

APPROVAL SHEET

WF20M / WF12M / WF08M / WF06M

0/-20% and 0/-30%

Trimmable chip resistors

Size 2010, 1206, 0805, 0603

FEATURE

1. Reduced size of final equipment
2. Lower assembly costs
3. Higher component and equipment reliability
4. Improved performance at high frequency
5. Low noise, when not trimmed
6. RoHS compliant and Lead free products

APPLICATION

- Consumer electrical equipment
- Automotive application
- EDP, Computer application
- Telecom application

DESCRIPTION

The resistors are constructed on a high-grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste, which is applied to the substrate. The composition of the paste is adjusted to give the approximate resistance required.

The resistive layer is covered with a transparent protective coating. Finally the two external end terminations are added. For case of soldering the outer of these end terminations is Tin (lead free) alloy.

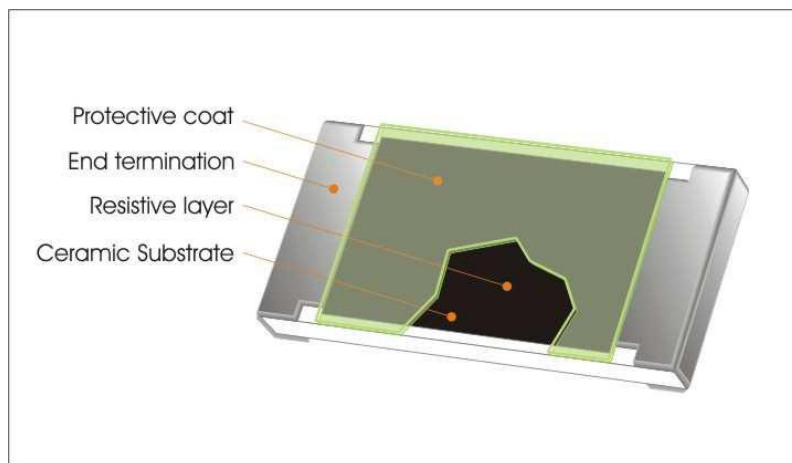


Fig 1. Construction of Trimmable Chip-R

QUICK REFERENCE DATA

Item	General Specification			
Series No.	WF20M	WF12M	WF08M	WF06M
Size code	2010 (5020)	1206 (3216)	0805 (2012)	0603 (1608)
Resistance Range	1Ω ~ 10MΩ Tolerance 0/-10% and 0/-20% and 0/-30% (E24 series)			
TCR (ppm/°C) ≥10Ω <10Ω	≤ ± 200 ppm/°C -300~+500 ppm/°C			
Max. dissipation at T _{amb} =70°C	1/2W	1/4 W	1/8W	1/10W
Max. Operation Voltage (DC or RMS)	200V	200V	100V	50V
Max. Over Load Voltage (DC or RMS)	400V	400V	200V	100V
Climatic category (IEC 60068)	55/155/56			

Note :

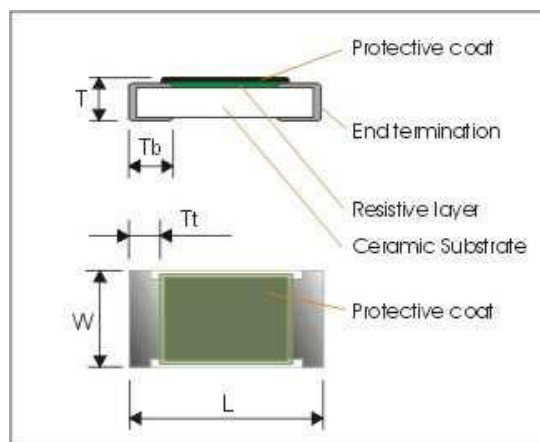
1. This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
2. Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

DIMENSIONS(unit : mm)

	WF20M	WF12M
L	5.00 ± 0.20	3.10 ± 0.10
W	2.50 ± 0.20	1.60 ± 0.10
T	0.55 ± 0.15	0.60 ± 0.15
Tb	0.65 ± 0.25	0.45 ± 0.20
Tt	0.60 ± 0.25	0.50 ± 0.20

	WF08M	WF06M
L	2.00 ± 0.10	1.60 ± 0.10
W	1.25 ± 0.10	0.80 ± 0.10
T	0.50 ± 0.15	0.45 ± 0.15
Tb	0.40 ± 0.20	0.30 ± 0.20
Tt	0.40 ± 0.20	0.30 ± 0.10



MARKING

No marking for Trimmable Chip Resistor

TRIMMING INTRODUCTIONS

Typical value for a YAG-laser;

cutting speed : 10-200 mm/sec,

laser power : 1-6 Watt,

bite size : 3~10 μ m (= speed / Q_rate , Bite Size is the distance each laser spot moving and influence the trimming accuracy)

maximum trimming length : 60% of resistive film width, minimum distance from end termination to trimming cut : 0.20mm, minimum distance between cuts (double-cut) : 0.5mm

Protection of the laser cut

by epoxy-fenol lacquers, epoxy resins or silicon alkyd-resins.

This is necessary for humidity test and stability under loaded.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of $\pm 5\%$, and E96 series for resistors with a tolerance of $\pm 1\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063"

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

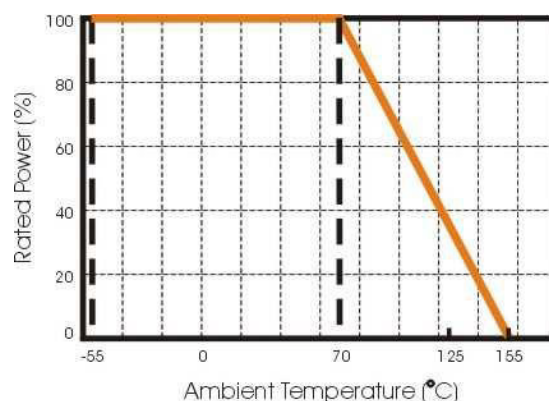


Figure 2 Maximum dissipation in percentage of rated power as a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

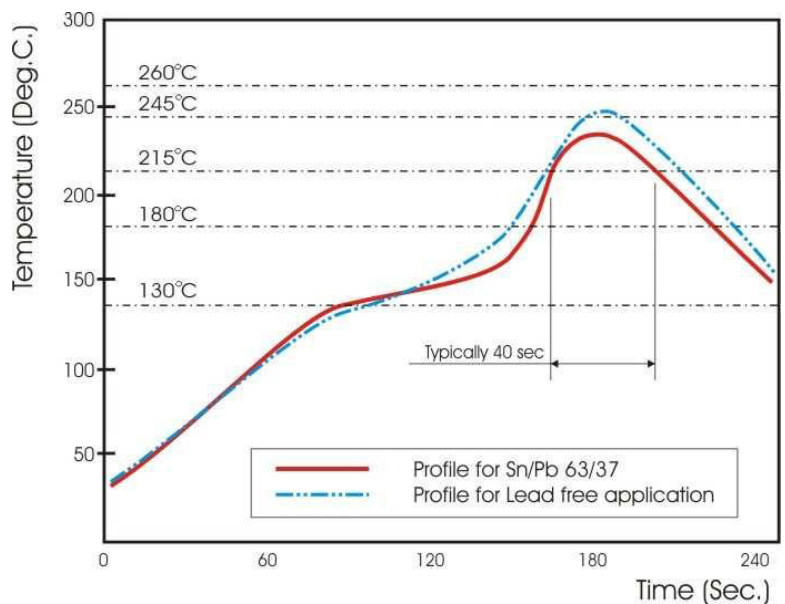


Fig 3. Infrared soldering profile for Chip Resistors

CATALOGUE NUMBERS

The resistors have a catalogue number starting with :

WF12	M	472_	M	T	L
Size code	Type code	Resistance code	Tolerance	Packaging code	Termination code
WF20 : 2010	M : Trimmable	E24 : 2 significant digits followed by no. of zeros and a blank	X : 0/-30%	T : 7" Reeled taping	L = Sn base (lead free)
WF12 : 1206			Y : 0/-20%	B : Bulk	
WF08 : 0805		4.7Ω =4R7_	Z : 0/-10%		
WF06 : 0603		10Ω =100_ 220Ω =221_ (“_” means a blank)			

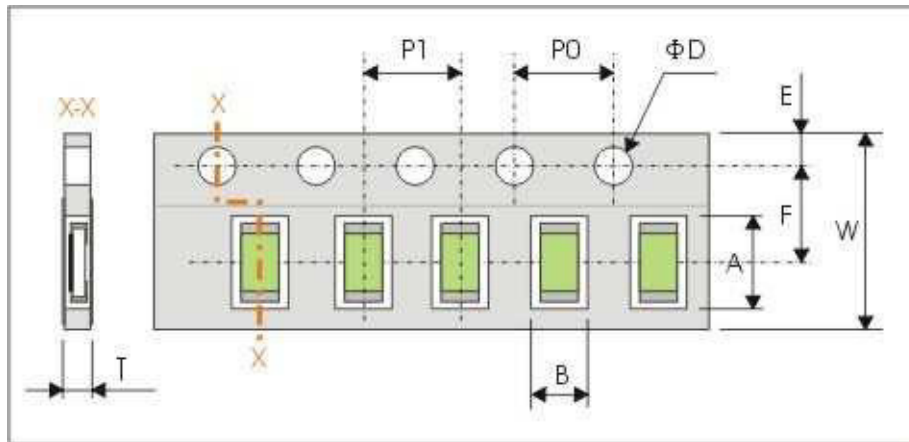
- Reeled tape packaging : WF12M / WF08M / WF06M - 8mm width paper taping 5000pcs per reel.
: WF20M – 12mm width paper taping 4000pcs per reel.
- Bulk packaging : WF12M / WF08M / WF06M - 5000pcs per polybag
: WF20M – 4000pcs per polybag

TEST AND REQUIREMENTS(JIS C 5201-1 : 1998)

TEST	PROCEDURE	REQUIREMENT
DC resistance Clause 4.5	DC resistance values measured at the test voltages specified below : <10Ω@0.1V, <100Ω@0.3V, <1KΩ@1.0V, <10KΩ@3V, <100KΩ@10V, <1MΩ@25V, <10MΩ@30V	Within the specified tolerance
Temperature Coefficient of Resistance(T.C.R) Clause 4.8	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6$ (ppm/°C) ; t1 : 20°C+5°C-1°C R1 : Resistance at reference temperature R2 : Resistance at test temperature	Refer to "QUICK REFERENCE DATA"
Short time overload (S.T.O.L) Clause 4.13	Permanent resistance change after a 5second application of a voltage 2.5 times RCWV or the maximum overload voltage specified in the above list, whichever is less.	ΔR/R max. ±(2.0%+0.10Ω)
Resistance to soldering heat(R.S.H) Clause 4.18	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260°C±5°C	no visible damage ΔR/R max. ±(1.0%+0.05Ω)
Solderability Clause 4.17	Un-mounted chips completely immersed for 2±0.5 second in a SAC solder bath at 235°C±5°C	good tinning (>95% covered) no visible damage
Temperature cycling Clause 4.19	30 minutes at -55°C±3°C, 2~3 minutes at 20°C+5°C-1°C, 30 minutes at +155°C±3°C, 2~3 minutes at 20°C+5°C-1°C, total 5 continuous cycles	no visible damage ΔR/R max. ±(0.5%+0.05Ω)
Load life (endurance) Clause 4.25	1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller 70±2°C, 1.5 hours on and 0.5 hours off	ΔR/R max. ±(3.0%+0.1Ω)
Load life in Humidity Clause 4.24	1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at 40°C±2°C and 90~95% relative humidity, 1.5hours on and 0.5 hours off	ΔR/R max. ±(3.0%+0.1Ω)
Bending strength Clause 4.33	Resistors mounted on a 90mm glass epoxy resin PCB(FR4); bending : 3 mm, once for 10 seconds. (only 2010: 2mm)	no visible damage ΔR/R max. ±(1%+0.05Ω)
Adhesion Clause 4.32	Pressurizing force: 5N, Test time: 10±1sec.	No remarkable damage or removal of the terminations.
Insulation Resistance Clause 4.6	Apply the maximum overload voltage (DC) for 1minute	R ≥ 10GΩ
Dielectric Withstand Voltage Clause 4.7	Apply the maximum overload voltage (AC) for 1 minute	No breakdown or flashover

PACKAGING

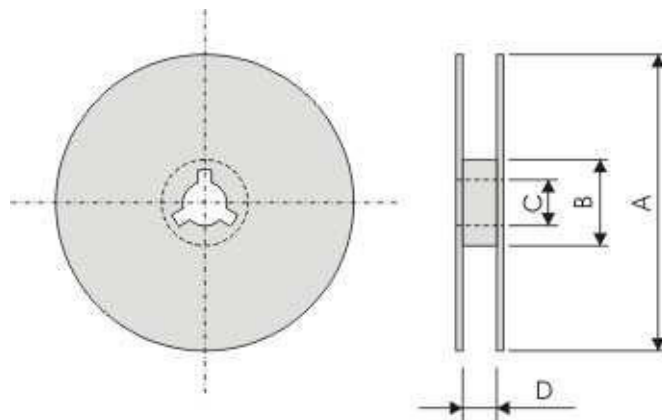
Paper Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF20M	5.50±0.20	2.80±0.20	12.00±0.30	5.50±0.1	1.75±0.10
WF12M	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF08M	2.40±0.20	1.65±0.20			
WF06M	1.90±0.20	1.10±0.20			

