High Pulse Load Carbon Film MINI-MELF Resistors

CMA 0204 carbon film MELF resistors with advanced pulse load capability are the perfect choice for the protection of circuitry with signal or mains input lines from surge pulses. The resistors are also suitable for circuits exposed to high levels of electromagnetic interference or electrostatic discharge. The applications are in all fields of automotive, telecommunication, industrial, and medical equipment.

FEATURES

- Special carbon film technology
- Surge voltage capability up to 4 kV 1.2/50 µs pulse
- ESD capability: 6 kV, human body model
- AEC-Q200 qualified
- Intrinsic sulfur resistance
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

Pb-free

RoHS COMPLIANT

HALOGEN FREE

GREEN (5-2008)

APPLICATIONS

- Automotive
- Telecommunication
- Industrial
- Medical equipment

TECHNICAL SPECIFICATIONS	
DESCRIPTION	**CMA 0204**
DIN size	0204
Metric size code	RC3715M
Resistance range	10 Ω to 100 kΩ
Resistance tolerance	± 2 %
Temperature coefficient	see TCR graph
Rated dissipation, P_{70} (1)	0.4 W
Operating voltage, $U_{max.}$ AC_{RMS}/DC	200 V
Permissible film temperature, $\vartheta_{F\ max.}$ (1)	155 °C
Operating temperature range (1)	-55 °C to 155 °C
Permissible voltage against ambient (insulation): 1 min; U_{ins}	300 V
Failure rate: $FIT_{observed}$	≤ 0.1 x 10^{-9}/h

Note

(1) Please refer to APPLICATION INFORMATION below

APPLICATION INFORMATION

The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly.

These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime. At the maximum permissible film temperature of 155 °C the useful lifetime is specified for 8000 h. The designer may estimate the performance of the particular resistor application or set certain load and temperature limits in order to maintain a desired stability.

MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION

OPERATION MODE		STANDARD	POWER
Rated dissipation, P_{70}	**CMA 0204**	0.25 W	0.4 W
Operating temperature range		-55 °C to 125 °C	-55 °C to 155 °C
Permissible film temperature, $\vartheta_{F\,max.}$		125 °C	155 °C
Max. resistance change at P_{70} for resistance range, $\lvert\Delta R/R\rvert$ after:	**CMA 0204**	10 Ω to 100 kΩ	10 Ω to 100 kΩ
	1000 h	≤ 1 %	≤ 2 %
	8000 h	≤ 2 %	≤ 4 %

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

TYPE / SIZE	TCR	TOLERANCE	RESISTANCE	E-SERIES
CMA 0204	see TCR graph	± 2 %	10 Ω to 100 kΩ	E24

PACKAGING

TYPE / SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
CMA 0204	B3 = BL	3000	Antistatic blister tape acc. IEC 60286-3 Type 2a	8 mm	4 mm	Ø 180 mm / 7"
	B0	10 000				Ø 330 mm / 13"

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: CMA02040X4701GB300

C	M	A	0	2	0	4	0	X	4	7	0	1	G	B	3	0	0

TYPE / SIZE	VERSION	TCR	RESISTANCE	TOLERANCE	PACKAGING
CMA0204	**0** = neutral	**X** = no indication	3 digit value 1 digit multiplier **Multiplier** **9** = $*10^{-1}$ **0** = $*10^{0}$ **1** = $*10^{1}$ **2** = $*10^{2}$ **3** = $*10^{3}$	**G** = ± 2 %	**B3** **B0**

Product Description: CMA 0204 2 % BL 4K7

CMA	0204	2 %	BL	4K7
TYPE	SIZE	TOLERANCE	PACKAGING	RESISTANCE
CMA	**0204**	± **2 %**	**BL** **B0**	**100R** = 100 Ω **4K7** = 4.7 kΩ

Note

- Products can be ordered using either the PART NUMBER or the PRODUCT DESCRIPTION

DESCRIPTION

Production of the CMA 0204 specialty MELF resistors with advanced pulse load capability is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous and dense carbon film is deposited on a high grade ceramic body (85 % Al_2O_3). Nickel plated steel termination caps are firmly pressed on the coated rods. A special laser is used to achieve the target value by smoothly cutting a helical groove in the resistive layer without damaging the ceramics. The resistors are covered by protective coating designed for electrical, mechanical and climatic protection.The terminations receive a final pure matte tin on nickel plating. Four color code rings designate the resistance value and tolerance in accordance with **IEC 60062** (1).

