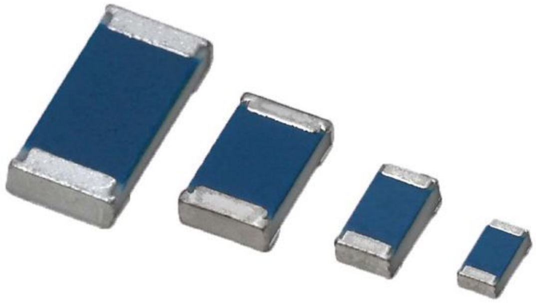
Professional Thin Film Chip Resistors



Automotive-grade MC AT professional thin film chip resistors are the perfect choice for most fields of modern professional electronics where reliability and stability is of major concern. Typical applications include automotive, telecommunication, industrial, medical equipment, precision test and measuring equipment.

FEATURES

- Operating temperature up to 175 °C for 1000 h
- Rated dissipation P_{85} up to 0.4 W for size 1206
- AEC-Q200 qualified
- Approved to EN 140401-801
- Sulfur resistance verified according to ASTM B 809
- Superior temperature cycling robustness
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE
Pb-free
RoHS
COMPLIANT

APPLICATIONS

- Automotive
- Telecommunication
- Medical equipment
- Industrial equipment

TECHNICAL SPECIFICATIONS

DESCRIPTION	MCS 0402 AT	MCT 0603 AT	MCU 0805 AT	MCA 1206 AT
Imperial size	0402	0603	0805	1206
Metric size code	RR1005M	RR1608M	RR2012M	RR3216M
Resistance range	2.43 Ω to 221 kΩ; 0 Ω	1 Ω to 511 kΩ; 0 Ω	1 Ω to 1 MΩ; 0 Ω	1 Ω to 1 MΩ; 0 Ω
Resistance tolerance	± 1 %, ± 0.5 %			
Temperature coefficient	± 50 ppm/K; ± 25 ppm/K			
Rated dissipation P_{85} (1)	0.100 W	0.150 W	0.200 W	0.400 W
Operating voltage, $U_{max.}$ AC_{RMS} or DC	50 V	75 V	150 V	200 V
Permissible film temperature, $\vartheta_{F\ max.}$ (1)	175 °C			
Operating temperature range (1)	-55 °C to 175 °C			
Insulation voltage:				
1 min; U_{ins}	75 V	100 V	200 V	300 V
Continuous	75 V	75 V	75 V	75 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 175 °C the useful lifetime is specified for 1000 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	ADVANCED TEMPERATURE
		P_{70}	P_{70}	P_{85}
Rated dissipation	**MCS 0402 AT**	0.063 W	0.100 W	0.100 W
	MCT 0603 AT	0.100 W	0.125 W	0.150 W
	MCU 0805 AT	0.125 W	0.200 W	0.200 W
	MCA 1206 AT	0.250 W	0.400 W	0.400 W
Applied maximum film temperature, $\vartheta_{\text{F max.}}$		125 °C	155 °C	175 °C
Max. resistance change at rated dissipation for resistance range	**MCS 0402 AT**	2.43 Ω to 221 kΩ	2.43 Ω to 221 kΩ	2.43 Ω to 221 kΩ
	MCT 0603 AT	1 Ω to 511 kΩ	1 Ω to 511 kΩ	1 Ω to 511 kΩ
	MCU 0805 AT	1 Ω to 1 MΩ	1 Ω to 1 MΩ	1 Ω to 1 MΩ
	MCA 1206 AT	1 Ω to 1 MΩ	1 Ω to 1 MΩ	1 Ω to 1 MΩ
$\lvert\Delta R/R\rvert_{\text{max.}}$, after:	1000 h	≤ 0.15 %	≤ 0.3 %	≤ 0.5 %
	8000 h	≤ 0.25 %	≤ 0.5 %	-
	225 000 h	≤ 1.0 %	-	-

