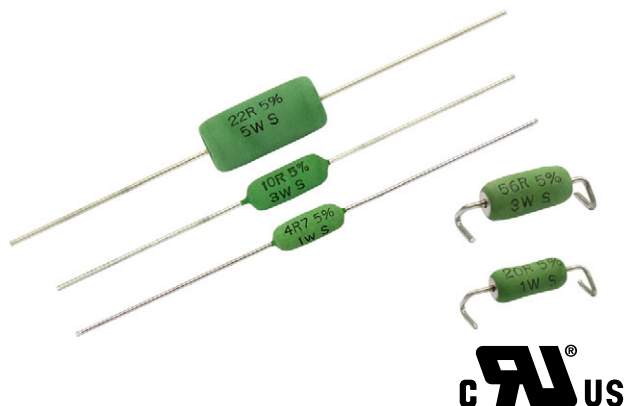


## Axial Leaded, WSZ (SMD) Cemented Fusible Wirewound Safety Resistors



### FEATURES

- UL1412 recognized; UL file no. E362452
- AEC-Q200 qualified
- Flameproof insulation coating meets UL 94 V-0 requirements
- Impulse voltage handling capability (up to 6 kV) (1.2 / 50  $\mu$ s pulse in IEC 61000-4-5)
- Silent and safe fusing
- WSZ-form lead bending available for SMD mounting
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



**RoHS**  
COMPLIANT  
HALOGEN  
**FREE**  
**GREEN**  
(5-2008)

### APPLICATIONS

- Automotive electronics
- Energy meters
- White goods
- Power supplies

### LINKS TO ADDITIONAL RESOURCES



ACxx-CS series wirewound safety resistors are designed to be used as fusible safety resistors (or AC mains input resistors). The resistor fuses “without a bang” when AC mains voltage is applied <sup>(1)</sup>. At the same time, it acts as an in-rush current limiting resistor for normal operation. The specially developed lacquer coating has superior thermal and electrical insulating properties. This allows designers to more easily meet the requirements of safety approval, whilst eliminating the need to put additional fuses in series with the input resistor.

#### Note

<sup>(1)</sup> For ohmic values below 3R9, silent fusing is not established when AC mains voltage of 120 V<sub>RMS</sub> / 240 V<sub>RMS</sub> is applied

### STANDARD ELECTRICAL SPECIFICATIONS

| TYPE    | POWER RATING<br>$P_{40}$ | POWER RATING<br>$P_{70}$ | LIMITING VOLTAGE<br>$U_{max.}$<br>V | RESISTANCE RANGE <sup>(1)</sup> | TOLERANCE  | TEMPERATURE COEFFICIENT |
|---------|--------------------------|--------------------------|-------------------------------------|---------------------------------|------------|-------------------------|
| AC01-CS | 1.1 W                    | 1 W                      | $\sqrt{P \times R}$                 | 1 $\Omega$ to 100 $\Omega$      | $\pm 5 \%$ | $\pm 200$ ppm/K         |
| AC03-CS | 3 W                      | 2.7 W                    | $\sqrt{P \times R}$                 | 1 $\Omega$ to 100 $\Omega$      | $\pm 5 \%$ | $\pm 200$ ppm/K         |
| AC05-CS | 5 W                      | 4.5 W                    | $\sqrt{P \times R}$                 | 1 $\Omega$ to 100 $\Omega$      | $\pm 5 \%$ | $\pm 200$ ppm/K         |

#### Note

<sup>(1)</sup> Resistance value to be selected for  $\pm 5 \%$  from E24 series

### TECHNICAL SPECIFICATIONS

| DESCRIPTION                                                                   | AC01-CS                     | AC03-CS | AC05-CS |
|-------------------------------------------------------------------------------|-----------------------------|---------|---------|
| Operating temperature range                                                   | -40 °C to 200 °C            |         |         |
| Max. resistance change for 116 % of $P_{70}$ , $\Delta R$ max., after 1000 h: | $\pm (5 \% R + 0.1 \Omega)$ |         |         |

### SAFETY REQUIREMENTS AND QUALIFICATIONS

| SAFETY REQUIREMENTS / QUALIFICATIONS | UL                                        | AEC-Q200      |               |               |
|--------------------------------------|-------------------------------------------|---------------|---------------|---------------|
| DESCRIPTION                          | UL1412 recognized;<br>UL file no. E362452 | AC01-CS axial | AC03-CS axial | AC05-CS axial |
|                                      | AC01-CS, AC03-CS, AC05-CS                 | AC01-CS WSZ   | AC03-CS WSZ   | -             |



