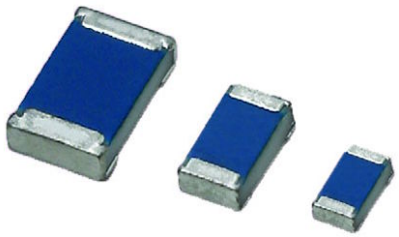
High Power Thin Film Chip Resistors



Automotive grade high power MC HP thin film chip resistors are the perfect choice for most fields of modern electronics where high power dissipation, reliability and stability is of major concern. The permissible power rating is specified with up to 400 mW and allows replacement of larger case sizes with next smaller ones. Typical applications include power electronics in automotive and industrial appliances.

FEATURES

AUTOMOTIVE GRADE

RoHS COMPLIANT

- Operating temperature up to 175 °C
- Rated dissipation up to 0.4 W for size 0805
- AEC-Q200 qualified
- Superior temperature cycling robustness
- Advanced sulfur resistance verified according to ASTM B 809
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS

- Automotive
- Industrial
- High power and high temperature applications
- Replacement for larger case sizes

TECHNICAL SPECIFICATIONS			
DESCRIPTION	**MCS 0402 HP**	**MCT 0603 HP**	**MCU 0805 HP**
Imperial size	0402	0603	0805
Metric size code	RR1005M	RR1608M	RR2012M
Resistance range	47 Ω to 100 kΩ	1 Ω to 100 kΩ	1 Ω to 100 kΩ
Resistance tolerance	± 1 %; ± 0.5 %; ± 0.1 %		
Temperature coefficient	± 50 ppm/K; ± 25 ppm/K		
Rated dissipation P_{85} (1)	0.200 W	0.250 W	0.400 W
Operating voltage, $U_{max.}$ AC_{RMS}/DC	50 V	75 V	150 V
Permissible film temperature, $\vartheta_{F\ max.}$ (1)	175 °C		
Operating temperature range	-55 °C to 175 °C		

Note

(1) Please refer to APPLICATION INFORMATION below

APPLICATION INFORMATION

When the resistor dissipates power, a temperature rise above the ambient temperature occurs, dependent on the thermal resistance of the assembled resistor together with the printed circuit board. 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.

MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION			
OPERATION MODE		**POWER**	**ADVANCED TEMPERATURE**
		P_{70}	P_{85}
Rated dissipation	**MCS 0402 HP**	0.200 W	0.200 W
	MCT 0603 HP	0.250 W	0.250 W
	MCU 0805 HP	0.400 W	0.400 W
Operating temperature range		-55 °C to 155 °C	-55 °C to 175 °C
Permissible film temperature, $\vartheta_{F\ max.}$		155 °C	175 °C
Max. resistance change at rated dissipation for resistance range, $\lvert\Delta R/R\rvert$ after:	**MCS 0402 HP**	47 Ω to 100 kΩ	47 Ω to 100 kΩ
	MCT 0603 HP	1 Ω to 100 kΩ	1 Ω to 100 kΩ
	MCU 0805 HP	1 Ω to 100 kΩ	1 Ω to 100 kΩ
	1000 h	≤ 0.2 %	≤ 0.3 %
	8000 h	≤ 0.4 %	-

Note

- The presented operation modes do not refer to different types of resistors, but actually show examples of different loads, that lead to different film temperatures and different achievable load-life stability (drift) of the resistance value. A suitable low thermal resistance of the circuit board assembly must be safeguarded in order to maintain the film temperature of the resistors within the specified limits. Please consider the application note “Thermal Management in Surface-Mounted Resistor Applications” (www.vishay.com/doc?28844) for information on the general nature of thermal resistance.

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE / SIZE	**TCR**	**TOLERANCE**	**RESISTANCE**	**E-SERIES**
MCS 0402 HP	± 50 ppm/K	± 1 %	47 Ω to 100 kΩ	E24; E96
	± 25 ppm/K	± 0.5 %	47 Ω to 100 kΩ	E24; E192
		± 0.1 %	47 Ω to 100 kΩ	
MCT 0603 HP	± 50 ppm/K	± 1 %	1 Ω to 100 kΩ	E24; E96
	± 25 ppm/K	± 0.5 %	10 Ω to 100 kΩ	E24; E192
		± 0.1 %	47 Ω to 100 kΩ	
MCU 0805 HP	± 50 ppm/K	± 1 %	1 Ω to 100 kΩ	E24; E96
	± 25 ppm/K	± 0.5 %	10 Ω to 100 kΩ	E24; E192
		± 0.1 %	47 Ω to 100 kΩ	