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

TYPE	TCR	TOLERANCE	RESISTANCE	E-SERIES
MCS 0402 AT	± 50 ppm/K	± 1 %	2.43 Ω to 221 kΩ	E24; E96
	± 25 ppm/K	± 0.5 %	10 Ω to 221 kΩ	E24; E192
	Jumper	≤ 20 mΩ	$I_{\text{max.}}$ = 0.63 A	-
MCT 0603 AT	± 50 ppm/K	± 1 %	1 Ω to 511 kΩ	E24; E96
	± 25 ppm/K	± 0.5 %	10 Ω to 511 kΩ	E24; E192
	Jumper	≤ 20 mΩ	$I_{\text{max.}}$ = 1 A	-
MCU 0805 AT	± 50 ppm/K	± 1 %	1 Ω to 1 MΩ	E24; E96
	± 25 ppm/K	± 0.5 %	10 Ω to 1 MΩ	E24; E192
	Jumper	≤ 20 mΩ	$I_{\text{max.}}$ = 1.5 A	-
MCA 1206 AT	± 50 ppm/K	± 1 %	1 Ω to 1 MΩ	E24; E96
	± 25 ppm/K	± 0.5 %	10 Ω to 1 MΩ	E24; E192
	Jumper	≤ 20 mΩ	$I_{\text{max.}}$ = 2 A	-

PACKAGING

TYPE	CODE	QUANTITY	CARRIER TAPE	WIDTH	PITCH	REEL DIAMETER
MCS 0402 AT	E0	10 000	Tape and reel cardboard tape acc. IEC 60286-3 type I	8 mm	2 mm	180 mm/7"
MCT 0603 AT	P5	5000		8 mm	4 mm	180 mm/7"
	PW	20 000		8 mm		330 mm/13"
MCU 0805 AT	P5	5000		8 mm	4 mm	180 mm/7"
	PW	20 000		8 mm		330 mm/13"
MCA 1206 AT	P5	5000		8 mm	4 mm	180 mm/7"

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: MCT0603MD4641DPW00

M	C	T	0	6	0	3	M	D	4	6	4	1	D	P	W	0	0

TYPE/SIZE	VERSION	TCR	RESISTANCE	TOLERANCE	PACKAGING
MCS0402 **MCT0603** **MCU0805** **MCA1206**	**M** = AT (Automotive)	**D** = ± 25 ppm/K **C** = ± 50 ppm/K **Z** = Jumper	3 digit value 1 digit multiplier **Multiplier** **8** = $*10^{-2}$ **9** = $*10^{-1}$ **0** = $*10^{0}$ **1** = $*10^{1}$ **2** = $*10^{2}$ **3** = $*10^{3}$ **4** = $*10^{4}$ **0000** = Jumper	**D** = ± 0.5 % **F** = ± 1 % **Z** = Jumper	**E0** **P5** **PW**

Product Description: MCT 0603-25 0.5 % AT PW 4K64

MCT	**0603**	**-25**	**0.5 %**	**AT**	**PW**	**4K64**
TYPE	SIZE	TCR	TOLERANCE	VERSION	PACKAGING	RESISTANCE
MCS **MCT** **MCU** **MCA**	**0402** **0603** **0805** **1206**	± **25** ppm/K ± **50** ppm/K	± **0.5 %** ± **1 %**	**AT** = Automotive	**E0** **P5** **PW**	**4K64** = 4.64 kΩ **0R0** = Jumper (1)

Notes

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

(1) Jumpers are ordered by the resistance value 0 Ω, e.g. MCT 0603 AT P5 0R0.

DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of special metal alloy is deposited on a high grade (Al_2O_3) ceramic substrate and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly cutting a meander groove in the resistive layer without damaging the ceramics. The resistor elements are covered by a unique protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel plating.

The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. This includes full screening for the elimination of products with potential risk of early field failures (feasible for $R \geq 10\ \Omega$). Only accepted products are laid directly into the paper tape in accordance with **IEC 60286-3** (1).

ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1** (1). 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, if applied, shall be qualified by appropriate means to ensure the long-term stability of the whole system.

The resistors are RoHS-compliant; the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **JIG 101** list of legal restrictions on hazardous substances.

This includes full compliance 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)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

APPROVALS

The resistors are approved within the IECQ-CECC Quality Assessment System for Electronic Components to the detail specification **EN 140401-801** which refers to **EN 60115-1**, **EN 140400** and the variety of environmental test procedures of the **IEC 60068** (1) series. The detail specification refers to the climatic categories 55/125/56, which relates to the "standard operation mode" of this datasheet.

Conformity is attested by the use of the **CECC** logo (⊜) as the mark of conformity on the package label.

The resistors are qualified according to AEC-Q200.

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** is granted for the Vishay BEYSCHLAG manufacturing process.

RELATED PRODUCTS

For more information about products with better TCR and tighter tolerance please refer to the precision datasheet (www.vishay.com/doc?28785).

