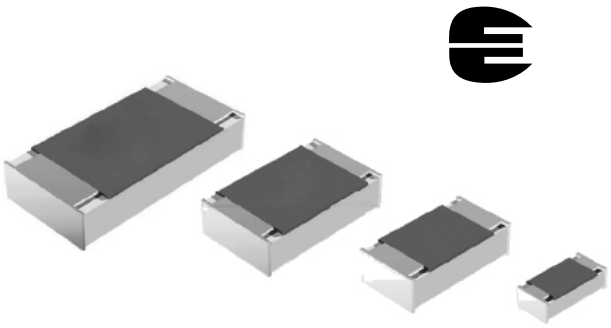
Precision Thin Film Chip Resistors
Superior Moisture Resistivity



FEATURES

- Superior moisture resistivity, $|\Delta R/R| < 0.5$ % (85 °C; 85 % RH; 1000 h)
- Rated dissipation P_{70} up to 0.4 W for size 1206
- AEC-Q200 qualified
- Approved according to EN 140401-801
- Lead (Pb)-free solder contacts
- Compliant to RoHS directive 2002/95/EC

AUTOMOTIVE GRADE

RoHS COMPLIANT

APPLICATIONS

- Automotive
- Telecommunication
- Medical equipment
- Industrial equipment

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

METRIC SIZE				
INCH	0402	0603	0805	1206
METRIC	RR 1005M	RR 1608M	RR 2012M	RR 3216M

TECHNICAL SPECIFICATIONS				
DESCRIPTION	**MCS 0402 AT**	**MCT 0603 AT**	**MCU 0805 AT**	**MCA 1206 AT**
Metric size	RR 1005M	RR 1608M	RR 2012M	RR 3216M
Resistance range	47 Ω to 47 kΩ	47 Ω to 100 kΩ	47 Ω to 100 kΩ	47 Ω to 100 kΩ
Resistance tolerance	± 0.1 %			
Temperature coefficient	± 25 ppm/K; ± 15 ppm/K			
Rated dissipation P_{70} (1)	0.063 W	0.125 W	0.200 W	0.400 W
Operating voltage, $U_{max.}$ AC/DC	50 V	75 V	150 V	200 V
Permissible film temperature (1)	155 °C			
Insulation voltage				
1 min; U_{ins}	75 V	100 V	200 V	300 V
Continuous	75 V	75 V	75 V	75 V

Note

(1) Please refer to APPLICATION INFORMATION next page.

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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. 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}	P_{70}
MCS 0402 AT	0.063 W	0.100 W
MCT 0603 AT	0.100 W	0.125 W
MCU 0805 AT	0.125 W	0.200 W
MCA 1206 AT	0.250 W	0.400 W
Film temperature	125 °C	155 °C
Max. resistance change at rated dissipation for resistance range:		
MCS 0402 AT	47 Ω to 47 kΩ	47 Ω to 47 kΩ
MCT 0603 AT	47 Ω to 100 kΩ	47 Ω to 100 kΩ
MCU 0805 AT	47 Ω to 100 kΩ	47 Ω to 100 kΩ
MCA 1206 AT	47 Ω to 100 kΩ	47 Ω to 100 kΩ
$\lvert\Delta R/R\rvert$ max., after:		
1000 h	≤ 0.1 %	≤ 0.2 %
8000 h	≤ 0.2 %	≤ 0.4 %
225 000 h	≤ 0.6 %	-

PART NUMBER AND PRODUCT DESCRIPTION (1)

Part Number: MCT0603MD4641BPW00

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

MODEL/SIZE	VERSION	TCR	VALUE	TOLERANCE	PACKAGING	SPECIAL
MCS0402 **MCT0603** **MCU0805** **MCA1206**	**M** = AT (Automotive)	**E** = ± 15 ppm/K **D** = ± 25 ppm/K	**3 digit value** **1 digit multiplier** MULTIPLIER **9** = $*10^{-1}$ **0** = $*10^{0}$ **1** = $*10^{1}$ **2** = $*10^{2}$ **3** = $*10^{3}$	**B** = ± 0.1 %	**E1** **E0** **P1** **P5** **PW**	Up to 2 digits **00** = Standard

Product Description: MCT 0603 - 25 0.1 % AT PW 4K64

MCT	0603	- 25	0.1 %	AT	PW	4K64
MODEL	SIZE	TCR	TOLERANCE VALUE	VERSION	PACKAGING	RESISTANCE VALUE
MCS **MCT** **MCU** **MCA**	**0402** **0603** **0805** **1206**	± **15** ppm/K ± **25** ppm/K	± **0.1 %**	**AT** = Automotive	**E1** **E0** **P1** **P5** **PW**	**47K** = 47 kΩ