Series No.	P1	P0	ΦD	T
WF20M	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.2
WF12M / WF08M				Max. 1.0
WF06M				0.65±0.05

Reel dimensions



Symbol (unit : mm)	A	B	C	D
WF12M / WF08M / WF06	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	9.0±0.5
WF20M	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	14.0±0.2

APPROVAL SHEET

WF25N, WF20N, WF12N, WF08N, WF06N

$\pm 1\%$, $\pm 5\%$

Thick Film High Voltage Chip Resistors

UL Safety Certification

Size 2512, 2010, 1206, 0805, 0603

Automotive AEC Q200 Compliant

*Contents in this sheet are subject to change without prior notice

FEATURE

1. Special materials and design for higher working voltage required.
2. Compatible with flow and reflow soldering.
3. Suitable for lead free soldering.
4. Max. Voltage coefficient resistance below 300ppm.
5. Meet AEC-Q200, RoHS compliant & Halogen Free.
6. Safety resistor certificate meet :
 - UL/IEC 62368-1: 2020 resistor requirement certificated
 - UL/IEC 60950-1 2.5KV impulse certificated
 - UL/IEC 60065 10KV impulse certificated

APPLICATION

- Power supply
- Automotive industry
- Measurement instrument
- Back light inverter
- Medical or Military equipment

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

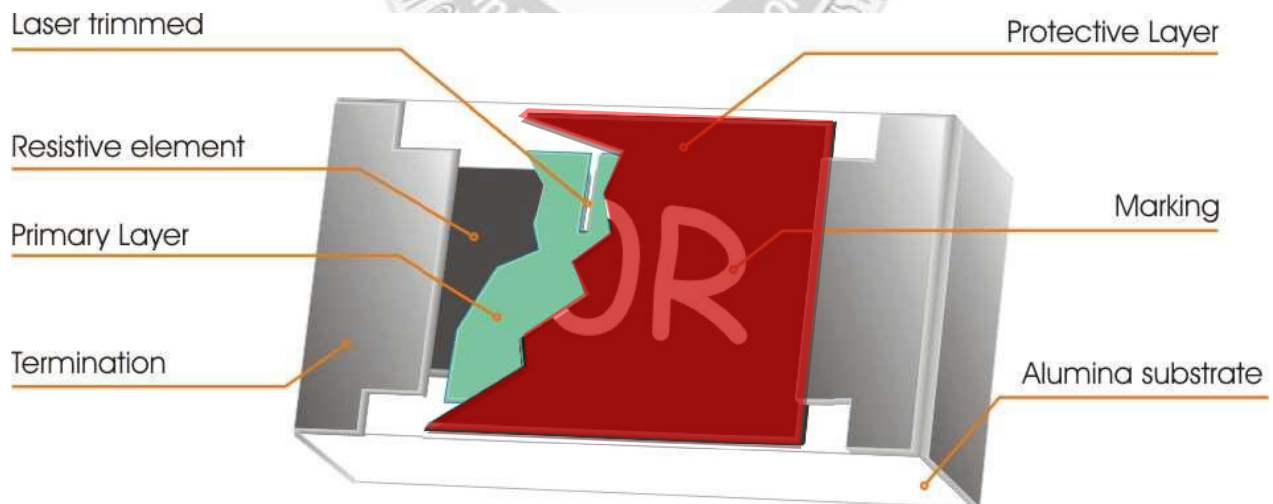


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

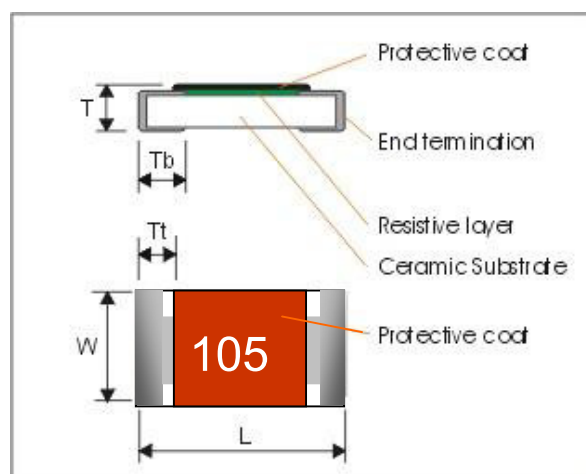
Type	Size	Power Rating at 70°C	Max. RCWV	Max. Overload Voltage	Resistance Tolerance	Temperature Coefficient (ppm/°C)	Resistance Range		Standard Resistance Values
							Min.	Max.	
WF06N	0603	1/10W	200V	400V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±5%(J)	±200	100KΩ	22MΩ	E24
WF08N	0805	1/8W	400V	800V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±5%(J)	±200	100KΩ	22MΩ	E24
WF12N	1206	1/4W	800V	1600V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±1%(F)	±200	11MΩ	22MΩ	E24
					±5%(J)	±200	100KΩ	100MΩ	E24
WF20N	2010	1/2W	2000V	3000V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±1%(F)	±200	11MΩ	22MΩ	E24
					±5%(J)	±200	100KΩ	100MΩ	E24
WF25N	2512	1W	3000V	4000V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±1%(F)	±200	11MΩ	22MΩ	E24
					±5%(J)	±200	100KΩ	100MΩ	E24

Note:

- This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
- Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

MECHANICAL DATA



Symbol	WF25N	WF 20N	WF12N	WF08N	WF06N
L	6.40 ± 0.20	5.00 ± 0.20	3.10 ± 0.10	2.00 ± 0.10	1.60 ± 0.10
W	3.20 ± 0.20	2.50 ± 0.20	1.60 ± 0.10	1.25 ± 0.10	0.80 ± 0.10
T	0.60 ± 0.15	0.60 ± 0.10	0.55 ± 0.10	0.50 ± 0.10	0.45 ± 0.10
Tt	0.60 ± 0.25	0.60 ± 0.25	0.45 ± 0.20	0.35 ± 0.20	0.30 ± 0.20
Tb	0.90 ± 0.25	0.60 ± 0.25	0.50 ± 0.20	0.40 ± 0.20	0.30 ± 0.20

MARKING

For E24 $\pm 5\%$ series, each resistor is marked with a three-digit code on the protective coating to designate the nominal resistance value.

0603/0805/1206/2010/2512



$$301 \rightarrow 30 \times 10^1 = 300 \Omega$$

For E24/E96 $\pm 1\%$ series, each resistor is marked with a four-digit code on the protective coating to designate the nominal resistance value. 0603 is marked with three-digits.

0805/1206/2010/2512



$$1542 \rightarrow 154 \times 10^2 = 15.4 \text{ K}\Omega$$

E24 $\pm 1\%$: 3 Digits marking to identify the resistance value

0603



$$222 \rightarrow 22 \times 10^2 = 2.2 \text{ K}\Omega$$

E96 $\pm 1\%$: 3 Digits marking to identify the resistance value

0603



$$01B \rightarrow \text{Refer 0603 marking table} = 1 \text{ K}\Omega$$

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of $\pm 1\%$, $\pm 5\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Derating curve

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

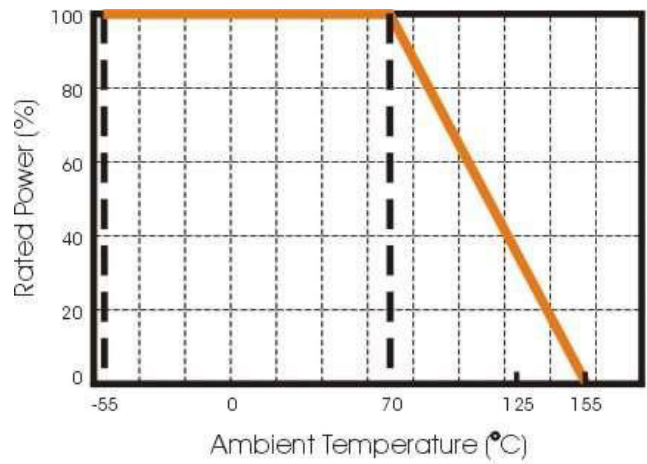
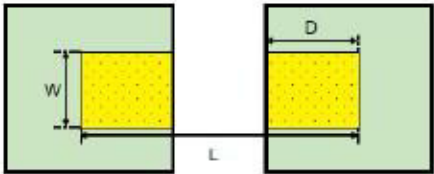


Figure 2 Maximum dissipation in percentage of rated power as a function of the ambient temperature

Recommend Solder Pad Dimensions :

Type	W	D	L
FVS03	0.90	1.00	3.00
FVS05	1.30	1.15	3.50
FVS06	1.80	1.30	4.70
FVS20	3.00	1.50	6.80
FVS25	3.70	1.60	7.60

Unit:mm



SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

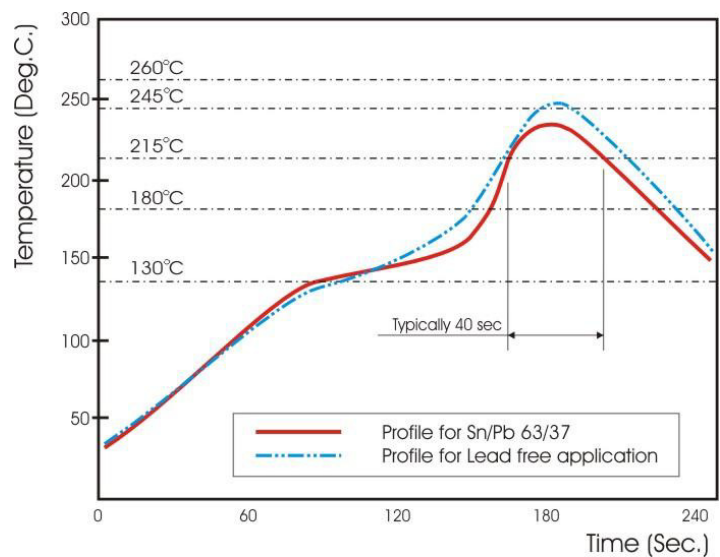


Fig 3. Infrared soldering profile

CATALOGUE NUMBERS

The resistors have a catalogue number starting with .

WF25	N	105	J	T	L	J
Size code	Type code	Resistance code	Tolerance	Packaging code	Termination code	Special code
WF25 : 2512	N :High Voltage UL certified	±5% E24: 2 significant digits followed by no. of zeros and a blank 1 MΩ = 105 ±1%, E24+E96: 3 significant digits followed by no. of zeros 1 MΩ = 1004	J : ±5% F : ±1%	T : 7" inch reel	L = Sn base (lead free)	J = AEC Q200 compliant
WF20 : 2010				0603/0805/1206: paper tape, 5kpcs/reel		
WF12 : 1206				2010,2512 : plastic tape, 4kpcs/reel		
WF08 : 0805						
WF06 : 0603						

Tape packaging WF12, WF08, WF06 : 8mm width paper taping 5,000pcs per reel.

WF25 ; WF20: 12mm width plastic taping 4,000pcs per reel.

TEST REQUIREMENTS (AEC Q200)

Test Item	Specification	Test Method (AEC-Q200. IEC 60115)
*DC Resistance	F : $\pm 1\%$; J : $\pm 5\%$	AEC-Q200 TABLE 7.1 IEC 60115-1 / JIS C 5201-1 , Clause 4.5 Measure the resistance Value.
High Temperature Exposure (Storage)	J : $\Delta R \leq \pm(3\%+0.1\Omega)$ F : $\Delta R \leq \pm(1\%+0.05\Omega)$	AEC-Q200 TABLE 7.3 1000 hrs. @ T=155°C, Unpowered. Measurement at 24 $\pm$ 2 hours after test conclusion.
*Temperature Cycling	$\Delta R \leq \pm(1\%+0.1\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.4 1000 Cycles (-55°C to +155°C). Measurement at 24 $\pm$ 2 hours after test conclusion.
Moisture Resistance	$\Delta R \leq \pm(1\%+0.1\Omega)$	AEC-Q200 TABLE 7.6 Test 65°C/80~100%RH/10Cycles. Measurement at 24 $\pm$ 2 hours after test conclusion. (t=24hrs/cycle).
Biased Humidity	J : $\Delta R \leq \pm(5\%+0.1\Omega)$ F : $\Delta R \leq \pm(3\%+0.05\Omega)$ VCR within the spec.	AEC-Q200 TABLE 7.7 1000 hours 85°C/85%RH. 10% of operating power. Measurement at 24 $\pm$ 2 hours after test conclusion.
Operational Life	J : $\Delta R \leq \pm(5\%+0.1\Omega)$ F : $\Delta R \leq \pm(3\%+0.05\Omega)$ VCR within the spec.	AEC-Q200 TABLE 7.8 Test 1000hr @ TA=125°C at specified rated power. Measurement at 24 $\pm$ 2 hours after test conclusion.
External Visual	No visual damage and refer WTC marking code.	AEC-Q200 TABLE 7.9 Inspect device construction, marking and workmanship.
Physical Dimension	Within the spec.	AEC-Q200 TABLE 7.10 Verify physical dimensions to the applicable device detail specification.