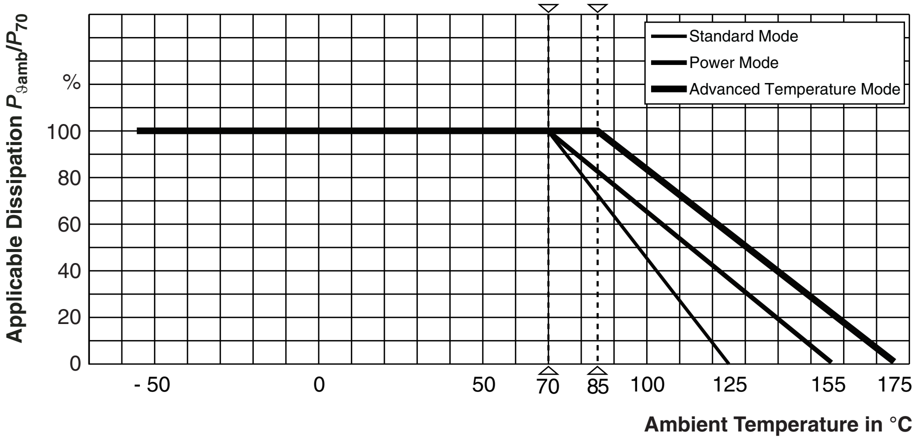
Chip resistor arrays may be used in sensing applications or precision amplifiers where close matching between multiple resistors is necessary. Please refer to the ACAS AT - Precision datasheet (www.vishay.com/doc?28770).

MC AT series is also available with gold termination for conductive gluing. Please refer to the datasheet (www.vishay.com/doc?28877).

Note

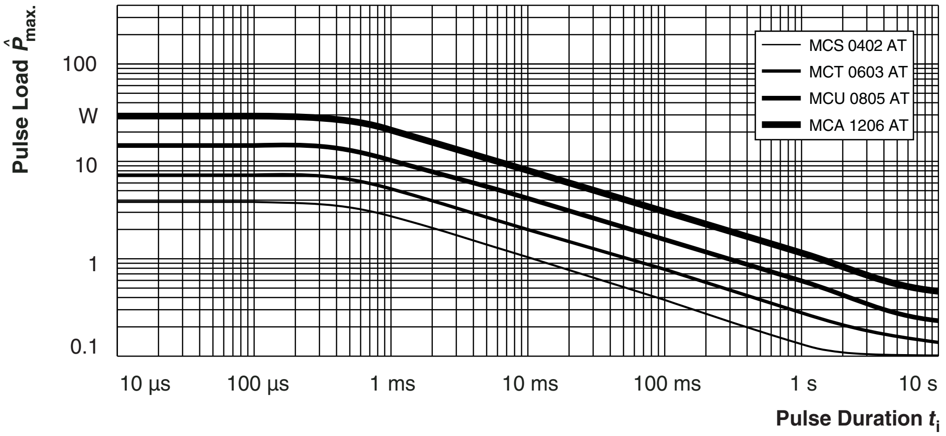
(1) The quoted IEC standards are also released as EN standards with the same number and identical contents.

FUNCTIONAL PERFORMANCE



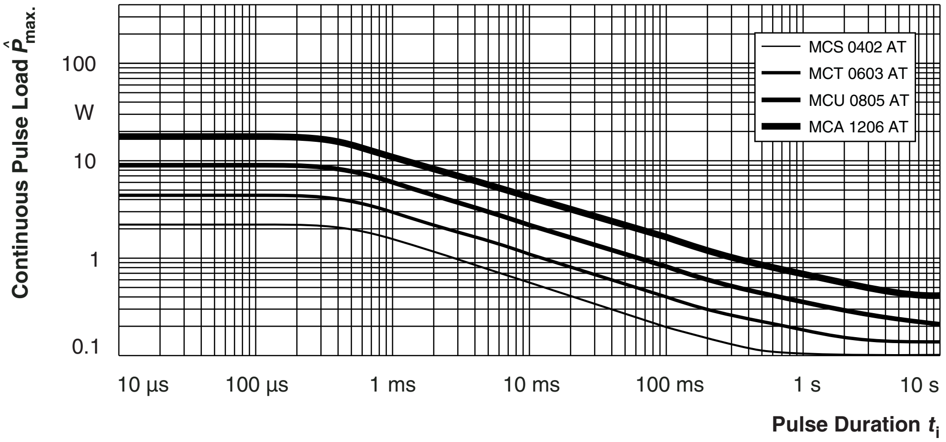
For permissible resistance change please refer to table MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION, above

