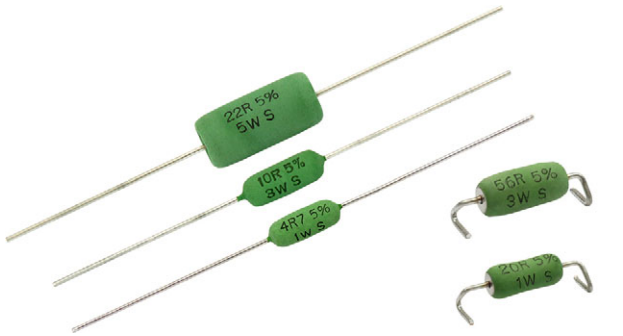
Axial Leaded, WSZ (SMD) Cemented Fusible Wirewound Safety Resistors



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 µs 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

Pb-free

RoHS COMPLIANT

HALOGEN FREE GREEN (5-2008)

APPLICATIONS

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

LINKS TO ADDITIONAL RESOURCES

3D Models

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 (1). 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

(1) For ohmic values below 3R9, silent fusing is not established when AC mains voltage of 120 V_{RMS} / 240 V_{RMS} is applied

STANDARD ELECTRICAL SPECIFICATIONS

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

Note

(1) Resistance value to be selected for ± 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}, ΔR max., after 1000 h:	± (5 % R + 0.1 Ω)		

SAFETY REQUIREMENTS AND QUALIFICATIONS

SAFETY REQUIREMENTS / QUALIFICATIONS	UL	AEC-Q200		
DESCRIPTION	UL1412 recognized; 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	-

For technical questions, contact: ww1resistors@vishay.com

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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 **AC03** = AC03000 **AC05** = AC05000	**0** = neutral **1** = radial taped **9** = WSZ (Z formed leads for AC01-CS / AC03-CS)	**0** = neutral	**3 digit value** **1 digit multiplier** MULTIPLIER **8** = $*10^{-2}$ **9** = $*10^{-1}$ **0** = $*10^{0}$	**J** = ± 5 %	**AC** **6B** **6F** **R1** **RB** **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 **AC03-CS** **AC05-CS**		± 5 %	**AC** **6B** **6F** **R1** **RB** **BM**	**G63** **G83** **G93**	

Note

- Former variants A = ≤ 4 kV or B = ≤ 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

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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 (1). 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 (1).

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 (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

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 (5). 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

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

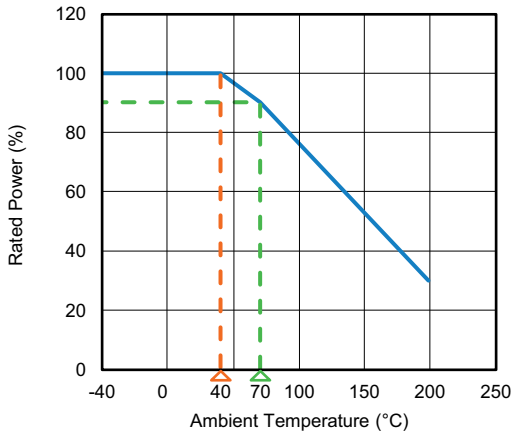
Notes

(1) For ohmic values below 3R9, silent fusing is not established when AC mains voltage of 120 V_{RMS} / 240 V_{RMS} is applied
(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
(5) Other cleaning solvents with aggressive chemicals should be evaluated in actual cleaning process for their suitability

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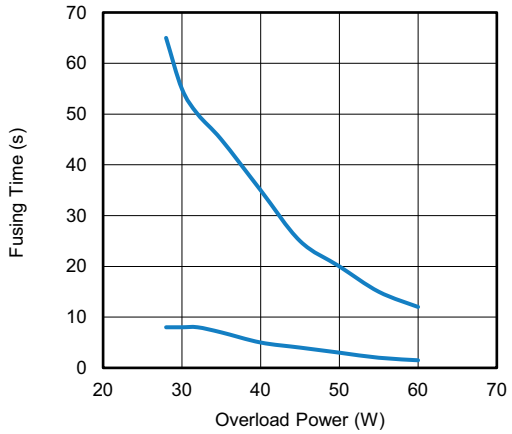
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FUNCTIONAL PERFORMANCE