## PART NUMBER AND PRODUCT DESCRIPTION

Part Number: AC03000002209JACCS  
AC03000902209JBMCS

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | C | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 9 | J | A | C | C | S |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| TYPE                                               | VERSION                                                                                    | TCR/MATERIAL | RESISTANCE                                                                                                             | TOLERANCE     | PACKAGING                        | SPECIAL     |
|----------------------------------------------------|--------------------------------------------------------------------------------------------|--------------|------------------------------------------------------------------------------------------------------------------------|---------------|----------------------------------|-------------|
| AC01 = AC01000<br>AC03 = AC03000<br>AC05 = AC05000 | 0 = neutral<br>1 = radial taped<br>9 = WSZ<br>(Z formed leads<br>for AC01-CS /<br>AC03-CS) | 0 = neutral  | 3 digit value<br>1 digit multiplier<br>MULTIPLIER<br>8 = $\times 10^{-2}$<br>9 = $\times 10^{-1}$<br>0 = $\times 10^0$ | J = $\pm 5\%$ | AC<br>6B<br>6F<br>R1<br>RB<br>BM | CS = safety |

Product Description: AC03-CS 22R 5 % AC G63 CDxxxx  
AC03-CS WSZ 22R 5 % BM CD1420

| AC03-CS                       | 22R        | 5 %       | AC                               | G63               | CDxxxx  |
|-------------------------------|------------|-----------|----------------------------------|-------------------|---------|
| TYPE                          | RESISTANCE | TOLERANCE | PACKAGING                        | TAPE WIDTH        | SPECIAL |
| AC01-CS<br>AC03-CS<br>AC05-CS |            | $\pm 5\%$ | AC<br>6B<br>6F<br>R1<br>RB<br>BM | G63<br>G83<br>G93 |         |

## Note

- Former variants A =  $\leq 4$  kV or B =  $\leq 6$  kV for AC05-CS are not necessary for new ordering codes

## PACKAGING

| TYPE        | PACKAGING CODE | QUANTITY | PACKAGING STYLE                                     | WIDTH | PITCH | DIMENSIONS               | PART NUMBER VARIANT |
|-------------|----------------|----------|-----------------------------------------------------|-------|-------|--------------------------|---------------------|
| AC01-CS     | AC             | 500      | Axial taped acc. to IEC 60286-1 fan-folded in a box | 63 mm | 10 mm | 85 mm x 72 mm x 260 mm   | 0                   |
|             | R1             | 1000     | Radial formed, taped acc. to IEC 60286-2 on reel    | -     | -     | 365 mm x 370 mm x 60 mm  | 1                   |
| AC01-CS WSZ | BM             | 1250     | Z formed, blister taped acc. to IEC 60286-3 on reel | -     | 8 mm  | 350 mm x 335 mm x 35 mm  | 9                   |
| AC03-CS     | AC             | 500      | Axial taped acc. to IEC 60286-1 fan-folded in a box | 63 mm | 10 mm | 85 mm x 120 mm x 270 mm  | 0                   |
|             | R1             | 1000     | Radial formed, taped acc. to IEC 60286-2 on reel    | -     | -     | 365 mm x 370 mm x 60 mm  | 1                   |
| AC03-CS WSZ | BM             | 1250     | Z formed, blister taped acc. to IEC 60286-3 on reel | -     | 8 mm  | 350 mm x 335 mm x 35 mm  | 9                   |
| AC05-CS     | 6B             | 250      | Axial taped acc. to IEC 60286-1 fan-folded in a box | 83 mm | 15 mm | 110 mm x 120 mm x 270 mm | 0                   |
|             | 6F             | 250      | Axial taped acc. to IEC 60286-1 fan-folded in a box | 93 mm |       | 120 mm x 120 mm x 270 mm | 0                   |
|             | RB             | 250      | Radial formed, taped acc. to IEC 60286-2 on reel    | -     | -     | 365 mm x 370 mm x 67 mm  | 1                   |

**DESCRIPTION**

ACxx-CS wirewound safety resistor series is designed to be used as fusible safety resistor (or, AC mains input resistors). It uses specially selected resistive winding wire and special non-flammable silicone cement coating material to ensure safe and silent fusing operation in overload conditions.

The resistor fuses “without a bang” when AC mains voltage is applied <sup>(1)</sup>. At the same time, it acts as an in-rush current limiting resistor for the normal operation.

The specially developed lacquer coating has superior thermal and electrical insulating properties. This allows designers to more easily meet the requirements of safety approval, whilst eliminating the need to put additional fuses in series with the input resistor.

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. Plated steel termination caps are firmly pressed on the ceramic rods. Connecting wires of electrolytic copper plated with 100 % pure matte tin are welded to the termination caps. Suitable resistive wire is selected as a winding material. An optimized number of windings are wound on a high grade ceramic body. The resistor elements are covered by a green protective coating designed for electrical, mechanical and climatic protection. The special coating provides ideal and silent fusing of the component in overload condition, without burning or explosion <sup>(1)</sup>.

The ohmic value, tolerance, rated dissipation is stamp marked. Also “S” is marked for safety version.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are stuck directly on the adhesive tapes according to IEC 60286-1 for axial leaded version, or according to IEC 60286-2 for the radial version, or blister taped according to IEC 60286-3 for the WSZ version.