PACKAGING

TYPE / SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
MCS 0402 HP	E1	1000 (1)	Paper tape acc. IEC 60286-3, Type 1a	8 mm	2 mm	Ø 180 mm / 7"
	E5	5000				
	E0	10 000				
MCT 0603 HP	P1	1000 (1)			4 mm	Ø 180 mm / 7"
	P5	5000				
	PW	20 000				Ø 330 mm / 13"
MCU 0805 HP	P1	1000 (1)				Ø 180 mm / 7"
	P5	5000				
	PW	20 000				Ø 330 mm / 13"

Note

(1) 1000 pieces packaging is available only for precision resistors with tolerance ± 0.1 %

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: MCT0603PD4641DPW00

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

TYPE / SIZE	VERSION	TCR	RESISTANCE	TOLERANCE	PACKAGING
MCS0402 **MCT0603** **MCU0805**	**P** = HP (high power, automotive)	**D** = ± 25 ppm/K **C** = ± 50 ppm/K	3 digit value 1 digit multiplier **Multiplier** **8** = $*10^{-2}$ **9** = $*10^{-1}$ **0** = $*10^{0}$ **1** = $*10^{1}$ **2** = $*10^{2}$ **3** = $*10^{3}$	**B** = ± 0.1 % **D** = ± 0.5 % **F** = ± 1 %	**E1** **E5** **E0** **P1** **P5** **PW**

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

MCT	0603	-25	0.5 %	HP	PW	4K64
TYPE	SIZE	TCR	TOLERANCE	VERSION	PACKAGING	RESISTANCE
MCS **MCT** **MCU**	**0402** **0603** **0805**	± **25** ppm/K ± **50** ppm/K	± **0.1 %** ± **0.5 %** ± **1 %**	**HP** = high power automotive	**E1** **E5** **E0** **P1** **P5** **PW**	**4K64** = 4.64 kΩ

Note

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

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 ceramic substrate (Al_2O_3) 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 matte 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 Type 1a** (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). 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.

The resistors are RoHS-compliant; the pure matte 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.

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 within the IECQ-CECC Quality Assessment System for Electronic Components to the detail specification **EN 140401-801** which refers to **EN 60115-1**, **EN 60115-8** and the variety of environmental test procedures of the **IEC 60068** (1) series.

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 03-3-1** is granted for the Vishay Beyschlag manufacturing process.

RELATED PRODUCTS

For high power and high temperature applications MCW AT wide terminal thin film chip resistors offer extremely high power ratings in compact 0406 and 0612 case size and extraordinary temperature cycling robustness. Please refer to the datasheets:

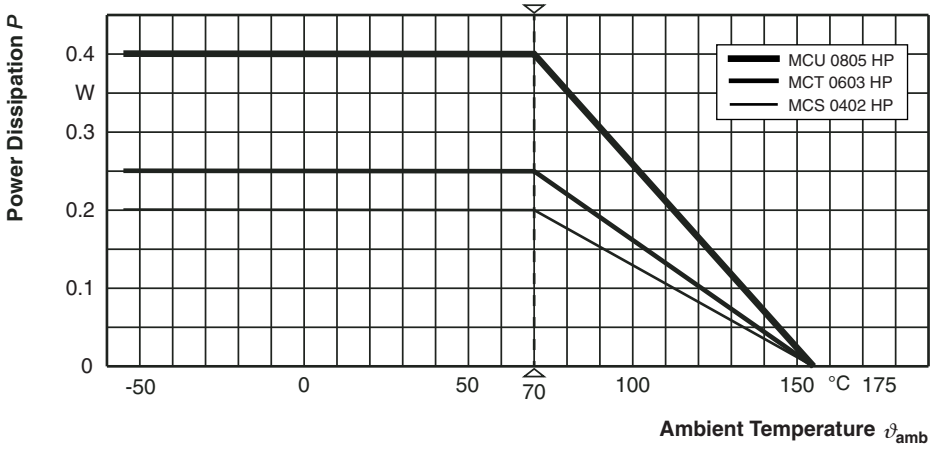
MCW 0406 AT - Precision
(www.vishay.com/doc?28847) and

MCW 0406 AT, MCW 0612 AT - Professional
(www.vishay.com/doc?28796).

