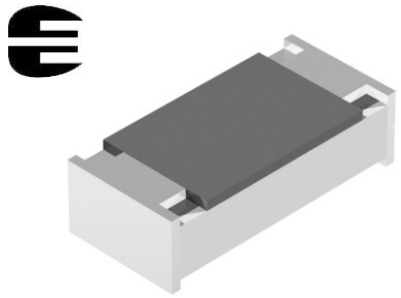
# Professional Flat Chip Resistors



MCS 0402, MCT 0603, MCU 0805 and MCA 1206 Professional Thin Film Flat Chip Resistors are the perfect choice for most fields of modern professional electronics where reliability and stability is of major concern. Typical applications include telecommunication, medical equipment and high-end computer and audio/video electronics.

## FEATURES

- Approved according to EN 140401-801
- Excellent overall stability: Class 0.5
- Advanced thin film technology
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant

RoHS COMPLIANT

## APPLICATIONS

- Automotive
- Telecommunication
- Medical equipment
- Industrial equipment

| METRIC SIZE | | | | |
|---|---|---|---|---|
| **INCH:** | 0402 | 0603 | 0805 | 1206 |
| **METRIC:** | RR 1005M | RR 1608M | RR 2012M | RR 3216M |

## TECHNICAL SPECIFICATIONS

| DESCRIPTION | MCS 0402 | | MCT 0603 | | MCU 0805 | | MCA 1206 | |
|---|---|---|---|---|---|---|---|---|
| Metric size | RR 1005M | | RR 1608M | | RR 2012M | | RR 3216M | |
| Resistance range | 10 Ω to 4.99 MΩ | | 1 Ω to 10 MΩ | | 1 Ω to 10 MΩ | | 1 Ω to 10 MΩ | |
| Resistance tolerance | ± 1 %; ± 0.5 % | | | | | | | |
| Temperature coefficient | ± 50 ppm/K; ± 25 ppm/K | | | | | | | |
| Operation mode | Standard | Power | Standard | Power | Standard | Power | Standard | Power |
| Climatic category (LCT/UCT/days) | 55/125/56 | 55/155/56 | 55/125/56 | 55/155/56 | 55/125/56 | 55/155/56 | 55/125/56 | 55/155/56 |
| Rated dissipation, $P_{70}$ (1) | 0.063 W | 0.1 W | 0.1 W | 0.125 W | 0.125 W | 0.2 W | 0.25 W | 0.4 W |
| Operating voltage, $U_{max.}$ AC/DC | 50 V | | 75 V | | 150 V | | 200 V | |
| Film temperature | 125 °C | 155 °C | 125 °C | 155 °C | 125 °C | 155 °C | 125 °C | 155 °C |
| Max. resistance change at $P_{70}$ for resistance range, $\Delta R/R$ max., after: | 10 Ω to 4.99 MΩ | | 1 Ω to 10 MΩ | | 1 Ω to 10 MΩ | | 1 Ω to 10 MΩ | |
| 1000 h | ≤ 0.25 % | ≤ 0.5 % | ≤ 0.25 % | ≤ 0.5 % | ≤ 0.25 % | ≤ 0.5 % | ≤ 0.25 % | ≤ 0.5 % |
| 8000 h | ≤ 0.5 % | ≤ 1.0 % | ≤ 0.5 % | ≤ 1.0 % | ≤ 0.5 % | ≤ 1.0 % | ≤ 0.5 % | ≤ 1.0 % |
| 225 000 h | ≤ 1.5 % | | ≤ 1.5 % | | ≤ 1.5 % | | ≤ 1.5 % | |
| Insulation voltage: | | | | | | | | |
| 1 min; $U_{ins}$ | 75 V | | 100 V | | 200 V | | 300 V | |
| continuous | 75 V | | 75 V | | 75 V | | 75 V | |
| $FIT_{observed}$ | ≤ 0.1 x $10^{-9}$/h | | ≤ 0.1 x $10^{-9}$/h | | ≤ 0.1 x $10^{-9}$/h | | ≤ 0.1 x $10^{-9}$/h | |

**Notes**

(1) 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.

- 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.

