Low Ohmic Wide Terminal Thin Film Chip Resistors

NCW AT low ohmic resistors are the perfect choice for most fields of modern professional power measurement electronics where reliability, stability, power dissipation and robust design is of major concern. The product features extraordinary temperature cycling robustness, verified through extensive testing. The permissible power rating is specified with up to 1 W for size 0612. Typical applications include power electronics in automotive and industrial appliances (e.g. burden resistors).

FEATURES

- Resistance range down to 0.1 Ω
- Low TCR of ± 50 ppm/K
- Excellent overall stability
- Rated power dissipation P_{85} up to 1 W for size 0612
- Advanced sulfur resistance verified according to ASTM B 809
- Superior moisture resistivity (85 °C; 85 % RH)
- AEC-Q200 qualified
- Superior temperature cycling robustness
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT

APPLICATIONS

- Automotive
- Industrial
- High power and high temperature applications

TECHNICAL SPECIFICATIONS		
DESCRIPTION	**NCW 0406 AT**	**NCW 0612 AT**
Imperial size	0406	0612
Metric size code	RR1016M	RR1632M
Resistance range	0.33 Ω to 0.91 Ω	0.10 Ω to 0.91 Ω
Resistance tolerance	± 1 %	
Temperature coefficient	± 50 ppm/K	
Rated dissipation P_{85} (1)	0.3 W	1 W
Operating voltage, $U_{max.}$ AC_{RMS}/DC	Limited by P_{85}	
Permissible film temperature, $\vartheta_{F\ max.}$ (1)	175 °C	
Operating temperature range	-55 °C to 175 °C	
Internal thermal resistance (1)	30 K/W	TBD
Permissible voltage against ambient (insulation): 1 min; U_{ins}	75 V	

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.

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.

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		STANDARD	POWER	ADVANCED TEMPERATURE
Rated dissipation		P_{70}	P_{70}	P_{85}
	NCW 0406 AT	0.2 W	0.25 W	0.3 W
	NCW 0612 AT	0.5 W	0.75 W	1.0 W [(1)]
Operating temperature range		-55 °C to 125 °C	-55 °C to 155 °C	-55 °C to 175 °C
Permissible film temperature, $\vartheta_{F\ max.}$		125 °C	155 °C	175 °C
Max. resistance change at P_{70} for resistance range, $\lvert \Delta R/R \rvert$ after:	NCW 0406 AT	0.33 Ω to 0.91 Ω	0.33 Ω to 0.91 Ω	0.33 Ω to 0.91 Ω
	NCW 0612 AT	0.10 Ω to 0.91 Ω	0.10 Ω to 0.91 Ω	0.10 Ω to 0.91 Ω
	1000 h	≤ 0.15 %	≤ 0.3 %	≤ 0.5 %
	8000 h	≤ 0.25 %	≤ 0.5 %	-
	225 000 h	≤ 1.0 %	-	-

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. 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

(1) Specified power rating requires a thermal resistance R_{th} ≤ 90 K/W of the circuit board assembly

The resistance value of low ohmic precision resistors is influenced by the resistance of the terminations. The exact resistance value of the soldered part on the PCB may deviate depending on e.g. solder quantity, pad layout, and soldering method. The resistance value of the unmounted part can be verified by a 4-point probe on the top side termination as shown below.

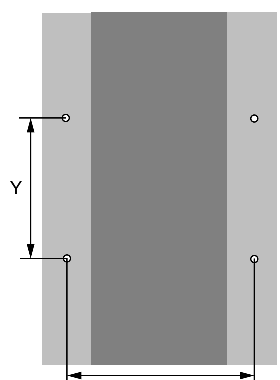


Fig. 1

DIMENSIONS FOR 4-POINT PROBE		
TYPE / SIZE	X (µm)	Y (µm)
NCW 0406 AT	870	600
NCW 0612 AT	1300	1240

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

TYPE / SIZE	TCR	TOLERANCE	RESISTANCE	E-SERIES
NCW 0406 AT	± 50 ppm/K	± 1 %	0.33 Ω to 0.91 Ω	E24
NCW 0612 AT	± 50 ppm/K	± 1 %	0.10 Ω to 0.91 Ω	E24; E96

PACKAGING

TYPE / SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
NCW 0406 AT	P5	5000	Tape and reel cardboard tape acc. IEC 60286-3, type 1a	8 mm	4 mm	Ø 180 mm / 7"
	PW	20 000				Ø 330 mm / 13"
NCW 0612 AT	P5	5000				Ø 180 mm / 7"

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: NCW0406MC3307FP500

N	C	W	0	4	0	6	M	C	3	3	0	7	F	P	5	0	0

TYPE / SIZE	VERSION	TCR	RESISTANCE	TOLERANCE	PACKAGING
NCW0406 **NCW0612**	**M** = AT automotive	**C** = ± 50 ppm/K	3 digit value 1 digit multiplier **Multiplier** **7** = $*10^{-3}$	**F** = ± 1 %	**P5** **PW**

