

FrelTec GmbH

Mathildenstr. 10A
82319 Starnberg
Germany

Carbon Film Resistor

SPECIFICATION

Part Number

051	012*	N*	_____	J*	TB*	1*	_*	_*
Type	Power Rating	Body Size	Value	Tolerance	Packing Type	Packing quantity	Option 1	Option 2
051 : Carbon Film Resistor	Code : Watt							
	012:0,125(1/8W)	N:Normal size	The last digit is the	F : ±1%***	TR : Tape in Reel	W : 100 pc	0 = PT-52mm	F : Non-Flame Product**
	025:0,25 (1/4 W)	S:Small Size)	multiplier which denotes	G : ±2%	TB : Tape in Box	Z : 400 pc	8 = PT-58mm	I : Non-Inductive product)
	033:0,33 (1/3 W)	U : Ultra small size	the number of zero following	J : ±5%	BP : Bulk Packing	A : 500 pc	9 = PT-64mm	
	050:0,50(1/2W)		0000 = 00Ohm	K : ±10%		1 : 1k pc	P = Panasert type	
	100:1,0 (1 W)					2 : 2k pc	1 = Avisert type 1	
	200:2,0 (2 W)		Example: R010 = 0,01Ohm			B : 2.500 pc	2 = Avisert type 2	
	300:3,0 (3 W) (only small size)		97R6=			3 : 3k pc	3 = Avisert type 3	
			9760 = 976Ohm			4 : 4k pc	A = Cutting type CO 1/4W -A type	* not all combination is possible
			1001 = 1kOhm			5 : 5k pc	B = Cutting type CO 1/4W -B type	**only Ultra Small size
							7 = Lead wire(H) 38mm	*** Please check availability

Example:

Part Number

051025N1000JTR1:

Description

Carbon Film Fixed Resistor, 1/4W, Normal Size, 100Ω, ±5% tolerance, Tape in Reel 1kpc

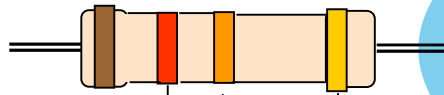
1. Applicable Scope:

This specification is for use in **CARBON FILM FIXED RESISTORS**
 Characteristics and specifications are according to those of:
 JIS C 5202

2. Marking

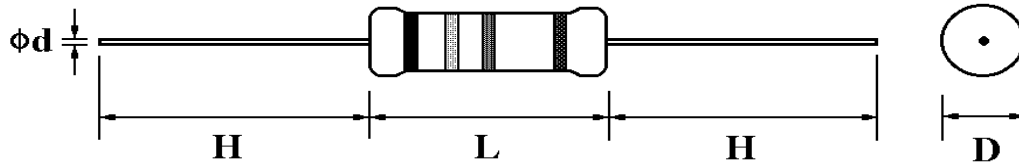
Colour code indication for nominal resistance value and tolerance

Fixed resistors of which the nominal resistance value and tolerance are indicated by colour codes in accordance with JIS C 0802, following the standard as below:



COLOR	1 ST DIGIT	2 ND DIGIT	MULTIPLIER	TOLERANCE
BLACK	0	0	1	
BROWN	1	1	10	F (±1%)
RED	2	2	100	G (±2%)
ORANGE	3	3	1.000	
YELLOW	4	4	10.000	
GREEN	5	5	100.000	
BLUE	6	6	1.000.000	
VIOLET	7	7	10.000.000	
GREY	8	8		
WHITE	9	9		
GOLD			0.1	J (±5%)
SILVER			0.01	K (±10%)

3. DIMENSIONS:

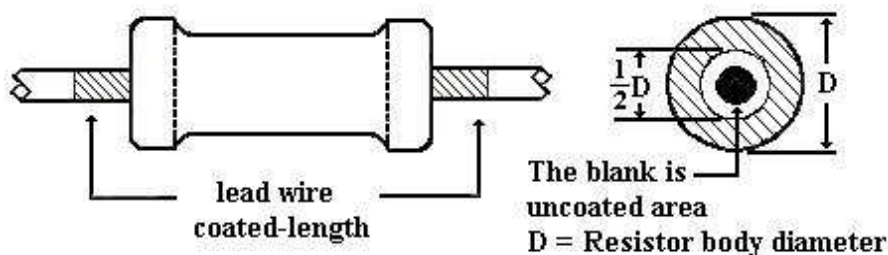


Normal size (not for Non-Flame and not for Non Inductive)					
Part No.	Power Rating at 70 °C	Dimension (mm)			
		D (Max.)	L (Max.)	$d \pm 0.05$	$H \pm 3$
051 012 N	1/8W (0,125W)	1,85	3,5	0,45	28
051 025 N	1/4W (0,25W)	2,5	6,8	0,54	28
051 050 N	1/2W (0,50W)	3,5	10,0	0,54	28
051 100 N	1W	5,5	16,0	0,70	28
051 200 N	2W	6,5	17,5	0,75	28

Small size (not for Non-Flame and not for Non Inductive)					
Part No.	Power Rating at 70 °C	Dimension (mm)			
		D (Max.)	L (Max.)	$d \pm 0.05$	$H \pm 3$
051 025 S	1/4W (0,25W)	1,85	3,5	0,45	28
051 050 U	1/2W (0,50W)	2,5	6,8	0,54	28
051 050 S	1/2W (0,50W)	3,0	9,0	0,54	28
051 100 S	1W	5,0	12,0	0,70	25
051 200 S	2W	5,5	16,0	0,70	28
051 300 S	3W	6,5	17,5	0,75	28

