

FrelTec GmbH

Mathildenstr. 10A
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Germany

Thin Film Chip Resistor
SMD
High Precision (1% to 0,01%)
Low TCR (1 to 100 ppm)
and Thin Film current sensing

SMD

SPECIFICATION

Part Number

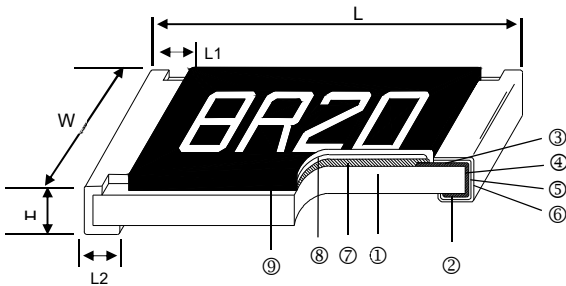
036	05*	1001*	J*	T05**	D	C
Type	Size	Value	Tolerance	Packing	TCR	Power Rating
036 : SMD Thin Film Chip Resistor	01 : 0201	The last digit is the multiplier which denotes the number of zero following	F : $\pm 1\%$	T05: Tape and Reel for 5k pc (7"reel)	R: $\pm 1\text{ppm}/^\circ\text{C}$	A: 1/32W
High Precision Low TCR	02 : 0402		D : $\pm 0,5\%$	T10: Tape and Reel for 10kpc (7"reel)	S : $\pm 2\text{ppm}/^\circ\text{C}$	B: 1/16W
	03 : 0603	Example: 57M9 = 0,0579Ohm (for less than 0,1Ohm) R100 = 0,1Ohm 97R6= 97,6Ohm 9760 = 976Ohm 1001 = 1kOhm	C : $\pm 0,25\%$	E04: Tape and reel for 4k pc (7"reel)	T : $\pm 3\text{ppm}/^\circ\text{C}$	C: 1/10W
	05 : 0805		B : $\pm 0,1\%$		A : $\pm 5\text{ppm}/^\circ\text{C}$	D: 1/8W
	06 : 1206		A : $\pm 0,05\%$		B : $\pm 10\text{ppm}/^\circ\text{C}$	R: 1/6W
	10 : 1210		T : $\pm 0,01\%$	** T10 for 0201 and 0402 all Paper Type	C : $\pm 15\text{ppm}/^\circ\text{C}$	S: 1/5W
	20 : 2010			** T05 for 0603 to 1210 all Paper Type	D : $\pm 25\text{ppm}/^\circ\text{C}$	E: 1/4W
	25 : 2512			** E04 for 2010 and 2512 Embossed Plastic Type	E : $\pm 50\text{ppm}/^\circ\text{C}$	G: 1/3W
					F : $\pm 100\text{ppm}/^\circ\text{C}$	H: 1/2W
					G : $\pm 200\text{ppm}/^\circ\text{C}$	I: 3/4W
					* not all combination is possible	J: 1W
						M: 3W

All products according to RoHS (2015/863/EU)

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THIN FILM CHIP RESISTORS

Construction



① Alumina Substrate	③ Edge Electrode	⑤ Resistor Layer
② Bottom Electrode	④ Barrier Layer	⑥ Overcoat
③ Top Electrode	⑥ External Electrode	⑨ Marking