**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 <sup>(2)</sup>
- The Global Automotive Declarable Substance List (GADSL) <sup>(3)</sup>
- The REACH regulation (1907/2006/EC) and the related list of substances with very high concern (SVHC) <sup>(4)</sup> for its supply chain

**Notes**

- <sup>(1)</sup> For ohmic values below 3R9, silent fusing is not established when AC mains voltage of 120 V<sub>RMS</sub> / 240 V<sub>RMS</sub> is applied
- <sup>(2)</sup> The IEC 62474 list of declarable substances is maintained in a dedicated database, which is available at <http://std.iec.ch/iec62474>
- <sup>(3)</sup> The Global Automotive Declarable Substance List (GADSL) is maintained by the American Chemistry Council and available at [www.gadsl.org](http://www.gadsl.org)
- <sup>(4)</sup> The SVHC list is maintained by the European Chemical Agency (ECHA) and available at <http://echa.europa.eu/candidate-list-table>
- <sup>(5)</sup> Other cleaning solvents with aggressive chemicals should be evaluated in actual cleaning process for their suitability

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](http://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](http://www.vishay.com/doc?49037)

**ASSEMBLY**

The resistors are suitable for processing on automatic insertion equipment and cutting and bending machines. Excellent solderability is proven, even after extended storage. They are suitable for automatic soldering using wave or dipping.

The resistors are completely lead (Pb)-free, the pure matte tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth, in compliance with IEC 60068-2-82, has been proven under extensive testing.

The encapsulant is resistant to cleaning solvent specified in IEC 60115-1 <sup>(5)</sup>. The suitability of conformal coatings, if applied, shall be qualified by appropriate means to ensure the long-term stability of the whole system.

**APPROVALS**

These resistors AC01-CS, AC03-CS, and AC05-CS have UL 1412 recognition UL file no. E362452.

**RELATED PRODUCTS**

For a correlated range of standard cemented wirewound resistors, please see:

AC, AC-AT, AC-NI series

“Standard: AC, AEC-Q200 Qualified: AC-AT, Non-Inductive AC-NI Cemented Leaded Wirewound Resistors”

[www.vishay.com/doc?28730](http://www.vishay.com/doc?28730)

For a correlated range of wirewound resistors with high pulse handling capability, please see:

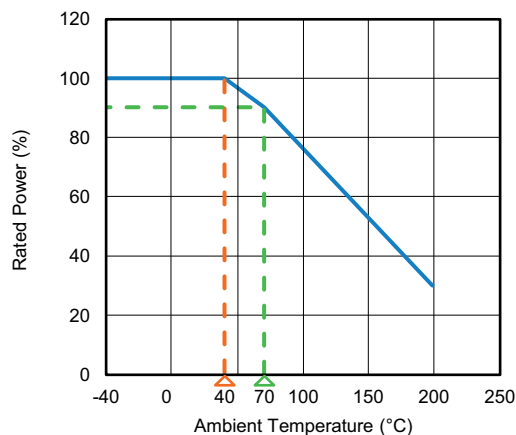
Z300-Cxx series

“High Surge Axial Cemented Wirewound Resistors”

[www.vishay.com/doc?21027](http://www.vishay.com/doc?21027)