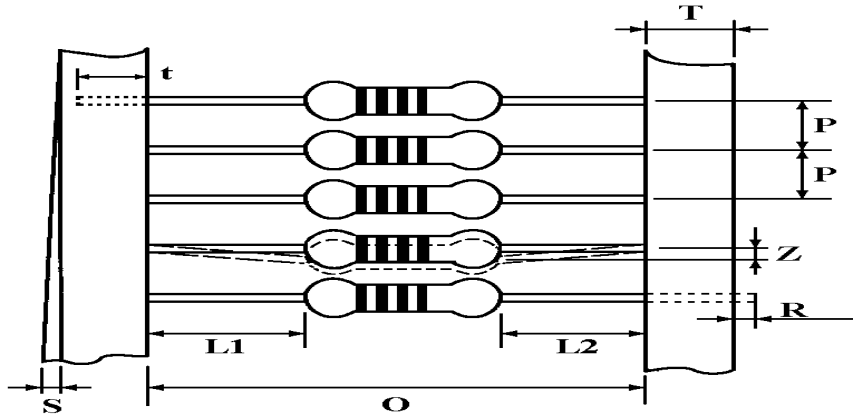
4. Painting method:

Welding point, terminal and lead wire, is permissible to be exposed without the outer coated cover. The extent should be within 1/2 of the angle.



5. Packing

Tape Packing



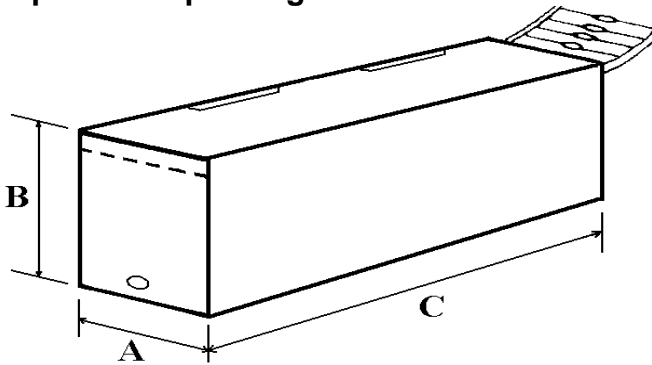
Normal size									
Part No.	Style	O	P	L1-L2	T	Z	R	t	S
051 012 N	PT-52	52 ± 1	5 ± 0.3	1 Max.	6 ± 1	1 Max.	0	4 ± 1	0,5 Max,
051 025 N	PT-52	52 ± 1	5 ± 0.3	1 Max.	6 ± 1	1 Max.	0	4 ± 1	0,5 Max,
051 050 N	PT-52	52 ± 1	5 ± 0.3	1 Max.	6 ± 1	1 Max.	0	4 ± 1	0,5 Max,
051 100 N	PT-64	64 ± 1	10 ± 0.5	1 Max.	6 ± 1	1 Max.	0	5 ± 1	0,5 Max,
051 200 N	PT-64	64 ± 1	10 ± 0.5	1 Max.	6 ± 1	1 Max.	0	5 ± 1	0,5 Max,

Small size									
Part No.	Style	O	P	L1-L2	T	Z	R	t	S
051 025 S	PT-52	52 ± 1	5 ± 0.3	1 Max.	6 ± 1	1 Max.	0	4 ± 1	0,5 Max,
051 050 S	PT-52	52 ± 1	5 ± 0.3	1 Max.	6 ± 1	1 Max.	0	4 ± 1	0,5 Max,
051 100 S	PT-52	52 ± 1	5 ± 0.3	1 Max.	6 ± 1	1 Max.	0	4 ± 1	0,5 Max,
051 200 S	PT-64	64 ± 1	10 ± 0.5	1 Max.	6 ± 1	1 Max.	0	5 ± 1	0,5 Max,
051 300 S	PT-64	64 ± 1	10 ± 0.5	1 Max.	6 ± 1	1 Max.	0	5 ± 1	0,5 Max,

Carbon Film

Resistors

Tape in Box packing:



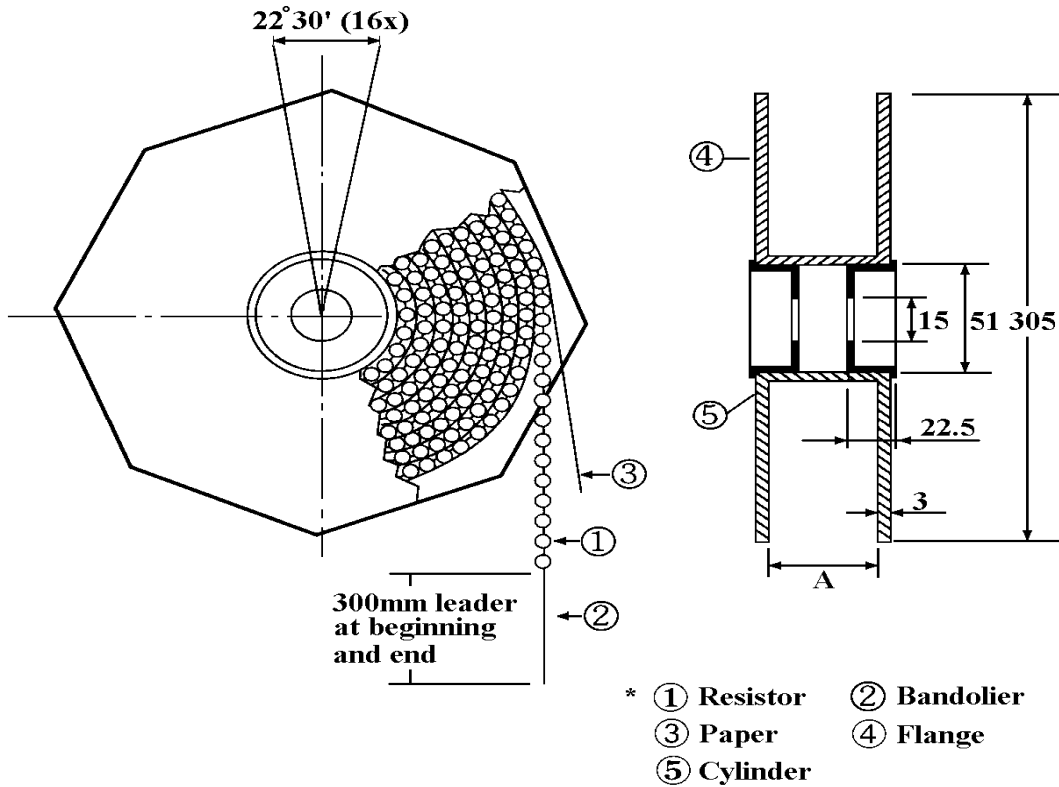
Bandoliers may also be contained in a cardboard box ("Ammopack")

Normal size					
Part No.	Style	L (C) ±5	W (A) ±5	H (B) ±5	Quantity Per Box (pcs.)
051 012 N	PT-52	250	75	66	5.000
051 025 N	PT-52	250	75	96	5.000
051 050 N	PT-52	255	75	43	1.000
051 100 N	PT-64	260	94	87	1.000
051 200 N	PT-64	262	96	69	500

Small size					
Part No.	Style	L (C) ±5	W (A) ±5	H (B) ±5	Quantity Per Box (pcs.)
051 025 S	PT-52	250	75	66	5.000
051 050 U	PT-52	250	75	96	5.000
051 050 S	PT-52	255	75	56	2.000
051 100 S	PT-52	255	79	73	1.000
051 200 S	PT-64	260	94	87	1.000
051 300 S	PT-64	262	96	69	500

"Ammopack" is an abbreviation of "ammunition pack"

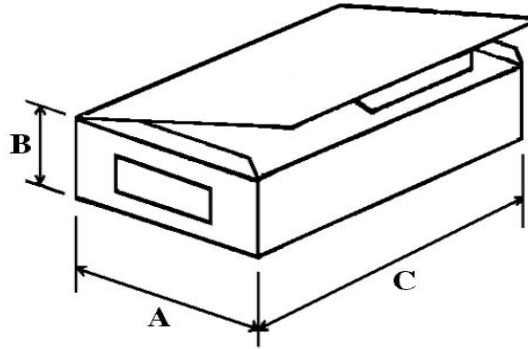
Tape in Reel packing:



Normal size			
Part No.	Style	Across Flange (A)	Quantity Per Reel
051 012 N	PT-52	73 ± 2	5.000
051 025 N	PT-52	73 ± 2	5.000
051 050 N	PT-52	73 ± 2	2.500
051 100 N	PT-64	81 ± 5	1.000
051 200 N	PT-64	81 ± 5	500

Small size			
Part No.	Style	Across Flange (A)	Quantity Per Reel
051 025 S	PT-52	73 ± 2	5.000
051 050 U	PT-52	73 ± 2	5.000
051 050 S	PT-52	73 ± 2	5.000
051 100 S	PT-52	73 ± 2	2.500
051 200 S	PT-64	81 ± 5	1.000
051 300 S	PT-64	81 ± 5	500

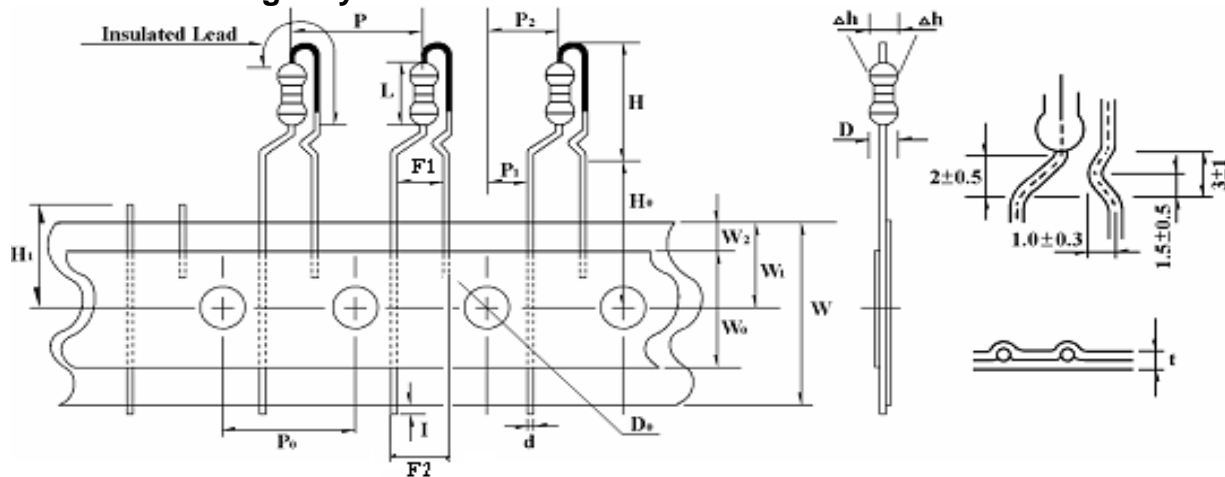
Bulk in box packing:
(plastic bag)