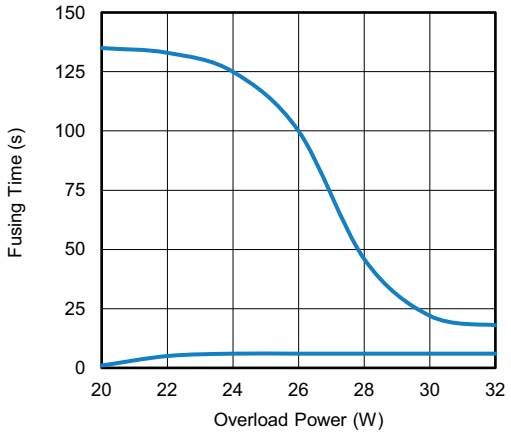


DERATING

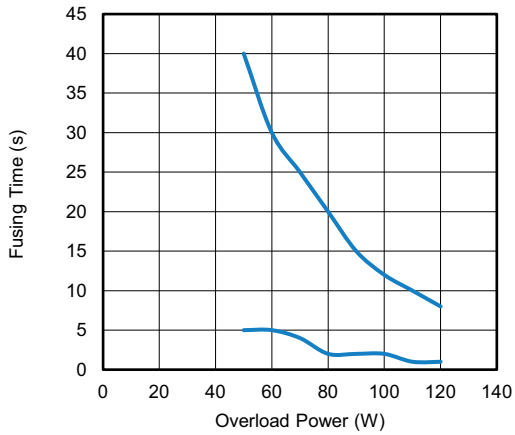
Fusing time window defined against overload power applied.



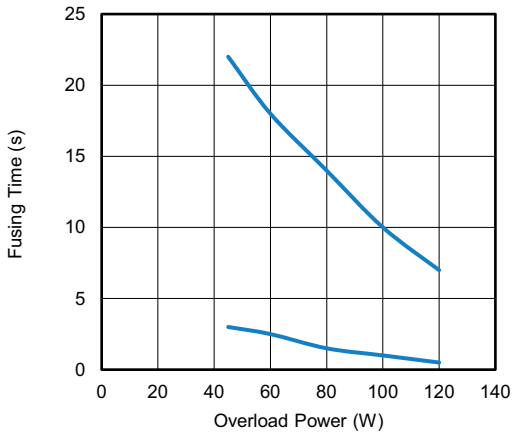
FUSING CHARACTERISTICS OF AC01-CS: 1 Ω ≤ R ≤ 2.7 Ω



FUSING CHARACTERISTICS OF AC01-CS: 3 Ω ≤ R ≤ 100 Ω



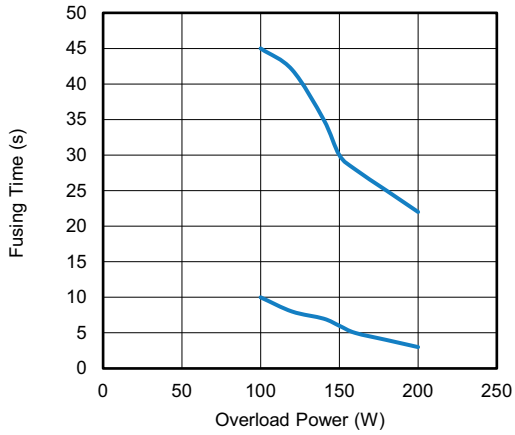
FUSING CHARACTERISTICS OF AC03-CS: 1 Ω ≤ R ≤ 4.3 Ω