Derating



Maximum pulse load, single pulse; applicable if $\bar{P} \to 0$ and n ≤ 1000 and $\hat{U} \le \hat{U}_{max.}$;
for permissible resistance change equivalent to 8000 h operation in standard operation mode

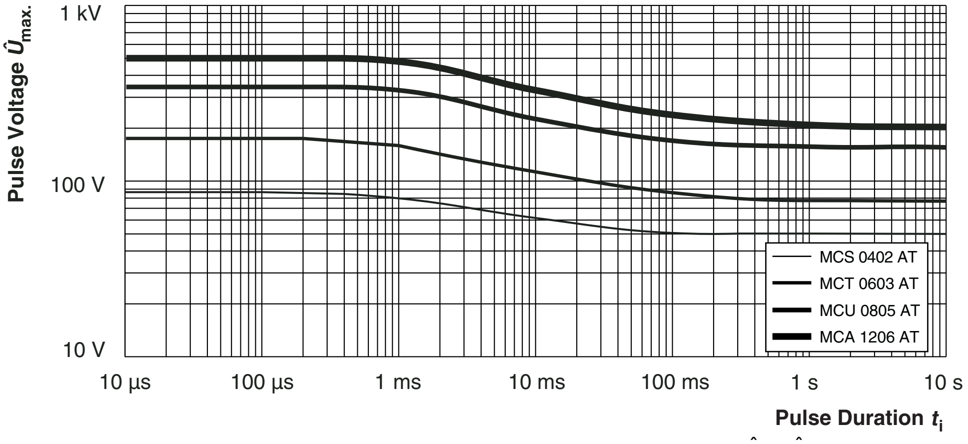
Single Pulse



Maximum pulse load, continuous pulses; applicable if $\bar{P} \le P(\vartheta_{amb})$ and $\hat{U} \le \hat{U}_{max.}$;
for permissible resistance change equivalent to 8000 h operation in standard operation mode