Normal size				
Part No.	L(C) ± 5	W(A) ± 5	H(B) ± 5	Quantity Per Bag (Pcs.)
051 012 N	150	77	33	500 / 1.000
051 025 N	150	77	33	500 / 1.000
051 050 N	150	75	67	100 / 1.000
051 100 N	155	95	53	100 / 500
051 200 N	155	95	53	100 / 400

Small size				
	L(C) ± 5	W(A) ± 5	H(B) ± 5	Quantity Per Bag (Pcs.)
051 025 S	150	77	33	500 / 1.000
051 050 U	150	77	33	500 / 1.000
051 050 S	150	75	67	100 / 1.000
051 100 S	155	95	53	100 / 500
051 200 S	155	95	53	100 / 500
051 300 S	155	95	53	100 / 400

Panasert-Forming only 1/4W:



Items	Symbol	Dimension (mm)	Items	Symbol	Dimension (mm)
Body diameter	D	2,5 Max,	Tape width	W	18 ± 1
Body length	L	6,8 Max,	Hold down tape width	W0	12,5 Min
Body height	H	12 Max,	Hole position	W1	9 ± 0,5
Lead wire diameter	d	0,54 +/-0,05	Hold down tape position	W2	3,0 Max
Pitch of component	P	12,7 ± 1	Lead wire clinch height	H0	16,5 Max
Feed hold pitch	P0	12,7 ± 0,3	Length of snipped lead	H1	11,0 Max
Hole center to lead	P1	3,85 ± 0,7	Lead wire protrusion	I	1,0 Max
Hole center to body		6,35 ± 1,3	Feed hole diameter	D0	4,0 ± 0,3
Lead to lead spacing	F1	4,19 Min	Total tape thickness	t	0,5 ± 0,2
	F2	6,22 Max	Length of lead cut	H1 - H2	2 ± 0,5
Component alignment	Δh	0 ± 1			

Remark: P0 Cumulative pitch error 1 mm / 20 pitch.

Size and Type	Ammo packing		Reel packing	
Figure				
Dimension	A	50 mm.	A	30 mm.
	B	150 mm.	B	50 mm.
	C	330 mm.	D	370 mm.
	D	50 mm.	W1	41 mm.
			W2	45 mm.
Quantity	2.000 pcs.		2.500 pcs.	

Ordering number example: 051025N1103FTRBP

Carbon Film resistor 1/4W, 110kOhm, 1% Tape in Reel, 2.5kpc Panasert-Forming

10/5/2010

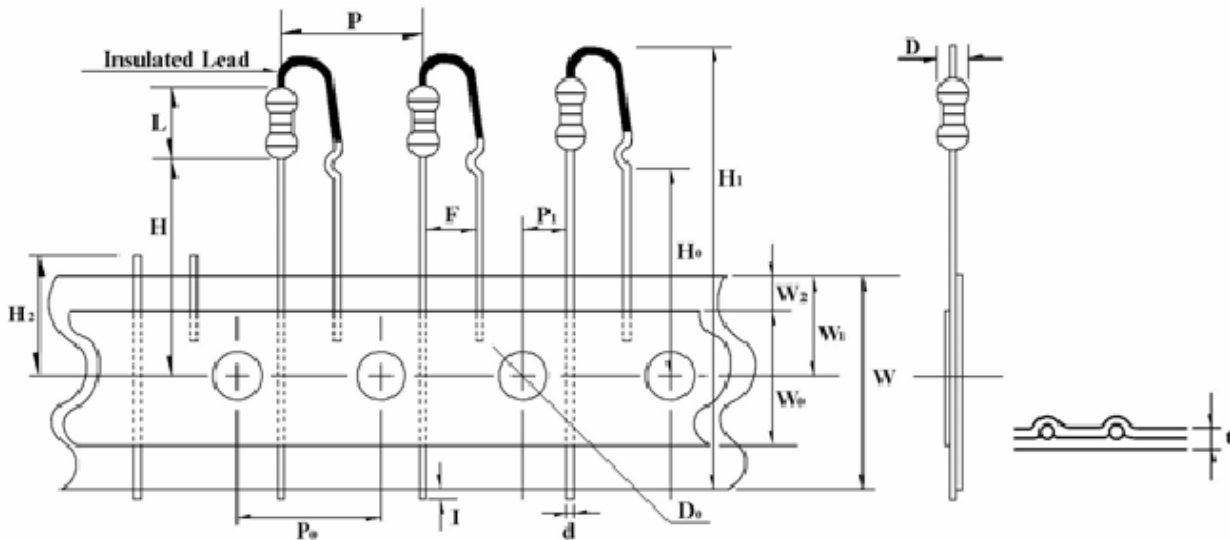
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Avisert-Type 1, only 1/4W:



Items	Symbol	Dimension (mm)	Items	Symbol	Dimension (mm)
Body diameter	D	2,5 Max,	Hold down tape width	W ₀	12,5 Min
Body length	L	6,8 Max,	Hole position	W ₁	9,5 ± 0,5
Lead wire diameter	d	0,54 +/-0,05	Hold down tape position	W ₂	3,0 Max
Pitch of component	P	12,7 ± 1	Height of Component from tape center	H	17±0,5
Feed hold pitch	P ₀	12,7 ± 0,3	Lead wire clinch height	H ₀	16±0,5
Feed hole center to lead	P ₁	3,85 ± 0,7	Component height	H ₁	34,50 Max
Lead to lead distance	F	5±1	Length of snipped lead	H ₂	11,0 Max
Component alignment	Δh	0 ± 1	Lead wire protrusion	l	1,0 Max
Tape width	W	18 ± 1	Feed hole diameter	D ₀	4,0 ± 0,3
Remark: P ₀ Cumulative pitch error 1 mm / 20 pitch.			Total tape thickness	t	0,5 ± 0,2

Size and Type	Ammo packing		Reel packing	
Figure				
Dimension	A	50 mm.	A	30 mm.
	B	150 mm.	B	50 mm.
	C	330 mm.	D	370 mm.
	D	50 mm.	W ₁	41 mm.
			W ₂	45 mm.
Quantity	2.000 pcs.		2.500 pcs.	

Ordering number example: 051025N1103FTRB1

Carbon Film resistor 1/4W, 110kOhm, 1% Tape in Reel, 2.5kpc Avisert type 1 - Forming

10/5/2010

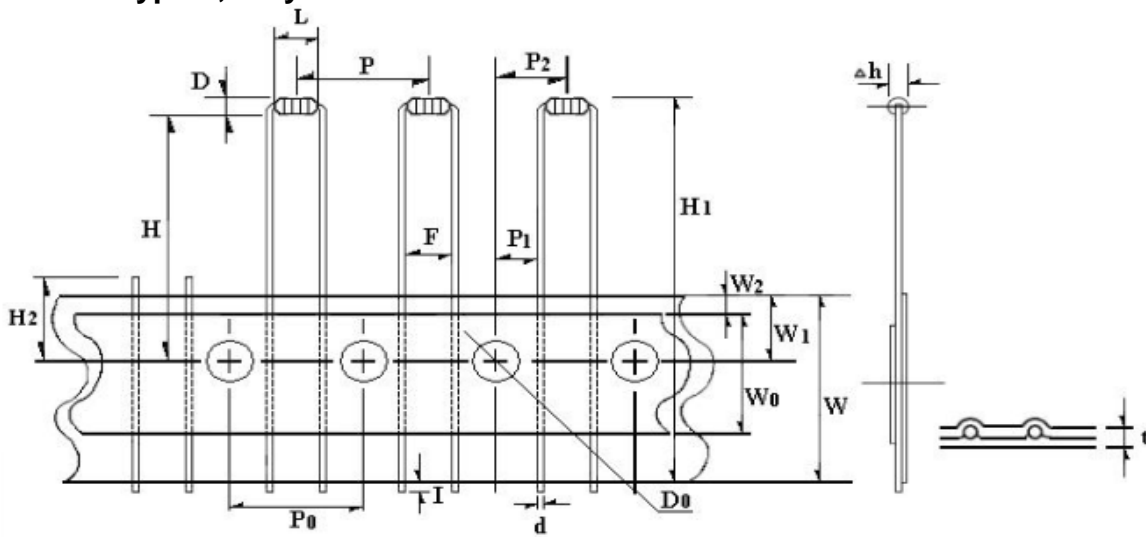
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Avisert-Type 2, only 1/8W:



Items	Symbol	Dimension (mm)	Items	Symbol	Dimension (mm)
Body diameter	D	1,85 Max,	Tape width	W	18 ± 1
Body length	L	3,5 Max,	Hole down tape width	W ₀	12,5 Min
Lead wire diameter	d	0,45 +/-0,05	Hole position	W ₁	9 ± 0,5
Pitch of component	P	12,7 ± 1	Hold down tape position	W ₂	3,0 Max
Feed hold pitch	P ₀	12,7 ± 0,3	Component height	H ₁	32,25 Max
Hole center to lead	P ₁	3,84 ± 0,7	Lead wire clinch height	H	21,25 Max
Hole center to component Center	P ₂	6,35 ± 1,3	Lead wire protrusion	l	1,0 Max
Lead to lead distance	F	5 ± 1	Feed hole diameter	D ₀	4,0 ± 0,3
Component alignment	Δh	0 ± 1	Total tape thickness	t	0,5 ± 0,2
Remark: P ₀ Cumulative pitch error 1 mm / 20 pitch.			Length of snapped lead	H ₂	11,0 Max

Size and Type	Ammo packing		Reel packing	
Figure				
Dimension	A	50 mm.	A	30 mm.
	B	150 mm.	B	50 mm.
	C	330 mm.	D	370 mm.
	D	50 mm.	W ₁	41 mm.
			W ₂	45 mm.
Quantity	2.000 pcs.		2.500 pcs.	