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are laid directly into the blister tape in accordance with **IEC 60286-3, Type 2a** (1).

ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapor phase as shown in **IEC 61760-1** (1). Solderability is specified for 2 years after production or requalification, however, excellent solderability is proven after extended storage in excess of 10 years. The permitted storage time is 20 years.

The resistors are completely lead (Pb)-free, the pure matte tin plating provides compatibility with lead (Pb)-free soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing.

The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The suitability of conformal coatings, potting compounds and their processes, if applied, shall be qualified by appropriate means to ensure the long-term stability of the whole system.

MATERIALS

Vishay acknowledges the following systems for the regulation of hazardous substances:

- IEC 62474, Material Declaration for Products of and for the Electrotechnical Industry, with the list of declarable substances given therein (2)
- The Global Automotive Declarable Substance List (GADSL) (3)
- The REACH regulation (1907/2006/EC) and the related list of substances with very high concern (SVHC) (4) for its supply chain

The products do not contain any of the banned substances as per IEC 62474, GADSL, or the SVHC list, see www.vishay.com/how/leadfree.

Hence the products fully comply with the following directives:

- 2000/53/EC End-of-Life Vehicle Directive (ELV) and Annex II (ELV II)
- 2011/65/EU Restriction of the Use of Hazardous Substances Directive (RoHS) with amendment 2015/863/EU
- 2012/19/EU Waste Electrical and Electronic Equipment Directive (WEEE)

Vishay pursues the elimination of conflict minerals from its supply chain, see the Conflict Minerals Policy at www.vishay.com/doc?49037.

APPROVALS

Where applicable the resistors are tested in accordance with **EN 140 401-803** which refers to **EN 60115-1, EN 60115-8** and the variety of environmental test procedures of the **IEC 60068** (1) series.

Vishay Beyschlag has achieved "**Approval of Manufacturer**" in accordance with **IECQ 03-1**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IECQ 03-3-1** is granted for the Vishay Beyschlag manufacturing process.

The resistors are qualified according to AEC-Q200.

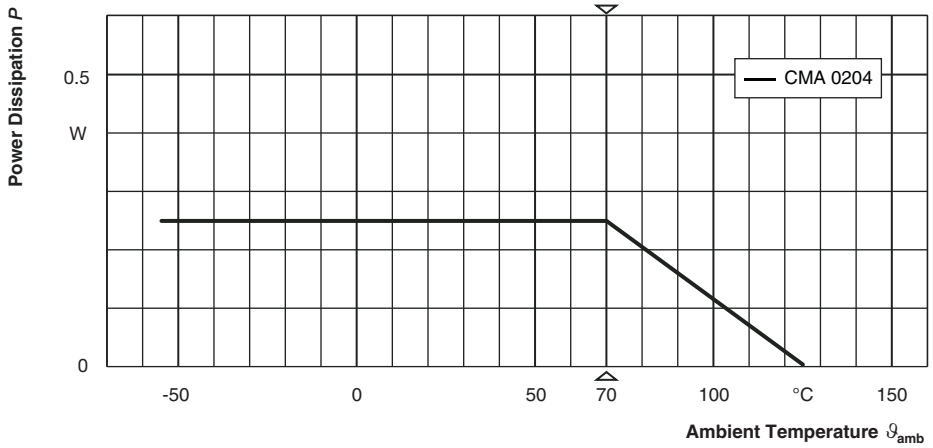
RELATED PRODUCTS

- "Professional Thin Film MELF Resistors" (www.vishay.com/doc?28713)
- "Precision Thin Film MELF Resistors" (www.vishay.com/doc?28714)
- "High Pulse Load Carbon Film MELF Resistors of case size 0207" (www.vishay.com/doc?28755)