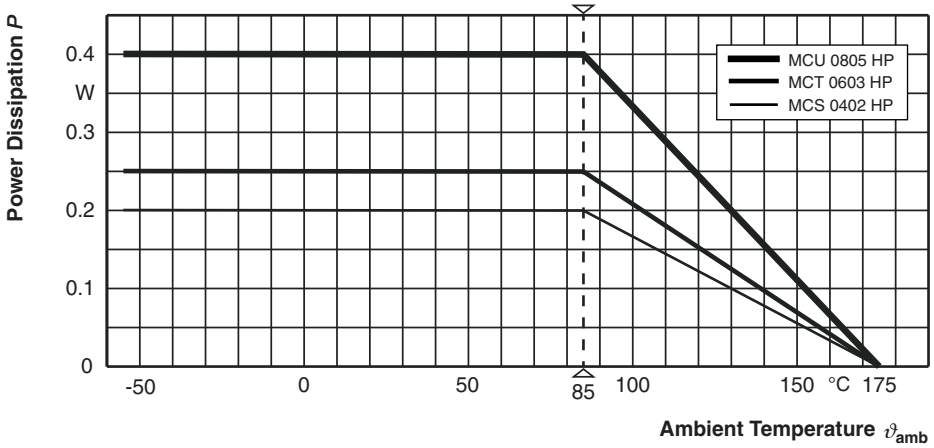
Notes

(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

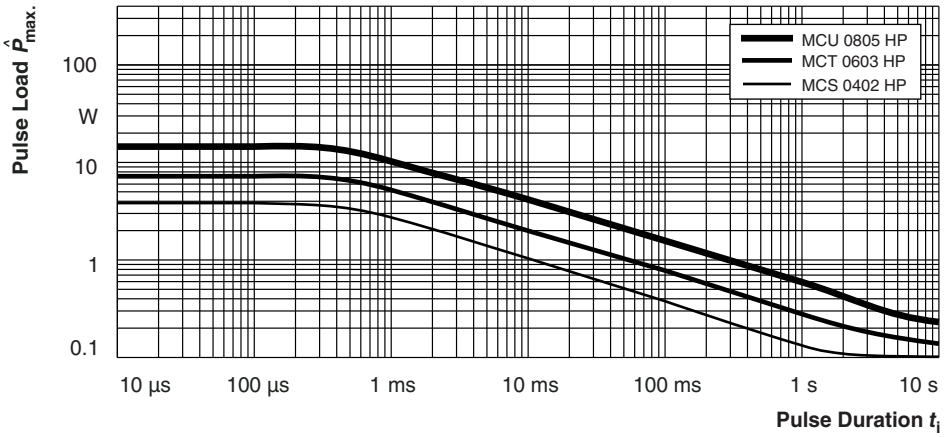
FUNCTIONAL PERFORMANCE



Derating - Power Operation

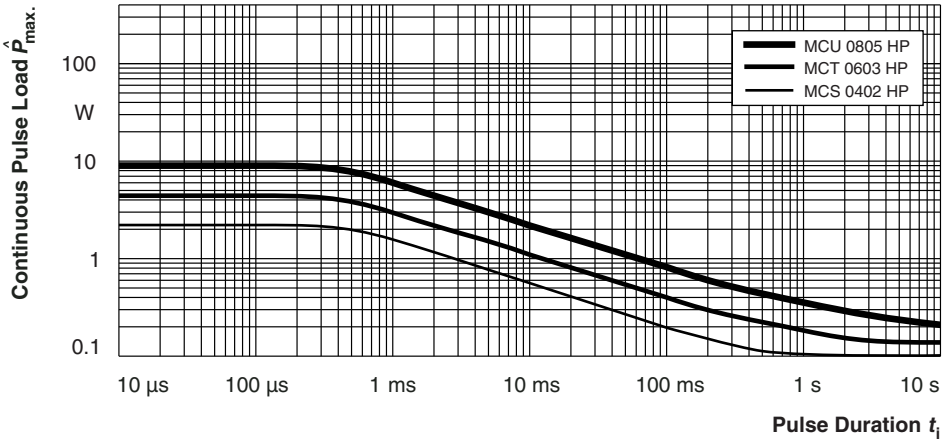


Derating - Advanced Temperature Operation



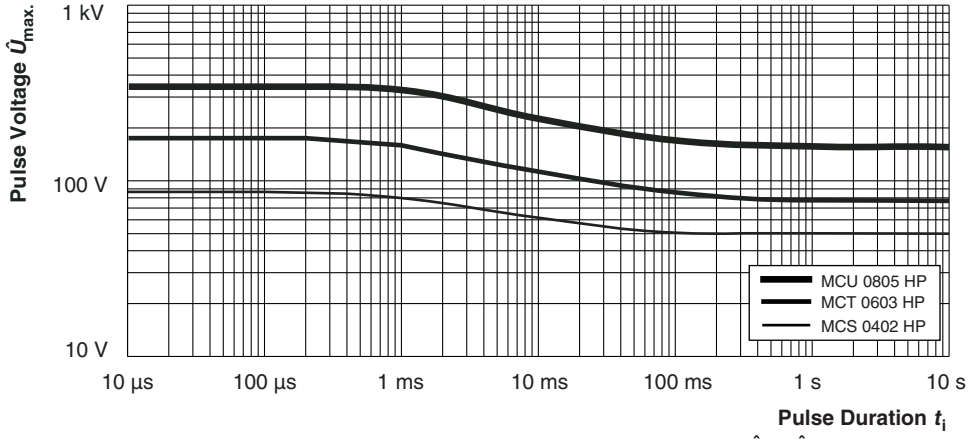
Maximum pulse load, single pulse; applicable if $\overline{P} \rightarrow 0$ and $n \leq 1000$ and $\hat{U} \leq \hat{U}_{max.}$;