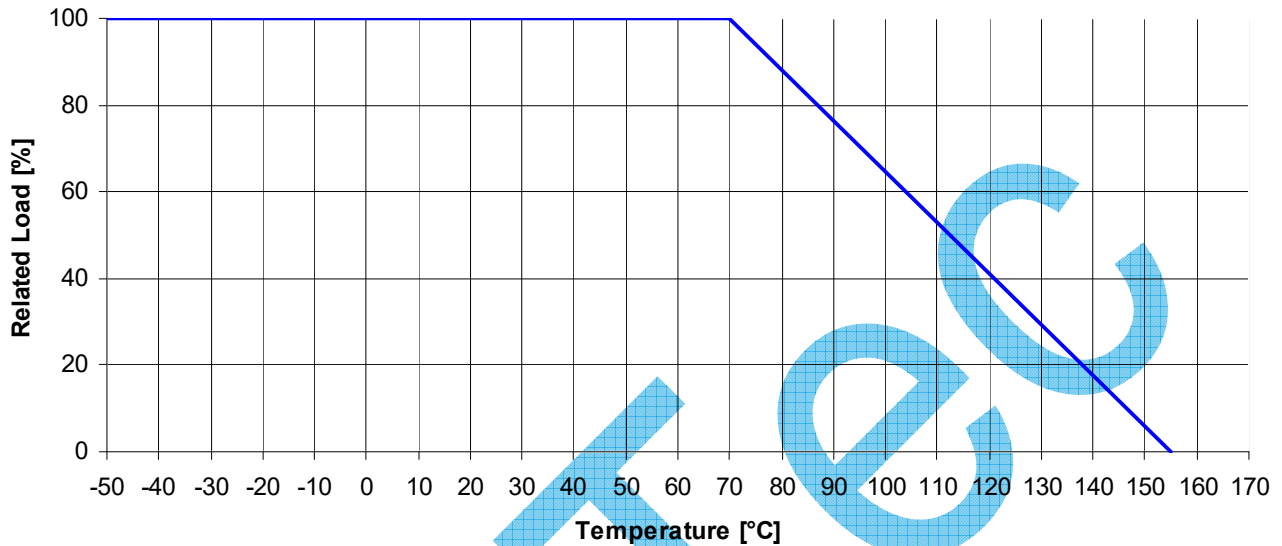
Dimensions

Size	L	W	H	L1	L2
0201	0,58±0,05	0,29±0,05	0,23±0,05	0,12±0,05	0,15±0,05
0402	1,00±0,05	0,50±0,05	0,30±0,05 0,32±0,10 for <10hm	0,20±0,10 0,20±0,10 for <10hm	0,20±0,10
0603	1,55±0,10 1,60±0,10 for <10hm	0,80±0,10	0,45±0,10	0,30±0,20	0,30±0,20
0805	2,00±0,15	1,25±0,15	0,55±0,10	0,30±0,20	0,40±0,25
1206	3,05±0,15	1,55±0,15	0,55±0,10	0,42±0,20 0,50±0,30 for <10hm	0,35±0,25 0,40±0,25 for <10hm
1210	3,10±0,15	2,40±0,15	0,55±0,10	0,40±0,20	0,55±0,25
2010	4,90±0,15 5,00±0,20 for <10hm	2,40±0,15 2,45±0,15 for <10hm	0,55±0,10 0,60±0,15 for <10hm	0,60±0,30	0,50±0,25
2512	6,30±0,15 6,35±0,20 for <10hm	3,10±0,15 3,15±0,15 for <10hm	0,55±0,10 0,60±0,10 for <10hm	0,60±0,30	0,50±0,25 0,55±0,25 for <10hm

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Power Derating Curve

For resistors operated in ambient temperatures above 70 °C , power rating shall be derated in accordance with figure below, Operating Temperature Range : -55°C 155°C



Voltage Rating:

Rated Voltage: 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]

