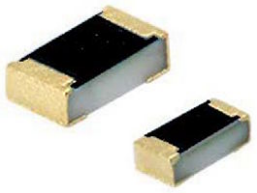
Sulfur Resistant, Gold Terminated Thick Film Chip Resistors for Conductive Gluing



FEATURES

- Gold (Au) terminations for conductive gluing
- Superior resistance against sulfur atmosphere (H_2S), according to ASTM B809-95
- Advanced operating temperature (175 °C, 1000 h)
- AEC-Q200 qualified
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT

HALOGEN FREE

The RCA-AU e4 thick film resistors series are designed for conductive gluing technology. They are the perfect choice for most fields of modern electronics where reliability and stability are of major concern.

Typical applications include automotive as well as industrial systems.

APPLICATIONS

- Automotive
- Industrial
- Hybrid circuits

TECHNICAL SPECIFICATIONS		
DESCRIPTION	**RCA0402-AU e4**	**RCA0603-AU e4**
Imperial size	0402	0603
Metric size code	RR1005M	RR1608M
Resistance range	1 Ω to 10 MΩ; jumper (0 Ω)	
Resistance tolerance	± 5 %; ± 1 %	
Temperature coefficient	± 200 ppm/K; ± 100 ppm/K	
Rated dissipation, P_{70} (1)	0.1 W	0.15 W
Operating voltage, $U_{max.}$ AC_{RMS}/DC	50 V	75 V
Permissible film temperature, $\vartheta_{F\ max.}$ (1)	175 °C	
Operating temperature range	-55 °C to +175 °C	
Permissible voltage against ambient (insulation): 1 min, U_{ins}	75 V	100 V

Notes

- An appropriate thermal resistance R_{th} has to be realized by adequate gluing connection and board material.

(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.

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MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION

OPERATION MODE		STANDARD	POWER	ADVANCED TEMPERATURE
		P_{70}	P_{70}	P_{85}
Rated dissipation, P_{70}	RCA0402-AU e4	0.063 W	0.1 W	0.1 W
	RCA0603-AU e4	0.1 W	0.125 W	0.15 W
Permissible film temperature, ϑ_F max.		125 °C	155 °C	175 °C
Max. resistance change at P_{70} for resistance range, $\lvert\Delta R/R\rvert$ after:	RCA-AU e4	1 Ω to 10 MΩ		
	1000 h	≤ 0.5 %	≤ 1.0 %	≤ 2.0 %
	8000 h	≤ 1.0 %	≤ 2.0 %	-

Notes

- 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.
- An appropriate thermal resistance R_{th} has to be realized by adequate gluing connection and board material.

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

TYPE / SIZE	TCR	TOLERANCE	RESISTANCE	E-SERIES
RCA0402-AU e4	± 200 ppm/K	± 5 %	1 Ω to 10 MΩ	E24
	± 100 ppm/K	± 1 %	1 Ω to 10 MΩ	E24; E96
	Jumper, $I_{max.}$ = 2.0 A	≤ 25 mΩ	0 Ω	-
RCA0603-AU e4	± 200 ppm/K	± 5 %	1 Ω to 10 MΩ	E24
	± 100 ppm/K	± 1 %	1 Ω to 10 MΩ	E24; E96
	Jumper, $I_{max.}$ = 2.4 A	≤ 25 mΩ	0 Ω	-

Note

- The temperature coefficient of resistance (TCR) is not specified for 0 Ω jumpers.

PACKAGING

TYPE / SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
RCA0402-AU e4	ED = ET7	10 000	Paper tape acc. to IEC 60286-3, Type 1a	8 mm	2 mm	Ø 180 mm/7"
	EE = EF4	50 000				Ø 330 mm/13"
RCA0603-AU e4	EI = ET2	5000			2 mm	Ø 180 mm/7"
	ED = ET3	10 000				Ø 180 mm/7"
	EL = ET4	20 000				Ø 285 mm/11.25"
	EE = ET8	50 000				Ø 330 mm/13"
	EA = ET1	5000			4 mm	Ø 180 mm/7"
	EB = ET5	10 000				Ø 285 mm/11.25"
	EC = ET6	20 000				Ø 330 mm/13"

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: RCA060318R0FKECAU
Part Number: RCA06030000Z0ECAU