Note

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

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

DESCRIPTION		RESISTANCE VALUE (2)			
TCR	**TOLERANCE**	**MCS 0402 AT**	**MCT 0603 AT**	**MCU 0805 AT**	**MCA 1206 AT**
± 25 ppm/K	± 0.1 %	47 Ω to 47 kΩ	47 Ω to 100 kΩ	47 Ω to 100 kΩ	47 Ω to 100 kΩ
± 15 ppm/K					

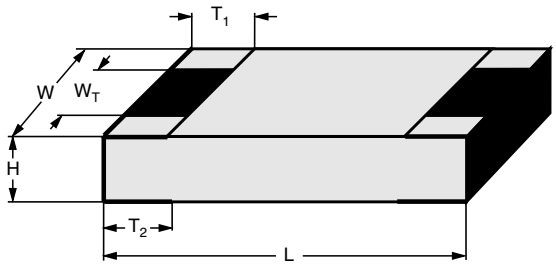
Note

(2) Resistance values to be selected from E96 and E192.

PACKAGING

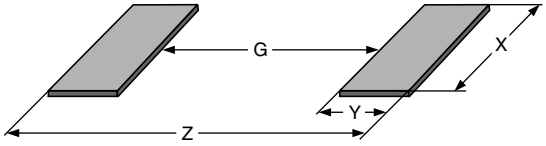
MODEL	REEL	
	PIECES/ PAPER TAPE ON REEL	**CODE**
MCS 0402 AT	1000	E1
	10 000	E0
MCT 0603 AT	1000	P1
	5000	P5
	20 000	PW
MCU 0805 AT	1000	P1
	5000	P5
	20 000	PW
MCA 1206 AT	1000	P1
	5000	P5

DIMENSIONS



DIMENSIONS AND MASS							
TYPE	H (mm)	L (mm)	W (mm)	W_T (mm)	T_1 (mm)	T_2 (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 boardmaterials may be required to maintain the reliability of the assembly. Specified power rating above 125 °C requires dedicated heat-sink pads, which depend on boardmaterials.

  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.

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. Only accepted products are laid directly into the paper tape in accordance with **IEC 60286-3** [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** [3]. 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 **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) and 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)

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** [3] 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. For MCS 0402 AT and products with TCR 15 ppm/K the certification according to DIN EN 140401-801:2008-05 is pending.

Vishay BEYSCHLAG has achieved **"Approval of Manufacturer"** in accordance with **IEC QC 001002-3, clause 2**. The release certificate for **"Technology Approval Schedule"** in accordance with **CECC 240001** based on **IEC QC 001002-3, clause 6** is granted for the Vishay BEYSCHLAG manufacturing process.

The resistors are qualified according to AEC-Q200.

RELATED PRODUCTS

For more information about products with higher operation temperature please refer to the **professional** datasheet document no. **28760**.

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 document no. **28770**.

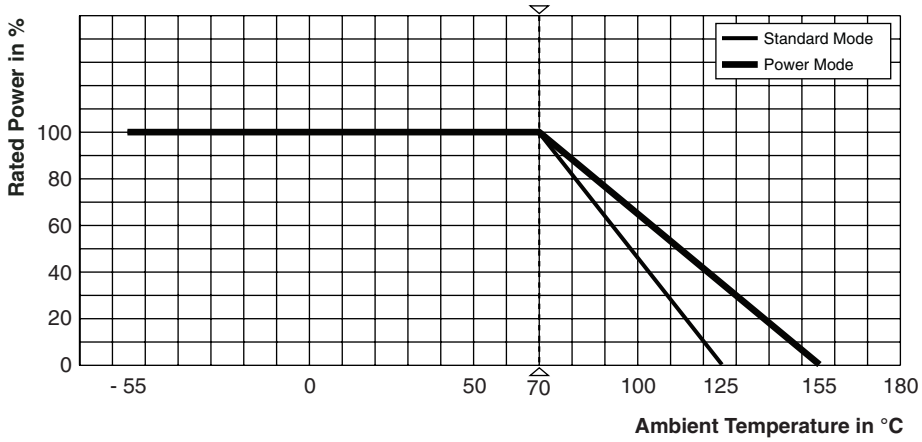
Notes

(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/index.php?id=995 → issues → environment policy → chemicals → chemicals for electronics.