## 12NC INFORMATION FOR HISTORICAL CODING REFERENCE ONLY

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packing; see the 12NC table.
- The remaining 4 digits indicate the resistance value:
  - The first 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with the Last digit of 12NC Indicating Resistance Decade table.

**Last Digit of 12NC Indicating Resistance Decade**

| RESISTANCE DECADE | LAST DIGIT |
|---|---|
| 1 Ω to 9.99 Ω | 8 |
| 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 |
| 1 MΩ to 9.99 MΩ | 5 |
| 10 MΩ to 99.9 MΩ | 6 |

**12NC example**

The 12NC of a MCT 0603 resistor, value 47 kΩ and TCR 50 with ± 1 % tolerance, supplied in cardboard tape of 5000 units per reel is: 2312 215 14703.

**12NC** - resistor type and packaging

| DESCRIPTION | | | ORDERING CODE 2312 ... ..... | | |
|---|---|---|---|---|---|
| | | | CARDBOARD TAPE ON REEL | | |
| TYPE | TCR | TOL. | P5 (5000 UNITS) | E0 (10 000 UNITS) | PW (20 000 UNITS) |
| MCS 0402 | ± 50 ppm/K | ± 1 % | - | 275 1.... | - |
| | | ± 0.5 % | - | 275 5.... | - |
| | ± 25 ppm/K | ± 0.5 % | - | 276 5.... | - |
| | Jumper | - | - | 275 90001 | - |
| MCT 0603 | ± 50 ppm/K | ± 1 % | 215 1.... | - | 205 1.... |
| | | ± 0.5 % | 215 5.... | - | 205 5.... |
| | ± 25 ppm/K | ± 0.5 % | 216 5.... | - | 206 5.... |
| | Jumper | - | 215 90001 | - | 205 90001 |
| MCU 0805 | ± 50 ppm/K | ± 0.5 % | 255 5.... | - | 245 5.... |
| | ± 25 ppm/K | ± 0.5 % | 256 5.... | - | 246 5.... |
| | Jumper | - | 255 90001 | - | 245 90001 |

**Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.**

## PART NUMBER AND PRODUCT DESCRIPTION (1)

**PART NUMBER: MCT06030D4641DPW00**

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

| MODEL/SIZE | SPECIAL CHARACTER | TCR | VALUE | TOLERANCE | PACKAGING (2) | SPECIAL |
|---|---|---|---|---|---|---|
| **MCS0402**<br>**MCT0603**<br>**MCU0805**<br>**MCA1206** | **0** = neutral | **D** = ± 25 ppm/K<br>**C** = ± 50 ppm/K<br>**Z** = Jumper | **3 digit value**<br>**1 digit multiplier**<br>MULTIPLIER<br>**7** = *10$^{-3}$<br>**8** = *10$^{-2}$<br>**9** = *10$^{-1}$<br>**0** = *10$^{0}$<br>**1** = *10$^{1}$<br>**2** = *10$^{2}$<br>**3** = *10$^{3}$<br>**4** = *10$^{4}$<br>**5** = *10$^{5}$<br>**6** = *10$^{6}$<br>**0000** = Jumper | **D** = ± 0.5 %<br>**F** = ± 1 %<br>**Z** = Jumper | **P5**<br>**PW**<br>**E0** | up to 2 digits<br>**00** = standard |

**PRODUCT DESCRIPTION: MCT 0603-25 0.5 % PW 4K64**

| MCT | 0603 | -25 | 0.5 % | PW | 4K64 |
|---|---|---|---|---|---|
| MODEL | SIZE | TCR | TOLERANCE | PACKAGING (2) | RESISTANCE VALUE |
| **MCS**<br>**MCT**<br>**MCU**<br>**MCA** | **0402**<br>**0603**<br>**0805**<br>**1206** | ± **25** ppm/K<br>± **50** ppm/K | ± **0.5** %<br>± **1** % | **P5**<br>**PW**<br>**E0** | **47K** = 47 kΩ<br>**50R1** = 50.1 Ω<br>**0R0** = Jumper (3) |