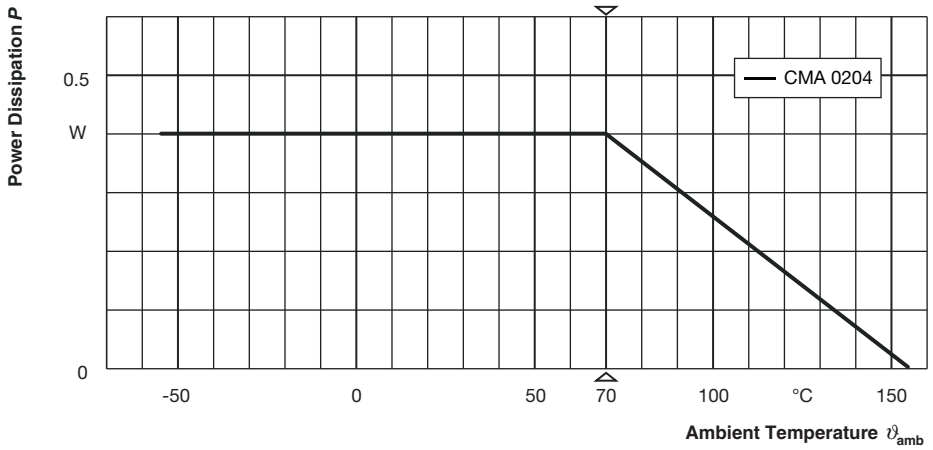
Notes

(1) The quoted IEC standards are also released as EN standards with the same number and identical contents
(2) The IEC 62474 list of declarable substances is maintained in a dedicated database, which is available at http://std.iec.ch/iec62474
(3) The Global Automotive Declarable Substance List (GADSL) is maintained by the American Chemistry Council and available at www.gadsl.org
(4) The SVHC list is maintained by the European Chemical Agency (ECHA) and available at http://echa.europa.eu/candidate-list-table