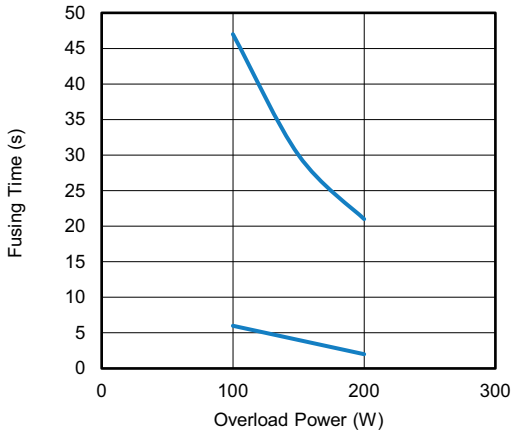
FUSING CHARACTERISTICS OF AC03-CS: 4.7 Ω ≤ R ≤ 100 Ω

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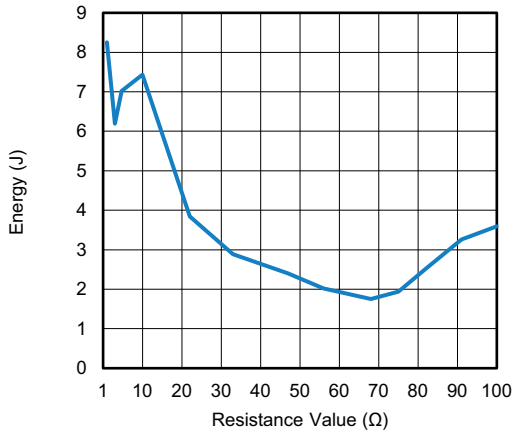


FUSING CHARACTERISTICS OF AC05-CS: 1 Ω ≤ R ≤ 9.1 Ω

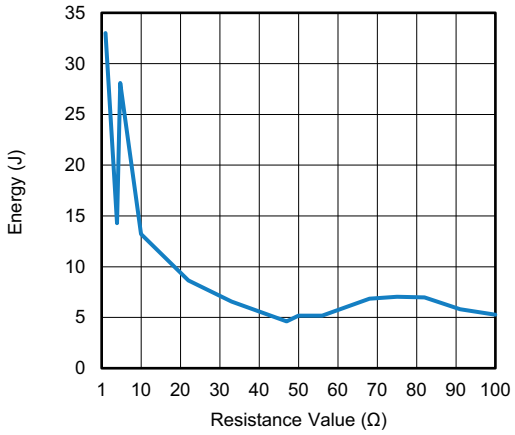


FUSING CHARACTERISTICS OF AC05-CS: 10 Ω ≤ R ≤ 100 Ω

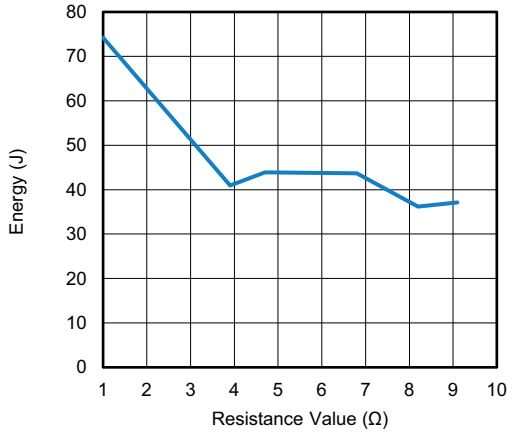
Pulse energy curve defined against the offered ohmic range.