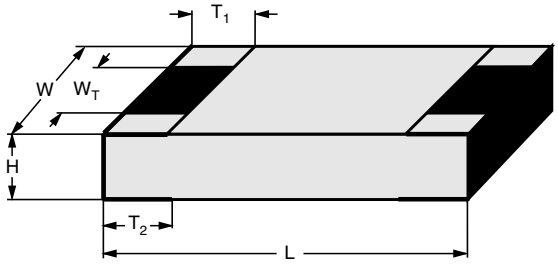
**Notes**

(1) Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER

(2) Please refer to table PACKAGING, next page

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

## DIMENSIONS




**DIMENSIONS -** chip resistor types, mass and relevant physical dimensions

| TYPE | H (mm) | L (mm) | W (mm) | $W_T$ (mm) | $T_1$ (mm) | $T_2$ (mm) | MASS (mg) |
|---|---|---|---|---|---|---|---|
| MCS 0402 | 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 | 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 | 0.45 + 0.1/- 0.05 | 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 | 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 |

## TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

| DESCRIPTION | | RESISTANCE VALUE [1] | | | |
|---|---|---|---|---|---|
| **TCR** | **TOLERANCE** | **MCS 0402** | **MCT 0603** | **MCU 0805** | **MCA 1206** |
| ± 50 ppm/K | ± 1 % | 10 Ω to 4.99 MΩ | 1 Ω to 10 MΩ | 1 Ω to 10 MΩ | 1 Ω to 10 MΩ |
| | ± 0.5 % | 100 Ω to 221 kΩ | 39 Ω to 511 kΩ | 10 Ω to 1.5 MΩ | 10 Ω to 2 MΩ |
| ± 25 ppm/K | ± 0.5 % | 100 Ω to 221 kΩ | 39 Ω to 511 kΩ | 10 Ω to 1.5 MΩ | 10 Ω to 2 MΩ |
| Jumper | - | ≤ 20 mΩ; $I_{max.}$ = 0.63 A | ≤ 20 mΩ; $I_{max.}$ = 1 A | ≤ 20 mΩ; $I_{max.}$ = 1.5 A | ≤ 20 mΩ; $I_{max.}$ = 2 A |

**Note**

[1] Resistance values to be selected for ± 1 % tolerance from E24 and E96; for ± 0.5 % tolerance from E24 and E192

**Resistance ranges printed in bold are preferred TCR/tolerance combinations with optimized availability.**

## PACKAGING

| MODEL | REEL | |
|---|---|---|
| | **PIECES/ PAPER TAPE ON REEL** | **CODE** |
| MCS 0402 | 10 000 | E0 |
| MCT 0603 | 5000 | P5 |
| | 20 000 | PW |
| MCU 0805 | 5000 | P5 |
| | 20 000 | PW |
| MCA 1206 | 5000 | P5 |
| | 20 000 | PW |

## DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of 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. For the high ohmic range, optimized Cermet products provide comparable properties. The resistor elements are covered by a 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. Only accepted products are laid directly into the paper tape in accordance with **EN 60286-3**.

## 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**. 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. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL** [1] and the **CEFIC-EECA-EICTA** [2] list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) an Annex II (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years.

## APPROVALS

The resistors are tested in accordance with **EN 140401-801** (superseding **CECC 40401-801**) which refers to **EN 60115-1** and **EN 140400**. Approval of conformity is indicated by the **CECC** logo on the package label.

Vishay BEYSCHLAG has achieved **"Approval of Manufacturer"** in accordance with **EN 100114-1**. The release certificate for **"Technology Approval Schedule"** in accordance with **CECC 240 001** based on **EN 100114-6** is granted for the Vishay BEYSCHLAG manufacturing process.