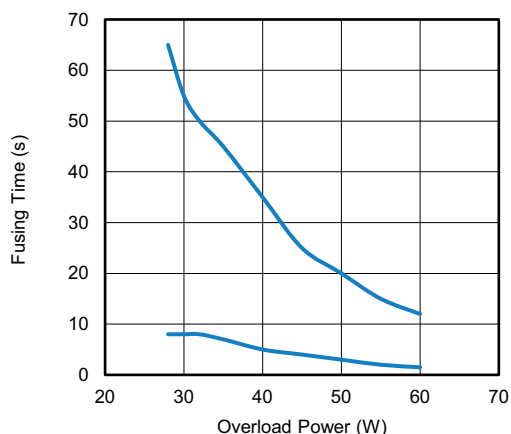


## FUNCTIONAL PERFORMANCE

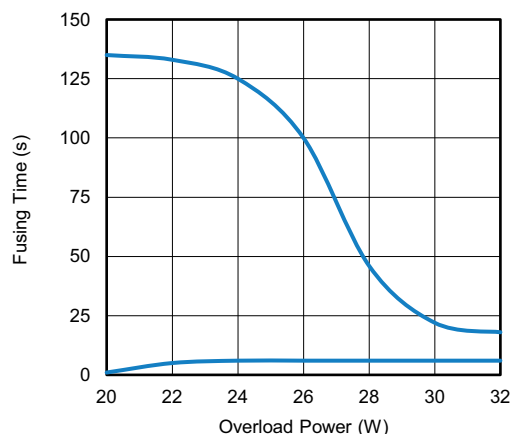


## DERATING

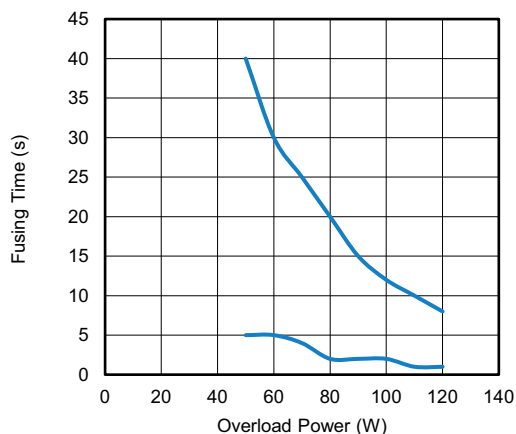
Fusing time window defined against overload power applied.



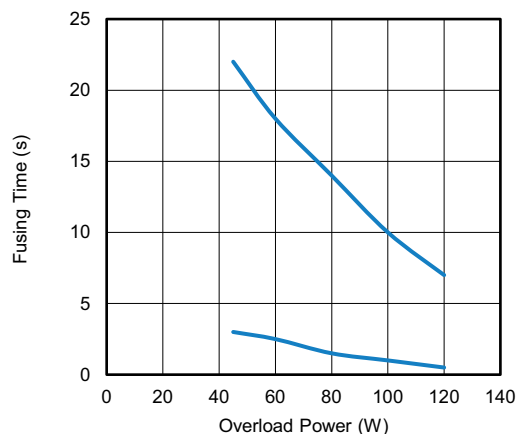
**FUSING CHARACTERISTICS**  
OF AC01-CS:  $1\ \Omega \leq R \leq 2.7\ \Omega$



**FUSING CHARACTERISTICS**  
OF AC01-CS:  $3\ \Omega \leq R \leq 100\ \Omega$



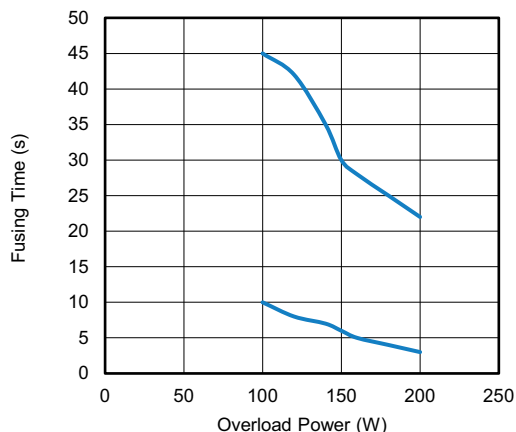
**FUSING CHARACTERISTICS**  
OF AC03-CS:  $1\ \Omega \leq R \leq 4.3\ \Omega$



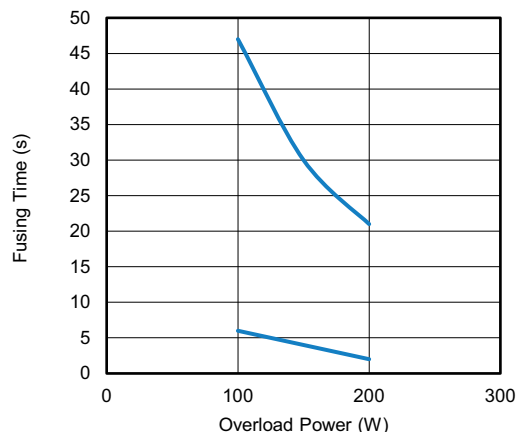
**FUSING CHARACTERISTICS**  
OF AC03-CS:  $4.7\ \Omega \leq R \leq 100\ \Omega$