R	C	A	0	6	0	3	1	8	R	0	F	K	E	C	A	U	

TYPE / SIZE	RESISTANCE	TOLERANCE	TCR	PACKAGING	SPECIAL
RCA0402 **RCA0603**	**R** = Decimal **K** = Thousand **M** = Million **0000** = jumper	**F** = ± 1.0 % **J** = ± 5.0 % **Z** = jumper	**K** = ± 100 ppm/K **N** = ± 200 ppm/K **0** = jumper	**EA, EB,** **EC, ED,** **EE, EI,** **EL**	Up to 3 digits **AU** = gold terminations

Product Description: RCA0603-AU 100 18R 1 % ET6 e4
Product Description: RCA0603-AU 0R0 ET6 e4

RCA0603-AU	100	18R	1 %	ET6	e4
TYPE / SIZE	TCR	RESISTANCE	TOLERANCE	PACKAGING	LEAD (Pb)-FREE
RCA0402-AU RCA0603-AU	**± 100** ppm/K **± 200** ppm/K	**1R** = 1 Ω **1K** = 1 kΩ **10K** = 10 kΩ **1M0** = 1 MΩ **0R0** = jumper	**± 1.0 %** **± 5.0 %**	**ET1, ET2,** **ET3, ET4,** **ET5, ET6,** **ET7, ET8,** **EF4**	**e4** = gold termination finish

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DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A cermet film layer and a glass-over are deposited on a high grade (Al_2O_3) ceramic substrate. Specially designed inner contacts, are deposited on both sides. A special laser is used to achieve the target value by smoothly fine trimming the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final gold (Au) layer appropriate for conductive gluing.

The result of the determined production is verified by an extensive testing procedure on 100 % of the individual chip resistors. Only accepted products are laid directly into the 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 conductive gluing technology. 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.

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

The resistors are qualified according to AEC-Q200.

Where applicable, the resistors are tested in accordance with **EN 140401-802** which refers to **EN 60115-1**, **EN 60115-8** and the variety of environmental test procedures of the **IEC 60068** (1) series.

RELATED PRODUCTS

The RCA e3 “Automotive, Sulfur Resistant Lead (Pb)-Free Thick Film, Rectangular Chip Resistors” is designed for those applications, where solderable terminations are mandatory.

For ordering RCA e3 please refer to latest edition of the datasheet: www.vishay.com/doc?20037.

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.

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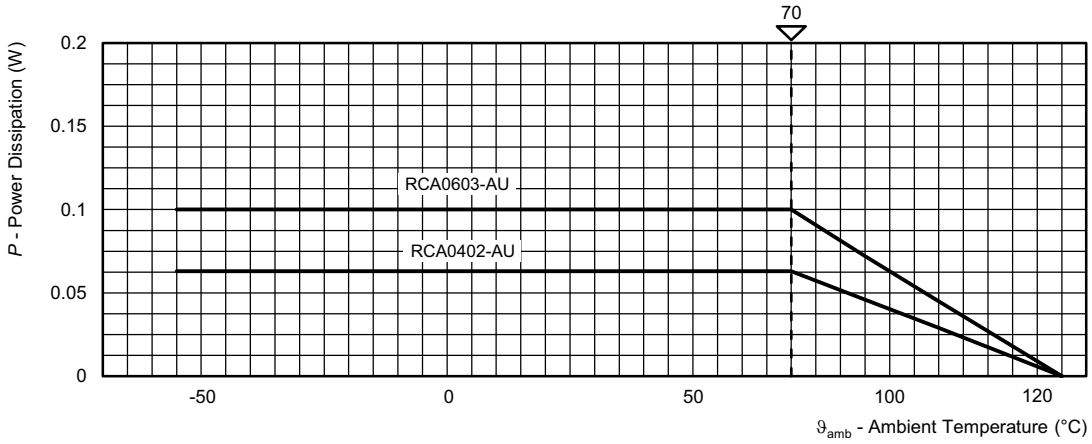
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FUNCTIONAL PERFORMANCE