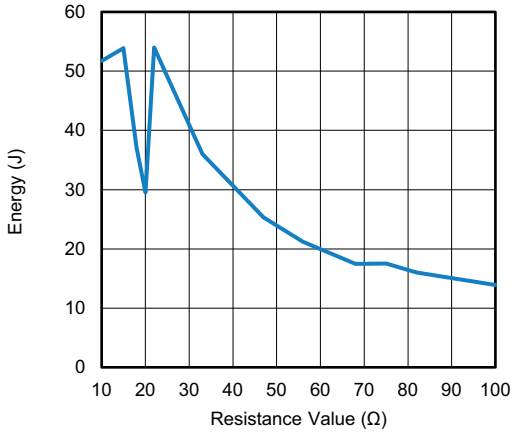
PULSE ENERGY CURVE FOR AC01-CS
(1.2 / 50 µs; 10 pulses at 30 s interval)



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)

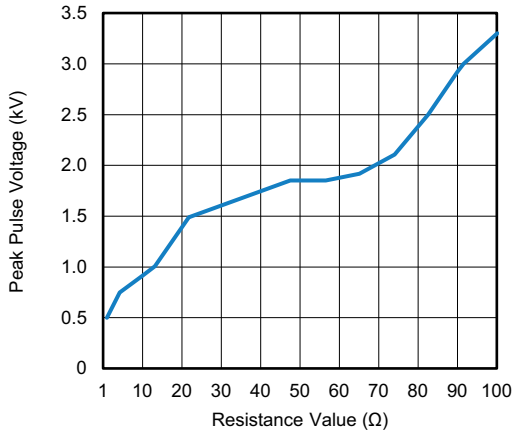


PULSE ENERGY CURVE FOR AC05-CS: 10 Ω to 100 Ω
(1.2 / 50 µs; 10 pulses at 30 s interval)

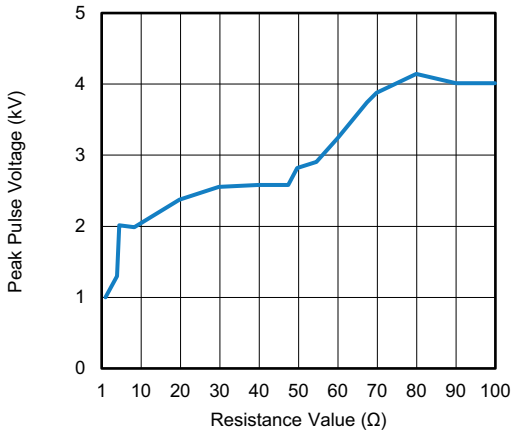
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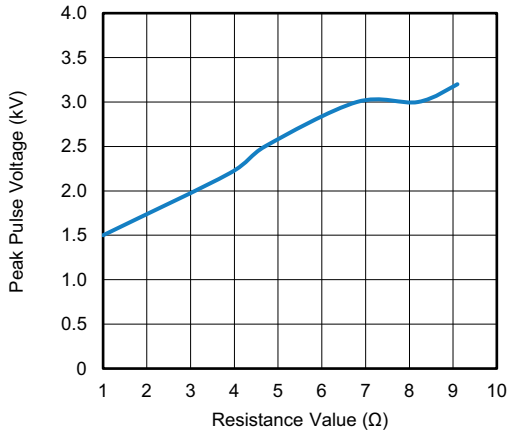
Peak voltage (1.2 / 50 µs) graph defined against offered ohmic range.



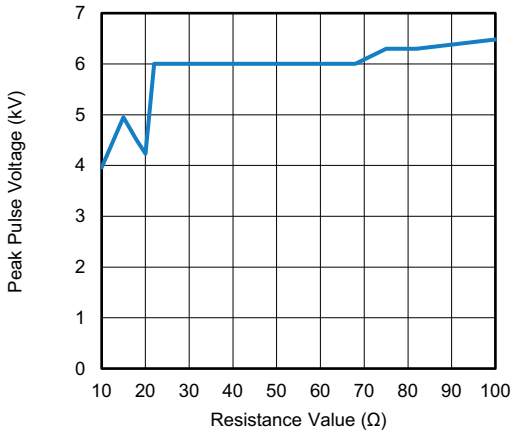
PEAK PULSE VOLTAGE LIMIT FOR AC01-CS
(1.2 / 50 µs; 10 pulses at 30 s interval)



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



PEAK PULSE VOLTAGE LIMIT FOR AC05-CS: 1 Ω to 9.1 Ω
(1.2 / 50 µs; 10 pulses at 30 s interval)



PEAK PULSE VOLTAGE LIMIT FOR AC05-CS: 10 Ω to 100 Ω
(1.2 / 50 µs; 10 pulses at 30 s interval)

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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.