## SPECIALS

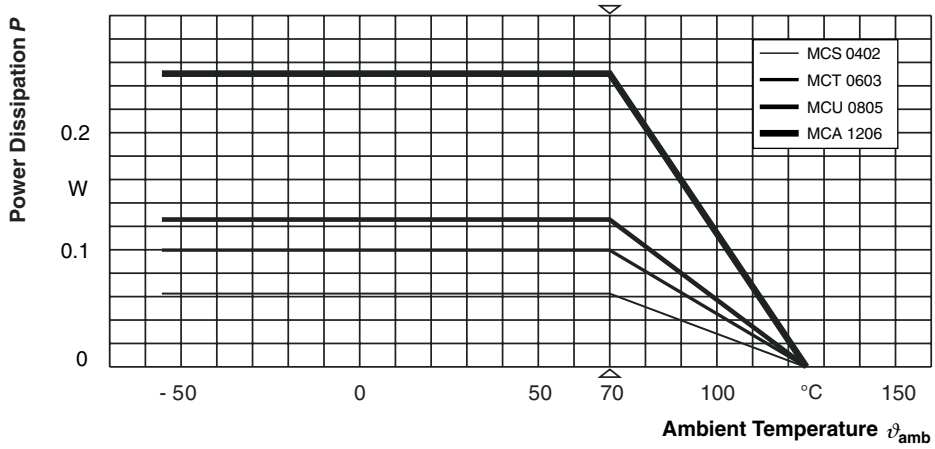
This product family of thin film flat chip resistors is completed by **Zero Ohm Jumpers**.
On request, resistors are available with established reliability in accordance with **EN 140401-801 Version E**. Please refer to the special data sheet for information on failure rate level, available resistance ranges and order codes.

**Notes**

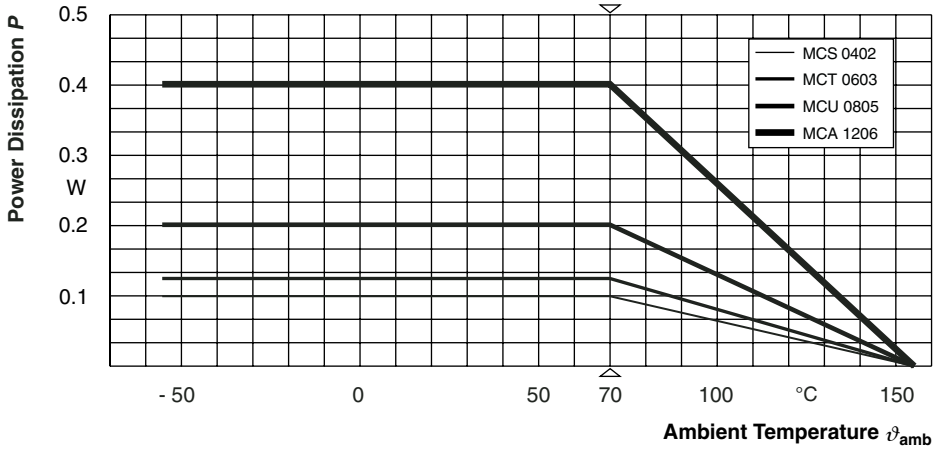
[1] Global Automotive Declarable Substance List, see www.gadsl.org

[2] CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see www.eicta.org → issue → environment policy → chemicals → chemicals for electronics