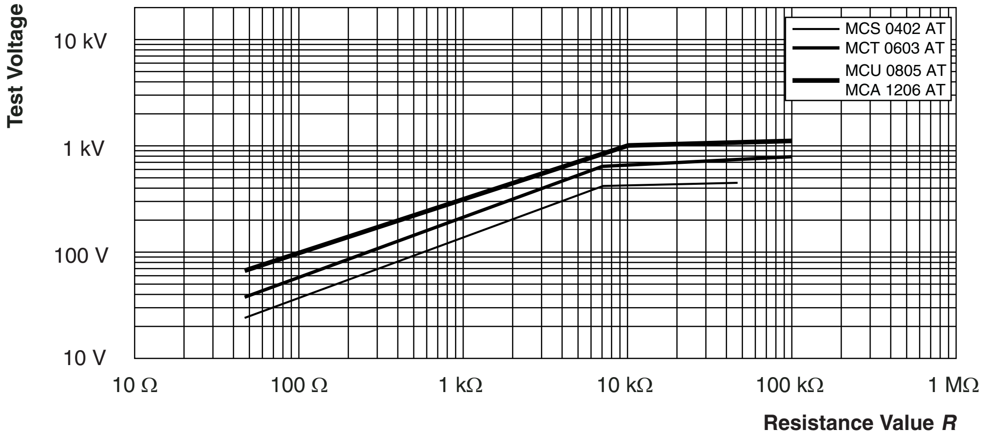
Continuous Pulse

FUNCTIONAL PERFORMANCE



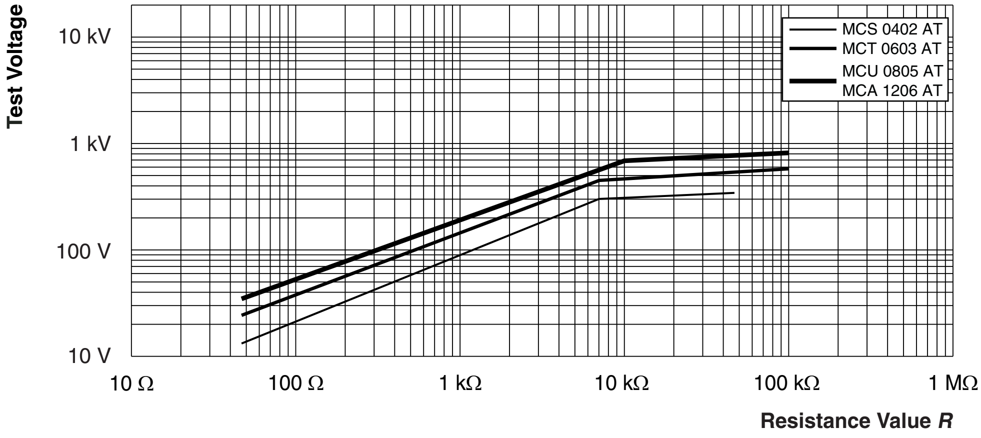
Maximum pulse voltage, single and continuous pulses; applicable if $\hat{P} \leq \hat{P}_{max.}$;
for permissible resistance change equivalent to 8000 h operation in standard operation mode

Pulse Voltage



Pulse load rating in accordance with EN 60115-1 clause 4.27; 1.2 µs/50 µs; 5 pulses at 12 s interval;
for permissible resistance change ± (0.5 % R + 0.05 Ω)

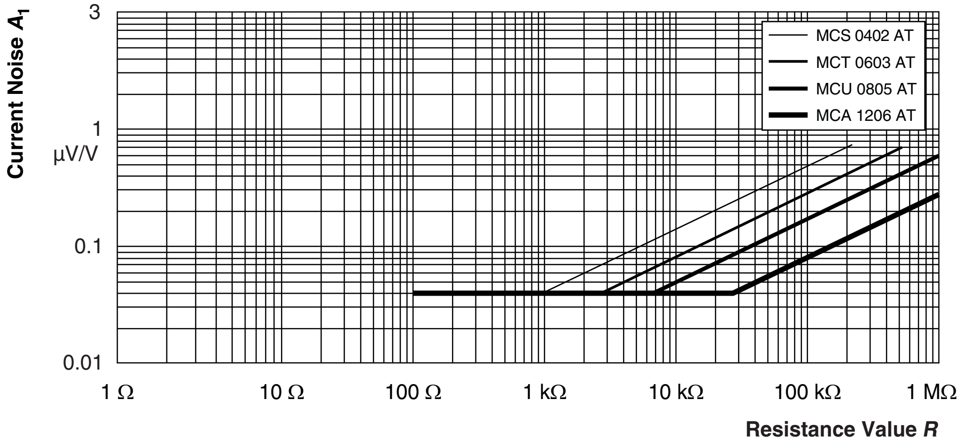
1.2/50 Pulse



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

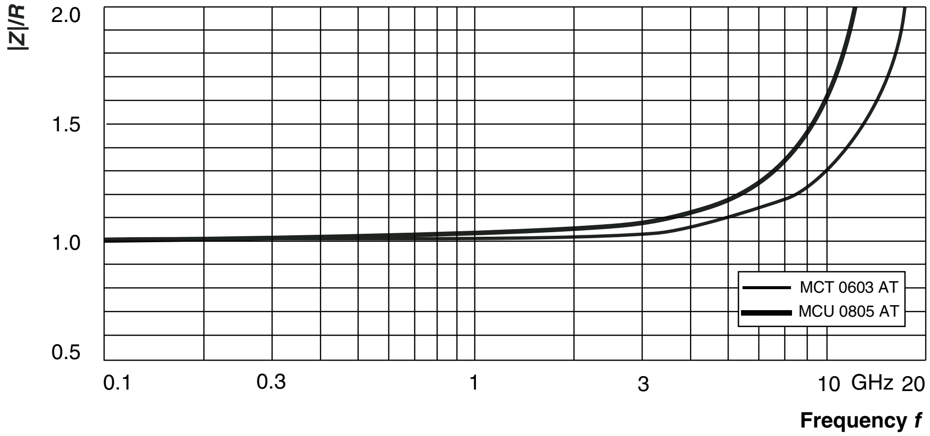
10/700 Pulse

FUNCTIONAL PERFORMANCE



Current noise A_1 in accordance with IEC 60195

Current Noise



|*Z*|/*R* for 49.9 Ω chip resistor

RF-Behaviour

TESTS AND REQUIREMENTS

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

EN 60115-1, generic specification

EN 140400, sectional specification

EN 140401-801, detail specification

The components are approved in accordance with the

IECQ-CECC-system, where applicable. The following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/ECA-703 and JIS-C-5201-1.