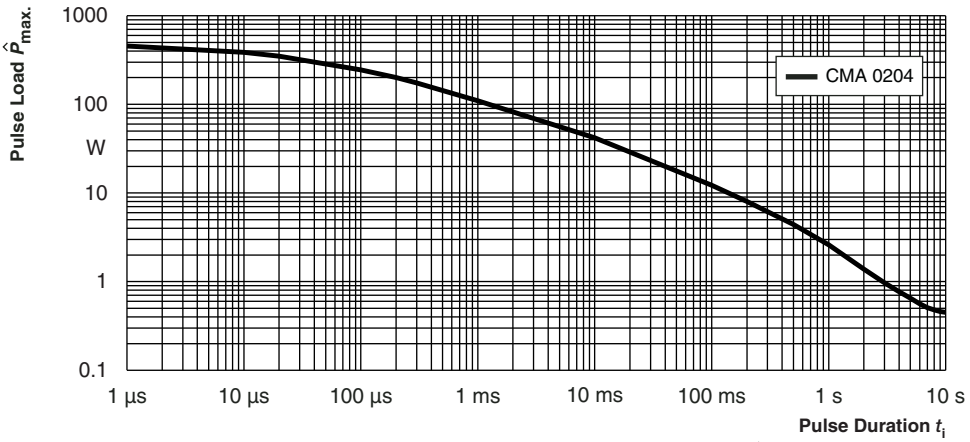
FUNCTIONAL PERFORMANCE



Derating - Standard Operation



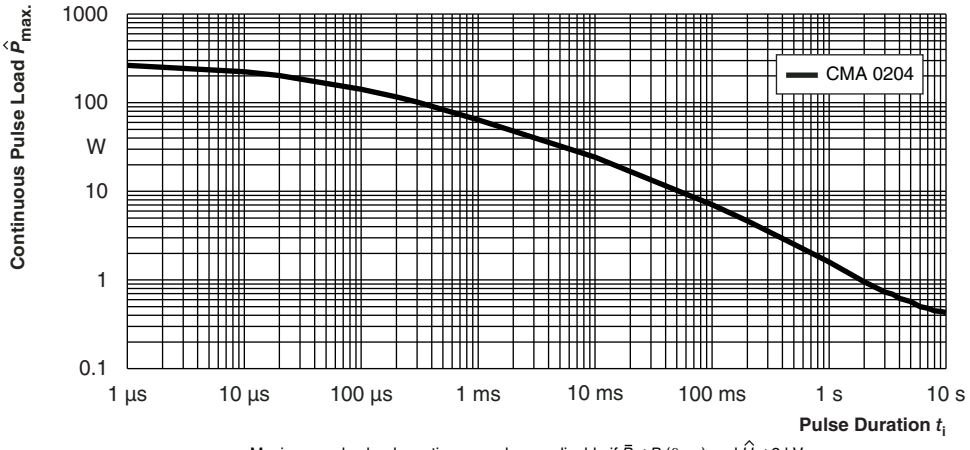
Derating - Power Operation



Maximum pulse load, single pulse; applicable if $\bar{P} \rightarrow 0$ and $n \leq 1000$ and $\hat{U} \leq 2$ kV;
for permissible resistance change ± (0.5 % R + 0.05 Ω)

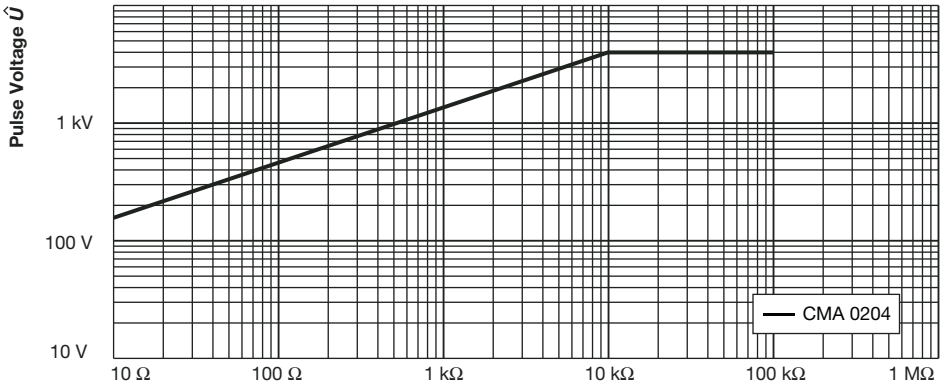
Single Pulse

FUNCTIONAL PERFORMANCE



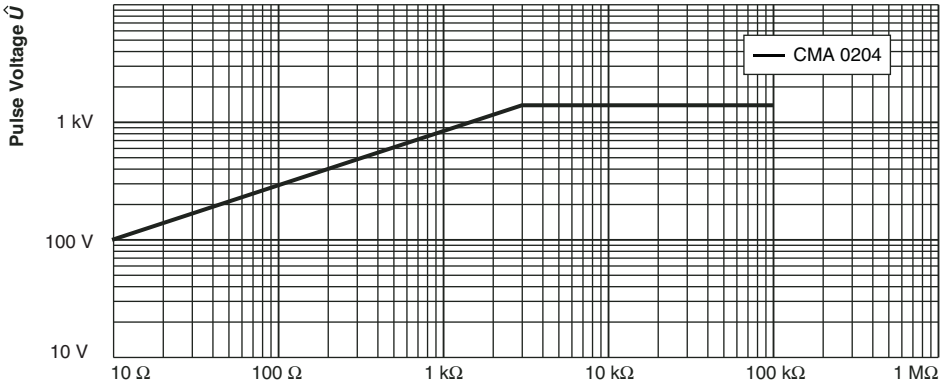
Maximum pulse load, continuous pulse; applicable if $\bar{P} \leq P$ (ϑ_{amb}) and $\hat{U} \leq 2$ kV;
for permissible resistance change ± (0.5 % R + 0.05 Ω)

Continuous Pulse



Pulse load rating in accordance with IEC 60115-1, 4.27; 1,2 µs/50 µs; 5 pulses at 12 s intervals;
for permissible resistance change ± (0.5 % R + 0.05 Ω)