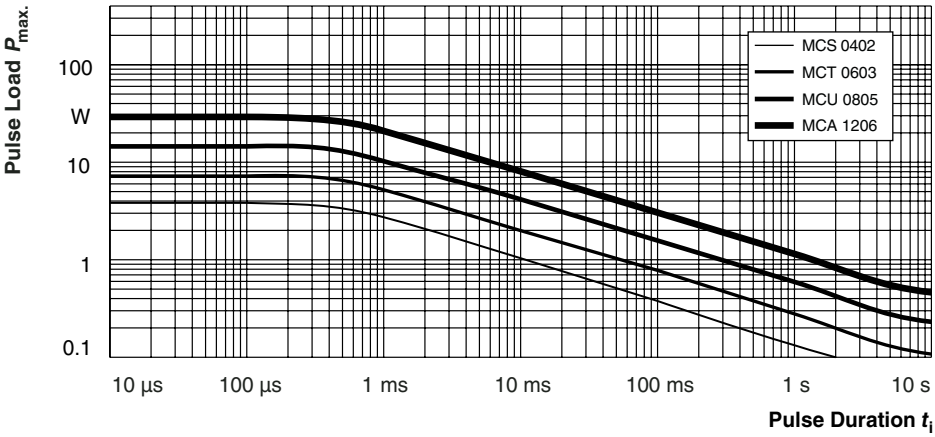
## FUNCTIONAL PERFORMANCE




**Derating - Standard Operation**

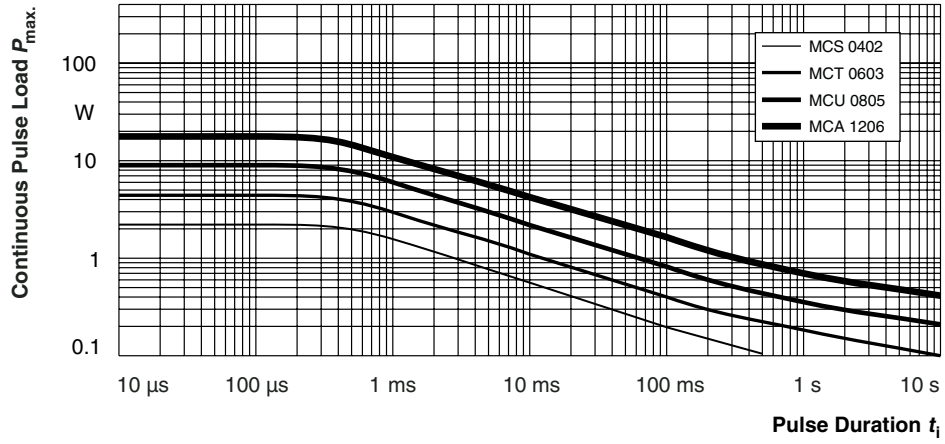



**Derating - Power Operation**



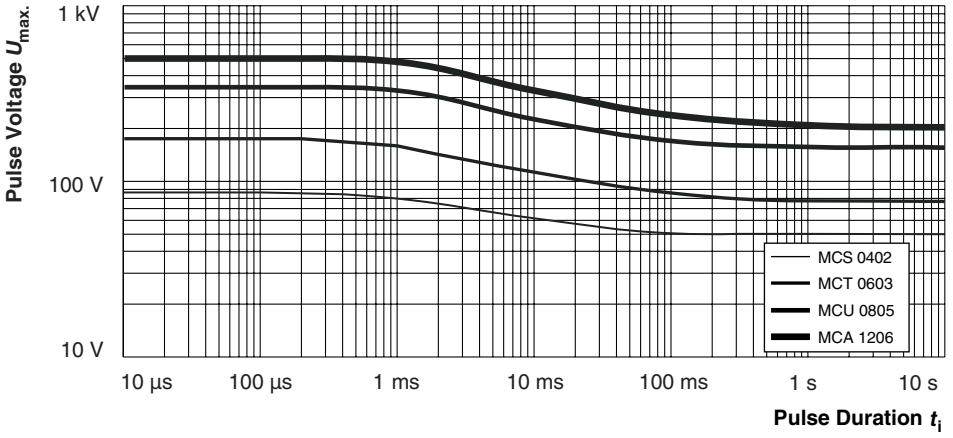

Maximum pulse load, single pulse; for permissible resistance change equivalent to 8000 h operation

**Single Pulse**



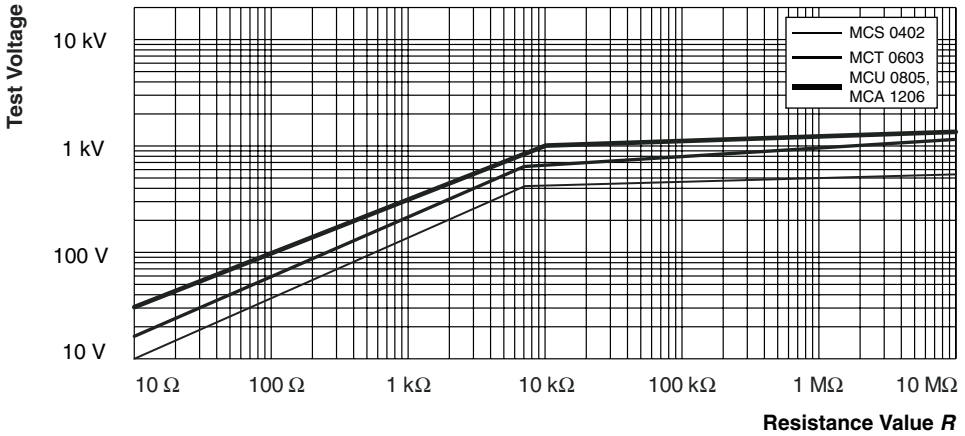

Maximum pulse load, continuous pulses; for permissible resistance change equivalent to 8000 h operation