## FUNCTIONAL PERFORMANCE

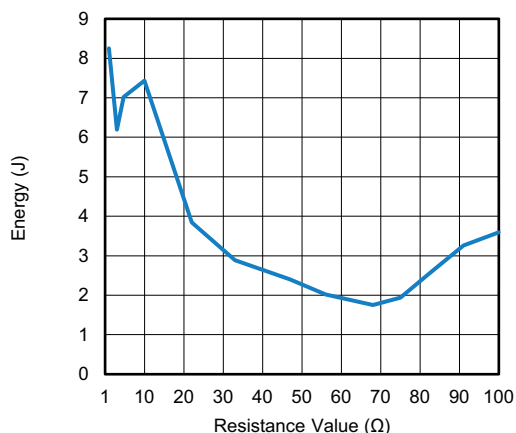


**FUSING CHARACTERISTICS  
OF AC05-CS: 1 Ω ≤ R ≤ 9.1 Ω**

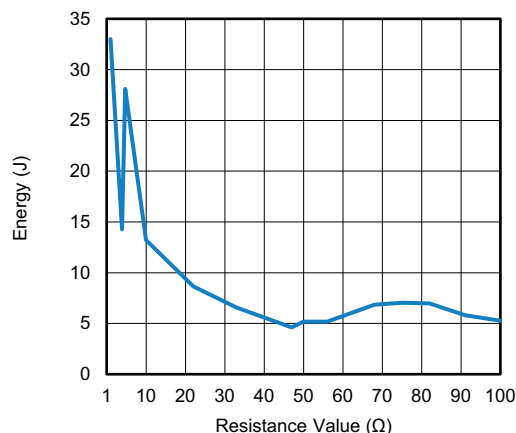


**FUSING CHARACTERISTICS  
OF AC05-CS: 10 Ω ≤ R ≤ 100 Ω**

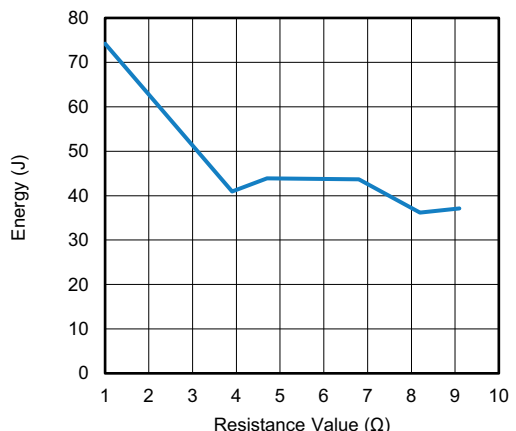
Pulse energy curve defined against the offered ohmic range.



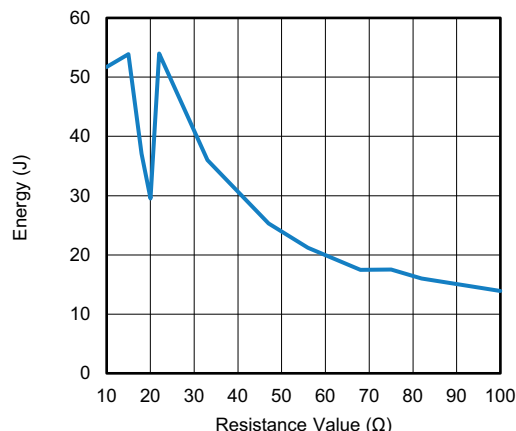
**PULSE ENERGY CURVE FOR AC01-CS**  
(1.2 / 50 μs; 10 pulses at 30 s interval)



**PULSE ENERGY CURVE FOR AC03-CS**  
(1.2 / 50 μs; 10 pulses at 30 s interval)



**PULSE ENERGY CURVE FOR AC05-CS: 1 Ω to 9.1 Ω**  
(1.2 / 50 μs; 10 pulses at 30 s interval)

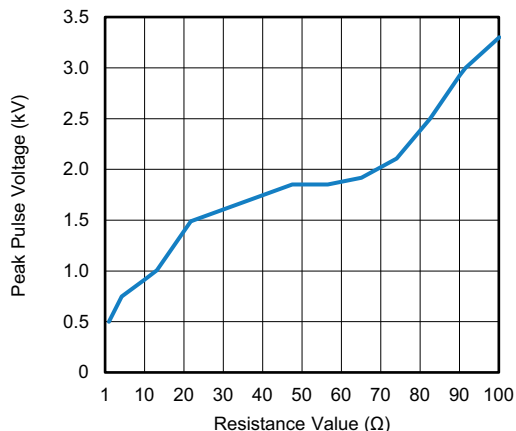


**PULSE ENERGY CURVE FOR AC05-CS: 10 Ω to 100 Ω**  
(1.2 / 50 μs; 10 pulses at 30 s interval)

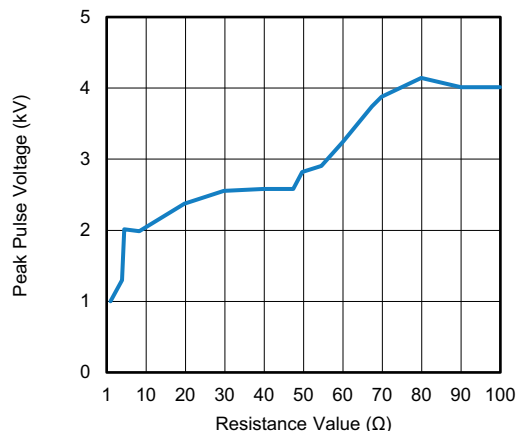


## FUNCTIONAL PERFORMANCE

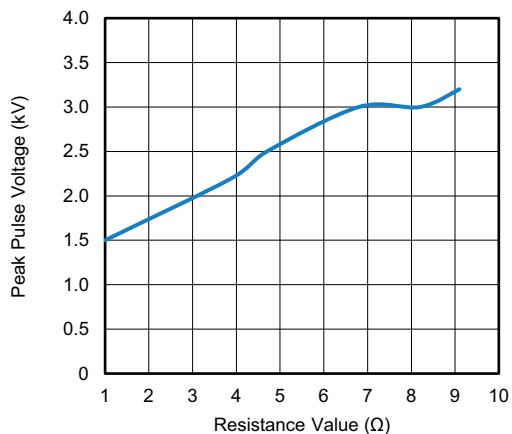
Peak voltage (1.2 / 50  $\mu$ s) graph defined against offered ohmic range.



