

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 are current measurements in power electronics within automotive and industrial appliances.

FEATURES

- Resistance range down to 0.1 Ω
- Low TCR of ± 50 ppm/K and ± 25 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 | ± 50 ppm/K; ± 25 ppm/K ⁽²⁾ |
| 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 | |

Notes

⁽¹⁾ Please refer to APPLICATION INFORMATION below

⁽²⁾ On request

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, $ \Delta R/R $ 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 | $\leq 0.05 \%$ | $\leq 0.1 \%$ | $\leq 0.5 \%$ |
| | 8000 h | $\leq 0.1 \%$ | $\leq 0.2 \%$ | - |
| | 225 000 h | $\leq 1.0 \%$ | - | - |

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 $R_{th} \leq 90$ 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.

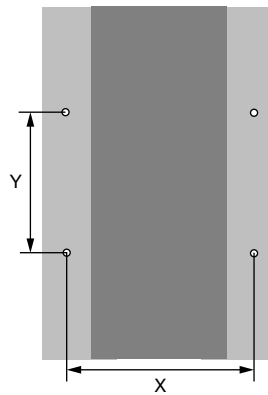


Fig. 1

| 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 |
| | ± 25 ppm/K ⁽¹⁾ | ± 1 % | 0.10 Ω to 0.91 Ω | E24; E96 |

Note

(1) On request

| 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 D = ± 25 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 ± 25 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

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>

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 AT series 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.

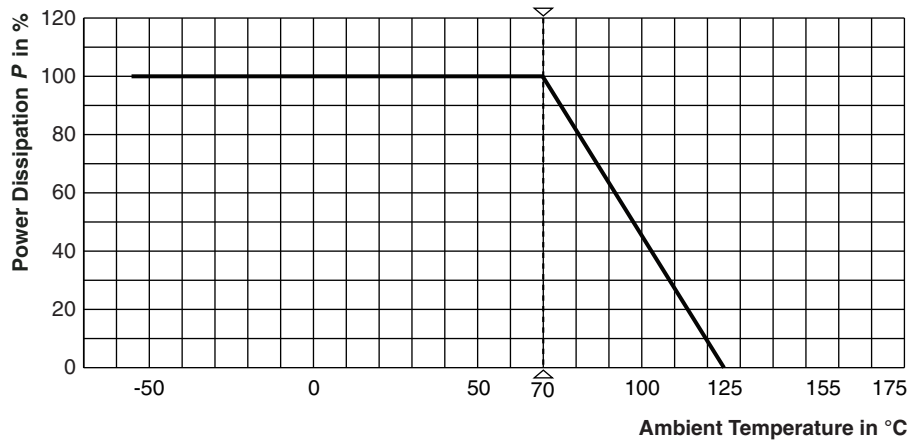
RELATED PRODUCTS

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

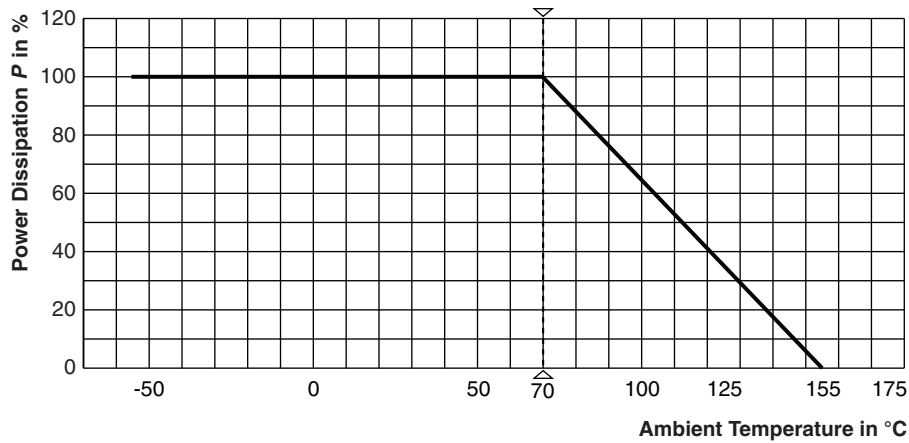
- MCW AT Precision (www.vishay.com/doc?28847)
- MCW AT Professional (www.vishay.com/doc?28796)