Mechanical Shock	Within product specification tolerance and no visible damage.	AEC-Q200 TABLE 7.13 Test Peak value:100g's,Wave:Hail-sine, Duration:6ms,Velocity:12.3ft/sec.
Vibration	No mechanical damage.	AEC-Q200 TABLE 7.14 5 g's for 20 min., 12 cycles each of 3 orientations. Test from 10-2000 Hz.
*Resistance to Solder Heat	$\Delta R \leq \pm(1\%+0.1\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.15 Solder dipping @ 270°C±5°C for 10sec.±1sec.
Thermal Shock	J : $\Delta R \leq \pm(1\%+0.1\Omega)$ F : $\Delta R \leq \pm(0.5\%+0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.16 -55 to 155°C/ dwell time 15min/ Max transfer time 20sec/ 300cycles.
ESD	$\Delta R \leq \pm(1\%+0.1\Omega)$ No mechanical damage.	AEC-Q200-002 Test contact min. 1KV.
*Solder Ability	Over 95% of termination must be covered with solder.	AEC-Q200 TABLE 7.18 a)Baking 155°C 4H, dipping 235°C 5s b)Steam 8H, dipping 215°C 5s c)Steam 8H, dipping 260°C 7s
Flammability	Refer UL-94.	AEC-Q200 TABLE 7.20 UL-94 V-0 or V-1 are acceptable
*Board Flex	J : $\Delta R \leq \pm(1\%+0.1\Omega)$ F : $\Delta R \leq \pm(0.5\%+0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.21 Bending 2mm 2512.2010.1210 3mm 0805.0603.1206
Terminal Strength	No mechanical damage	AEC-Q200 TABLE 7.22 Force 1 Kg for 60 seconds.
*Short Time Overload	J : $\Delta R \leq \pm(2\%+0.1\Omega)$ F : $\Delta R \leq \pm(1\%+0.1\Omega)$	IEC 60115-1, Clause 4.13 5 × Rated power for 5 seconds
*Load Life Humidity	J : $\Delta R \leq \pm(3\%+0.1\Omega)$ F : $\Delta R \leq \pm(1\%+0.1\Omega)$	IEC 60115-1, Clause 4.24 40±2°C with relative humidity 90% ~ 95% D.C. rated voltage for 1.5 hours ON 30 minutes OFF. Cycle repeated 1000 hours.

*Temperature Coefficient of Resistance (TCR)	Within the spec.	IEC 60115-1, Clause 4.8 $T_1 \quad T_2$ Test temperature : $25^{\circ}\text{C} \sim -55^{\circ}\text{C}$ $25^{\circ}\text{C} \sim +155^{\circ}\text{C}$ $\text{TCR}(\text{ppm}/^{\circ}\text{C}) =$ $(R_2 - R_1) / R_1 \times 1 / (T_2 - T_1) \times 10^6$
*Load Life	J : $\Delta R \leq \pm(3\% + 0.1\Omega)$ F : $\Delta R \leq \pm(1\% + 0.1\Omega)$	IEC 60115-1, Clause 4.25 Rated voltage for 1.5 hours for followed by a pause 0.5 hour at $70 \pm 2^{\circ}\text{C}$. Cycle repeated 1000 hours.
*Insulation Resistance	Between termination and coating must over 1000MΩ	IEC 60115-1, Clause 4.6 Test voltage : $100 \pm 15\text{V}$

Storage &. Handling

... Products are recommended to be used up within one year as ensured shelf life.

Check solder ability in case shelf life extension is needed.

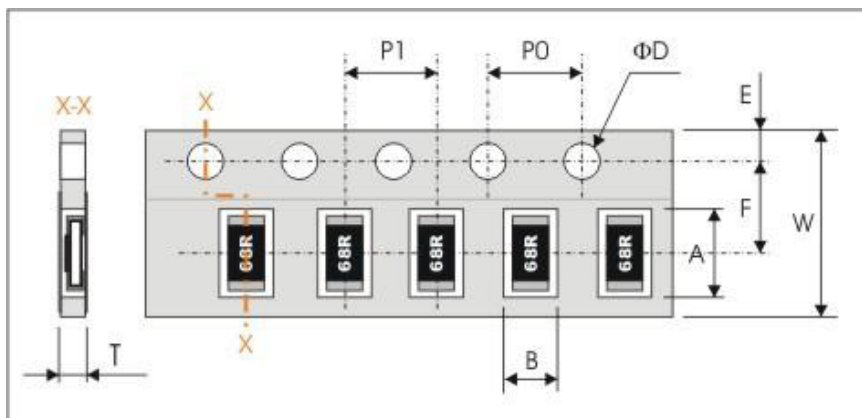
... To store products with following condition:

Temperature: 5 to 40°C ; Humidity: 20 to 70% relative humidity.



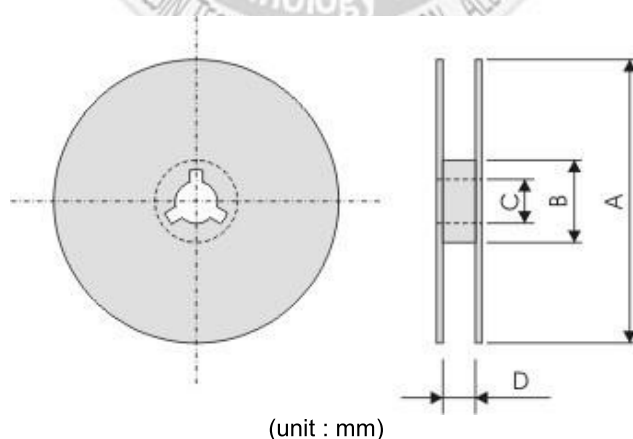
PACKAGING

Paper Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF25N	6.70±0.20	3.50±0.20	12.00±0.30	5.50±0.10	1.75±0.10
WF20N	5.50±0.20	2.80±0.20			
WF12N	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF08N	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF06N	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.20	1.75±0.10
Series No.	P1	P0	ΦD	T	
WF25N	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.2	
WF20N				Max. 1.0	
WF12N					
WF08N					
WF06N				0.65±0.10	

Reel dimensions



Reel / Tape	A	B	C	D
7" reel for 12mm tape	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	12.4±1.0
7" reel for 8mm tape				9.0±0.5

Appendix

0603 1% Marking Table (Table 1)

Code	E48	E96	Code	E48	E96	Code	E48	E96	Code	E48	E96
01	100	100	25	178	178	49	316	316	73	562	562
02		102	26		182	50		324	74		576
03	105	105	27	187	187	51	332	332	75	590	590
04		107	28		191	52		340	76		604
05	110	110	29	196	196	53	348	348	77	619	619
06		113	30		200	54		357	78		634
07	115	115	31	205	205	55	365	365	79	649	649
08		118	32		210	56		374	80		665
09	121	121	33	215	215	57	383	383	81	681	681
10		124	34		221	58		392	82		698
11	127	127	35	226	226	59	402	402	83	715	715
12		130	36		232	60		412	84		732
13	133	133	37	237	237	61	422	422	85	750	750
14		137	38		243	62		432	86		768
15	140	140	39	249	249	63	442	442	87	787	787
16		143	40		255	64		453	88		806
17	147	147	41	261	261	65	464	464	89	825	825
18		150	42		267	66		475	90		845
19	154	154	43	274	274	67	487	487	91	866	866
20		158	44		280	68		499	92		887
21	162	162	45	287	287	69	511	511	93	909	909
22		165	46		294	70		523	94		931
23	169	169	47	301	301	71	536	536	95	953	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}

※ All product specification and data are subject to change without notice.

APPROVAL SHEET

WF25N, WF20N, WF12N, WF08N, WF06N

$\pm 1\%$, $\pm 5\%$

Thick Film High Voltage Chip Resistors

UL Safety Certification

Size 2512,2010,1206, 0805, 0603



*Contents in this sheet are subject to change without prior notice.

FEATURE

1. Special materials and design for higher working voltage required.
2. Compatible with flow and reflow soldering.
3. Suitable for lead free soldering.
4. Max. Voltage coefficient resistance below 300ppm.
5. RoHS compliant & Halogen Free.
6. Safety resistor certificate meet :
 - UL/IEC 62368-1: 2020 resistor requirement certificated
 - UL/IEC 60950-1 2.5KV impulse certificated
 - UL/IEC 60065 10KV impulse certificated

APPLICATION

- Power supply
- Measurement instrument
- Back light inverter
- Medical or Military equipment

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

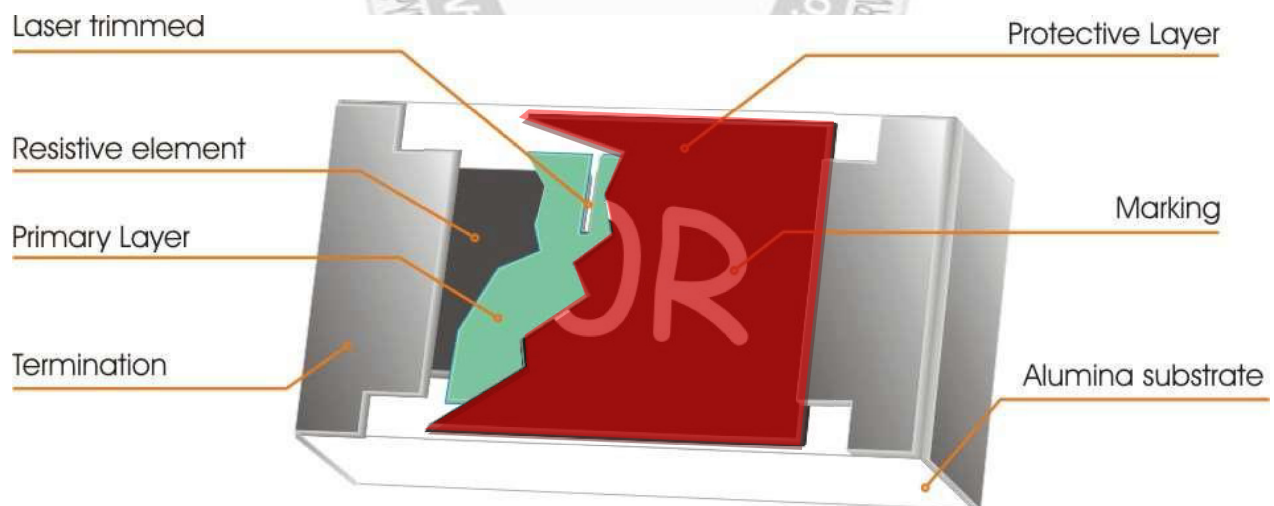


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

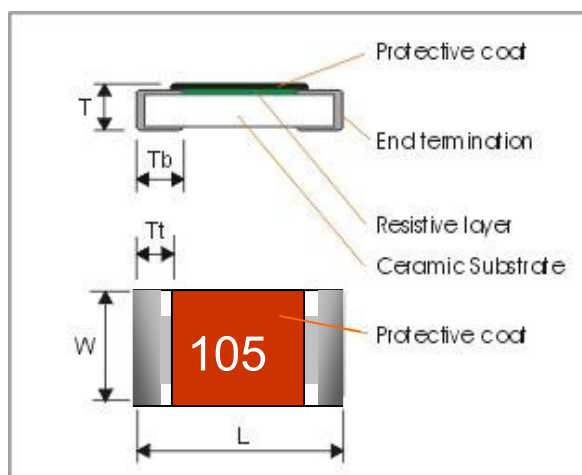
Type	Size	Power Rating at 70°C	Max. RCWV	Max. Overload Voltage	Resistance Tolerance	Temperature Coefficient (ppm/°C)	Resistance Range		Standard Resistance Values
							Min.	Max.	
WF06N	0603	1/10W	200V	400V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±5%(J)	±200	100KΩ	22MΩ	E24
WF08N	0805	1/8W	400V	800V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±5%(J)	±200	100KΩ	22MΩ	E24
WF12N	1206	1/4W	800V	1600V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±1%(F)	±200	11MΩ	22MΩ	E24
					±5%(J)	±200	100KΩ	100MΩ	E24
WF20N	2010	1/2W	2000V	3000V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±1%(F)	±200	11MΩ	22MΩ	E24
					±5%(J)	±200	100KΩ	100MΩ	E24
WF25N	2512	1W	3000V	4000V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±1%(F)	±200	11MΩ	22MΩ	E24
					±5%(J)	±200	100KΩ	100MΩ	E24

Note:

- Operation temperature: -55 ~ +155°C
- Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

MECHANICAL DATA



Symbol	WF25N	WF 20N	WF12N	WF08N	WF06N
L	6.40 ± 0.20	5.00 ± 0.20	3.10 ± 0.10	2.00 ± 0.10	1.60 ± 0.10
W	3.20 ± 0.20	2.50 ± 0.20	1.60 ± 0.10	1.25 ± 0.10	0.80 ± 0.10
T	0.60 ± 0.15	0.60 ± 0.10	0.55 ± 0.10	0.50 ± 0.10	0.45 ± 0.10
Tt	0.65 ± 0.25	0.65 ± 0.25	0.50 ± 0.20	0.40 ± 0.20	0.30 ± 0.20
Tb	0.90 ± 0.25	0.60 ± 0.25	0.50 ± 0.20	0.40 ± 0.20	0.30 ± 0.20

MARKING

For E24 $\pm 5\%$ series, each resistor is marked with a three-digit code on the protective coating to designate the nominal resistance value.