The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. A climatic category is applied, defined by the lower category temperature (LCT), the upper category temperature (UCT), and the number of days of the damp heat, steady-state test (56).

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

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

The components are mounted for testing on boards in accordance with EN 140400, 2.3.3 unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-801. However, some additional tests and a number of improvements against those minimum requirements have been included.

TEST PROCEDURES AND REQUIREMENTS

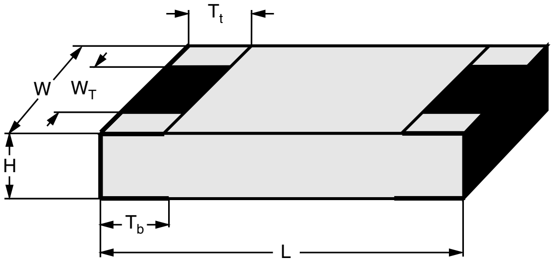
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
				STABILITY CLASS 0.5 OR BETTER
			Stability for product types:	
			MCS 0402 AT	2.43 Ω to 221 kΩ
			MCT 0603 AT	1 Ω to 511 kΩ
			MCU 0805 AT	1 Ω to 1 MΩ
			MCA 1206 AT	1 Ω to 1 MΩ
4.5	-	Resistance		± 1 % R; ± 0.5 % R
4.8.4.2	-	Temperature coefficient	At (20/-55/20) °C and (20/155/20) °C	± 50 ppm/K; ± 25 ppm/K
4.25.1	-	Endurance at 70 °C: Standard operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max.}$; whichever is the less severe; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	± (0.15 % R + 0.05 Ω) ± (0.25 % R + 0.05 Ω)
		Endurance at 70 °C: Power operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max.}$; whichever is the less severe; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	± (0.3 % R + 0.05 Ω) ± (0.5 % R + 0.05 Ω)
		Endurance at 85 °C: Advanced temperature operation mode	$U = \sqrt{P_{85} \times R}$ or $U = U_{max.}$; whichever is the less severe; 1.5 h on; 0.5 h off; 85 °C; 1000 h	± (0.5 % R + 0.05 Ω)
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h 175 °C; 1000 h	± (0.15 % R + 0.05 Ω) ± (0.3 % R + 0.05 Ω) ± (0.5 % R + 0.05 Ω)
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (0.1 % R + 0.05 Ω)
4.39	67 (Cy)	Damp heat, steady state, accelerated Standard operation mode	(85 ± 2) °C (85 ± 5) % RH $U = \sqrt{0.1 \times P_{70} \times R}$; $U \leq 0.3 \times U_{max.}$; 1000 h	± (0.5 % R + 0.05 Ω)
4.23		Climatic sequence: Standard operation mode		± (0.5 % R + 0.05 Ω)
4.23.2	2 (Ba)	Dry heat	155 °C; 16 h	
4.23.3	30 (Db)	Damp heat, cyclic	55 °C; 24 h; ≥ 90 % RH; 1 cycle	
4.23.4	1 (Aa)	Cold	-55 °C; 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	
-	1 (Aa)	Storage at low temperature	-55 °C; 2 h	± (0.1 % R + 0.01 Ω)
4.19	14 (Na)	Rapid change of temperature	30 min at -55 °C and 30 min at 155 °C; 1000 cycles	± (0.25 % R + 0.05 Ω)
4.13	-	Short time overload; Standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max.}$; whichever is the less severe; 5 s	± (0.1 % R + 0.01 Ω)
		Short time overload; Power operation mode		± (0.25 % R + 0.05 Ω)

