% -0.01%	0.026% 0.019%	± (0.5% +.05Ω)
SOLDERABILITY	Solder Dip at 230°C ±5°C for 3 sec. ±1 sec. ANSI-J-STD-002 Cat.1	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	- -	>95% >95%	>95% >95%	95% min Opt.ER, 90% min non-ER
MOISTURE RESISTANCE	MIL-STD-202, Method 106	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	0.43% 0.29%	0.02% 0.04%	0.248% 0.188%	± (5% + 0.05Ω)
LOAD LIFE @ 25°C	MIL-STD-202, Method 108, 1000 hrs	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	0.46% 0.33%	-0.17% -0.09%	0.241% 0.199%	± (5% + 0.05Ω)
SOLVENT RESISTANCE	MIL-STD-202 M.215	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	- -	- -	Pass Pass	Legible marking
DIELECTRIC STRENGTH	MIL-STD-202 M.311	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	- -	>100VAC >200VAC	>100VAC >200VAC	100V Min. 200V Min
INSULATION RESISTANCE	MIL-STD-202 M.302, Cond.A	1206 100Ω 3300PPM 0805 1KΩ 5000PPM	- -	>1GΩ >1GΩ	>1GΩ >1GΩ	1000M Min

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 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 +65°C (referenced to 25°C), the TC must be within the specified nominal value

7.4 Overload 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 1%+0.05ohm, and no arcing, charring, or other physical damage.

For shorter term pulses consult factory. .

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...

100V FLP0805, 200V FLP1206 (increased ratings available)

7.6 Insulation Resistance

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

7.8 Operating Temperature Range

-65°C to +150°C (wider range available on custom basis)

7.9 Power/ Voltage/Current Derating

Derate 1.25%/°C when ambient temperature exceeds 70°C

7.10 Flame Retardance

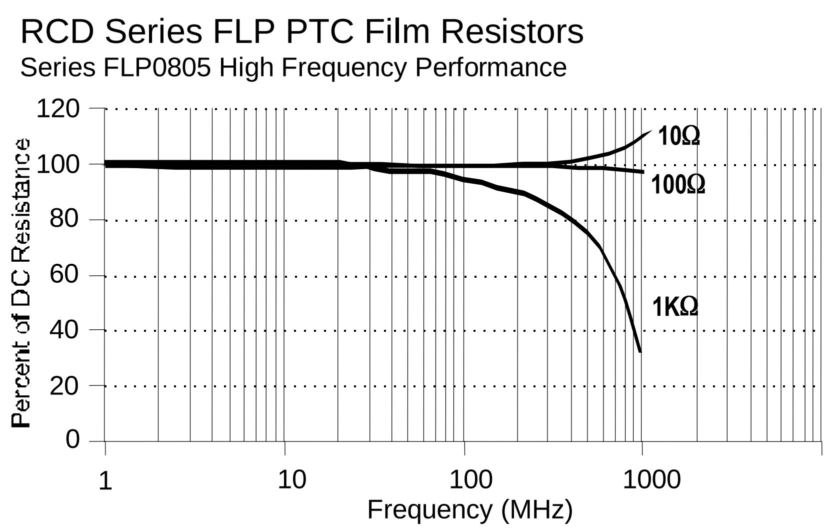
Series FLP are flame retardant in accordance with UL-94-V1 (V0 available).

7.11 Shelf Life

Typical shelf life stability is better than 0.1% ΔR/year

7.12 Reactance and High Frequency Performance

The reactance of RCD's FLP 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.



7.13 Voltage Rating

AC or DC voltage level not to exceed $(PR)^{1/2}$ or 50V whichever is less

8. RELIABILITY / FAILURE RATE (RELEVANT SPECIFICATIONS: MIL-HDBK-217, MIL-PRF-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 LEVEL

General failure rate level is 1 ~ 10 FIT depending on the application, temperature, derating factor, etc.

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 FLP

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
1.0

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

FAILURE RATE EXAMPLE: Type FLP1206 100 ohm to be utilized at 0.125W (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