Ordering number example: 051012N1103FTRB2

Carbon Film resistor 1/8W, 110kOhm, 1% Tape in Reel, 2.5kpc Avisert type 2 - Forming

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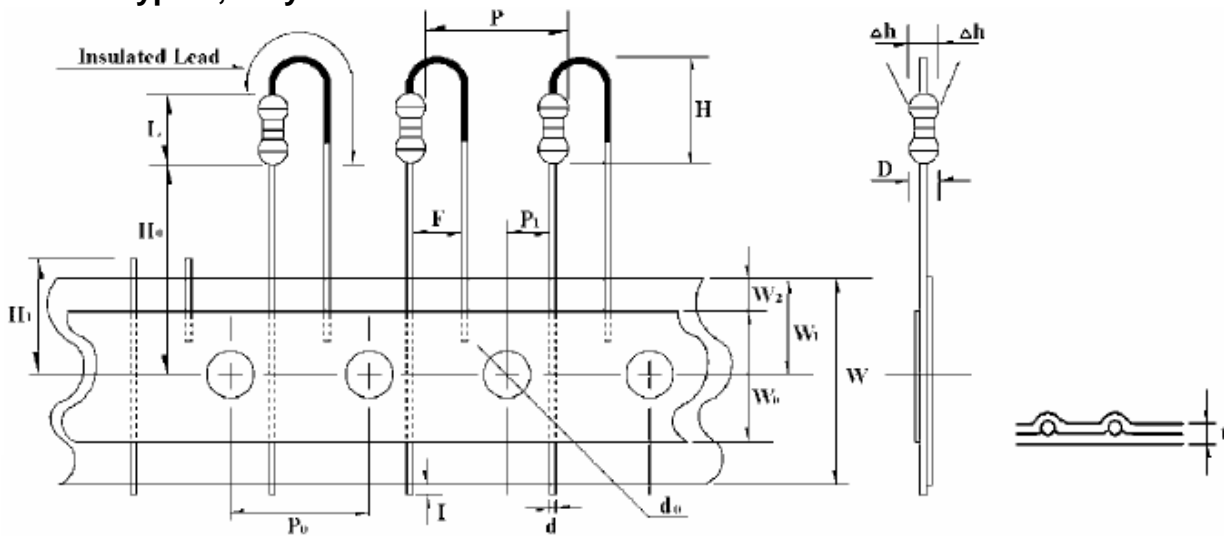
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Avisert-Type 3, only 1/8W and 1/4W:



Items	Symbol	Dimension (mm)		Items	Symbol	Dimension (mm)	
Body diameter	D	1/8W	2,0 Max	Tape width	W	18 ± 1	
		1/4W	2,5 Max			Hole down tape width	W0
Body length	L	1/8W	4,2 Max	Hole position	W1	9 ± 0,5	
		1/4W	6,8 Max	Hold down tape position	W2	3 Max	
Lead wire diameter	d	1/8W	0,45±0,05	Lead wire clinch position	H0	1/8W	20,0 Max
		1/4W	0,54±0,05			1/4W	16,5 Max
Pitch of component	P	12,7 ± 1		Length of snipped lead	H1	11,0 Max	
Feed hold pitch	P0	12,7 ± 0,3		Body height	H	1/8W	7,0 Max
						1/4W	10,0 Max
Hole center to lead	P1	3,85 ± 0,7		Lead wire protrusion	I	1,0 Max	
Lead to lead spacing	F	1/8W	2,5 ± 1	Feed hole diameter	d0	4,0 ± 0,3	
		1/4W	5 ± 1				
Component alignment	Δh	0 ± 1		Total tape thickness	t	0,5 ± 0,2	

Remark: P0 Cumulative pitch error 1 mm / 20 pitch.

Size and Type	Ammo packing		Reel packing	
Figure				
Dimension	A	50 mm.	A	30 mm.
	B	150 mm.	B	50 mm.
	C	330 mm.	D	370 mm.
	D	50 mm.	W1	41 mm.
			W2	45 mm.
Quantity	2.000 pcs.		2.500 pcs.	

Ordering number example: 051012N1103FTRB3

Carbon Film resistor 1/8W, 110kOhm, 1% Tape in Reel, 2.5kpc Avisert type 3 - Forming