### Continuous Pulse



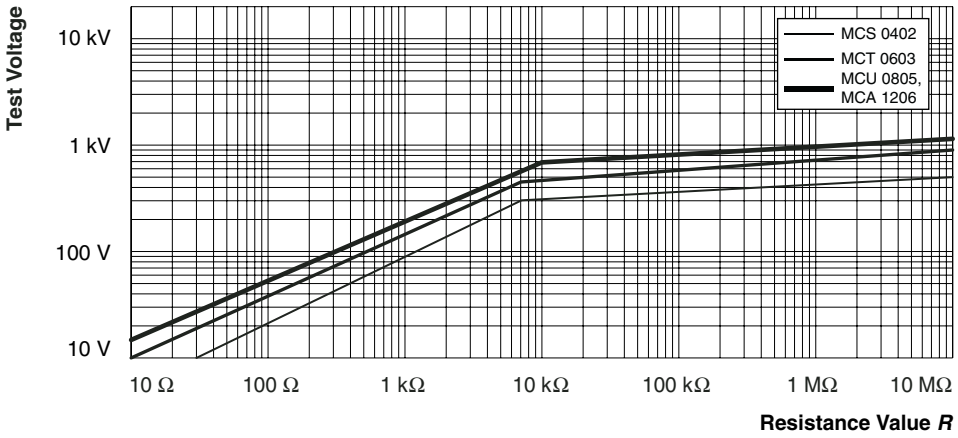

Maximum pulse voltage, single and continuous pulses; for permissible resistance change equivalent to 8000 h operation

### Pulse Voltage



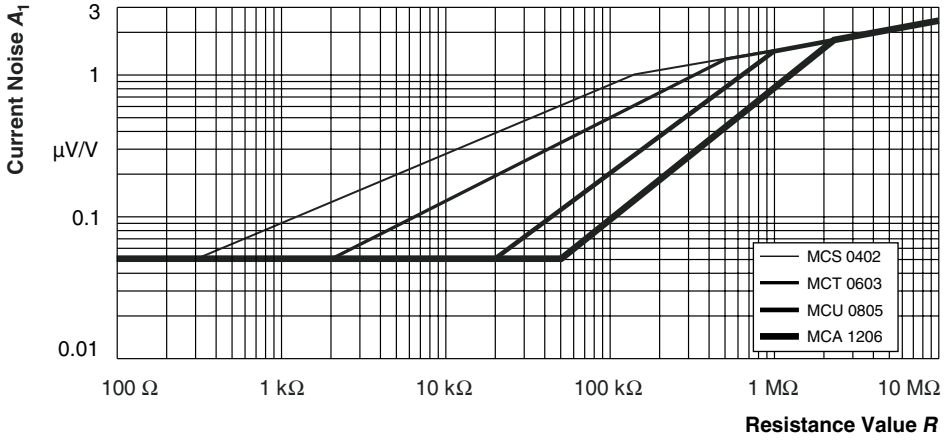

Pulse load rating in accordance with EN 60115-1 clause 4.27; 1.2 µs/50 µs; 5 pulses at 12 s interval;
for permissible resistance change 0.5 %