For technical questions, contact: thinfilmchip@vishay.com

TEST PROCEDURES AND REQUIREMENTS

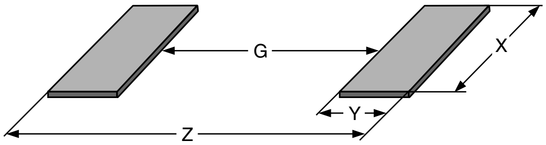
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
				STABILITY CLASS 0.5 OR BETTER
			Stability for product types:	
			MCS 0402 AT	2.43 Ω to 221 kΩ
			MCT 0603 AT	1 Ω to 511 kΩ
			MCU 0805 AT	1 Ω to 1 MΩ
			MCA 1206 AT	1 Ω to 1 MΩ
4.27	-	Single pulse high voltage overload: Standard operation mode	Severity no. 4: $U = 10 \times \sqrt{P_{70} \times R}$ $U = 2 \times U_{\text{max.}}$; whichever is the less severe; 10 pulses 10 µs/700 µs	± (0.25 % R + 0.05 Ω)
		Single pulse high voltage overload: Power operation mode		± (0.5 % R + 0.05 Ω)
4.37	-	Periodic electric overload: Standard operation mode	$U = \sqrt{15 \times P_{70} \times R}$ $U = 2 \times U_{\text{max.}}$ whichever is the less severe; 0.1 s on; 2.5 s off; 1000 cycles	± (0.5 % R + 0.05 Ω)
		Periodic electric overload: Power operation mode		± (1.0 % R + 0.05 Ω)
4.40	-	Electro Static Discharge (Human Body Model)	IEC 61340-3-1; 3 pos. + 3 neg. (equivalent to MIL-STD-883, method 3015) MCS 0402 AT: 500 V MCT 0603 AT: 1000 V MCU 0805 AT: 1500 V MCA 1206 AT: 2000 V	± (0.5 % R + 0.05 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	± (0.1 % R + 0.01 Ω) no visible damage
4.17.2	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
4.18.2	58 (Td)	Resistance to soldering heat	Solder bath method; (260 ± 5) °C; (10 ± 1) s	± (0.1 % R + 0.01 Ω) no visible damage
4.29	45 (XA)	Component solvent resistance	Isopropyl alcohol +50 °C; method 2	No visible damage
4.32	21 (Ue_3)	Shear (adhesion)	RR1005M and RR1608M; 9 N	No visible damage
			RR2012M and RR3216M; 45 N	
4.33	21 (Ue_1)	Substrate bending	Depth 2 mm, 3 times	± (0.1 % R + 0.01 Ω) no visible damage; no open circuit in bent position
4.7	-	Voltage proof	$U_{\text{RMS}} = U_{\text{ins}}$; (60 ± 5) s	No flashover or breakdown
4.35	-	Flammability	Needle flame test; 10 s	No burning after 30 s

DIMENSIONS



DIMENSIONS AND MASS							
TYPE	H (mm)	L (mm)	W (mm)	W_T (mm)	T_t (mm)	T_b (mm)	MASS (mg)
MCS 0402 AT	0.32 ± 0.05	1.0 ± 0.05	0.5 ± 0.05	> 75 % of W	0.2 + 0.1/- 0.15	0.2 ± 0.1	0.6
MCT 0603 AT	0.45 + 0.1/- 0.05	1.55 ± 0.05	0.85 ± 0.1	> 75 % of W	0.3 + 0.15/- 0.2	0.3 + 0.15/- 0.2	1.9
MCU 0805 AT	0.52 ± 0.1	2.0 ± 0.1	1.25 ± 0.15	> 75 % of W	0.4 + 0.1/- 0.2	0.4 + 0.1/- 0.2	4.6
MCA 1206 AT	0.55 ± 0.1	3.2 + 0.1/- 0.2	1.6 ± 0.15	> 75 % of W	0.5 ± 0.25	0.5 ± 0.25	9.2

SOLDER PAD DIMENSIONS



RECOMMENDED SOLDER PAD DIMENSIONS								
TYPE	WAVE SOLDERING				REFLOW SOLDERING			
	G (mm)	Y (mm)	X (mm)	Z (mm)	G (mm)	Y (mm)	X (mm)	Z (mm)
MCS 0402 AT	-	-	-	-	0.35	0.55	0.55	1.45
MCT 0603 AT	0.55	1.10	1.10	2.75	0.65	0.70	0.95	2.05
MCU 0805 AT	0.80	1.25	1.50	3.30	0.90	0.90	1.40	2.70
MCA 1206 AT	1.40	1.50	1.90	4.40	1.50	1.15	1.75	3.80

Note

- 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. Specified power rating above 125 °C requires dedicated heat-sink pads, which to a great extend depend on board materials and design.
  The given solder pad dimensions reflect the considerations for board design and assembly as outlined e.g. in standards IEC 61188-5-x, or in publication IPC-7351. They do not guarantee any supposed thermal properties, particularly as these are also strongly influenced by many other parameters.
  Still, the given solder pad dimensions will be found adequate for most general applications, e.g. those referring to "standard operation mode". Please note however that applications for "power operation mode" require special considerations for the design of solder pads and adjacent conductor areas.

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