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Specification

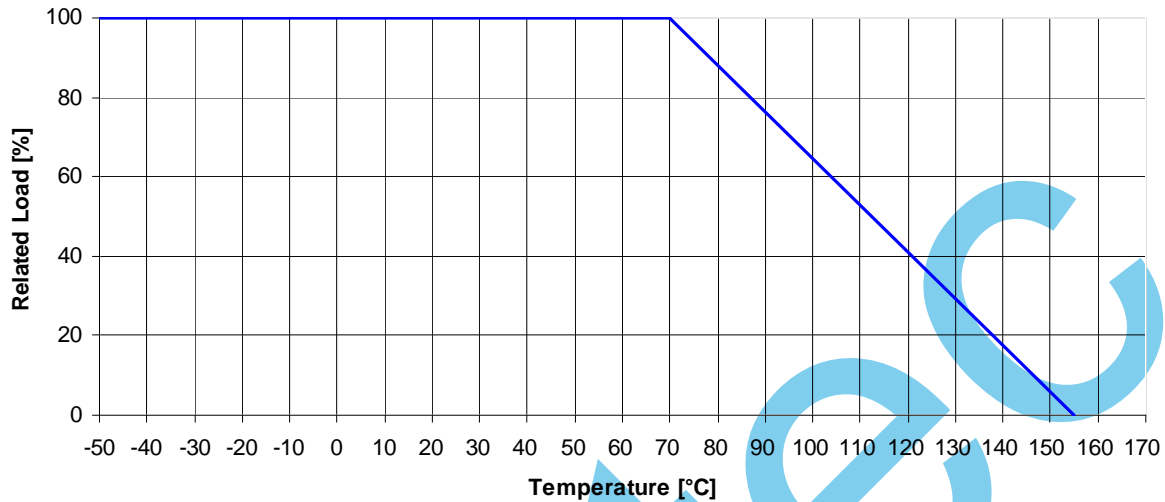
Type	Rated Power at 70°C	Max. Working Voltage	Max. Overload Voltage	Dielectric Withstanding Voltage	TCR °C	Resistance Range	Operating Temp. Range
051 012 N	1/8W (0,125W)	200 V	400 V	400 V	±350	1Ω--10Ω	-55°C - +155°C
					-450	11Ω--99kΩ	
					-700	100kΩ--10MΩ	
051 025 N	1/4W (0,25W)	250 V	500 V	500 V	±350	1Ω--10Ω	
					-450	11Ω--99kΩ	
					-700	100kΩ--1MΩ	
					-1500	1,1MΩ-10MΩ	
051 050 N	1/2W (0,50W)	350 V	700 V	700 V	±350	1Ω--10Ω	
					-450	11Ω--99kΩ	
					-700	100kΩ--1MΩ	
					-1500	1,1MΩ-10MΩ	
051 100 N	1W	500 V	1,000 V	1,000 V	±350	1Ω--10Ω	
					-450	11Ω--99kΩ	
					-700	100kΩ--1MΩ	
					-1500	1,1MΩ-10MΩ	
051 200 N	2W	500 V	1,000 V	1,000 V	±350	1Ω--10Ω	
					-450	11Ω--99kΩ	
					-700	100kΩ--1MΩ	
					-1500	1,1MΩ-10MΩ	
051 025 S	1/4W (0,25W)	200 V	400 V	400 V	±350	1Ω--10Ω	
					-450	11Ω--99kΩ	
					-700	100kΩ--10MΩ	
051 050 U	1/2W (0,50W)	250 V	500 V	250 V	±350	1Ω--10Ω	
					-450	11Ω--99kΩ	
					-700	100kΩ--1MΩ	
					-1500	1,1MΩ-10MΩ	
051 050 S	1/2W (0,50W)	350 V	700 V	700 V	±350	1Ω--10Ω	
					-450	11Ω--99kΩ	
					-700	100kΩ--1MΩ	
					-1500	1,1MΩ-10MΩ	
051 100 S	1W	500 V	1,000 V	1,000 V	±350	1Ω--10Ω	
					-450	11Ω--99kΩ	
					-700	100kΩ--1MΩ	
					-1500	1,1MΩ-10MΩ	
051 200 S	2W	500 V	1,000 V	1,000 V	±350	1Ω--10Ω	
					-450	11Ω--99kΩ	
					-700	100kΩ--1MΩ	
					-1500	1,1MΩ-10MΩ	
051 300 S	3W	500 V	1,000 V	1,000 V	±350	1Ω--10Ω	
					-450	11Ω--99kΩ	
					-700	100kΩ--1MΩ	
					-1500	1,1MΩ-10MΩ	

±2%, ±5%, ±10% E24 series

±1% please check availability of ohm values

6. Power rating:

Resistors shall have a power rating based on continuous full load operation at an ambient temperature of 70 °C. For temperature in excess of 70 °C , the load shall be derated as shown in the figure below.

**7. Voltage rating:**

The resistor shall have a DC continuous working voltage or a rms AC continuous working voltage at commercial-line frequency and wave form corresponding to the power rating, as determined from the following:

E= Rated voltage [V]

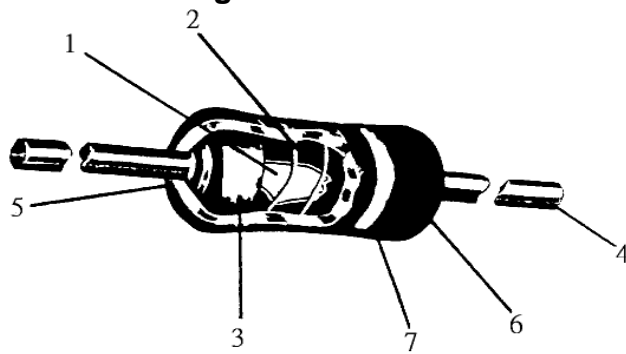
P= Power rating [W]

R= Nominal resistance [Ω]

$$E = \sqrt{R \cdot P}$$

Carbon Film

8. Structure Diagram



No.	Name	Material
1	Basic Body	Rod Type Ceramics
2	Resistance Film	Carbon Film
3	End Cap	Steel (Tin plated iron surface)
4	Lead Wire	Annealed copper wire coated with tin
5	Joint	By welding
6	Coating	Normal type: --Insulated resin (Color : Beige) Non-Flame type: --Insulated & Non-Flame paint (Color : Gray & Green mixed) meeting U L 94 V O standard
7	Color Code	Refer to 2. Marking

9. Nominal Resistance

Effective figures of nominal resistance shall be in accordance with E-96,E-24 series, and resistance tolerance shall be shown by table above.