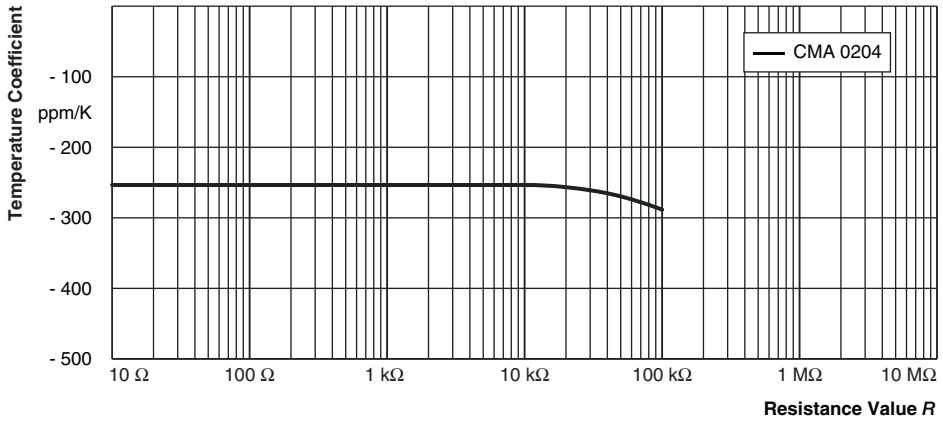
1.2/50 Pulse



Pulse load rating in accordance with IEC 60115-1, 4.27; 10 µs/700 µs;
10 pulses at 1 minute intervals; for permissible resistance change ± (0.5 % R + 0.05 Ω)

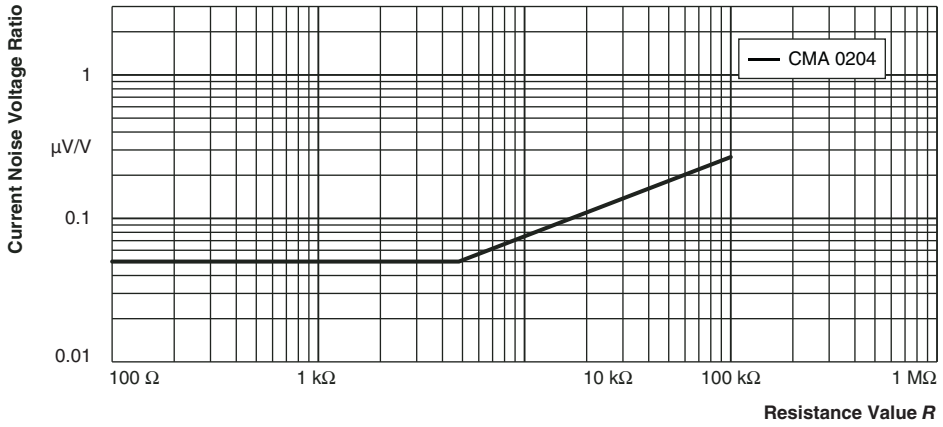
10/700 Pulse

FUNCTIONAL PERFORMANCE



Temperature coefficient of resistance

Temperature Coefficient (TCR) (Typical Curve)



In accordance with IEC 60 195

Current Noise Voltage Ratio

TESTS AND REQUIREMENTS

All tests are carried out in accordance with the following specifications:

EN 60115-1, generic specification

EN 60115-8 (successor of EN 140400), sectional specification

EN 140401-803, detail specification

IEC 60068-2-xx, test methods

The parameters stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-803. The table presents only the most important tests, for the full test schedule refer to the documents listed above. However, some additional tests and a number of improvements against those minimum requirements have been included.

The testing also covers most of the requirements specified by EIA/ECA-703 and JIS-C-5201-1.

The tests are carried out under standard atmospheric conditions in accordance with IEC 60068-1, 4.3, whereupon the following values are applied:

Temperature: 15 °C to 35 °C

Relative humidity: 25 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

A climatic category LCT / UCT / 56 is applied, defined by the lower category temperature (LCT), the upper category temperature (UCT), and the duration of exposure in the damp heat, steady state test (56 days).