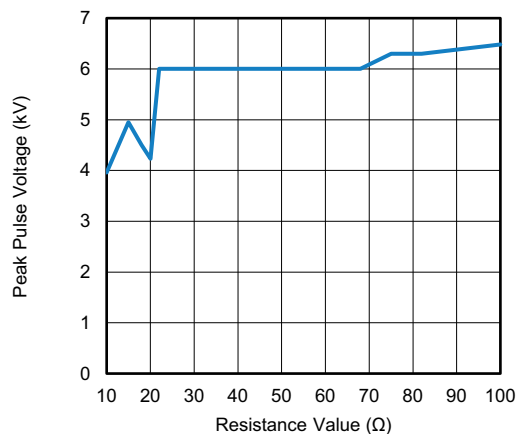
**PEAK PULSE VOLTAGE LIMIT FOR AC01-CS**  
(1.2 / 50  $\mu$ s; 10 pulses at 30 s interval)



**PEAK PULSE VOLTAGE LIMIT FOR AC03-CS**  
(1.2 / 50  $\mu$ s; 10 pulses at 30 s interval)



**PEAK PULSE VOLTAGE LIMIT FOR AC05-CS: 1  $\Omega$  to 9.1  $\Omega$**   
(1.2 / 50  $\mu$ s; 10 pulses at 30 s interval)



**PEAK PULSE VOLTAGE LIMIT FOR AC05-CS: 10  $\Omega$  to 100  $\Omega$**   
(1.2 / 50  $\mu$ s; 10 pulses at 30 s interval)

**TESTS PROCEDURES AND REQUIREMENTS**

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

- IEC 60115-1, generic specification (includes tests)

The test and requirements table contains only the most important tests. For the full test schedule refer to the documents above.

The tests are carried out in accordance with IEC 60068-2-xx test method and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3.

Climatic category -40 / 200 / 56 (rated temperature range: lower category temperature, upper category temperature; damp heat, steady state, test duration: 56 days) is valid.

Unless otherwise specified the following values apply:

- Temperature: 15 °C to 35 °C
- Relative humidity: 25 % to 75 %
- Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar)

For performing some of the tests, the components are mounted on a test board in accordance with IEC 60115-1, 5.5.

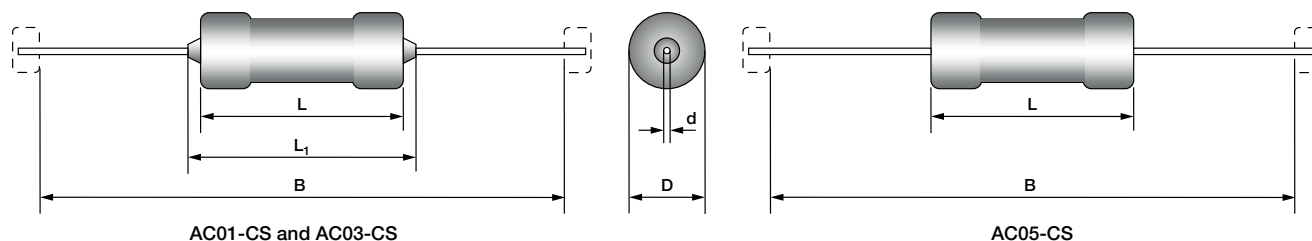
In test table below, only the relevant and commonly referred tests and related clauses of IEC 60115-1 and IEC 60068-2-xx test methods are mentioned.