Characteristics	Limits		Test Methods (JIS C 5201-1)
DC. resistance	Must be within the specified tolerance		The limit of error of measuring apparatus shall not exceed allowable range or 5% of resistance tolerance (Sub-clause 4.5)
Insulation resistance	Epoxy: Insulation resistance is 10 MΩ Min Non Flame Insulation resistance is 20 MΩ Min		Resistors shall be clamped in the trough of a 90° metallic V-block or foil method use a metal foil shall be wrapped closely around the body of the resistor. After that shall be tested at DC potential respectively specified in the above list for 60 +10/-0 sec. (Sub-clause 4.6)
Dielectric withstanding voltage	No evidence of flashover mechanical damage, arcing or insulation break down		Resistors shall be clamped in the trough of a 90° metallic V-block or foil method use a metal foil shall be wrapped closely around the body of the resistor. After that shall be tested at AC potential respectively specified in the table 1. for 60 +10/-0 sec. (Sub-clause 4.7)
Temperature coefficient	Resistance Range	T.C.R. (PPM/°C)	Natural resistance change per temp. degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \cdot 10^6 \text{ (PPM/°C)}$ R1: Resistance value at room temperature (t1) R2: Resistance value at room temp. plus 100°C (t2) (Sub-clause 4.8)
	< 10 Ω	0 ~ ±350	
	11Ω ~ 99K	0 ~ -450	
	100K ~ 1M	0 ~ -700	
	1,1M ~ 10M	0 ~ -1500	
Short time overload	Resistance change rate is ± (1 % + 0,05Ω) Max. with no evidence of mechanical damage		Permanent resistance change after the application of a potential of 2.5 times RCWV for 5 seconds. (Sub-clause 4.13)
Terminal strength	No evidence of mechanical damage.		Direct load: Resistance to a 2.5 kg direct load for 10 sec. in the direction of the longitudinal axis of the terminal leads. Twist test : Terminal leads shall be bent through 90 ° at a point of about 6mm from the body of the resistor and shall be rotated through 360° about the original axis of the bent terminal in alternating direction for a total of 3 rotations. (Sub-clause 4.16)
Solderability	95 % coverage Min.		The area covered with a new, smooth clean, shiny and continuous surface free from concentrated pinholes. Test temp. of solder : 245°C ± 3°C Dwell time in solder : 2 ~ 3 seconds (Sub-clause 4.17)

FrelTec

Carbon Film

Resistors

Soldering temp. reference	Electrical characteristics shall be satisfied. Without distinct deformation in appearance. (95 % coverage Min.)	The leads immersed into solder bath to 3.2 to 4.8 mm. from the body. Permanent resistance change shall be checked. <u>Wave soldering condition: (2 cycles Max.)</u> Pre-heat : 100 ~ 120 °C, 30 ± 5 sec. Suggestion solder temp.: 235 ~ 255 °C, 10 sec. (Max.) Peak temp.: 260 °C <u>Hand soldering condition:</u> Hand Soldering bit temp. : 380 ± 10 °C Dwell time in solder : 3 +1/-0 sec.													
Resistance to soldering heat	Resistance change rate is ± (1% + 0,05Ω) Max. with no evidence of mechanical damage.	Permanent resistance change when leads immersed to 3,2 to 4,8 mm from the body in 350°C ± 10 °C solder for 3 ± 0,5 sec (Sub-clause 4.18)													
Temperature cycling	Resistance change rate is ± (1% + 0.05Ω) Max. with no evidence of mechanical damage.	Resistance change after continuous 5 cycles for duty shown below:													
		<table border="1"> <thead> <tr> <th>Step</th> <th>Temperature</th> <th>Time</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>-55°C ±3°C</td> <td>30 mins</td> </tr> <tr> <td>2</td> <td>Room temp.</td> <td>10~15 mins</td> </tr> <tr> <td>3</td> <td>+155°C ±2°C</td> <td>30 mins</td> </tr> <tr> <td>4</td> <td>Room temp.</td> <td>10~15 mins</td> </tr> </tbody> </table>	Step	Temperature	Time	1	-55°C ±3°C	30 mins	2	Room temp.	10~15 mins	3	+155°C ±2°C	30 mins	4
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1	-55°C ±3°C	30 mins													
2	Room temp.	10~15 mins													
3	+155°C ±2°C	30 mins													
4	Room temp.	10~15 mins													
Vibration	Resistance change rate is ± (1% + 0.05Ω) Max.	55Hz, 3 planes 2hrs each Total amplitude = 1.5mm (Sub-clause 4.22)													
Load life in humidity	Resistance value														
	Normal Type	< 100KΩ ΔR/R ± 3 %													
		≥ 100KΩ ± 5 %													
	Non-Flame type	< 100KΩ ± 5 %													
≥ 100KΩ ± 10 %															
Load life	Resistance value														
	Normal Type	< 56KΩ ± 2 %													
		≥ 56KΩ ± 3 %													
	Non-Flame type	< 100KΩ ± 5 %													
≥ 100KΩ ± 10 %															
Resistance to solvent	No deterioration of protective coatings and markings	Specimens shall be immersed in a bath of trichroethane completely for 3 minutes with ultrasonic (Sub-clause 4.30)													

Environment Related Substance:

This product comply to EU RoHS directive, EU PAHs directive, EU PFOS directive and Halogen free.

Ozone layer depleting substances. Ozone depleting substance are not used in our manufacturing process of these products.

This product is not manufacture using Chloro fluorocabons (CFCs), Hydrochlorofluorocarbons (HCFCs), Hydrobromofluorocarbons (HBFCs) or other ozone depleting substance in any phase of the manufacturing process.

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