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

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THIN FILM CHIP RESISTORS

036 Series

GENERAL PURPOSE CHIP RESISTORS

Type	Size	Power Rating at 70°C	Max. Working Voltage	Max. Overload Voltage	Temperature Coefficient [TCR; ppm/°C]	Resistance Range [Ω]				
						T(±0,01%) E24, E96, E192*	A(±0,05%) E24, E96, E192*	B(±0,1%) E24, E96, E192*	C(±0,25%) E24, E96, E192*	D(±0,5%) E24, E96, E192*
036 01	0201	1/32W	15V	30V	±25	-				49,9Ω~4,99kΩ
					±50					49,9Ω~33kΩ
036 02	0402	1/16W	25V	50V	±1	49,9Ω~4,99kΩ			-	
					±2					
					±3	49,9Ω~20kΩ			-	
					±5					
					±10	49,9Ω~20kΩ		49,9Ω~100kΩ		
					±15					49,9Ω~69,8kΩ
					±25	-	49,9Ω~12kΩ	10Ω~511kΩ	4,7Ω~511kΩ	
±50	-	49,9Ω~12kΩ	10Ω~511kΩ	4,7Ω~511kΩ						
036 03	0603	1/16W	50V	100V	±1	24,9Ω~15kΩ			-	
					±2					
					±3	24,9Ω~60kΩ			-	
					±5					
					±10	24,9Ω~100kΩ	4,7Ω~332kΩ	4,7Ω~511kΩ		
					±15	24,9Ω~100kΩ	4,7Ω~332kΩ	4,7Ω~511kΩ		
					±25	-	4,7Ω~332kΩ	4,7Ω~1MΩ	1Ω~1MΩ	
±50	-	4,7Ω~332kΩ	4,7Ω~1MΩ	1Ω~1MΩ						
036 05	0805	1/10W	100V	200V	±1	24,9Ω~30kΩ			-	
					±2					
					±3	24,9Ω~150kΩ			-	
					±5					
					±10	24,9Ω~200kΩ	4,7Ω~1MΩ			
					±15	24,9Ω~200kΩ	4,7Ω~1MΩ			
					±25	-	4,7Ω~1MΩ	4,7Ω~2MΩ	1Ω~2MΩ	
±50	-	4,7Ω~1MΩ	4,7Ω~2MΩ	1Ω~2MΩ						
036 06	1206	1/8W	150V	300V	±1	24,9Ω~49,9kΩ			-	
					±2					
					±3	24,9Ω~300kΩ			-	
					±5					
					±10	24,9Ω~499kΩ	4,7Ω~1,5MΩ			
					±15	24,9Ω~499kΩ	4,7Ω~1,5MΩ			
					±25	-	4,7Ω~1MΩ	4,7Ω~2,49MΩ	1Ω~2,49MΩ	
±50	-	4,7Ω~1MΩ	4,7Ω~2,49MΩ	1Ω~2,49MΩ						
036 10	1210	1/4W	150V	300V	±1	24,9Ω~49,9kΩ			-	
					±2					
					±3	24,9Ω~300kΩ			-	
					±5					
					±10	24,9Ω~499kΩ	4,7Ω~1MΩ			
					±15	24,9Ω~499kΩ	4,7Ω~1MΩ			
					±25	-	4,7Ω~1MΩ	4,7Ω~2,49MΩ	1Ω~2,49MΩ	
±50	-	4,7Ω~1MΩ	4,7Ω~2,49MΩ	1Ω~2,49MΩ						
036 20	2010	1/4W	150V	300V	±1	24,9Ω~100kΩ			-	
					±2					
					±3	24,9Ω~300kΩ			-	
					±5					
					±10	24,9Ω~499kΩ	4,7Ω~1MΩ			
					±15	24,9Ω~499kΩ	4,7Ω~1MΩ			
					±25	-	4,7Ω~1MΩ	4,7Ω~3MΩ	1Ω~3MΩ	
±50	-	4,7Ω~1MΩ	4,7Ω~3MΩ	1Ω~3MΩ						
036 25	2512	1/2W	150V	300V	±1	24,9Ω~100kΩ			-	
					±2					
					±3	24,9Ω~100kΩ			-	
					±5					
					±10	24,9Ω~499kΩ	4,7Ω~1MΩ			
					±15	24,9Ω~499kΩ	4,7Ω~1MΩ			
					±25	-	4,7Ω~1MΩ	4,7Ω~3MΩ	1Ω~3MΩ	
±50	-	4,7Ω~1MΩ	4,7Ω~3MΩ	1Ω~3MΩ						