| <b>TEST PROCEDURES AND REQUIREMENTS</b>                          |                                                  |                                                                                                                                  |                                                                                                                                                              |                                                                                      |
|------------------------------------------------------------------|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| IEC 60115-1<br>CLAUSE                                            | IEC 60068-2<br>TEST<br>METHOD                    | TEST                                                                                                                             | PROCEDURE                                                                                                                                                    | REQUIREMENTS<br>PERMISSIBLE CHANGE ( $\Delta R_{MAX.}$ )                             |
| 8.1                                                              | -                                                | Short time overload                                                                                                              | Room temperature;<br>10x rated power $P_{40}$ ;<br>5 s                                                                                                       | $\pm (2 \% R + 0.1 \Omega)$                                                          |
| 9.5                                                              | 21 (Ua)<br>21 (Ub)<br>21 (Uc)                    | Robustness of terminations                                                                                                       | Tensile, bending and torsion                                                                                                                                 | No damage<br>$\pm (0.5 \% R + 0.05 \Omega)$                                          |
| 11.2                                                             | 20 (Tb)                                          | Resistance to soldering heat                                                                                                     | Unmounted components<br>( $260 \pm 5$ ) °C; (10 $\pm$ 1) s                                                                                                   | $\pm (0.5 \% R + 0.05 \Omega)$                                                       |
| 10.3<br>10.3.4.2<br>10.3.4.3<br>10.3.4.4<br>10.3.4.5<br>10.3.4.6 | 2 (Bb)<br>30 (Db)<br>1 (Ab)<br>13 (M)<br>30 (Db) | Climatic sequence:<br>Dry heat<br>Damp heat (accelerated)<br>1st cycle<br>Cold<br>Low air pressure<br>Damp heat remaining cyclic | 16 h; 200 °C<br>24 h; 55 °C;<br>90 % to 100 % RH<br>2 h; -55 °C<br>1 h; (1 $\pm$ 0.1) kPa;<br>15 °C to 35 °C<br>5 days; 55 °C;<br>95 % to 100 % RH; 5 cycles | $\pm (1 \% R + 0.05 \Omega)$                                                         |
| 10.4                                                             | 78 (Cab)                                         | Damp heat, (steady state)                                                                                                        | 56 days; (40 $\pm$ 2) °C;<br>(93 $\pm$ 5) % RH                                                                                                               | $\pm (5 \% R + 0.1 \Omega)$                                                          |
| 7.2                                                              | -                                                | Endurance (at room temperature)                                                                                                  | 1000 h;<br>loaded with 116 % of $P_{70}$ ;<br>1.5 h ON and 0.5 h OFF                                                                                         | $\pm (5 \% R + 0.1 \Omega)$                                                          |
| 7.3                                                              | -                                                | Endurance (at 200 °C)                                                                                                            | 1000 h; loaded with 30 % of $P_{70}$ ;<br>1.5 h ON and 0.5 h OFF                                                                                             | $\pm (5 \% R + 0.1 \Omega)$                                                          |
| -                                                                | -                                                | 1.2 / 50 $\mu$ s impulse test as defined in IEC 61000-4-5 (up to 6 kV)                                                           | Internal impedance of surge tester is 2 $\Omega$ ;<br>10 pulses at 30 s interval                                                                             | $\pm (5 \% R + 0.1 \Omega)$                                                          |
| -                                                                | -                                                | Fail safe mains fusing <sup>(1)</sup> at 230 V <sub>AC</sub>                                                                     | -                                                                                                                                                            | Resistance > 100 k $\Omega$ , fusing time < 2 s (fusing without flame and explosion) |

**Note**

<sup>(1)</sup> For ohmic values below 3R9, silent fusing is not established when AC mains voltage of 120 V<sub>RMS</sub> / 240 V<sub>RMS</sub> is applied

## DIMENSIONS



AC01-CS and AC03-CS

AC05-CS

### DIMENSIONS - Leded resistor types, mass and relevant physical dimensions

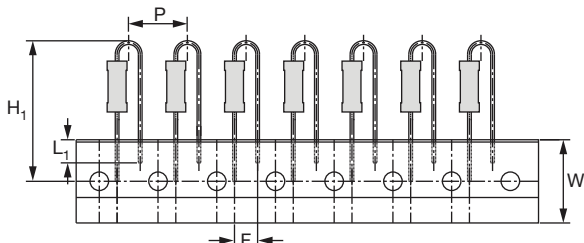
| MODEL                  | L <sub>max.</sub> | L <sub>1 max.</sub> | D <sub>max.</sub> | d <sub>max.</sub> | B     | MASS   |
|------------------------|-------------------|---------------------|-------------------|-------------------|-------|--------|
| AC01-CS <sup>(1)</sup> | 11.0 mm           | 15.0 mm             | 5.0 mm            | 0.7 mm            | 63 mm | 0.52 g |
| AC03-CS                | 13.0 mm           | 19.0 mm             | 6.0 mm            | 0.8 mm            | 63 mm | 0.78 g |
| AC05-CS <sup>(2)</sup> | 17.0 mm           | 17.0 mm             | 10.0 mm           | 0.8 mm            | 83 mm | 2.25 g |
|                        |                   |                     |                   |                   | 93 mm | 2.5 g  |

#### Notes

- (1) For AC01-CS, dimension given is applicable for 10R to 100R; for lower ohmic values < 10R, D<sub>max.</sub> might reach 5.5 mm  
(2) For AC05-CS, L = L<sub>1</sub>; there is no lacquer on termination lead

### AC01-CS RADIAL

Pitch of components 5.0 mm

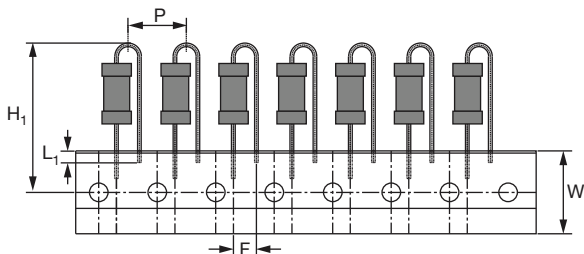


#### DIMENSIONS in millimeters

|                                             |                |                 |
|---------------------------------------------|----------------|-----------------|
| Pitch of components                         | P              | 12.7 ± 1.0      |
| Lead to lead distance                       | F              | 4.8 + 0.7 / - 0 |
| Tape width                                  | W              | 18 ± 0.5        |
| Component height                            | H <sub>1</sub> | 30.0 ± 3        |
| Min. lead wire (tape portion) shortest lead | L <sub>1</sub> | 2.5             |