The components are mounted for testing on printed circuit boards in accordance with EN 60115-8, 2.4.2, unless otherwise specified.

TEST PROCEDURES AND REQUIREMENTS

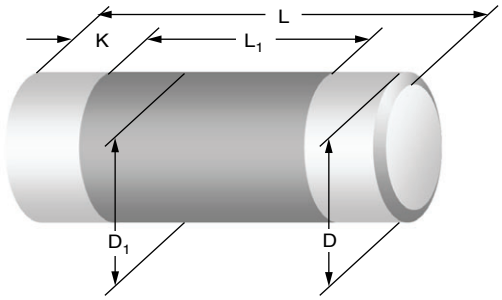
EN 60115-1 CLAUSE	IEC 60068-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			Stability for product types:	
			CMA 0204	10 Ω to 100 kΩ
4.5	-	Resistance	-	± 2 % R
4.8	-	Temperature coefficient	At (20 / -55 / 20) °C and (20 / 125 / 20) °C	see Temperature Coefficient graph
4.25.1	-	Endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R} \leq U_{max.}$; whichever is the less severe; 1.5 h on; 0.5 h off;	
			70 °C; 1000 h	± (1 % R + 0.05 Ω)
			70 °C; 8000 h	± (2 % R + 0.05 Ω)
	-	Endurance at 70 °C: power operation mode	$U = \sqrt{P_{70} \times R} \leq U_{max.}$; whichever is the less severe; 1.5 h on; 0.5 h off;	
			70 °C; 1000 h	± (2 % R + 0.05 Ω)
			70 °C; 8000 h	± (4 % R + 0.05 Ω)
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h	± (2 % R + 0.05 Ω)
			155 °C; 1000 h	± (4 % R + 0.05 Ω)
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (1 % R + 0.1 Ω)
4.37	67 (Cy)	Damp heat, steady state, accelerated	(85 ± 2) °C (85 ± 5) % RH $U = \sqrt{0.3 \times P_{70} \times R} \leq 100$ V and $U = 0.3 \times U_{max.}$; (the smaller value is valid) 1000 h	± (2 % R + 0.1 Ω)
4.23		Climatic sequence:		
4.23.2	2 (Bb)	dry heat	UCT; 16 h	
4.23.3	30 (Db)	damp heat, cyclic	55 °C; 24 h; ≥ 90 % RH; 1 cycle	
4.23.4	1 (Ab)	cold	LCT; 2 h	
4.23.5	13 (M)	low air pressure	8.5 kPa; 2 h; (25 ± 10) °C	
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 24 h; ≥ 90 % RH; 5 cycles	
4.23.7	-	DC load	$U = \sqrt{P_{70} \times R} \leq U_{max.}$; 1 min	
			LCT = -55 °C; UCT = 155 °C	± (1 % R + 0.1 Ω)
-	1 (Aa)	Cold	-55 °C; 2 h	± (0.5 % R + 0.1 Ω)