*E192 Series no marking on chip, availability need checking with sales

9/24/2019

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Special High Power

Type	Size	Power Rating at 70°C	Max, Working Voltage	Max, Overload Voltage	Temperature Coefficient [TCR; ppm/°C]	Resistance Range [Ω]					
						T(±0,01%) E24, E96, E192*	A(±0,05%) E24, E96, E192*	B(±0,1%) E24, E96, E192*	C(±0,25%) E24, E96, E192*	D(±0,5%) E24, E96, E192*	F(±1%) E24, E96, E192*
036 02	0402	1/10W	50V	100V	±1	24,9Ω~4,99kΩ			-		
					±2						
					±3						
					±5	49,9Ω~4,99kΩ					
					±10	49,9Ω~12kΩ		49,9Ω~60kΩ			
					±15			49,9Ω~69,8kΩ			
					±25	-	49,9Ω~12kΩ	10Ω~255kΩ	4,7Ω~255kΩ		
±50											
036 03	0603	1/10W	75V	150V	±1	24,9Ω~15kΩ			-		
					±2						
					±3						
					±5	24,9Ω~15kΩ					
					±10	24,9Ω~100kΩ		4,7Ω~332kΩ		4,7Ω~332kΩ	
					±15					4,7Ω~1MΩ	
					±25						
	±50										
	±25	-	10Ω~332kΩ								
	±50										
036 05	0805	1/8W	150V	300V	±2	24,9Ω~30kΩ			-		
					±1						
					±2						
					±5	24,9Ω~30kΩ					
					±10	24,9Ω~200kΩ		4,7Ω~511kΩ		4,7Ω~511kΩ	
					±15					4,7Ω~1MΩ	
					±25					4,7Ω~1MΩ	
	±50										
	±25	-	10Ω~499kΩ								
	±50										
036 06	1206	1/4W	200V	400V	±1	24,9Ω~49,9kΩ			-		
					±2						
					±3						
					±5	24,9Ω~49,9kΩ					
					±10	24,9Ω~499kΩ		4,7Ω~1MΩ			
					±15						
					±25						
	±50										
	±25	-	10Ω~1MΩ								
	±50										
036 10	1210	1/3W	200V	400V	±1	24,9Ω~49,9kΩ			-		
					±2						
					±3						
					±5	24,9Ω~49,9kΩ					
					±10	24,9Ω~499kΩ		4,7Ω~1MΩ			
					±15						
					±25						
±50											
±25											
±50											
036 20	2010	1/3W	200V	400V	±1	24,9Ω~49,9kΩ			-		
					±2						
					±3						
					±5	24,9Ω~49,9kΩ					
					±10	24,9Ω~499kΩ		4,7Ω~1MΩ			
					±15						
					±25						
±50											
±25											
±50											
036 25	2512	3/4W	200V	400V	±10	24,9Ω~2kΩ		4,7Ω~2kΩ		1Ω~2kΩ	
					±15						
					±25						
		±50									
		±25			-	4,7Ω~100Ω		1Ω~100Ω			
±50											

*E192 Series no marking on chip, availability need checking with sales

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Current sensing <10hm

Type	Size	Power Rating at 70°C	Temperature Coefficient [TCR; ppm/°C]	Resistance Range [mΩ]	
				±0,5% E24, E96	±1% E24, E96
036 02	0402	1/16W	±100	500-1000	
			±50	500-1000	
036 03	0603	1/10W	±100	200-300	
			±50	301-1000	
036 05	0805	1/8W	±100	200-300	
			±50	301-1000	
036 06	1206	1/4W	±200	-	50-100
			±100	101-300	
			±50	301-1000	
036 20	2010	3/4W	±200	50-100	
			±100	101-300	
			±50	301-1000	
036 25	2512	1W	±200	50-100	
			±100	101-300	
			±50	301-1000	
		3W	±100	100-1000	

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SPECIFICATION

10hm and higher

E192 series and size 0201 and 0402 no marking
0805 to 2512

4 digit marking, first three digits marking are significant figures;
forth digit is multiplier (10^x),

examples: 1542 = $154 \times 10^2 = 15,400 \text{ Ohm} = 15,4\text{kOhm}$

0603 E69

examples: 12C (Table below) = $130 \times 10^2 = 13\text{kOhm}$



0603 E-24 series

3 digit marking, first two digits marking are significant figures; third
digit is multiplier (10^x),