0603/0805/1206/2010/2512



$$301 \rightarrow 30 \times 10^1 = 300 \Omega$$

For E24/E96 $\pm 1\%$ series, each resistor is marked with a four-digit code on the protective coating to designate the nominal resistance value. 0603 is marked with three-digits.

0805/1206/2010/2512



$$1542 \rightarrow 154 \times 10^2 = 15.4 \text{ K}\Omega$$

E24 $\pm 1\%$: 3 Digits marking to identify the resistance value

0603



$$222 \rightarrow 22 \times 10^2 = 2.2 \text{ K}\Omega$$

E96 $\pm 1\%$: 3 Digits marking to identify the resistance value

0603



$$01B \rightarrow \text{Refer 0603 marking table} = 1 \text{ K}\Omega$$

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of $\pm 1\%$, $\pm 5\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Derating curve

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

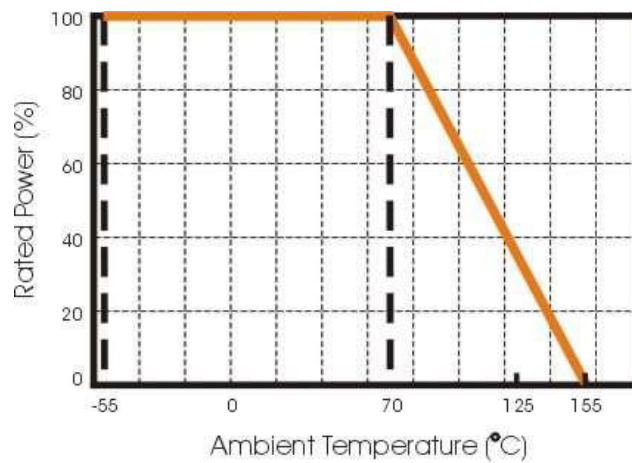
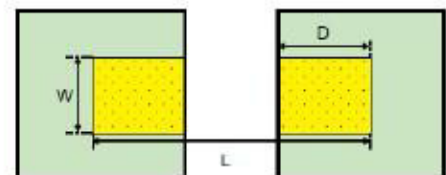


Figure 2 Maximum dissipation in percentage of rated power as a function of the ambient temperature

Recommend Solder Pad Dimensions :

Type	W	D	L
WF06N	0.90	1.00	3.00
WF08N	1.30	1.15	3.50
WF12N	1.80	1.30	4.70
WF20N	3.00	1.50	6.80
WF25N	3.70	1.60	7.60

Unit:mm



SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

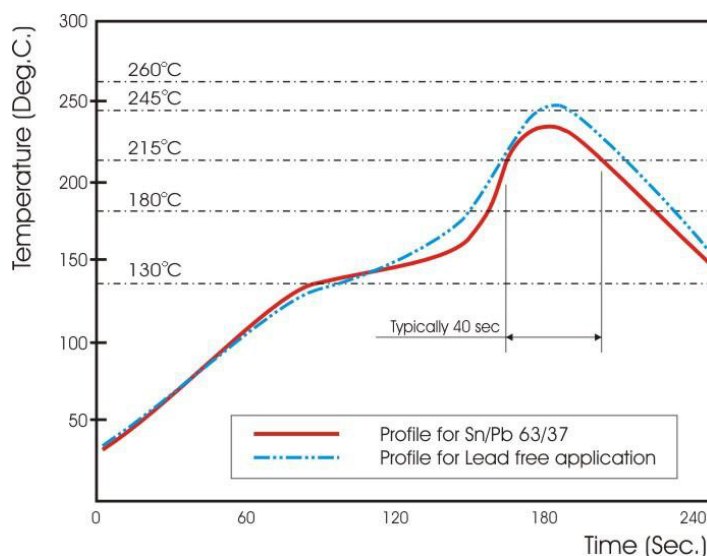


Fig 3. Infrared soldering profile

CATALOGUE NUMBERS

The resistors have a catalogue number starting with .

WF25	N	105	J	T	L
Size code	Type code	Resistance code	Tolerance	Packaging code	Termination code
WF25 : 2512	N :High Voltage UL certified	±5% E24: 2 significant digits followed by no. of zeros and a blank 1 MΩ = 105 ±1%, E24+E96: 3 significant digits followed by no. of zeros 1 MΩ = 1004	J : ±5% F : ±1%	T : 7" inch reel	L = Sn base (lead free)
WF20 : 2010				0603/0805/1206: paper tape, 5kpcs/reel	
WF12 : 1206				2010,2512 : plastic tape, 4kpcs/reel	
WF08 : 0805					
WF06 : 0603					

Tape packaging WF12, WF08, WF06 : 8mm width paper taping 5,000pcs per reel.

WF25 : WF20: 12mm width plastic taping 4,000pcs per reel.

Storage &. Handling

... Products are recommended to be used up within one year as ensured shelf life.

Check solder ability in case shelf life extension is needed.

... To store products with following condition:

Temperature: 5 to 40°C ; Humidity: 20 to 70% relative humidity.

TEST AND REQUIREMENTS(JIS C 5201-1 : 1998)

Essentially all tests are carried out according to the schedule of IEC publication 115-8, category **LCT/UCT/56**(rated temperature range : **Lower Category Temperature**, **Upper Category Temperature**; damp heat, long term, 56 days). The testing also meets the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 68, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to IEC 60068-1, subclause 5.3. Unless otherwise specified, the following value supplied :

Temperature: 15°C to 35°C.

Relative humidity: 45% to 75%.

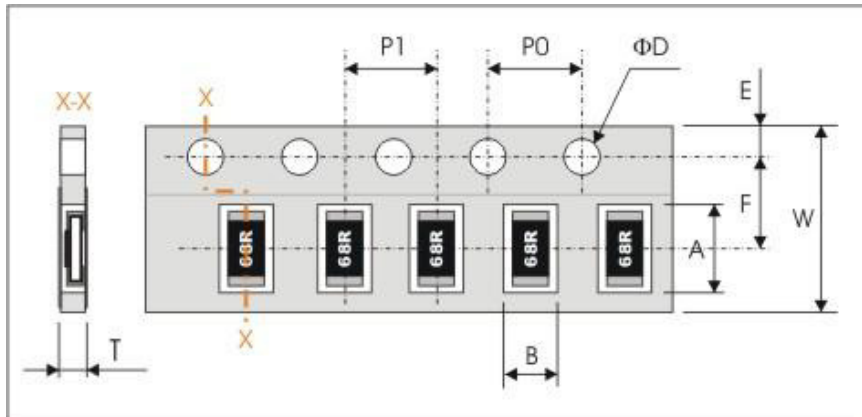
Air pressure: 86kPa to 106 kPa (860 mbar to 1060 mbar).

All soldering tests are performed with mildly activated flux.

TEST	PROCEDURE	REQUIREMENT
Temperature Coefficient of Resistance(T.C.R) Clause 4.8	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/°C)}$ R ₁ : Resistance at reference temperature R ₂ : Resistance at test temperature t ₁ : 20°C+5°C-1°C	Refer to "QUICK REFERENCE DATA"
Short time overload (S.T.O.L) Clause 4.13	Permanent resistance change after a 5 second application of 5 times of rated power.	No visible damage J: ΔR/R max. ±(2%+0.1Ω) F: ΔR/R max. ±(1%+0.1Ω)
Resistance to soldering heat(R.S.H) Clause 4.18	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260°C±5°C	no visible damage ΔR/R max. ±(1%+0.15Ω)
Solderability Clause 4.17	Un-mounted chips completely immersed for 3±0.5second in a SAC solder bath at 245°C±5°C	good tinning (>95% covered) no visible damage
Temperature cycling Clause 4.19	30 minutes at -55°C±3°C, 2~3 minutes at 20°C+5°C-1°C, 30 minutes at +155°C±3°C, 2~3 minutes at 20°C+5°C-1°C, total 5 continuous cycles	no visible damage ΔR/R max. ±(1%+0.1Ω)
Load life (endurance) Clause 4.25	1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller 70±2°C, 1.5 hours on and 0.5 hours off	no visible damage J: ΔR/R max. ±(3%+0.1Ω) F: ΔR/R max. ±(1%+0.1Ω)
Load life in Humidity Clause 4.24	1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at 40°C±2°C and 95% relative humidity, 1.5hours on and 0.5 hours off	no visible damage J: ΔR/R max. ±(3%+0.1Ω) F: ΔR/R max. ±(1%+0.1Ω)
Bending strength Clause 4.33	Resistors mounted on a 90mm glass epoxy resin PCB(FR4), 2512, 2010, 1206 bending : 2 mm once for 10 seconds 0805, 0603 bending: 3mm once for 10 seconds	ΔR/R max. ±(0.5%+0.05Ω)
Insulation Resistance Clause 4.6	Apply voltage 100+/-15V for 1minute	R ≥ 1GΩ

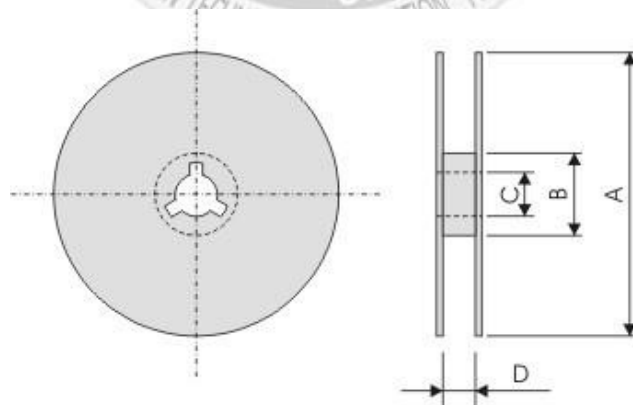
PACKAGING

Paper Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF25N	6.70±0.20	3.50±0.20	12.00±0.30	5.50±0.10	1.75±0.10
WF20N	5.50±0.20	2.80±0.20			
WF12N	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF08N	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF06N	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.20	1.75±0.10
Series No.	P1	P0	ΦD	T	
WF25N	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.2	
WF20N					
WF12N				Max. 1.0	
WF08N					
WF06N				0.65±0.10	

Reel dimensions



(unit : mm)

Reel / Tape	A	B	C	D
7" reel for 12mm tape	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	12.4±1.0
7" reel for 8mm tape				9.0±0.5

Appendix

■ 0603 1% Marking Table (Table 1)

Code	E48	E96	Code	E48	E96	Code	E48	E96	Code	E48	E96
01	100	100	25	178	178	49	316	316	73	562	562
02		102	26		182	50		324	74		576
03	105	105	27	187	187	51	332	332	75	590	590
04		107	28		191	52		340	76		604
05	110	110	29	196	196	53	348	348	77	619	619
06		113	30		200	54		357	78		634
07	115	115	31	205	205	55	365	365	79	649	649
08		118	32		210	56		374	80		665
09	121	121	33	215	215	57	383	383	81	681	681
10		124	34		221	58		392	82		698
11	127	127	35	226	226	59	402	402	83	715	715
12		130	36		232	60		412	84		732
13	133	133	37	237	237	61	422	422	85	750	750
14		137	38		243	62		432	86		768
15	140	140	39	249	249	63	442	442	87	787	787
16		143	40		255	64		453	88		806
17	147	147	41	261	261	65	464	464	89	825	825
18		150	42		267	66		475	90		845
19	154	154	43	274	274	67	487	487	91	866	866
20		158	44		280	68		499	92		887
21	162	162	45	287	287	69	511	511	93	909	909
22		165	46		294	70		523	94		931
23	169	169	47	301	301	71	536	536	95	953	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}

※ All product specification and data are subject to change without notice.

APPROVAL SHEET

**WF06P, WF08P, WF12P, WF10P, WF20P,
WF25P**

$\pm 1\%$, $\pm 5\%$ 0Ω , $1\Omega \sim 1M\Omega$

Thick film High Power Chip Resistors

Size 0603, 0805, 1206, 1210, 2010, 2512

(Automotive Grade)

*Contents in this sheet are subject to change without prior notice.