for permissible resistance change ± (0.5 % R + 0.05 Ω)

Single Pulse



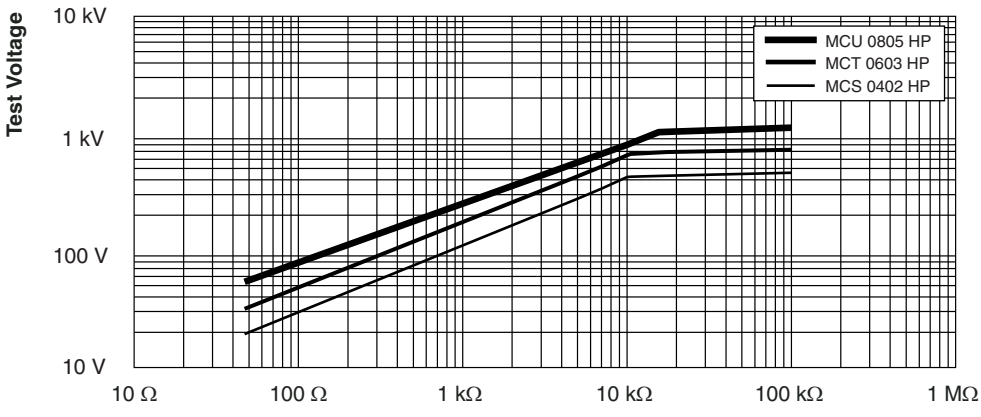
Maximum pulse load, continuous pulses; applicable if $\overline{P} \leq P\ (\vartheta_{amb})$ and $\hat{U} \leq \hat{U}_{max.}$;
for permissible resistance change ± (0.5 % R + 0.05 Ω)

Continuous Pulse



Maximum pulse voltage, single and continuous pulses; applicable if $\hat{P} \leq \hat{P}_{max.}$;
for permissible resistance change ± (0.5 % R + 0.05 Ω)