examples: 222 = $22 \times 10^2 = 2,2\text{kOhm}$

3 digit Marking Table E96

Code	E96	Code	E96	Code	E96	Code	E96
01	100	25	178	49	316	73	562
02	102	26	182	50	324	74	576
03	105	27	187	51	332	75	590
04	107	28	191	52	340	76	604
05	110	29	196	53	348	77	619
06	113	30	200	54	357	78	634
07	115	31	205	55	365	79	649
08	118	32	210	56	374	80	665
09	121	33	215	57	383	81	681
10	124	34	221	58	392	82	698
11	127	35	226	59	402	83	715
12	130	36	232	60	412	84	732
13	133	37	237	61	422	85	750
14	137	38	243	62	432	86	768
15	140	39	249	63	442	87	787
16	143	40	255	64	453	88	806
17	147	41	261	65	464	89	825
18	150	42	267	66	475	90	845
19	154	43	274	67	487	91	866
20	158	44	280	68	499	92	887
21	162	45	287	69	511	93	909
22	165	46	294	70	523	94	931
23	169	47	301	71	536	95	953
24	174	48	309	72	549	96	976

Code	A	B	C	D	E	F	G	H	X	Y	Z
Multiplier	10^0	10^1	10^2	10^3	10^4	10^5	10^6	10^7	10^{-1}	10^{-2}	10^{-3}

3 digit Marking Table E24

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Thin Film Chip Resistors

E24	10	11	12	13	15	16	18	20	22	24	27	30	33	36	39	43	47	51	56	62	68	75	82	91
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SPECIFICATION <10hm

0603 3 digit marking:

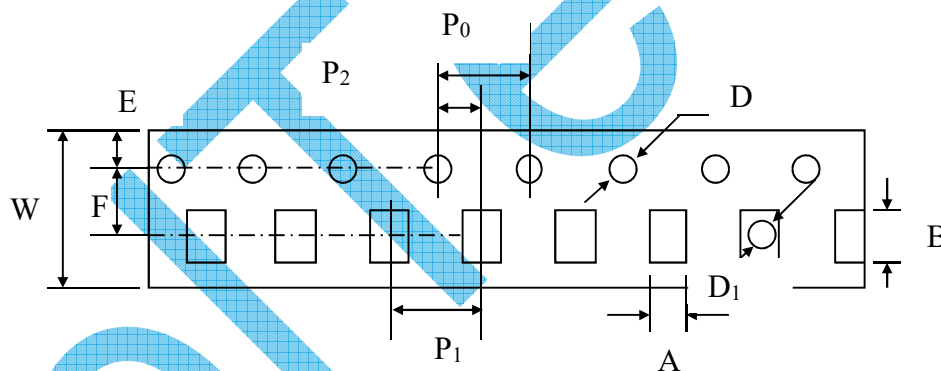
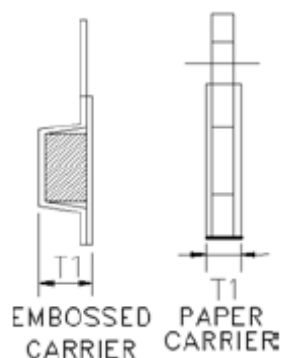
Resistance	1 Ω	0,1 Ω	0,15 Ω	0,01 Ω	0,101 Ω	0,035 Ω
Codes	1R0	R10	R15	R01	<u>101</u>	<u>035</u>