FEATURE

1. Automotive grade AEC Q-200 compliant
2. 100% CCD inspection
3. RoHS compliant and Lead free products
4. High power rating

APPLICATION

1. High accuracy dc-power supply
2. Digital multi-meter
3. Telecommunication
4. Computer
5. Automotive industry
6. Medical and military equipment

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

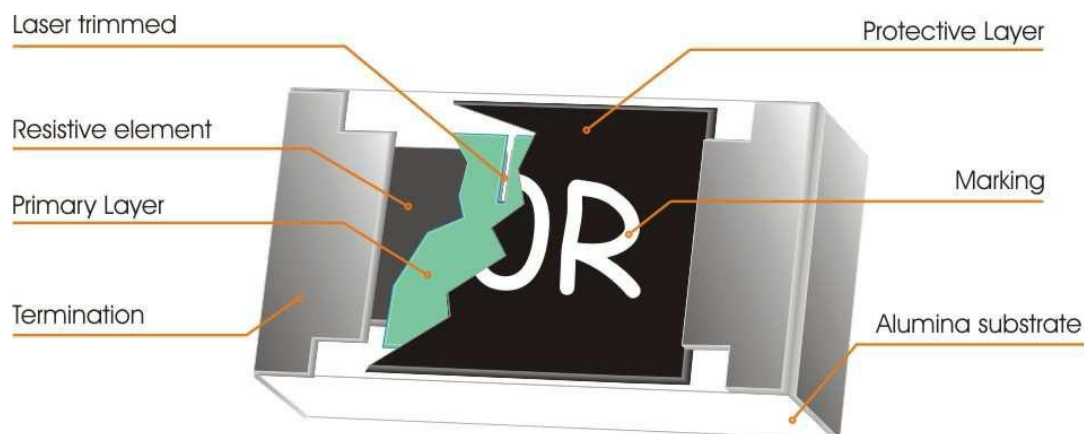


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification					
Series No.	WF06P	WF08P	WF12P	WF10P	WF20P	WF25P
Size code	0603 (1608)	0805 (2012)	1206 (3216)	1210 (3225)	2010 (5025)	2512 (6432)
Resistance Tolerance	$\pm 1\%$, $\pm 5\%$					
Resistance Range	0 Ω , 1 Ω ~ 1M Ω (E96+E24 series)					
TCR (ppm/ $^{\circ}$ C) 20 $^{\circ}$ C ~ +155 $^{\circ}$ C 10.2 Ω ~ 1M Ω 1 Ω ~ 10 Ω	$\leq \pm 100$ $\leq \pm 100$	$\leq \pm 100$ $\leq \pm 100$	$\leq \pm 100$	$\leq \pm 100$ $\leq \pm 200$	$\leq \pm 100$	
TCR (ppm/ $^{\circ}$ C) 20 $^{\circ}$ C ~ - 55 $^{\circ}$ C 10.2 Ω ~ 1M Ω 1 Ω ~ 10 Ω	$\leq \pm 100$ $\leq \pm 150$	$\leq \pm 100$ $\leq \pm 150$		$\leq \pm 100$ $\leq \pm 200$		
Max. dissipation at $T_{amb}=70^{\circ}$ C	1/8 W	1/4 W	1/2W	1/2W	1W	2W
Max. Operation Voltage	50V	150V	200V	200V	200V	300V
Max. Overload Voltage	100V	300V	400V	400V	400V	500V
Operation temperature	-55 ~ +155 $^{\circ}$ C					

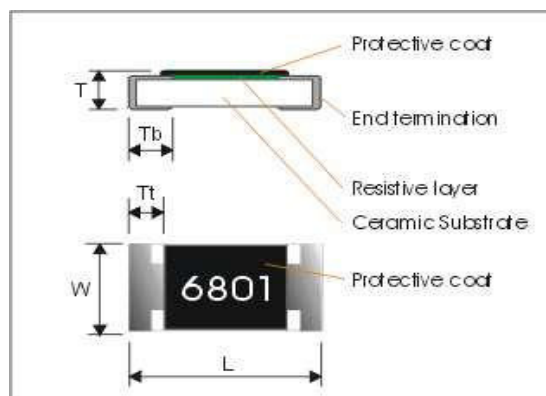
Note :

- This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
- Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}}$$
or Max. RCWV listed above, whichever is lower.

DIMENSIONS (unit : mm)

Part No	WF06P	WF08P	WF12P	WF10P	WF20P	WF25P
L	1.60 $\pm$ 0.10	2.00 $\pm$ 0.10	3.10 $\pm$ 0.15	3.10 $\pm$ 0.10	5.00 $\pm$ 0.20	6.30 $\pm$ 0.20
W	0.80 $\pm$ 0.10	1.25 $\pm$ 0.10	1.60 $\pm$ 0.15	2.60 $\pm$ 0.10	2.50 $\pm$ 0.20	3.10 $\pm$ 0.20
T	0.45 $\pm$ 0.15	0.50 $\pm$ 0.15	0.55 $\pm$ 0.10	0.55 $\pm$ 0.10	0.60 $\pm$ 0.10	0.60 $\pm$ 0.15
Tt	0.30 $\pm$ 0.10	0.40 $\pm$ 0.20	0.50 $\pm$ 0.25	0.50 $\pm$ 0.20	0.60 $\pm$ 0.25	0.60 $\pm$ 0.25
Tb	0.30 $\pm$ 0.15	0.40 $\pm$ 0.20	0.50 $\pm$ 0.25	0.50 $\pm$ 0.20	0.60 $\pm$ 0.25	1.80 $\pm$ 0.25



MARKING

Size \ Nr. Of digit of code\ tolerance	$\pm 5\%$	$\pm 1\%$
2512 (6432)	3-digits marking	4-digits marking
2010 (5025)	3-digits marking	4-digits marking
1210 (3225)	3-digits marking	4-digits marking
1206 (3216)	3-digits marking	4-digits marking
0805 (2012)	3-digits marking	4-digits marking
0603 (1608)	3-digits marking	3-digits marking

3-digits marking ($\pm 5\%$: 2512, 2010, 1210, 1206, 0805, 0603)

Each resistor is marked with a three digits code on the protective coating to designate the nominal resistance value.

3-digits marking ($\pm 1\%$: 0603)

Nominal resistance				Description											
1.E-24 series				As 0603 WR06X $\pm 5\%$.											
2.E-96 series				The 1st two digit codes are referring to the CODE on the table, the 3rd code is the index of resistance value : $Y=10^{-2}$, $X=10^{-1}$, $A=10^0$, $B=10^1$, $C=10^2$, $D=10^3$, $E=10^4$, $F=10^5$ EX : 17.8 Ω =25X, 178 Ω =25A, 1K78=25B 17K8=25C, 178K=25D, 1M78=25E											
3. Remark				There is no marking for the items are not under E-24 and E-96 series											
CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value
01	100	13	133	25	178	37	237	49	316	61	422	73	562	85	750
02	102	14	137	26	182	38	243	50	324	62	432	74	576	86	768
03	105	15	140	27	187	39	249	51	332	63	442	75	590	87	787
04	107	16	143	28	191	40	255	52	340	64	453	76	604	88	806
05	110	17	147	29	196	41	261	53	348	65	464	77	619	89	825
06	113	18	150	30	200	42	267	54	357	66	475	78	634	90	845
07	115	19	154	31	205	43	274	55	365	67	487	79	649	91	866
08	118	20	158	32	210	44	280	56	374	68	499	80	665	92	887
09	121	21	162	33	215	45	287	57	383	69	511	81	681	93	909
10	124	22	165	34	221	46	294	58	392	70	523	82	698	94	931
11	127	23	169	35	226	47	301	59	402	71	536	83	715	95	953
12	130	24	174	36	232	48	309	60	412	72	549	84	732	96	976

4-digits marking ($\pm 1\%$: 2512/ 2010/ 1210/ 1206/ 0805)

Each resistor is marked with a four digits code on the protective coating to designate the nominal resistance value.

Example

RESISTANCE	10 Ω	12 Ω	100 Ω	6800 Ω	47000 Ω
3-digits marking (1206 & 0805 & 0603 $\pm 5\%$)	100	120	101	682	473
4-digits marking	10R0	12R0	1000	6801	4702

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96&E24 series for resistors with a tolerance of $\pm 1\%$, $\pm 5\%$. The values of the E96/E24 series are in accordance with "IEC publication 60063".

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

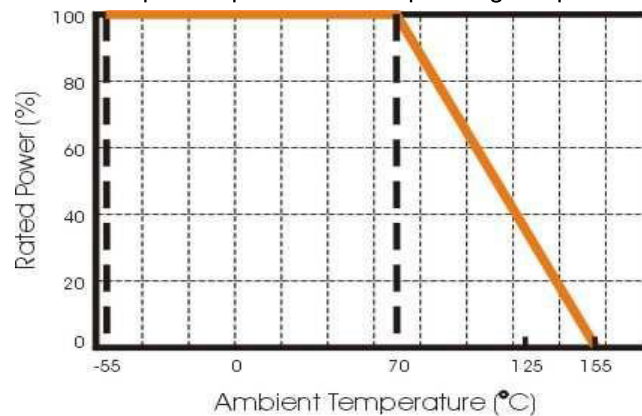


Fig.2 Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

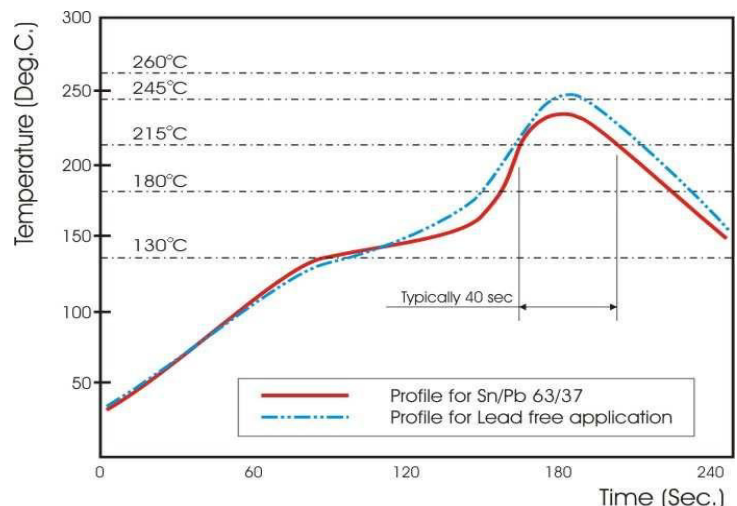


Fig 3. Infrared soldering profile for Chip Resistors

CATALOGUE NUMBERS

The resistors have a catalogue number starting with .

WF08	P	1002	F	T	L	J
Size code WF06: 0603 WF08: 0805 WF12: 1206 WF10: 1210 WF20: 2010 WF25: 2512	Type code P :Power 0603 size = 1/8W 0805 size = 1/4W 1206 size = 1/2W 1210 size = 1/2W 2010 size = 1W 2512 size = 2W	Resistance code 5%, E24: 2 significant digits followed by No. of zeros e.g.: 3ohm =3R0 10ohm =100 56Kohm =563 1%, E24+E96: 3 significant digits followed by No. of zeros 100Ω =1000 37.4KΩ =3742	Tolerance J : ±5% F : ±1% P : Jumper	Packaging code T: 7" Reeled taping .	Termination code L = Sn base (lead free)	Special code J = Automotive grade and Anti-Sulfuration 10ppm x 240hrs

- Reeled tape packaging : 8mm width paper taping 5000pcs per 7" reel for 0603-1210 sizes.
- Reeled tape packaging : 12mm width plastic taping 4000pcs per 7" reel for 2010, 2512 sizes.

TEST CONDITIONS FOR JUMPER (0 Ω)

Item	WF25P	WF20P	WF12P	WF10P	WF08P	WF06P
Power Rating At 70°C	2W	1W	1/2W	1/2W	1/4W	1/8W
Resistance	Max. 20mΩ					
Rated Current	10A	7A	5A	5A	3.5A	2.5A
Peak Current	25A	17.5A	12.5A	12.5A	8.8A	6.2A
Operating Temperature	-55 ~ +155°C					

TEST AND REQUIREMENTS

Essentially all tests are carried out according to the schedule of IEC publication 115-8, category **LCT/UCT/56**(rated temperature range : **Lower Category Temperature, Upper Category Temperature**; damp heat, long term, 56 days). The testing also meets the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 68, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to IEC 60068-1, subclause 5.3. Unless otherwise specified, the following value supplied :

Temperature: 15°C to 35°C.

Relative humidity: 45% to 75%.

Air pressure: 86kPa to 106 kPa (860 mbar to 1060 mbar).

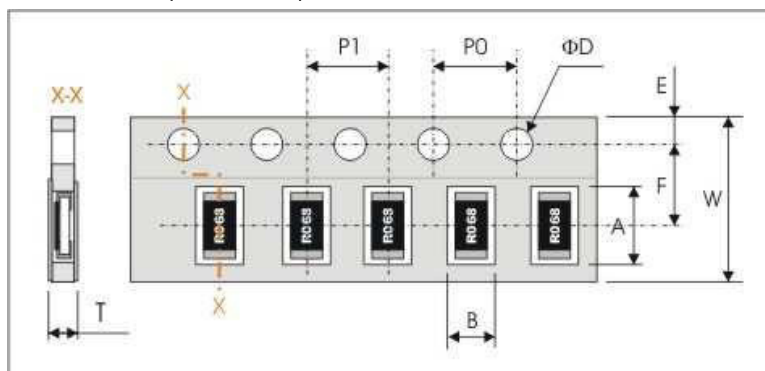
All soldering tests are performed with mildly activated flux.