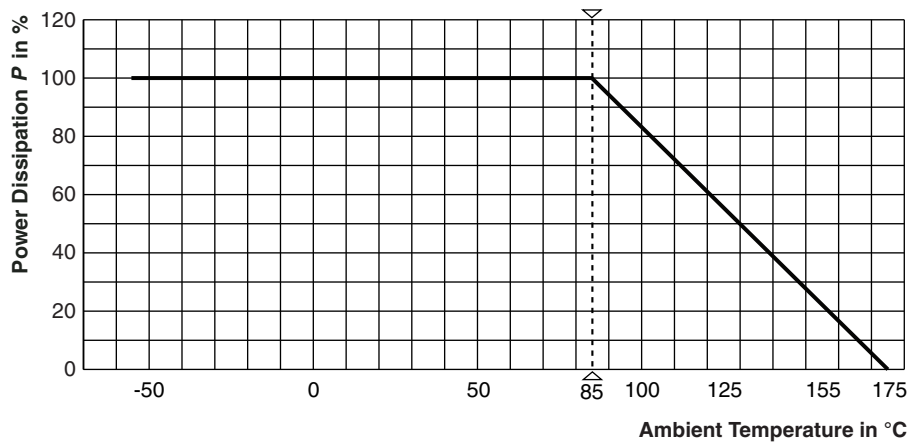
FUNCTIONAL PERFORMANCE



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, 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.

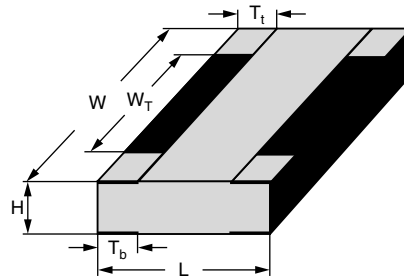
| TEST PROCEDURES AND REQUIREMENTS | | | | |
|----------------------------------|-----------------------------|---|---|---|
| EN 60115-1 CLAUSE | IEC 60068-2 (1) TEST METHOD | TEST | PROCEDURE | REQUIREMENTS PERMISSIBLE CHANGE (ΔR) |
| | | | Stability for product types: | |
| | | | NCW 0406 AT | 0.33 Ω to 0.91 Ω |
| | | | NCW 0612 AT | 0.10 Ω to 0.91 Ω |
| 4.5 | - | Resistance | - | $\pm 1 \% R$ |
| 4.8 | - | Temperature coefficient | At (20 / -55 / 20) °C and (20 / 155 / 20) °C | ± 50 ppm/K; ± 25 ppm/K (2) |
| 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 | $\pm (0.05 \% R + 0.005 \Omega)$ $\pm (0.10 \% R + 0.005 \Omega)$ |
| | | 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 | $\pm (0.10 \% R + 0.005 \Omega)$ $\pm (0.20 \% R + 0.005 \Omega)$ |
| | | 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 | $\pm (0.50 \% R + 0.005 \Omega)$ |
| 4.25.3 | - | Endurance at upper category temperature | 125 °C; 1000 h 155 °C; 1000 h 175 °C; 1000 h | $\pm (0.05 \% R + 0.0005 \Omega)$ $\pm (0.10 \% R + 0.0005 \Omega)$ $\pm (0.50 \% R + 0.0005 \Omega)$ |
| 4.24 | 78 (Cab) | Damp heat, steady state | (40 \pm 2) °C; 56 days; (93 \pm 3) % RH | $\pm (0.10 \% R + 0.0005 \Omega)$ |
| 4.37 | 67 (Cy) | Damp heat, steady state, accelerated: Standard operation mode | (85 \pm 2) °C (85 \pm 5) % RH $U = \sqrt{0.1 \times P_{70} \times R}$; $U \leq 0.3 \times U_{max}$; 1000 h | NCW 0406 AT: $\pm (0.25 \% R + 0.05 \Omega)$ NCW 0612 AT: $\pm (0.25 \% R + 0.0005 \Omega)$ |
| - | 1 (Ab) | Storage at low temperature | -55 °C; 2 h | $\pm (0.05 \% R + 0.01 \Omega)$ |