0805 to 2512 4 digit marking

Resistance	1 Ω	0,1 Ω	0,05 Ω	0,015 Ω	0,01 Ω
Codes	1R00	R100	R050	R015	R010

SPECIFICATION

Tape And Reel Package



Type	A	B	W	E	F	P ₀	P ₁	P ₂	ΦD	ΦD ₁	T ₁
0201	0,40±0,05	0,70±0,05	8,00±0,10	1,75±0,05	3,5±0,05	4,00±0,10	2,00±0,05	2,00±0,05	1,55±0,03	-	0,42±0,02
0402	0,70±0,05	1,16±0,05	8,00±0,10	1,75±0,05	3,5±0,05	4,00±0,10	2,00±0,05	2,00±0,05	1,55±0,05	-	0,40±0,03
0603	1,10±0,05	1,90±0,05	8,00±0,10	1,75±0,05	3,5±0,05	4,00±0,10	4,00±0,10	2,00±0,05	1,55±0,05	-	0,60±0,03
0805	1,60±0,05	2,37±0,05	8,00±0,10	1,75±0,05	3,5±0,05	4,00±0,10	4,00±0,10	2,00±0,05	1,55±0,05	-	0,75±0,05
1206	2,00±0,05	3,55±0,05	8,00±0,10	1,75±0,05	3,5±0,05	4,00±0,10	4,00±0,10	2,00±0,05	1,55±0,05	-	0,75±0,05
1210	2,75±0,05	3,40±0,05	8,00±0,10	1,75±0,05	3,5±0,05	4,00±0,05	4,00±0,10	2,00±0,05	1,60±0,10	-	0,75±0,05
2010	2,85±0,10	5,45±0,10	12,0±0,10	1,75±0,10	5,5±0,05	4,00±0,05	4,00±0,10	2,00±0,05	1,50±0,10	1,4 min	1,00±0,20
2512	3,40±0,10	6,65±0,10	12,0±0,10	1,75±0,10	5,5±0,05	4,00±0,05	4,00±0,10	2,00±0,05	1,50±0,10	1,4 min	1,00±0,20

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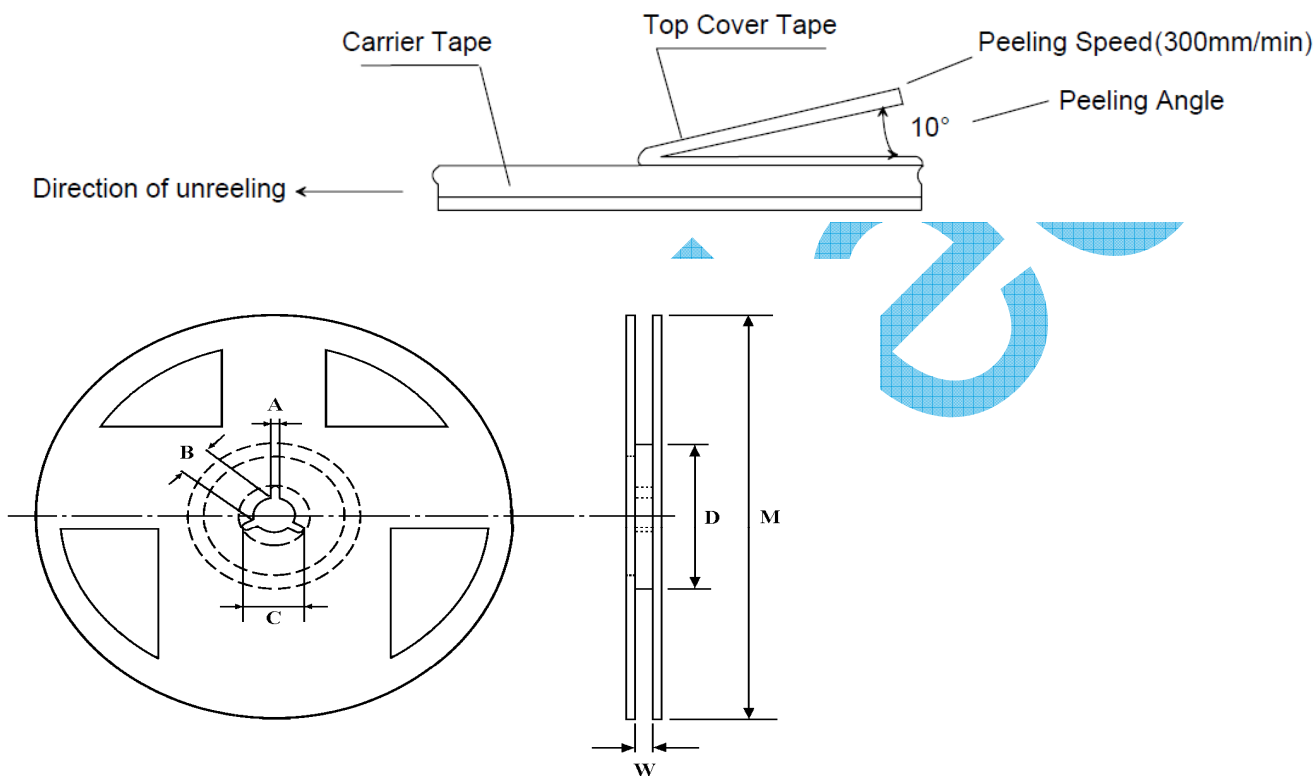
Cover Tape Peel off Strength