### AC03-CS RADIAL

Pitch of components 5.0 mm

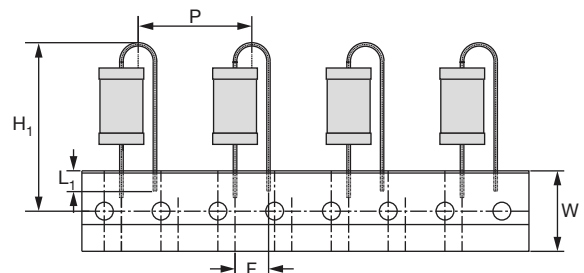


#### DIMENSIONS in millimeters

|                                             |                |            |
|---------------------------------------------|----------------|------------|
| Pitch of components                         | P              | 12.7 ± 1.0 |
| Lead to lead distance                       | F              | 5.00 ± 0.5 |
| Tape width                                  | W              | 18 ± 0.5   |
| Maximum component height                    | H <sub>1</sub> | 34         |
| Min. lead wire (tape portion) shortest lead | L <sub>1</sub> | 2.5        |

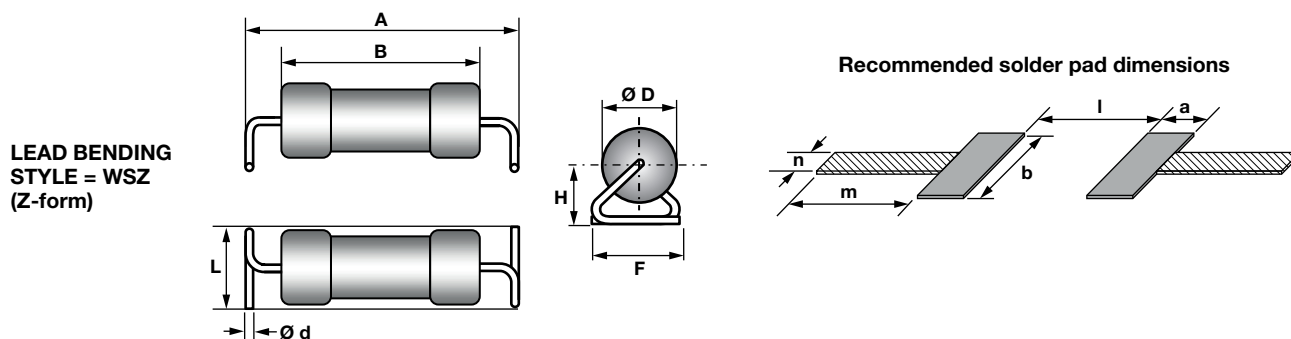
### AC05-CS RADIAL

Pitch of components 7.50 mm



#### DIMENSIONS in millimeters

|                                             |                |            |
|---------------------------------------------|----------------|------------|
| Pitch of components                         | P              | 25.4 ± 1.0 |
| Lead to lead distance                       | F              | 7.50 ± 0.5 |
| Tape width                                  | W              | 18 ± 0.5   |
| Component height                            | H <sub>1</sub> | 37 ± 2     |
| Min. lead wire (tape portion) shortest lead | L <sub>1</sub> | 2.5        |

**Z-FORM LEADS FOR SMD MOUNTING** in millimeters


| TYPE WSZ    | Ø d <sub>max.</sub> | Ø D <sub>max.</sub> | A        | B <sub>max.</sub> | F         | H         | L         | a | b | l    | m <sup>(1)</sup> | n <sup>(1)</sup> |
|-------------|---------------------|---------------------|----------|-------------------|-----------|-----------|-----------|---|---|------|------------------|------------------|
| AC01-CS WSZ | 0.7                 | 5.0                 | 17 ± 0.3 | 11.0              | 4.8 ± 0.3 | 3.6 ± 0.2 | 5.0 ± 0.5 | 4 | 8 | 12.2 | 25               | 2                |
| AC03-CS WSZ | 0.8                 | 6.0                 | 17 ± 0.3 | 13.0              | 4.8 ± 0.3 | 3.6 ± 0.2 | 5.0 ± 0.5 | 4 | 8 | 12.2 | 25               | 2                |

**Note**

- <sup>(1)</sup> Dimensions "m" and "n" represent minimum conducting track area in actual PCB, based on test conditions at full rated power.  
Customers needs to reassess temperature restrictions based on the solder type, PCB material, and other factors specific to their application



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