TEST	PROCEDURE / TEST METHOD	REQUIREMENT
		Resistor
Electrical Characteristics JISC5201-1: 1998 Clause 4.8	- DC resistance values measurement - Temperature Coefficient of Resistance (T.C.R) Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/}^\circ\text{C)} \quad t_1 : 20^\circ\text{C}+5^\circ\text{C}-1^\circ\text{C}$ R ₁ : Resistance at reference temperature R ₂ : Resistance at test temperature	Within the specified tolerance Refer to "QUICK REFERENCE DATA"
Resistance to soldering heat(R.S.H) MIL-STD-202 method 210	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 270°C±5°C	ΔR/R max. ±(1.0%+0.05Ω) no visible damage
Solderability J-STD-002	a) Bake the sample for 155°C dwell time 4hrs/ solder dipping 235°C/ 5sec. b) Steam the sample dwell time 8 hour/ solder dipping 215°C/ 5sec. c) Steam the sample dwell time 8 hour/ solder dipping 260°C/ 7sec.	95% coverage min., good tinning and no visible damage
Temperature cycling JESD22 Method JA-104	1000 cycles, -55°C ~ +155°C, dwell time 30min maximum.	ΔR/R max. ±(1.0%+0.05Ω) No visible damage
Moisture Resistance MIL-STD-202 method 106	65±2°C, 80~100% RH, 10 cycles, 24 hours/ cycle	ΔR/R max. ±(1.0%+0.05Ω) No visible damage
Bias Humidity MIL-STD-202 method 103	1000+48/-0 hours; 85°C, 85% RH, 10% of operation power	ΔR/R max. ±(2.0%+0.10Ω) No visible damage
Operational Life MIL-STD-202 method 108	1000+48/-0 hours; 35% of operation power, 125±2°C	ΔR/R max. ±(2.0%+0.1Ω) No visible damage
High Temperature Exposure MIL-STD-202 Method 108	1000+48/-0 hours; without load in a temperature chamber controlled 155±3°C	ΔR/R max. ±(2.0%+0.10Ω) No visible damage
Board Flex AEC-Q200-005	Resistors mounted on a 90mm glass epoxy resin PCB(FR4),bending once 2mm for 60sec.	ΔR/R max. ±(1.0%+0.05Ω) No visible damage

Terminal strength AEC-Q200-006	Pressurizing force: 1Kg, Test time: 60±1sec.	No remarkable damage or removal of the terminations
Thermal shock MIL-STD-202 method 107	Test -55 to 155°C/ dwell time 15min/ Max transfer time 20sec 300cycles	$\Delta R/R$ max. $\pm(1.0\%+0.05\Omega)$ No visible damage
ESD AEC-Q200-002	Test contact 1.0KV (0.5KV for 0402 only)	$\Delta R/R$ max. $\pm(1.0\%+0.05\Omega)$ No visible damage
Mechanical Shock MIL-STD-202 method 213	Test ½ Sine Pulse, Peak value: 100g, normal duration: 6ms, Velocity change:12.3ft/sec. Three shocks in each direction, total 18 shocks.	Within product specification tolerance and no visible damage.
Vibration MIL-STD-202 method 204	Test 5g's for 20 min., 12 cycles each of 3 orientations.	$\Delta R/R$ max. $\pm(1\%+0.05\Omega)$ and no visible damage
Resistance to Solvents : MIL-STD-202 Method 215	Solvent is Isopropyl alcohol, immersion 3mins at 25°C and brush 10 strokes with a toothbrush with a handle made of a non-reactive material (wet bristle), immersion and brush 3 times and then air blow dry.	No superficial defect on marking, encapsulation, coating, appearance. Electrical characteristics within products specification and tolerance. Inspect at 3X max. for marking, inspect at 10X for part damage.
External Visual MIL-STD-883 method 2009	Electrical test not required. Inspect device construction, marking and workmanship	No visual damage and refer WTC marking code.
Physical Dimension JESD22 method JB-100	Verify physical dimensions(L, W, T, Tb, Tt)	Within the specified tolerance for WTC.

PACKAGING

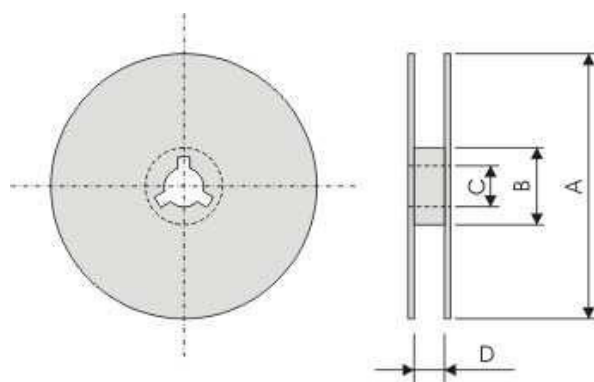
Paper Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF25P	6.90±0.20	3.20±0.20	12.00±0.30	5.50±0.10	1.75±0.10
WF20P	5.50±0.20	2.80±0.20	12.00±0.30	5.50±0.10	1.75±0.10
WF10P	3.60±0.20	3.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF12P	3.60±0.20	2.00±0.20			
WF08P	2.40±0.20	1.65±0.20			
WF06P	1.90±0.20	1.10±0.20			

Series No.	P1	P0	ΦD	T
WF25P	4.00±0.10	4.00±0.10	$\Phi 1.50^{+0.1}_{-0.0}$	Max. 1.2
WF20P				Max. 1.2
WF10P				Max. 1.0
WF12P				Max. 1.0
WF08P				Max. 1.0
WF06P				0.65±0.05

Reel dimensions



Symbol	A	B	C	D
12 mm tape	$\Phi 178.0 \pm 2.0$	$\Phi 60.0 \pm 1.0$	13.0 ± 0.2	12.4 ± 1.0
8 mm tape	$\Phi 178.0 \pm 2.0$	$\Phi 60.0 \pm 1.0$	13.0 ± 0.2	9.0 ± 0.5

APPROVAL SHEET

WF04P, WF06P, WF08P, WF12P

$\pm 1\%$, $\pm 5\%$ 0Ω , $1\Omega \sim 10M\Omega$

Thick Film High Power Lead Free Chip
Resistors

Size 0402, 0603, 0805, 1206

RoHS exemption free and Lead $<100\text{ppm}$

*Contents in this sheet are subject to change without prior notice.

FEATURE

1. High power rating
2. High reliability and stability
3. RoHS exemption free and Lead free products

APPLICATION

1. High accuracy dc-power supply
2. Digital multi-meter
3. Telecommunication
4. Computer
5. Automotive industry
6. Medical and military equipment

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

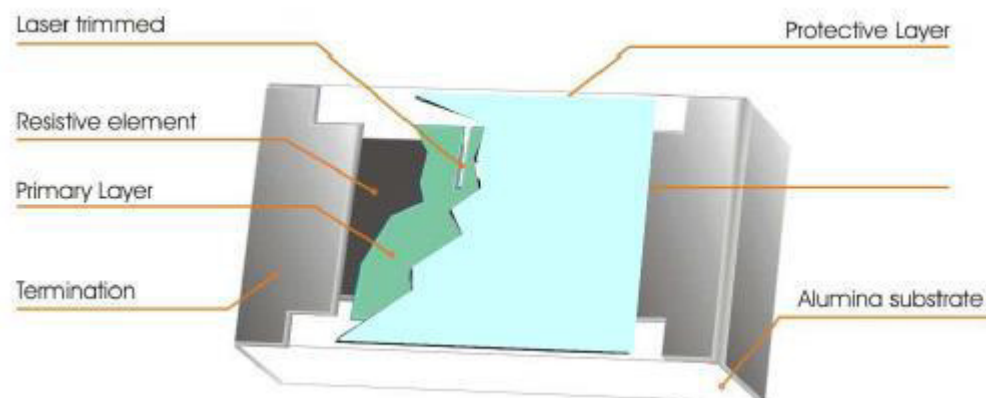


Fig 1. Construction of Chip-R

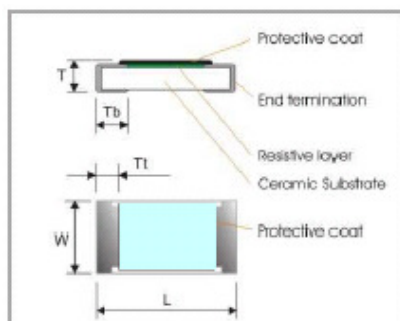
QUICK REFERENCE DATA

Item	General Specification			
Series No.	WF04P	WF06P	WF08P	WF12P
Size code	0402 (1005)	0603 (1608)	0805 (2012)	1206 (3216)
Resistance Tolerance	±1%, ±5%			
Resistance Range	0Ω, 1Ω~ 1MΩ (E96+E24 series)	0Ω, 1Ω~ 1MΩ (E96+E24 series)	0Ω, 1Ω~ 10MΩ (E96+E24 series)	0Ω, 1Ω~ 10MΩ (E96+E24 series)
TCR (ppm/°C) 10Ω ~ 10MΩ < 10Ω	≤ ± 100 ppm/°C ≤ ± 200 ppm/°C	≤ ± 100 ppm/°C ≤ ± 150 ppm/°C	≤ ± 100 ppm/°C ≤ ± 150 ppm/°C	≤ ± 100 ppm/°C ≤ ± 100 ppm/°C
Max. dissipation at T _{amb} =70°C	1/8W	1/8W	1/4 W	1/2 W
Max. Operation Voltage	50V	75V	150V	200V
Max. Overload Voltage	100V	150V	300V	400V
Operation temperature	-55 ~ +155°C			

Note :

1. This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
2. Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

DIMENSIONS(unit : mm)

Part No	WF04P	WF06P	WF08P	WF12P
L	1.00 ± 0.05	1.60 ± 0.10	2.00 ± 0.10	3.10 ± 0.15
W	0.50 ± 0.05	0.80 ± 0.10	1.25 ± 0.10	1.60 ± 0.15
T	0.35 ± 0.05	0.45 ± 0.15	0.50 ± 0.15	0.55 ± 0.10
Tb	0.25 ± 0.10	0.30 ± 0.15	0.40 ± 0.20	0.50 ± 0.25
Tt	0.20 ± 0.10	0.30 ± 0.10	0.40 ± 0.20	0.50 ± 0.25

MARKING

All series are defined as no marking!

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96&E24 series for resistors with a tolerance of $\pm 1\%$, $\pm 5\%$. The values of the E96/E24 series are in accordance with "IEC publication 60063".

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

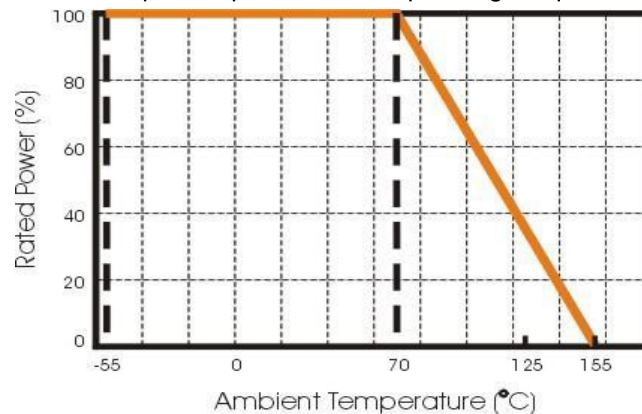


Fig.2 Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

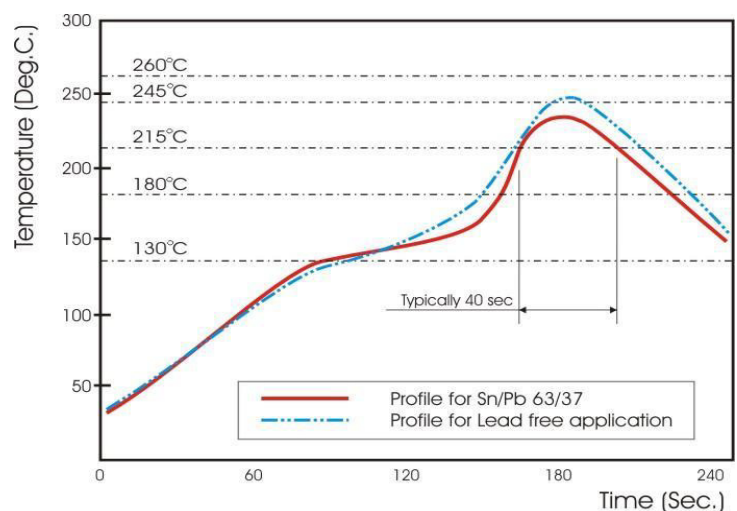


Fig 3. Infrared soldering profile for Chip Resistors

CATALOGUE NUMBERS

The resistors have a catalogue number starting with .

WF08	P	1002	F	T	R
Size code WF08: 0805 WF12: 1206	Type code P :Power 0805 size = 1/4W 1206 size = 1/2W	Resistance code 5% E24: 2 significant digits followed by No. of zeros e.g.: 3ohm =3R0 10ohm =100 56Kohm =563 1% E24+E96: 3 significant digits followed by No. of zeros 100Ω =1000 37.4KΩ =3742	Tolerance J : ±5% F : ±1% P : Jumper	Packaging code T : 7" Reeled taping paper taping 5kpcs/reel.	RoHS code R = lead free (Lead < 100ppm)

- Reeled tape packaging : 8mm width paper taping 5000pcs per 7" reel.