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	**IEC 60068-2 (1) TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE (ΔR)**
			Stability for product types:	
			CMA 0204	10 Ω to 100 kΩ
4.19	14 (Na)	Rapid change of temperature	30 min at LCT; 30 min at UCT; LCT = -55 °C; UCT = 125 °C 5 cycles 1000 cycles	 ± (0.5 % R + 0.1 Ω) ± (1.5 % R + 0.1 Ω)
4.13	-	Short time overload; standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max.}$; whichever is the less severe; 5 s	± (0.25 % R + 0.1 Ω)
		Short time overload; power operation mode	$U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max.}$; whichever is the less severe; 5 s	± (0.5 % R + 0.1 Ω)
4.22	6 (Fc)	Vibration	Endurance by sweeping; 10 Hz to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s^2; 7.5 h	± (0.25 % R + 0.1 Ω)
4.38	-	Electrostatic discharge (human body model)	IEC 61340-3-1 (1); 3 pos. + 3 neg. (equivalent to MIL-STD-883, method 3015) CMA 0204: 6 kV	± (0.5 % R + 0.05 Ω)
4.17	58 (Td)	Solderability	Solder bath method; SnPb40; non-activated flux; (215 ± 3) °C; (3 ± 0.3) s	Good tinning (≥ 95 % covered); no visible damage
			Solder bath method; SnAg3Cu0.5 or SnAg3.5; non-activated flux; (235 ± 3) °C; (2 ± 0.2) s	Good tinning (≥ 95 % covered); no visible damage
4.18	58 (Td)	Resistance to soldering heat	Solder bath method; (260 ± 5) °C; (10 ± 1) s	± (0.5 % R + 0.1 Ω)
			Reflow method 2 (IR / forced gas convection); (260 ± 5) °C; (10 ± 1) s	± (0.25 % R + 0.1 Ω)
4.29	45 (XA)	Component solvent resistance	Isopropyl alcohol; 50 °C; method 2	No visible damage
4.30	45 (XA)	Solvent resistance of marking	Isopropyl alcohol; 50 °C; method 1, toothbrush	Marking legible; no visible damage
4.32	21 (Ue_3)	Shear (adhesion)	45 N	No visible damage
4.33	21 (Ue_1)	Substrate bending	Depth 2 mm, 3 times	No visible damage; no open circuit in bent position ± (0.25 % R + 0.1Ω)
4.7	-	Voltage proof	$U_{RMS} = U_{ins}$; 60 s	No flashover or breakdown
4.35	-	Flammability	IEC 60695-11-5 (1), needle flame test; 10 s	No burning after 30 s

Note

(1) The quoted IEC standards are also released as EN standards with the same number and identical contents

DIMENSIONS

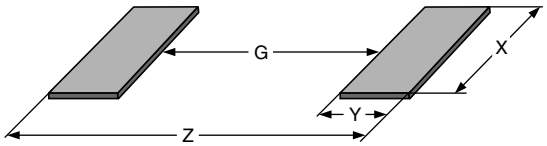


DIMENSIONS AND MASS						
TYPE / SIZE	L (mm)	D (mm)	$L_{1\ min.}$ (mm)	D_1 (mm)	K (mm)	MASS (mg)
CMA 0204	3.6 + 0/- 0.2	1.4 + 0/- 0.1	1.8	D + 0/- 0.15	0.75 ± 0.1	19

Note

- Color code marking is applied according to IEC 60062 (1) in four bands (E24 series). Each color band appears as a single solid line, voids are permissible if at least $^2/_3$ of the band is visible from each radial angle of view. The last color band for tolerance is approximately 50 % wider than the other bands. An interrupted brown band between the 2nd and 3rd full band identifies the special carbon film

PATTERN STYLES FOR MELF RESISTORS



RECOMMENDED SOLDER PAD DIMENSIONS								
TYPE / SIZE	WAVE SOLDERING				REFLOW SOLDERING			
	G (mm)	Y (mm)	X (mm)	Z (mm)	G (mm)	Y (mm)	X (mm)	Z (mm)
CMA 0204	1.5	1.5	1.8	4.5	1.7	1.2	1.6	4.1

Notes

- The given solder pad dimensions reflect the considerations for board design and assembly as outlined e.g. in standards IEC 61188-5-x (1), or in publication IPC-7351

(1) The quoted IEC standards are also released as EN standards with the same number and identical contents

HISTORICAL 12NC INFORMATION

- The resistors had a 12-digit numeric code starting with 2312
- The subsequent 4 digits indicated the resistor type, specification and packaging; see the 12NC table
- The remaining 4 digits indicated the resistance value:
  - The first 3 digits indicated the resistance value
  - The last digit indicated the resistance decade in accordance with the 12NC Indicating Resistance Decade table

Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4

Historical 12NC Example

The 12NC of a CMA 0204 resistor, value 47 kΩ with ± 2 % tolerance, supplied in blister tape of 3000 units per reel was: 2312 159 24703.

HISTORICAL 12NC - Resistor Type and Packaging

DESCRIPTION		CODE 2312	
		BLISTER TAPE ON REEL	
TYPE	TOL.	BL 3000 UNITS	B0 10 000 UNITS
CMA 0204	± 2 %	159 2....	149 2....

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