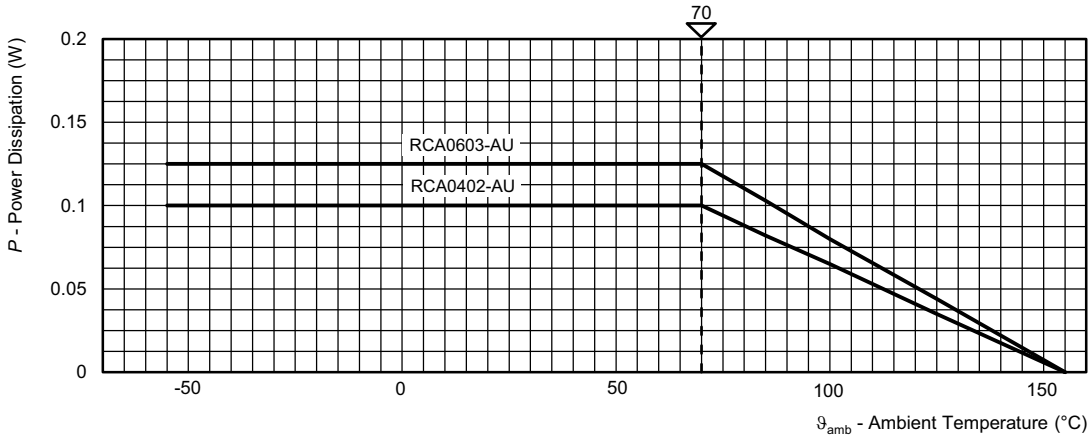
PERFORMANCE IN SULFUR - CONTAINING AMBIANCE		
TEST NAME	**HUMID SULFUR VAPOR TEST**	**HUMID SULFUR VAPOR TEST (ACCELERATED)**
Reference specification	ASTM B809-95	ASTM B809-95 (accelerated conditions)
Test conditions (temperature, humidity)	60 °C ± 2 °C 85 % ± 4 % RH	90 °C ± 2 °C 74 % ± 7 % RH
Aggressive agent	Sulfur (saturated vapor)	Sulfur (saturated vapor)
Failure criteria in VI under magnification	No silver sulfide grow at the interface between termination and protective overcoat. No signs of mechanical damage.	No silver sulfide grow at the interface between termination and protective overcoat. No signs of mechanical damage.
Failure criteria in electrical test	$\Delta R \leq (1\ \%\ R + 0.05\ \Omega)$	$\Delta R \leq (1\ \%\ R + 0.05\ \Omega)$
Time before failure	8000 h	1000 h

DERATING

Standard Operation Mode



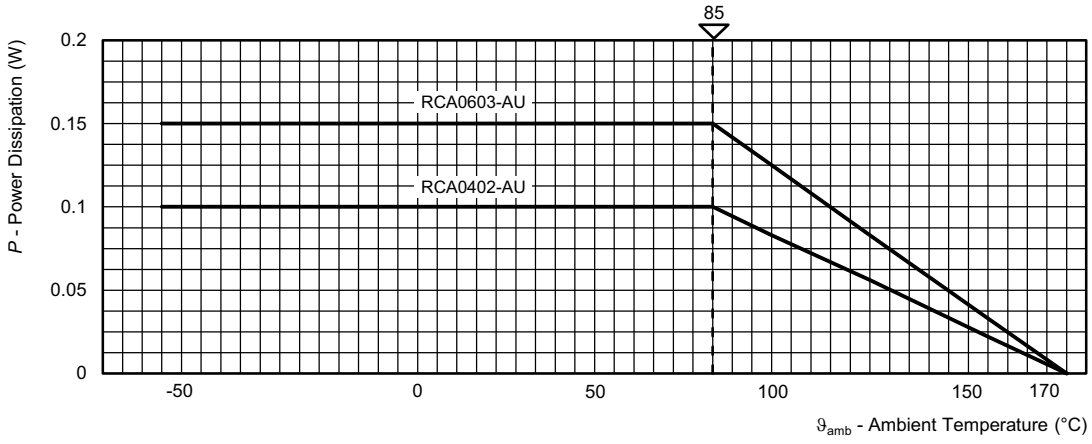
Power Operation Mode



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DERATING

Advanced Temperature Operation Mode



TESTS AND REQUIREMENTS

All executed 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 140401-802, 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 140401-802. 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/IS-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).