Product Description: NCW 0406-50 1 % AT P5 0R33

NCW	0406	-50	1 %	AT	P5	0R33

TYPE	SIZE	TCR	TOLERANCE	VERSION	PACKAGING	RESISTANCE
NCW	**0406** **0612**	± **50** ppm/K	± **1** %	**AT** = automotive	**P5** **PW**	**0R33** = 0.33 Ω

Note

- Products can be ordered using either the PART NUMBER or 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. 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 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 by 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 detail specification refers to the climatic category 55/125/56, which relates to the "standard operation mode" of this datasheet. The NCW 0406 AT is AEC-Q200 qualified.

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

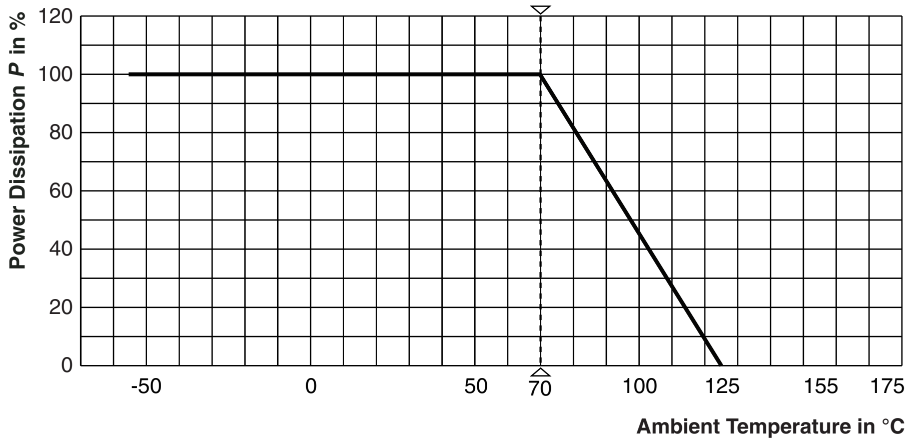
For more information about wide terminal precision resistors with higher resistance values please refer to the following datasheets:

- MCW AT Precision (www.vishay.com/doc?28847)
- MCW AT Professional (www.vishay.com/doc?28796)