TEST CONDITION FOR JUMPER (0 Ω)

Item	WF12P	WF08P	WF06P	WF04P
Power Rating	1/2W	1/4W	1/8W	1/8W
Resistance	Max. 20mΩ	Max. 20mΩ	Max. 20mΩ	Max. 50mΩ
Rated Current	5A	4A	2A	1.5A
Peak Current	12.5A	10A	5A	3.8A
Operating temperature	-55 ~ +155'C			

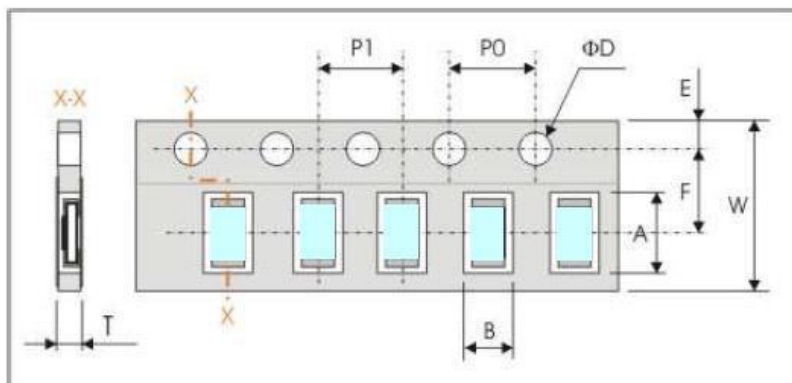
TEST AND REQUIREMENTS

Basic specification : JIS C 5201-1 : 1998

TEST	PROCEDURE	REQUIREMENT
Clause 4.8 Temperature Coefficient of Resistance (TCR)	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/}^\circ\text{C)}$ R ₁ : Resistance at reference temperature R ₂ : Resistance at test temperature t ₁ : 20°C+5°C-1°C	Refer to quick reference data for T.C.R specification
Clause 4.13 Short time overload	5.0× Rated power or Max. Overload Voltage for 5 sec. Measure resistance after 30 minutes..	ΔR/R max. J: ≤ ±(2%+0.1Ω) F: ≤ ±(1%+0.05Ω)
Clause 4.18 Resistance to soldering heat	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260°C±5°C	No visible damage ΔR/R max. J: ≤ ±(1%+0.1Ω) F: ≤ ±(0.5%+0.05Ω)
Clause 4.17 Solderability	Un-mounted chips completely immersed for 2±0.5 second in a SAC solder bath at 235°C±5°C	Good tinning (>95% covered) No visible damage
Clause 4.18 Leach Test	Un-mounted chips completely immersed for 60±1second in a solder bath at 260°C±5°C	Ditto
Clause 4.19 Temperature cycling	30 minutes at -55°C±3°C, 2~3 minutes at 20°C+5°C-1°C, 30 minutes at +155°C±3°C, 2~3 minutes at 20°C+5°C-1°C, total 5 continuous cycles	No visible damage ΔR/R max. J: ≤ ±(1%+0.1Ω) F: ≤ ±(0.5%+0.05Ω)
Clause 4.25 Load life (endurance)	1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller 70±2°C, 1.5 hours on and 0.5 hours off	No visible damage ΔR/R max. J: ≤ ±(3%+0.1Ω) F: ≤ ±(1%+0.05Ω)
Clause 4.24 Load life in Humidity	1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at 40°C±2°C and 90~95% relative humidity, 1.5hours on and 0.5 hours off	No visible damage ΔR/R max. J: ≤ ±(3%+0.1Ω) F: ≤ ±(1%+0.05Ω)
Clause 4.33 Bending strength	Resistors mounted on a 90mm glass epoxy resin PCB(FR4); bending : 2 mm(2512;2010) 3mm(1206), once for 10 seconds	No visible damage ΔR/R max. J: ≤ ±(1%+0.1Ω) F: ≤ ±(0.5%+0.05Ω)
Clause 4.32 Adhesion	Pressurizing force: 5N, Test time: 10±1sec	No remarkable damage or removal of the terminations
Clause 4.6 Insulation resistance	Apply the maximum overload voltage (DC) for 1minute	R ≥ 10GΩ
Clause 4.7 Dielectric withstand voltage	Apply the maximum overload voltage (AC) for 1 minute	No breakdown or flashover

PACKAGING

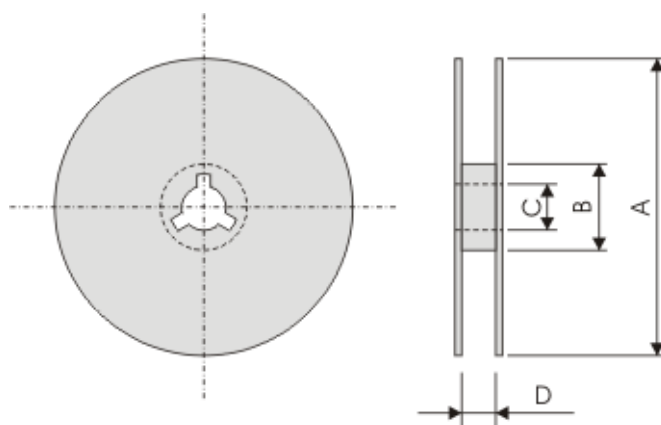
Paper Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF12P	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF08P	2.40±0.20	1.65±0.20			
WF06P	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF04P	1.20±0.10	0.70±0.10	8.00±0.30	3.50±0.20	1.75±0.10

Series No.	P1	P0	ΦD	T
WF12P	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.0
WF08P				Max. 1.0
WF06P	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.65±0.05
WF04P	2.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.40±0.05

Reel dimensions



Symbol	A	B	C	D
(unit : mm)	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	9.0±0.5

APPROVAL SHEET

**WF04P, WF06P, WF08P, WF12P, WF20P,
WF25P**

$\pm 1\%$, $\pm 5\%$ 0 Ω , 1 Ω ~1M Ω

Thick film High Power Chip Resistors

Size 0402, 0603, 0805, 1206, 2010, 2512

(Automotive & Anti-Sulfuration)

RoHS 2 Compliant with exemption 7C-1
Halogen free

*Contents in this sheet are subject to change without prior notice.

FEATURE

1. Automotive grade AEC Q-200 compliant
2. 100% CCD inspection
3. RoHS 2 Compliant with exemption 7C-1 and Halogen free
4. High power rating
5. Anti-sulfuration ASTM B-809-95 compliant

APPLICATION

1. High accuracy dc-power supply
2. Digital multi-meter
3. Telecommunication
4. Computer
5. Automotive industry
6. Medical and military equipment

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

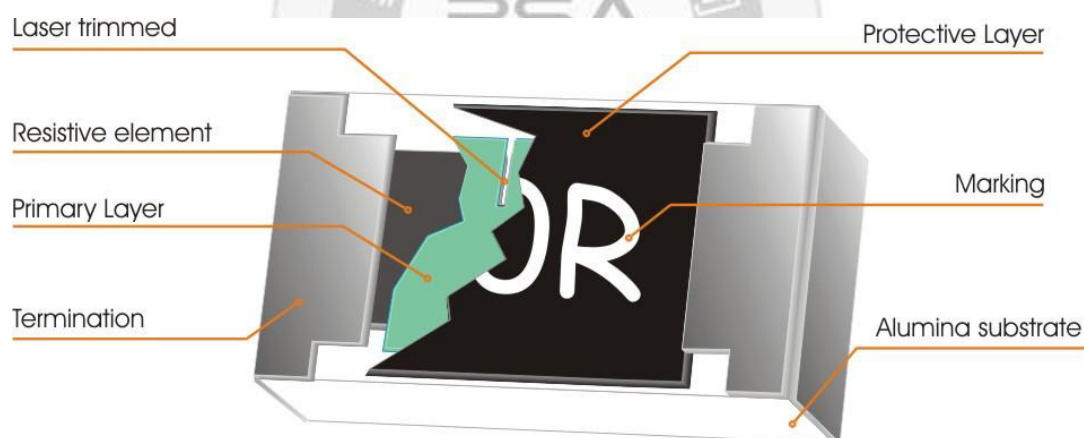


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification					
Series No.	WF04P	WF06P	WF08P	WF12P	WF20P	WF25P
Size code	0402 (1005)	0603 (1608)	0805 (2012)	1206 (3216)	2010 (5025)	2512 (6432)
Resistance Tolerance	±1%, ±5%					
Resistance Range	0Ω, 1Ω~ 1MΩ (E96+E24 series)					
TCR (ppm/°C) 10.2Ω ~ 1MΩ 1Ω ~ 10Ω	≤ ± 100 -200/+400	≤ ± 100 ≤ ± 150	≤ ± 100 ≤ ± 150	≤ ± 100 ≤ ± 100	≤ ± 100 ≤ ± 100	≤ ± 100 ≤ ± 100
Max. dissipation at T _{amb} =70°C	1/8 W	1/8 W	1/4W	1/2W	1W	2W
Max. Operation Voltage	50V	75V	150V	200V	200V	200V
Max. Overload Voltage	100V	150V	300V	400V	400V	400V
Operation temperature	-55 ~ +155°C					
Basic specification	JIS C 5201-1:1998 / IEC 60068-2-58:2004					

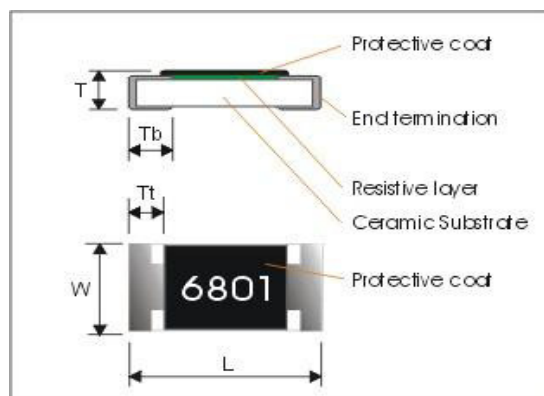
Note :

1. This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
2. Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}}$$
or Max. RCWV listed above, whichever is lower.

DIMENSIONS (unit : mm)

Type	WF04P	WF06P	WF08P	WF12P	WF20P	WF25P
L	1.00 ± 0.05	1.60 ± 0.10	2.00 ± 0.10	3.10 ± 0.15	5.00 ± 0.20	6.30 ± 0.20
W	0.50 ± 0.05	0.80 ± 0.10	1.25 ± 0.10	1.60 ± 0.15	2.50 ± 0.20	3.10 ± 0.20
T	0.35 ± 0.05	0.45 ± 0.15	0.50 ± 0.15	0.55 ± 0.10	0.60 ± 0.10	0.60 ± 0.15
Tb	0.25 ± 0.10	0.30 ± 0.15	0.40 ± 0.20	0.50 ± 0.25	0.60 ± 0.25	1.80 ± 0.25
Tt	0.20 ± 0.10	0.30 ± 0.10	0.40 ± 0.20	0.50 ± 0.25	0.60 ± 0.25	0.60 ± 0.25



MARKING

Size \ Nr. Of digit of code\ tolerance	$\pm 5\%$	$\pm 1\%$
2512 (6432)	3-digits marking	4-digits marking
2010 (5025)	3-digits marking	4-digits marking
1206 (3216)	3-digits marking	4-digits marking
0805 (2012)	3-digits marking	4-digits marking
0603 (1608)	3-digits marking	3-digits marking
0402 (1005)	No marking	No marking

3-digits marking ($\pm 5\%$: 2512, 2010, 1206, 0805, 0603)

Each resistor is marked with a three digits code on the protective coating to designate the nominal resistance value.

3-digits marking ($\pm 1\%$: 0603)

Nominal resistance				Description											
1.E-24 series				As 0603 WR06X ±5%.											
2.E-96 series				The 1st two digit codes are referring to the CODE on the table, the 3rd code is the index of resistance value : Y=10 ⁻² , X=10 ⁻¹ , A=10 ⁰ , B=10 ¹ , C=10 ² , D=10 ³ , E=10 ⁴ , F=10 ⁵ EX : 17.8Ω=25X , 178Ω=25A , 1K78 =25B 17K8=25C , 178K=25D , 1M78=25E											
3. Remark				There is no marking for the items are not under E-24 and E-96 series											
CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value
01	100	13	133	25	178	37	237	49	316	61	422	73	562	85	750
02	102	14	137	26	182	38	243	50	324	62	432	74	576	86	768
03	105	15	140	27	187	39	249	51	332	63	442	75	590	87	787
04	107	16	143	28	191	40	255	52	340	64	453	76	604	88	806
05	110	17	147	29	196	41	261	53	348	65	464	77	619	89	825
06	113	18	150	30	200	42	267	54	357	66	475	78	634	90	845
07	115	19	154	31	205	43	274	55	365	67	487	79	649	91	866
08	118	20	158	32	210	44	280	56	374	68	499	80	665	92	887
09	121	21	162	33	215	45	287	57	383	69	511	81	681	93	909
10	124	22	165	34	221	46	294	58	392	70	523	82	698	94	931
11	127	23	169	35	226	47	301	59	402	71	536	83	715	95	953
12	130	24	174	36	232	48	309	60	412	72	549	84	732	96	976

4-digits marking ($\pm 1\%$: 2512/ 2010/ 1206/ 0805)

Each resistor is marked with a four digits code on the protective coating to designate the nominal resistance value.