TEST PROCEDURES AND REQUIREMENTS

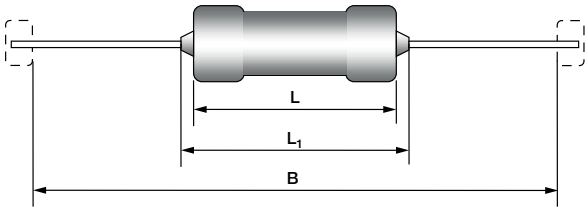
IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R_{MAX.}$)
8.1	-	Short time overload	Room temperature; 10x rated power P_{40}; 5 s	± (2 % R + 0.1 Ω)
9.5	21 (Ua_1) 21 (Ub) 21 (Uc)	Robustness of terminations	Tensile, bending and torsion	No damage ± (0.5 % R + 0.05 Ω)
11.2	20 (Tb)	Resistance to soldering heat	Unmounted components (260 ± 5) °C; (10 ± 1) s	± (0.5 % R + 0.05 Ω)
10.3		Climatic sequence:		± (1 % R + 0.05 Ω)
10.3.4.2	2 (Bb)	Dry heat	16 h; 200 °C	
10.3.4.3	30 (Db)	Damp heat (accelerated) 1st cycle	24 h; 55 °C; 90 % to 100 % RH	
10.3.4.4	1 (Ab)	Cold	2 h; -55 °C	
10.3.4.5	13 (M)	Low air pressure	1 h; (1 ± 0.1) kPa; 15 °C to 35 °C	
10.3.4.6	30 (Db)	Damp heat remaining cyclic	5 days; 55 °C; 95 % to 100 % RH; 5 cycles	
10.4	78 (Cab)	Damp heat, (steady state)	56 days; (40 ± 2) °C; (93 ± 5) % RH	± (5 % R + 0.1 Ω)
7.2	-	Endurance (at room temperature)	1000 h; loaded with 116 % of P_{70}; 1.5 h ON and 0.5 h OFF	± (5 % R + 0.1 Ω)
7.3	-	Endurance (at 200 °C)	1000 h; loaded with 30 % of P_{70}; 1.5 h ON and 0.5 h OFF	± (5 % R + 0.1 Ω)
-	-	1.2 / 50 µs impulse test as defined in IEC 61000-4-5 (up to 6 kV)	Internal impedance of surge tester is 2 Ω; 10 pulses at 30 s interval	± (5 % R + 0.1 Ω)
-	-	Fail safe mains fusing (1) at 230 V_{AC}	-	Resistance > 100 kΩ, fusing time < 2 s (fusing without flame and explosion)

Note

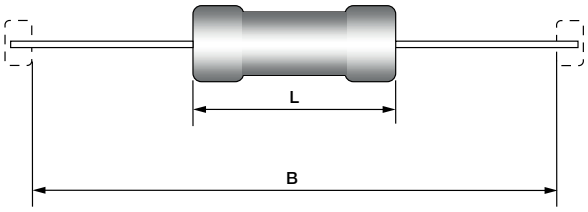
(1) For ohmic values below 3R9, silent fusing is not established when AC mains voltage of 120 V_{RMS} / 240 V_{RMS} is applied

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DIMENSIONS



AC01-CS and AC03-CS



AC05-CS

DIMENSIONS - Leaded resistor types, mass and relevant physical dimensions						
MODEL	**$L_{max.}$**	**$L_{1\ max.}$**	**$D_{max.}$**	**$d_{max.}$**	**B**	**MASS**
AC01-CS (1)	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 (2)	17.0 mm	17.0 mm	10.0 mm	0.8 mm	83 mm	2.25 g
					93 mm	2.5 g