Specifications: 0201, 0402, 0603, 0805, 1206, 1210 – peel force of top cover tape shall be between 20 to 80g for >10Ω and 8 to 40g for <10Ω
10 to 100g

The peel speed shall be about 300mm/min±5%

for 2010, 2512 – peel force of top cover tape shall be between 20 to 80g and for <10Ω 10 to 100g

The peel speed shall be about 300mm/min±5%

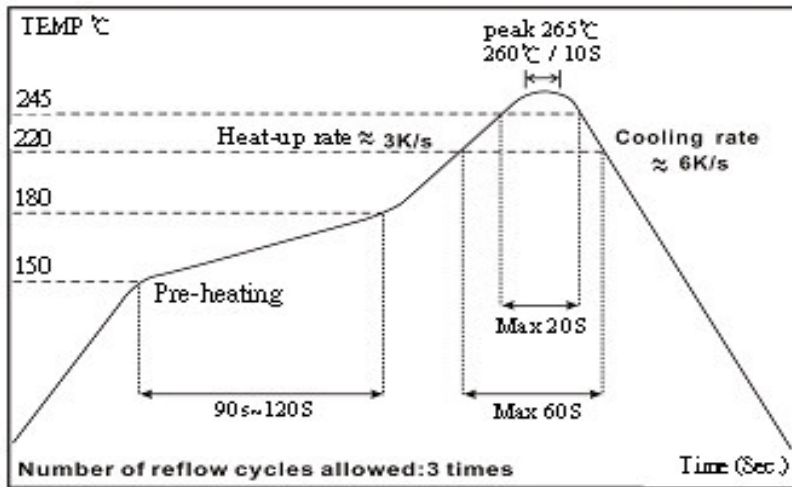


Type	Packaging	M	A	B	C	D	W	T
036 01 ... T10	Paper	178,0±1,0	2±0,5	13,5±0,7	21±0,5	60,0+1,0	9,5±1,0	11,5±1,0
036 02 ... T10								
036 03 ... T05								
036 05 ... T05								
036 06 ... T05								
036 10 ... T05	Embossed						13,5±1,0	15,5±1,0
036 20 ... E04								
036 25 ... E04								

Stock period

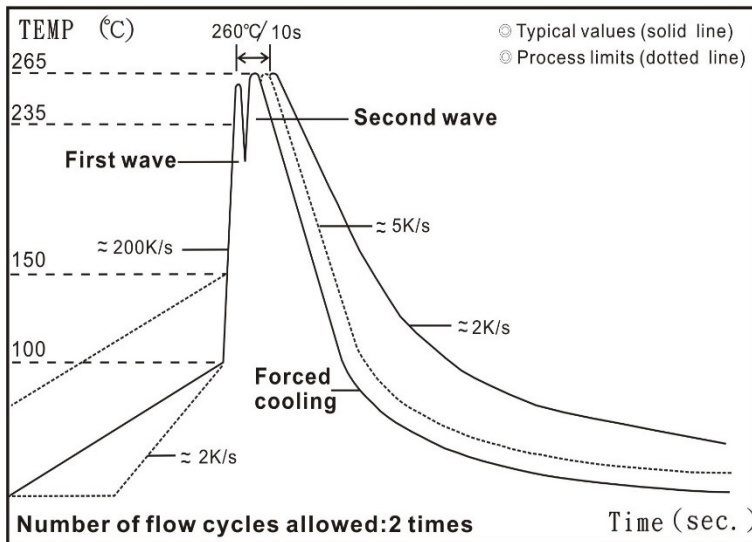
The performance of these products, including the solderability, is guaranteed for 12 month, provided that they remain packed as they were when delivered and stored at a temperature of 25°C ± 3°C and a relative humidity less than 80%RH