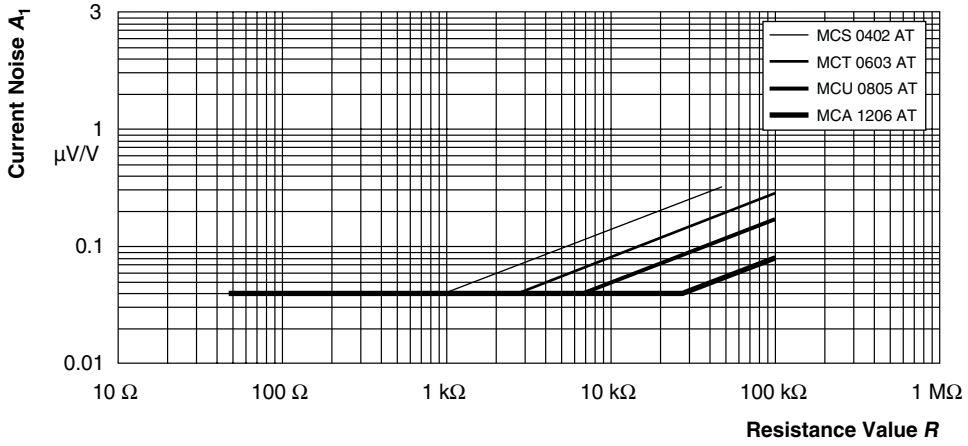
(3) The quoted IEC standards are also released as EN standards with the same number and identical contents.

FUNCTIONAL PERFORMANCE



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

Derating



Current noise A_1 in accordance with IEC 60195

Current Noise

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/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 (LCT = - 55 °C/UCT = 125 °C).

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 0.25 OR BETTER [1]
			Stability for product types:	
			MCS 0402 AT	47 Ω to 47 kΩ
			MCT 0603 AT	47 Ω to 100 kΩ
			MCU 0805 AT	47 Ω to 100 kΩ
			MCA 1206 AT	47 Ω to 100 kΩ
4.5	-	Resistance		± 0.1 % R
4.8.4.2	-	Temperature coefficient	At (20/- 55/20) °C and (20/155/20) °C	± 25 ppm/K; ± 15 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	± (0.1 % R + 0.02 Ω) ± (0.2 % R + 0.02 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	± (0.2 % R + 0.02 Ω) ± (0.4 % R + 0.05 Ω)
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	± (0.15 % R + 0.02 Ω) ± (0.3 % R + 0.02 Ω)
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (0.1 % R + 0.02 Ω)
4.39	67 (Cy)	Damp heat, steady state, accelerated	(85 ± 2) °C (85 ± 5) % RH $U = 0.1 \times \sqrt{P_{70} \times R}$ ≤ 100 V; 1000 h	± (0.5 % R + 0.05 Ω)
4.23		Climatic sequence:		
4.23.2	2 (Ba)	Dry heat	125 °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	± (0.25 % R + 0.02 Ω)
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; 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	± (0.05 % R + 0.01 Ω)
4.19	14 (Na)	Rapid change of temperature	30 min at - 55 °C and 30 min at 125 °C; 1000 cycles	± (0.25 % R + 0.02 Ω)
4.13	-	Short time overload; standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$ ≤ 2 × $U_{max.}$; 5 s	± (0.05 % R + 0.01 Ω)
4.27	-	Single pulse high voltage overload; standard operation mode	Severity no. 4: $U = 10 \times \sqrt{P_{70} \times R}$ ≤ 2 x $U_{max.}$; 10 pulses	± (0.25 % R + 0.05 Ω)

Note

[1] According to the detail specification EN 140401-801 the stability class applies to the category temperatures 85 °C and 125 °C and their respective test conditions.

TEST PROCEDURES AND REQUIREMENTS

EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
				STABILITY CLASS 0.25 OR BETTER (1)
			Stability for product types:	
			MCS 0402 AT	47 Ω to 47 kΩ
			MCT 0603 AT	47 Ω to 100 kΩ
			MCU 0805 AT	47 Ω to 100 kΩ
			MCA 1206 AT	47 Ω to 100 kΩ
4.37	-	Periodic electric overload; standard operation mode	$U = \sqrt{15 \times P_{70} \times R} \leq 2 \times U_{max.}$; 0.1 s on; 2.5 s off; 1000 cycles	± (0.5 % R + 0.05 Ω)
4.40	-	ESD (Electro Static Discharge)	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; 6 h	± (0.05 % 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	± (0.05 % 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)	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	± (0.05 % 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	Needle flame test; 10 s	No burning after 30 s

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