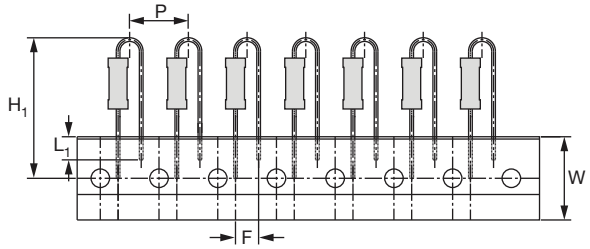
Notes

(1) For AC01-CS, dimension given is applicable for 10R to 100R; for lower ohmic values < 10R, $D_{max.}$ might reach 5.5 mm

(2) For AC05-CS, L = L_1; there is no lacquer on termination lead

AC01-CS RADIAL

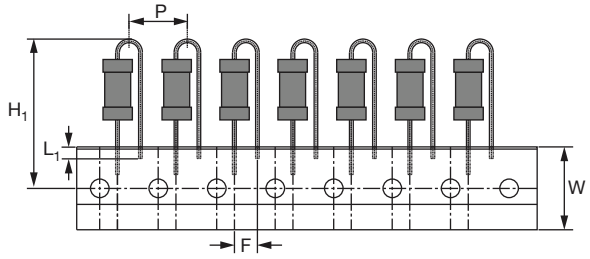
Pitch of components 5.0 mm



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_1	30.0 ± 3
Min. lead wire (tape portion) shortest lead	L_1	2.5

AC03-CS RADIAL

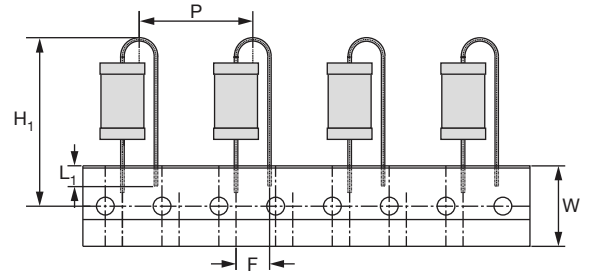
Pitch of components 5.0 mm



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_1	34
Min. lead wire (tape portion) shortest lead	L_1	2.5

AC05-CS RADIAL

Pitch of components 7.50 mm



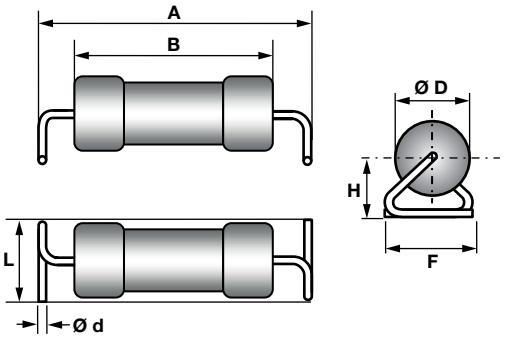
DIMENSIONS in millimeters		
Pitch of components	P	25.4 ± 1.0
Lead to lead distance	F	7.50 ± 0.5
Tape width	W	18 ± 0.5
Component height	H_1	37 ± 2
Min. lead wire (tape portion) shortest lead	L_1	2.5

For technical questions, contact: ww1resistors@vishay.com

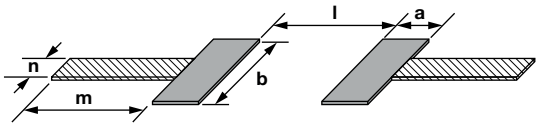
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Z-FORM LEADS FOR SMD MOUNTING in millimeters

LEAD BENDING
STYLE = WSZ
(Z-form)



Recommended solder pad dimensions



TYPE WSZ	Ø $d_{max.}$	Ø $D_{max.}$	A	$B_{max.}$	F	H	L	a	b	l	m (1)	n (1)
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

(1) 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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