Lead Free IR Reflow Soldering Profile



Time of IR reflow soldering at maximum temperature point 260°C: 10s

<10hm, Lead Free Wave Soldering (Flow Soldering)

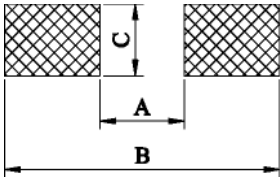


Time of wave soldering at maximum temperature point 260°C: 10s

Time of soldering iron at maximum temperature point 410°C: 5s

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Recommended Land Pattern Design (mm):



Size	A	B	C
0201	0,25	0,85	0,40±0,2
0402	0,50	1,50	0,60±0,2
0603	0,80	2,80	0,90±0,2
0805	1,00	3,00	1,35±0,2
1206	2,00	4,30	1,70±0,2
1210	2,00	4,30	2,50±0,2
2010	3,60	6,40	2,50±0,2
2512	4,90	8,10	3,10±0,2

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Environmental Characteristics

Item	Requirement		Test Method
	Tol. $\leq 0,05\%$	Tol. $> 0,05\%$	
Temperature Coefficient of Resistance (T.C.R.)	As spec.		MIL-STD-202F Method 304 +25/-55/+25/+125/+25°C
Short Time Overload	$\Delta R \pm 0,05\%$	$\Delta R \pm 0,2\%$	JIS-C-5201-1 4.13 RCWV*2,5 or Max. overload voltage whichever is lower for 5 seconds
	$\Delta R \pm 0,2\%$ for high power rating <1Ohm: $\pm 1\%$		
Insulation Resistance	>9999 M Ω		MIL-STD-202 Method 302 Apply 100V _{DC} for 1 minute
	<1Ohm: >1000 M Ω		
Endurance	$\Delta R \pm 0,05\%$	$\Delta R \pm 0,2\%$	MIL-STD-202 Method 108A 70 $\pm 2^\circ\text{C}$, Max. working voltage for 1000 hrs with 1,5 hrs "ON" and 0,5 hrs "OFF"
	$\Delta R \pm 0,5\%$ for high power rating		
	0201: >7k Ω -> $\Delta R \pm 0,5\%$ $\leq 7k\Omega$ -> $\Delta R \pm 0,2\%$		
	<1Ohm: $\pm 1\%$		
Damp Heat with Load	$\Delta R \pm 0,05\%$	$\Delta R \pm 0,3\%$	MIL-STD-202 Method 103B 40 $\pm 2^\circ\text{C}$, 90–95% R.H. Max. for 1000 hrs with 1,5 hrs "ON" and 0,5 hrs "OFF"
	$\Delta R \pm 0,5\%$ for high power rating		
	<1Ohm: $\pm 0,5\%$		
Bending Strength	$\Delta R \pm 0,05\%$	$\Delta R \pm 0,1\%$	JIS-C-5201-1 4.33 Bending amplitude 3 mm for 10 seconds >1Ohm: 2010 2512 sizes: 2 mm Other sizes: 3 mm
	<1Ohm: As spec.		
Solderability	95% min. coverage		MIL-STD-202 Method 208H 245 $\pm 5^\circ\text{C}$ for 3 seconds
Resistance to Soldering Heat	$\Delta R \pm 0,05\%$	$\Delta R \pm 0,1\%$	MIL-STD-202 Method 210E 260 $\pm 5^\circ\text{C}$ for 10 seconds
	<1Ohm: $\pm 0,5\%$		
Dielectric Withstand Voltage	By Type		MIL-STD-202 Method 301 Max. overload voltage for 1 minute
Thermal Shock <1Ohm	$\pm 0,5\%$		MIL-STD-202 Method 107G -55°C ~150°C, 100 cycles
Low Temperature Operation	$\Delta R \pm 0,05\%$	$\Delta R \pm 0,2\%$	JIS-C-5201-1 4.36 1 hour, -65°C, followed by 45 minutes of RCWV
	$\Delta R \pm 0,5\%$ for high power rating and for <1Ohm		
High Temperature Operation >1Ohm	$\Delta R \pm 0,05\%$		MIL-STD-202 Method 108 At 165°C, for 1000h

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