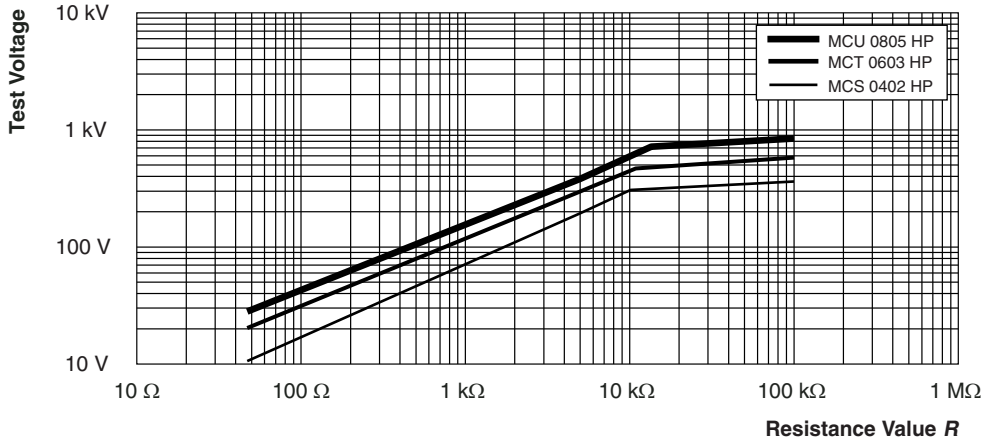
Pulse Voltage



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

FUNCTIONAL PERFORMANCE



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

TESTS AND REQUIREMENTS

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

EN 60115-1, generic specification

EN 60115-8, sectional specification

EN 140401-801, 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 140401-801. 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 (Δ*R*)
			Stability for product types:	
			MCS 0402 HP	47 Ω to 100 kΩ
			MCT 0603 HP	1 Ω to 100 kΩ
			MCU 0805 HP	1 Ω to 100 kΩ
4.5	-	Resistance	-	± 1 % *R*; ± 0.5 % *R*; ± 0.1 % *R*
4.8	-	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: 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	 ± (0.2 % *R* + 0.05 Ω) ± (0.4 % *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	± (0.3 % *R* + 0.05 Ω)

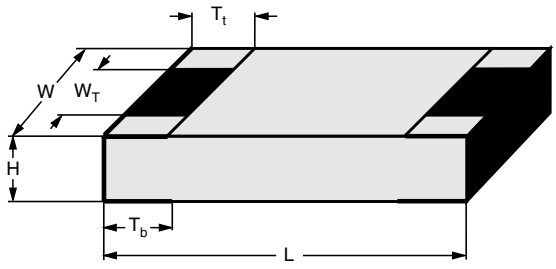
TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	**IEC 60068-2 [1] TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE (ΔR)**
			Stability for product types:	
			MCS 0402 HP	47 Ω to 100 kΩ
			MCT 0603 HP	1 Ω to 100 kΩ
			MCU 0805 HP	1 Ω to 100 kΩ
4.25.3	-	Endurance at upper category temperature	155 °C; 1000 h 175 °C; 1000 h	± (0.2 % R + 0.05 Ω) ± (0.3 % 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)
4.37	67 (Cy)	Damp heat, steady state, accelerated Power 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)
4.19	14 (Na)	Rapid change of temperature	30 min. at -55 °C and 30 min. at 155 °C; 1 000 cycles	± (0.25 % R + 0.05 Ω)
		Extended rapid change of temperature	30 min at -40 °C; 30 min at 125 °C [2]; MCS 0402 HP: 3000 cycles MCT 0603 HP: 2000 cycles MCU 0805 HP: 1500 cycles	± (0.25 % R + 0.05 Ω); (≥ 50 % of initial shear force)
4.13	-	Short time overload; power operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max.}$; whichever is the less severe; 5 s	± (0.25 % R + 0.05 Ω)
4.38	-	Electro static discharge (human body model)	IEC 61340-3-1 [1]; 3 pos. + 3 neg. (equivalent to MIL-STD-883, method 3015) MCS 0402 HP: 500 V MCT 0603 HP: 1000 V MCU 0805 HP: 1500 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 + 0.05 Ω) no visible damage
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	
4.18	58 (Td)	Resistance to soldering heat	Solder bath method; (260 ± 5) °C; (10 ± 1) s	± (0.1 % 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)	RR1005M and RR1608M; 9 N	No visible damage
			RR2012M; 45 N	
4.33	21 (Ue_1)	Substrate bending	Depth 2 mm, 3 times	± (0.1 % R + 0.05 Ω) no visible damage; no open circuit in bent position
4.7	-	Voltage proof	U_{RMS}; MCS 0402 HP: 75 V MCT 0603 HP: 100 V MCU 0805 HP: 200 V (60 ± 5) s	No flashover or breakdown
4.35	-	Flammability	IEC 60695-11-5 [1] needle flame test; 10 s	No burning after 30 s

Notes

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

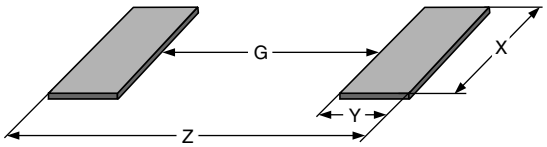
[2] Tested on a 4-layer printed circuit board with SAC micro alloy

DIMENSIONS



DIMENSIONS AND MASS							
TYPE / SIZE	H (mm)	L (mm)	W (mm)	W_T (mm)	T_t (mm)	T_b (mm)	MASS (mg)
MCS 0402 HP	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 HP	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 HP	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

SOLDER PAD DIMENSIONS



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)
MCS 0402 HP	-	-	-	-	0.35	0.55	0.55	1.45
MCT 0603 HP	0.55	1.10	1.10	2.75	0.65	0.70	0.95	2.05
MCU 0805 HP	0.80	1.25	1.50	3.30	0.90	0.90	1.40	2.70

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

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