TEST PROCEDURES AND REQUIREMENTS

EN 60115-1 CLAUSE	IEC 60082-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (Δ*R*)	
				STABILITY CLASS 1 OR BETTER	STABILITY CLASS 2 OR BETTER
			Stability for product types: RCA-AU e4	1 Ω to 10 MΩ	
4.5	-	Resistance	-	± 1 %	± 5 %
4.8	-	Temperature coefficient	(20 / -55 / 20) °C and (20 / 155 / 20) °C	± 100 ppm/K	± 200 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	 ± (0.5 % *R* + 0.05 Ω) ± (1 % *R* + 0.1 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	 ± (1 % *R* + 0.05 Ω) ± (2 % *R* + 0.1 Ω)	

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TEST PROCEDURES AND REQUIREMENTS

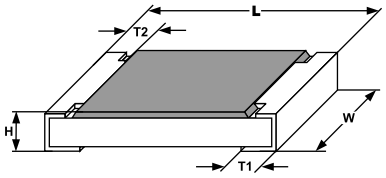
EN 60115-1 CLAUSE	IEC 60082-2 [1] TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)	
				STABILITY CLASS 1 OR BETTER	STABILITY CLASS 2 OR BETTER
			Stability for product types:	1 Ω to 10 MΩ	
			RCA-AU e4		
4.25.1	-	Endurance at 85 °C: advanced temperature operation mode	$U = \sqrt{P_{85} \times R}$ or $U = U_{max.}$ whichever is the less severe; 1.5 h on; 0.5 h off 85 °C; 1000 h	± (2 % R + 0.05 Ω)	
4.25.3	-	Endurance at upper category temperature	155 °C; 1000 h 175 °C; 1000 h	± (1 % R + 0.05 Ω) ± (2 % R + 0.1 Ω)	
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (1 % R + 0.05 Ω)	± (2 % R + 0.1 Ω)
4.37	67 (Cy)	Damp heat, steady state, accelerated power operation mode	(85 ± 2) °C; (85 ± 5) % RH $U = 0.1 \times \sqrt{P_{70} \times R} \leq 100$ V; 1000 h	± (2 % R + 0.1 Ω)	
4.23	-	Climatic sequence:			
4.23.2	2 (Bb)	Dry heat	125 °C; 16 h	± (1 % R + 0.05 Ω)	± (2 % R + 0.1 Ω)
4.23.3	30 (Db)	Damp	55 °C; 24 h; ≥ 90 % RH; 1 cycle		
4.23.4	1 (Ab)	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)	Cold	-55 °C; 2 h	± (0.25 % R + 0.05 Ω)	± (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; 1000 cycles	± (1 % R + 0.05 Ω) no visible damage	
4.13	-	Short time overload	$U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max.}$; whichever is the less severe; 5 s; power operation mode	± (2 % R + 0.05 Ω)	
4.27	-	Single pulse high voltage overload power 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	± (2 % R + 0.1 Ω) no visible damage	
4.39	-	Periodic electric overload power operation mode	$U = \sqrt{15 \times P_{70} \times R} \leq 2 \times U_{max.}$; whichever is the less severe; 0.1 s on; 2.5 s off; 1000 cycles	± (2 % R + 0.05 Ω) no visible damage	
4.40	-	Electrostatic discharge (human body model)	IEC 61340-3-1 [1]; 3 pos. + 3 neg. discharges RCA0402-AU e4: 300 V RCA0603-AU e4: 500 V	± (1 % 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	± (0.25 % R + 0.05 Ω) no visible damage	± (0.5 % 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 (Uu_3)	Shear (adhesion)	RCA0402-AU e4 and RCA0603-AU e4: 9 N	No visible damage	
4.33	21 (Uu_1)	Substrate bending	Depth 2 mm; 3 times	± (1 % R + 0.05 Ω) no visible damage, no open circuit in bent position	
4.7	-	Voltage proof	$U = 1.4 \times U_{ins}$; 60 s	No flashover or breakdown	
4.35	-	Flammability, needle flame test	IEC 60695-11-5 [1]; 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.

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DIMENSIONS



DIMENSIONS AND MASS						
TYPE / SIZE	L (mm)	W (mm)	H (mm)	T1 (mm)	T2 (mm)	MASS (mg)
RCA0402-AU e4	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.25 ± 0.1	0.2 ± 0.1	0.65
RCA0603-AU e4	1.55 + 0.10 / - 0.05	0.85 ± 0.10	0.45 ± 0.05	0.3 ± 0.20	0.3 ± 0.2	2

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