### 1.2/50 Pulse



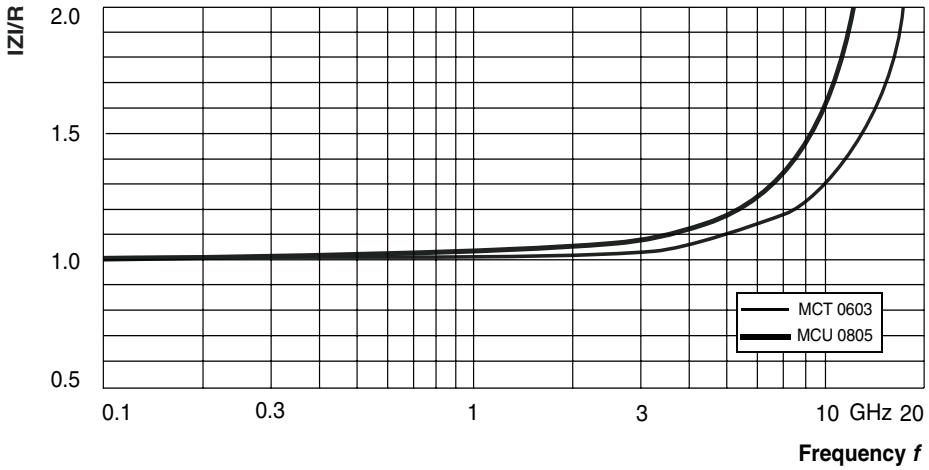

Pulse load rating in accordance with EN 60115-1 clause 4.27; 10 µs/700 µs;
10 pulses at 1 min intervals; for permissible resistance change 0.5 %

### 10/700 Pulse




Current noise $A_1$ in accordance with IEC 60 195

### Current Noise




IZI/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 (includes tests)

EN 140 400, Sectional specification (includes schedule for qualification approval)

EN 140 401-801, Detail specification (includes schedule for conformance inspection)

The components are approved in accordance with the European 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/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid.

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 60115-1, 4.31 unless otherwise specified.

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140 401-801. 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 ($\Delta R/R$) | |
|---|---|---|---|---|---|
| | | | | STABILITY CLASS 0.5 | STABILITY CLASS 1 |
| | | | Stability for product types: | | |
| | | | **MCS 0402** | 10 Ω to 33.2 kΩ | > 33.2 kΩ to 4.99 MΩ |
| | | | **MCT 0603** | 10 Ω to 100 kΩ | 1 Ω to < 10 Ω; > 100 kΩ to 10 MΩ |
| | | | **MCU 0805** | 10 Ω to 221 kΩ | 1 Ω to < 10 Ω; > 221 kΩ to 10 MΩ |
| | | | **MCA 1206** | 10 Ω to 332 kΩ | 1 Ω to < 10 Ω; > 332 kΩ to 10 MΩ |
| 4.5 | - | Resistance | | ± 1 %; ± 0.5 % | |
| 4.8.4.2 | - | Temperature coefficient | At 20/- 55/20 °C and 20/125/20 °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 | ± (0.25 % $R$ + 0.05 Ω) | |
| | | | 1.5 h on; 0.5 h off | ± (0.5 % $R$ + 0.05 Ω) | |
| | | | 70 °C; 1000 h | | |
| | | | 70 °C; 8000 h | | |
| | | 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 | | |
| | | | 1.5 h on; 0.5 h off | | |
| | | | 70 °C; 1000 h | ± (0.5 % $R$ + 0.05 Ω) | |
| | | | 70 °C; 8000 h | ± (1 % R + 0.05 Ω) | |