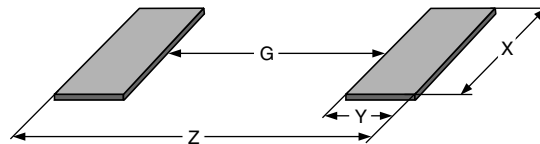
| TEST PROCEDURES AND REQUIREMENTS | | | | |
|----------------------------------|-----------------------------|---|--|---|
| EN 60115-1 CLAUSE | IEC 60068-2 (1) TEST METHOD | TEST | PROCEDURE | REQUIREMENTS PERMISSIBLE CHANGE (ΔR) |
| | | | Stability for product types: | |
| | | | NCW 0406 AT | 0.33 Ω to 0.91 Ω |
| | | | NCW 0612 AT | 0.10 Ω to 0.91 Ω |
| 4.19 | 14 (Na) | Rapid change of temperature | 30 min at -55 °C; 30 min at 155 °C; 1000 cycles | $\pm (0.10 \% R + 0.005 \Omega)$ |
| | | Extended rapid change of temperature | 30 min at -40 °C; 30 min at 125 °C; NCW 0406 AT: 3000 cycles (3) NCW 0612 AT: TBD | $\pm (0.25 \% R + 0.05 \Omega)$; ($\geq 50 \%$ of initial shear force) |
| 4.13 | - | Short time overload: Standard operation mode | $U = 2.5 \times \sqrt{P_{70} \times R}$ $\leq 2 \times U_{max}; 5 \text{ s}$ | $\pm (0.05 \% R + 0.01 \Omega)$ |
| | | Short time overload: Power operation mode | | $\pm (0.10 \% R + 0.05 \Omega)$ |
| 4.38 | - | Electro Static Discharge (Human Body Model) | IEC 61340-3-1 (1); 3 pos. + 3 neg. (equivalent to MIL-STD-883, method 3015) NCW 0406 AT: 500 V NCW 0612 AT: 1000 V | $\pm (0.50 \% R + 0.0005 \Omega)$ |
| 4.22 | 6 (Fc) | Vibration | Endurance by sweeping; 10 Hz to 2000 Hz; no resonance; amplitude $\leq 1.5 \text{ mm}$ or $\leq 200 \text{ m/s}^2$; 7.5 h | $\pm (0.05 \% R + 0.0005 \Omega)$ no visible damage |
| 4.17 | 58 (Td) | Solderability | Solder bath method; SnPb40; non-activated flux (215 \pm 3) °C; (3 \pm 0.3) s | Good tinning ($\geq 95 \%$ covered); no visible damage |
| | | | Solder bath method; SnAg3Cu0.5 or SnAg3.5; non-activated flux; (235 \pm 3) °C; (2 \pm 0.2) s | Good tinning ($\geq 95 \%$ covered); no visible damage |
| 4.18 | 58 (Td) | Resistance to soldering heat | Solder bath method; (260 \pm 5) °C; (10 \pm 1) s | $\pm (0.05 \% R + 0.005 \Omega)$ 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) | 9 N | No visible damage |
| 4.33 | 21 (Ue ₁) | Substrate bending | Depth 2 mm, 3 times | $\pm (0.05 \% R + 0.0005 \Omega)$ no visible damage; no open circuit in bent position |
| 4.7 | - | Voltage proof | $U_{RMS} = U_{ins}; (60 \pm 5) \text{ s}$ | 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) On request
- (3) 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



Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Hyperlinks included in this datasheet may direct users to third-party websites. These links are provided as a convenience and for informational purposes only. Inclusion of these hyperlinks does not constitute an endorsement or an approval by Vishay of any of the products, services or opinions of the corporation, organization or individual associated with the third-party website. Vishay disclaims any and all liability and bears no responsibility for the accuracy, legality or content of the third-party website or for that of subsequent links.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.