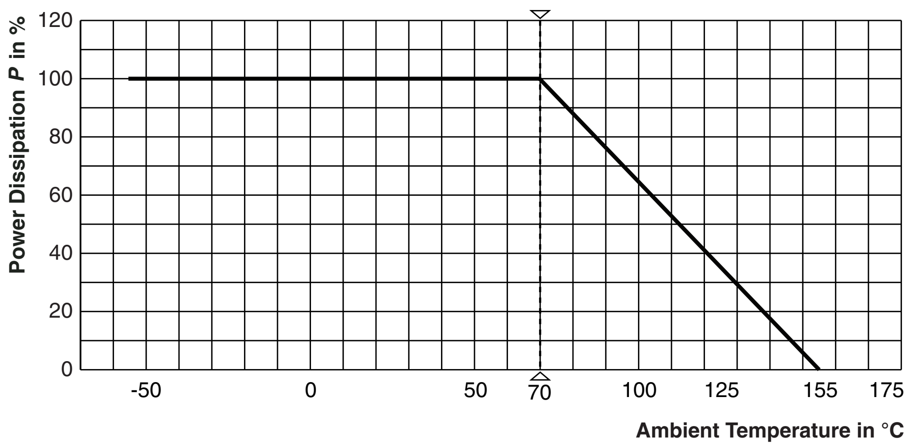
Notes

(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

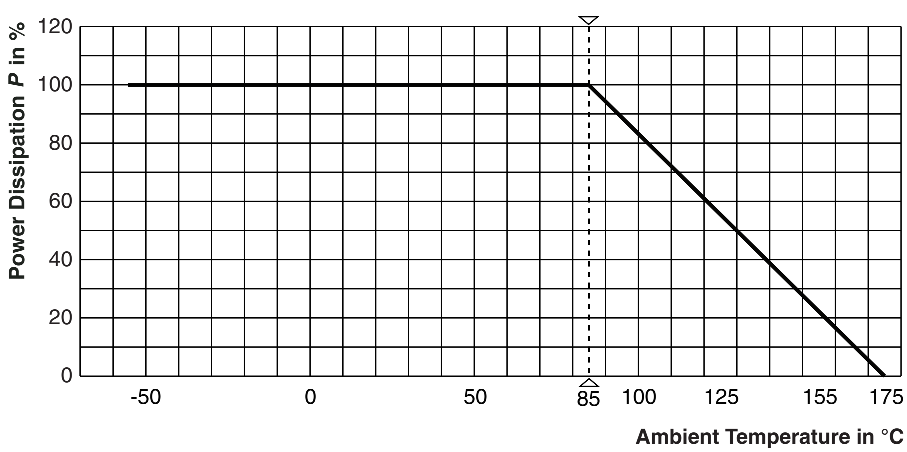
FUNCTIONAL PERFORMANCE



Derating - Standard Mode



Derating - Power Mode



Derating - Advanced Temperature Mode

TESTS AND REQUIREMENTS

All 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 140401-801, 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 (ΔR)
			Stability for product types:	
			NCW 0406 AT	0.33 Ω to 0.91 Ω
			NCW 0612 AT	0.10 Ω to 0.91 Ω
4.5	-	Resistance	-	± 1 % *R*
4.8	-	Temperature coefficient	At (20 / -55 / 20) °C and (20 / 155 / 20) °C	± 50 ppm/K
4.25.1	-	Endurance at 70 °C: Standard operation mode	$U = \sqrt{P_{70} \times R}$; 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	$U = \sqrt{P_{70} \times R}$; 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	$U = \sqrt{P_{85} \times R}$; 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* + 0.02 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)
4.37	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)

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 [1] TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			Stability for product types:	
			NCW 0406 AT	0.33 Ω to 0.91 Ω
			NCW 0612 AT	0.10 Ω to 0.91 Ω
4.23		Climatic sequence: Standard operation mode:		± (0.5 % R + 0.05 Ω)
4.23.2	2 (Bb)	Dry heat	UCT; 16 h	
4.23.3	30 (Db)	Damp heat, cyclic	55 °C; 24 h; ≥ 90 % RH; 1 cycle	
4.23.4	1 (Ab)	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; 24 h ≥ 90 % RH; 5 cycles	
4.23.7	-	DC load	$U = \sqrt{P_{70} \times R} \leq U_{max.}$; 1 min; LCT = -55 °C; UCT = 125 °C	
-	1 (Ab)	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; 30 min at 155 °C; 1000 cycles	± (0.25 % R + 0.05 Ω)
		Extended rapid change of temperature	30 min at -40 °C; 30 min at 125 °C; NCW 0406 AT: 3000 cycles [2] NCW 0612 AT: TBD	± (0.25 % R + 0.05 Ω); (≥ 50 % of initial shear force)
4.13	-	Short time overload: Standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R} \leq 2 \times U_{max.}$; 5 s	± (0.1 % R + 0.01 Ω)
		Short time overload: Power operation mode		± (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) 500 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	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	58 (Td)	Resistance to soldering heat	Solder bath method; (260 ± 5) °C; (10 ± 1) s	± (0.1 % R + 0.02 Ω) no visible damage

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:	
			NCW 0406 AT	0.33 Ω to 0.91 Ω
			NCW 0612 AT	0.10 Ω to 0.91 Ω
4.29	45 (XA)	Component solvent resistance	Isopropyl alcohol +50 °C; method 2	No visible damage
4.32	21 (Ue_3)	Shear (adhesion)	9 N	No visible damage
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	Needle flame test; 10 s	No burning after 30 s

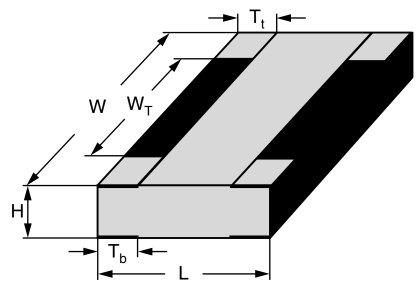
Notes

- Resistance measured in mounted condition

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

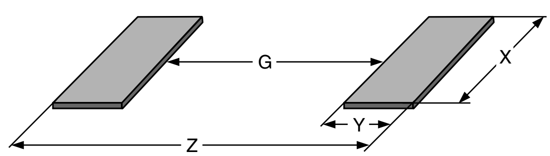
(2) Tested on a 4-layer printed circuit board with SAC micro alloy

DIMENSIONS



DIMENSIONS AND MASS							
TYPE / SIZE	H (mm)	L (mm)	W (mm)	W_T (mm)	T_t (mm)	T_b (mm)	MASS (mg)
NCW 0406 AT	0.32 ± 0.05	1.0 ± 0.15	1.5 ± 0.15	> 75 % of W	0.2 + 0.1/- 0.15	0.2 ± 0.1	1.9
NCW 0612 AT	0.45 ± 0.15	1.6 ± 0.15	3.1 ± 0.15	> 75 % of W	0.25 ± 0.15	0.3 ± 0.15	9.0

SOLDER PAD DIMENSIONS



RECOMMENDED SOLDER PAD DIMENSIONS				
TYPE / SIZE	REFLOW SOLDERING			
	G (mm)	Y (mm)	X (mm)	Z (mm)
NCW 0406 AT	0.35	0.55	1.75	1.45
NCW 0612 AT	0.75	0.7	3.3	2.15

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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