## TEST PROCEDURES AND REQUIREMENTS

| EN 60115-1 CLAUSE | IEC 60068-2 TEST METHOD | TEST | PROCEDURE | REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R/R$) | |
|---|---|---|---|---|---|
| | | | | STABILITY CLASS 0.5 | STABILITY CLASS 1 |
| | | | Stability for product types: | | |
| | | | **MCS 0402** | 10 Ω to 33.2 kΩ | > 33.2 kΩ to 4.99 MΩ |
| | | | **MCT 0603** | 10 Ω to 100 kΩ | 1 Ω to < 10 Ω;<br>> 100 kΩ to 10 MΩ |
| | | | **MCU 0805** | 10 Ω to 221 kΩ | 1 Ω to < 10 Ω;<br>> 221 kΩ to 10 MΩ |
| | | | **MCA 1206** | 10 Ω to 332 kΩ | 1 Ω to < 10 Ω;<br>> 332 kΩ to 10 MΩ |
| 4.25.3 | - | Endurance at upper category temperature | 125 °C; 1000 h<br>155 °C; 1000 h | ± (0.25 % $R$ + 0.05 Ω)<br>± (0.5 % $R$ + 0.05 Ω) | ± (0.5 % $R$ + 0.05 Ω)<br>± (1 % $R$ + 0.05 Ω) |
| 4.24 | 78 (Cab) | Damp heat, steady state | (40 ± 2) °C; 56 days;<br>(93 ± 3) % RH | ± (0.5 % R + 0.05 Ω) | ± (1 % R + 0.05 Ω) |
| 4.23 | | Climatic sequence: | | ± (0.5 % R + 0.05 Ω) | ± (1 % R + 0.05 Ω) |
| 4.23.2 | 2 (Ba) | Dry heat | UCT; 16 h | | |
| 4.23.3 | 30 (Db) | Damp heat, cyclic | 55 °C; 24 h; > 90 % RH;<br>1 cycle | | |
| 4.23.4 | 1 (Aa) | 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; 5 days; > 90 % RH;<br>5 cycles | | |
| 4.23.7 | - | D.c. load | $U = \sqrt{P_{70} \times R} \leq U_{max.}$;<br>1 min<br>LCT = - 55 °C<br>UCT = 125 °C | | |
| - | 1 (Aa) | Cold | - 55 °C; 2 h | ± (0.1 % R + 0.01 Ω) | ± (0.25 % R + 0.05 Ω) |
| 4.19 | 14 (Na) | Rapid change of temperature | 30 min at LCT and<br>30 min at UCT;<br>LCT = - 55 °C;<br>UCT = 125 °C; 5 cycles | ± (0.1 % R + 0.01 Ω)<br>no visible damage | |
| | | | LCT = - 55 °C;<br>UCT = 125 °C; 1000 cycles | ± (0.25 % R + 0.05 Ω)<br>no visible damage | |
| 4.13 | - | Short time overload; standard operation mode | $U = 2.5 \times \sqrt{P_{70} \times R}$ or<br>$U = 2 \times U_{max.}$;<br>whichever is the less severe;<br>5 s | ± (0.1 % R + 0.01 Ω) | ± (0.25 % R + 0.05 Ω) |
| | | Short time overload; power operation mode | | ± (0.25 % R + 0.05 Ω) | ± (0.5 % R + 0.05 Ω) |

## TEST PROCEDURES AND REQUIREMENTS

| EN 60115-1 CLAUSE | IEC 60068-2 TEST METHOD | TEST | PROCEDURE | REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R/R$) | |
|---|---|---|---|---|---|
| | | | | STABILITY CLASS 0.5 | STABILITY CLASS 1 |
| | | | Stability for product types: | | |
| | | | **MCS 0402** | 10 Ω to 33.2 kΩ | > 33.2 kΩ to 4.99 MΩ |
| | | | **MCT 0603** | 10 Ω to 100 kΩ | 1 Ω to < 10 Ω; > 100 kΩ to 10 MΩ |
| | | | **MCU 0805** | 10 Ω to 221 kΩ | 1 Ω to < 10 Ω; > 221 kΩ to 10 MΩ |
| | | | **MCA 1206** | 10 Ω to 332 kΩ | 1 Ω to < 10 Ω; > 332 kΩ to 10 MΩ |
| 4.27 | - | Single pulse high voltage overload; standard operation mode | Severity no. 4: $U = 10 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max.}$; whichever is the less severe; 10 pulses 10 µs/700 µs | ± (0.5 % R + 0.05 Ω) no visible damage | |
| 4.37 | - | Periodic electric overload; standard operation mode | $U = \sqrt{15 \times P_{70} \times R}$ or $U = 2 \times U_{max.}$; whichever is the less severe; 0.1 s on; 2.5 s off; 1000 cycles | ± (0.5 % R + 0.05 Ω) no visible damage | |
| | | Periodic electric overload; power operation mode | | ± (1 % R + 0.05 Ω) no visible damage | |
| 4.22 | 6 (Fc) | Vibration | Endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s²; 6 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 | ± (0.25 % R + 0.05 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) | RR 1005M and RR 1608M; 9 N | No visible damage | |
| | | | RR 2012M and RR 3216M; 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 | $U_{rms} = U_{ins}$; 60 ± 5 s | No flashover or breakdown | |
| 4.35 | - | Flammability | IEC 60695-11-5, needle flame test; 10 s | No burning after 30 s | |

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