Example

RESISTANCE	10 Ω	12 Ω	100 Ω	6800 Ω	47000 Ω
3-digits marking (1206 & 0805 & 0603 $\pm 5\%$)	100	120	101	682	473
4-digits marking	10R0	12R0	1000	6801	4702

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96&E24 series for resistors with a tolerance of $\pm 1\%$, $\pm 5\%$. The values of the E96/E24 series are in accordance with "IEC publication 60063".

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

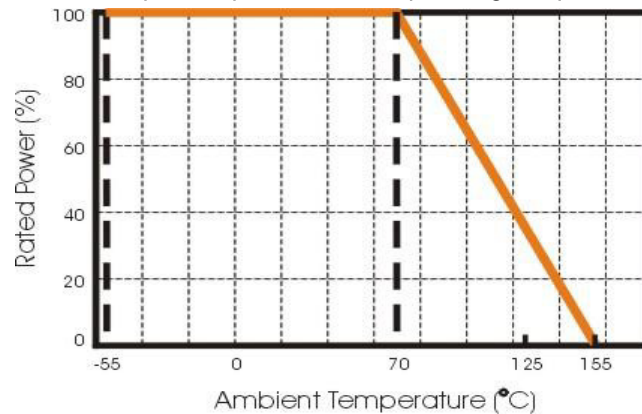


Fig.2 Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

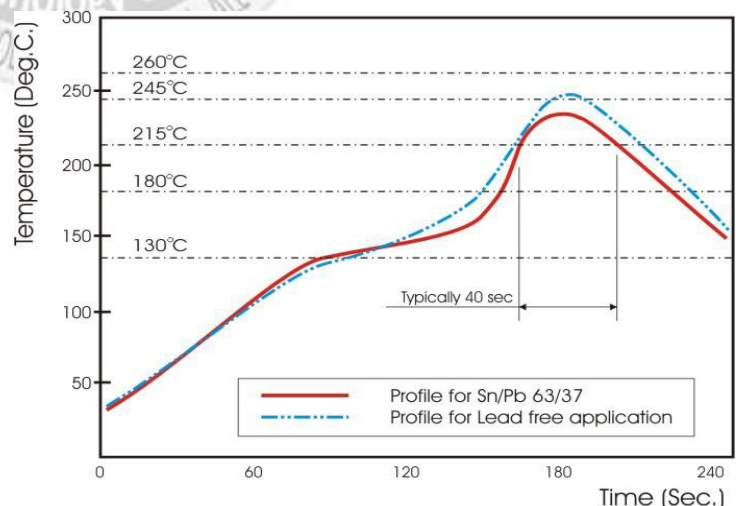


Fig 3. Infrared soldering profile for Chip Resistors

CATALOGUE NUMBERS

The resistors have a catalogue number starting with .

WF08	P	1002	F	T	L	V
Size code WF04: 0402 WF06: 0603 WF08: 0805 WF12: 1206 WF20: 2010 WF25: 2512	Type code P :Power 0402 size = 1/8W 0603 size = 1/8W 0805 size = 1/4W 1206 size = 1/2W 2010 size = 1W 2512 size = 2W	Resistance code 5%, E24: 2 significant digits followed by no. of zeros & a blank e.g.: 3ohm =3R0 10ohm =100 56Kohm =563 1%, E24+E96: 3 significant digits followed by No. of zeros 100Ω =1000 37.4KΩ =3742	Tolerance J : ±5% F : ±1% P : Jumper	Packaging code T: 7" Reeled taping . D: 7" Reeled taping	Termination code L = Sn base (lead free)	Special code V = 1. AEC Q200 Compliant 2. Anti-Sulfuration ASTM B-809-95 compliant 60°C x 480hrs 3. 100% CCD visual inspection

- Reeled tape packaging : 8mm width paper taping 5000pcs per 7" reel for 0603-1210 sizes. 10kpcs for 0402 size!
- Reeled tape packaging : 12mm width plastic taping 4000pcs per 7" reel for 2010 size.

TEST CONDITIONS FOR JUMPER (0 Ω)

Item	WF25P	WF20P	WF12P	WF08P	WF06P	WF04P
Power Rating At 70°C	2W	1W	1/2W	1/4W	1/8W	1/8W
Resistance	Max. 20mΩ					Max. 50 mΩ
Rated Current	10A	7A	5A	4A	2.5A	1.5A
Peak Current	25A	17.5A	12.5A	10A	6A	3.8A
Operating Temperature	-55 ~ +155°C					

TEST AND REQUIREMENTS

Essentially all tests are carried out according to the schedule of IEC publication 115-8, category **LCT/UCT/56**(rated temperature range : **Lower Category Temperature, Upper Category Temperature**; damp heat, long term, 56 days). The testing also meets the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 68, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to IEC 60068-1, subclause 5.3. Unless otherwise specified, the following value supplied :

Temperature: 15°C to 35°C.

Relative humidity: 45% to 75%.

Air pressure: 86kPa to 106 kPa (860 mbar to 1060 mbar).

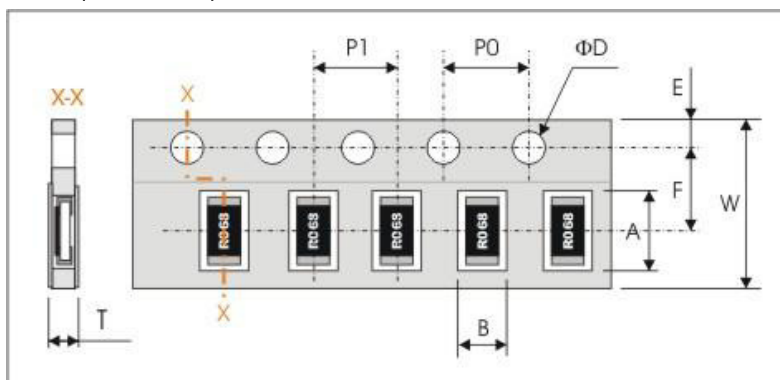
All soldering tests are performed with mildly activated flux.

TEST	PROCEDURE / TEST METHOD	REQUIREMENT
		Resistor
Electrical Characteristics JISC5201-1: 1998 Clause 4.8	- DC resistance values measurement - Temperature Coefficient of Resistance (T.C.R) Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/°C)} \quad t_1 : 20^\circ\text{C} + 5^\circ\text{C} - 1^\circ\text{C}$ R_1 : Resistance at reference temperature R_2 : Resistance at test temperature	Within the specified tolerance Refer to "QUICK REFERENCE DATA"
Resistance to soldering heat(R.S.H) MIL-STD-202 method 210	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 270°C±5°C	ΔR/R max. ±(1.0%+0.05Ω) no visible damage
Solderability J-STD-002	a) Bake the sample for 155°C dwell time 4hrs/ solder dipping 235°C/ 5sec. b) Steam the sample dwell time 8 hour/ solder dipping 215°C/ 5sec. c) Steam the sample dwell time 8 hour/ solder dipping 260°C/ 7sec.	95% coverage min., good tinning and no visible damage
Temperature cycling JESD22 Method JA-104	1000 cycles, -55°C ~ +155°C, dwell time 30min maximum.	ΔR/R max. ±(1.0%+0.05Ω) No visible damage
Moisture Resistance MIL-STD-202 method 106	65±2°C, 80~100% RH, 10 cycles, 24 hours/ cycle	ΔR/R max. ±(1.0%+0.05Ω) No visible damage
Bias Humidity MIL-STD-202 method 103	1000+48/-0 hours; 85°C, 85% RH, 10% of operation power	ΔR/R max. ±(2.0%+0.10Ω) No visible damage
Operational Life MIL-STD-202 method 108	1000+48/-0 hours; 35% of operation power, 125±2°C	ΔR/R max. ±(2.0%+0.1Ω) No visible damage
High Temperature Exposure MIL-STD-202 Method 108	1000+48/-0 hours; without load in a temperature chamber controlled 155±3°C	ΔR/R max. ±(2.0%+0.10Ω) No visible damage

TEST	PROCEDURE / TEST METHOD	REQUIREMENT
		Resistor
Board Flex AEC-Q200-005	Resistors mounted on a 90mm glass epoxy resin PCB(FR4),bending once 2mm for 60sec.	$\Delta R/R$ max. $\pm(1.0\%+0.05\Omega)$ No visible damage
Terminal strength AEC-Q200-006	Pressurizing force: 1Kg, Test time: 60 $\pm$ 1sec.	No remarkable damage or removal of the terminations
Thermal shock MIL-STD-202 method 107	Test -55 to 155°C/ dwell time 15min/ Max transfer time 20sec 300cycles	$\Delta R/R$ max. $\pm(1.0\%+0.05\Omega)$ No visible damage
ESD AEC-Q200-002	Test contact 1.0KV (0.5KV for 0402 only)	$\Delta R/R$ max. $\pm(1.0\%+0.05\Omega)$ No visible damage
Mechanical Shock MIL-STD-202 method 213	Test ½ Sine Pulse, Peak value: 100g, normal duration: 6ms, Velocity change:12.3ft/sec. Three shocks in each direction, total 18 shocks.	Within product specification tolerance and no visible damage.
Vibration MIL-STD-202 method 204	Test 5g's for 20 min., 12 cycles each of 3 orientations.	$\Delta R/R$ max. $\pm(1\%+0.05\Omega)$ and no visible damage
Resistance to Solvents : MIL-STD-202 Method 215	Solvent is Isopropyl alcohol, immersion 3mins at 25°C and brush 10 strokes with a toothbrush with a handle made of a non-reactive material (wet bristle), immersion and brush 3 times and then air blow dry.	No superficial defect on marking, encapsulation, coating, appearance. Electrical characteristics within products specification and tolerance. Inspect at 3X max. for marking, inspect at 10X for part damage.
External Visual MIL-STD-883 method 2009	Electrical test not required. Inspect device construction, marking and workmanship	No visual damage and refer WTC marking code.
Physical Dimension JESD22 method JB-100	Verify physical dimensions(L, W, T, Tb, Tt)	Within the specified tolerance for WTC.
Sulfuration test ASTM B-809-95	ASTM B-809 60°C 480hrs	$\Delta R/R$ max. $\pm(2\%+0.10\Omega)$ No visible damage

PACKAGING

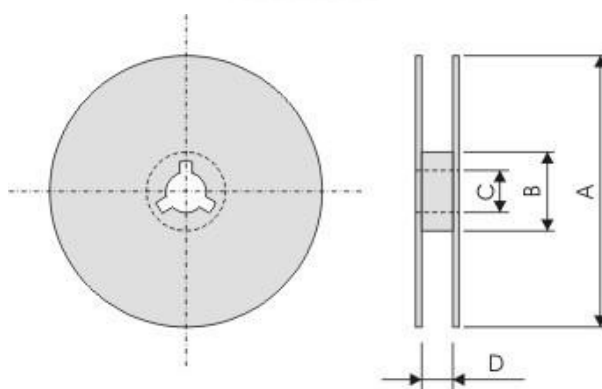
Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF25P	6.90±0.20	3.60±0.20	12.00±0.30	5.50±0.10	1.75±0.10
WF20P	5.50±0.20	2.80±0.20	12.00±0.30	5.50±0.10	1.75±0.10
WF12P	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF08P	2.40±0.20	1.65±0.20			
WF06P	1.90±0.20	1.10±0.20			
WF04P	1.20±0.10	0.70±0.10			

Series No.	P1	P0	ΦD	T
WF25P	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.2
WF20P				Max. 1.2
WF12P				Max. 1.0
WF08P				Max. 1.0
WF06P				0.65±0.05
WF04P	2.00±0.10	4.00±0.10		0.40±0.05

Reel dimensions



Symbol	A	B	C	D
12 mm tape	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	12.4±1.0
8 mm tape	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	9.0±0.5

APPROVAL SHEET

**WF25P, WF20P, WF10P, WF12P, WF08P,
WF06P, WF04P**

$\pm 5\%$, $\pm 1\%$, $\pm 0.5\%$, $\pm 0.1\%$ $1\Omega \sim 10M\Omega$

Thick Film High Power Chip Resistors

**Size 2512 2W, 2010 1W, 1210 1/2W,
1206 1/2W, 0805 1/4W, 0603 1/8W, 0402 1/8W**

**RoHS 2 Compliant with exemption 7C-I
Halogen free**

*Contents in this sheet are subject to change without prior notice.

FEATURE

1. High power rating and compact size
2. High reliability and stability
3. Reduced size of final equipment
4. RoHS 2 compliant with exemption 7C-I and Halogen free products
5. Flame Retardant

APPLICATION

- Power supply
- PDA
- Digital meter
- Computer
- Automotives
- Battery charger
- DC-DC power converter

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

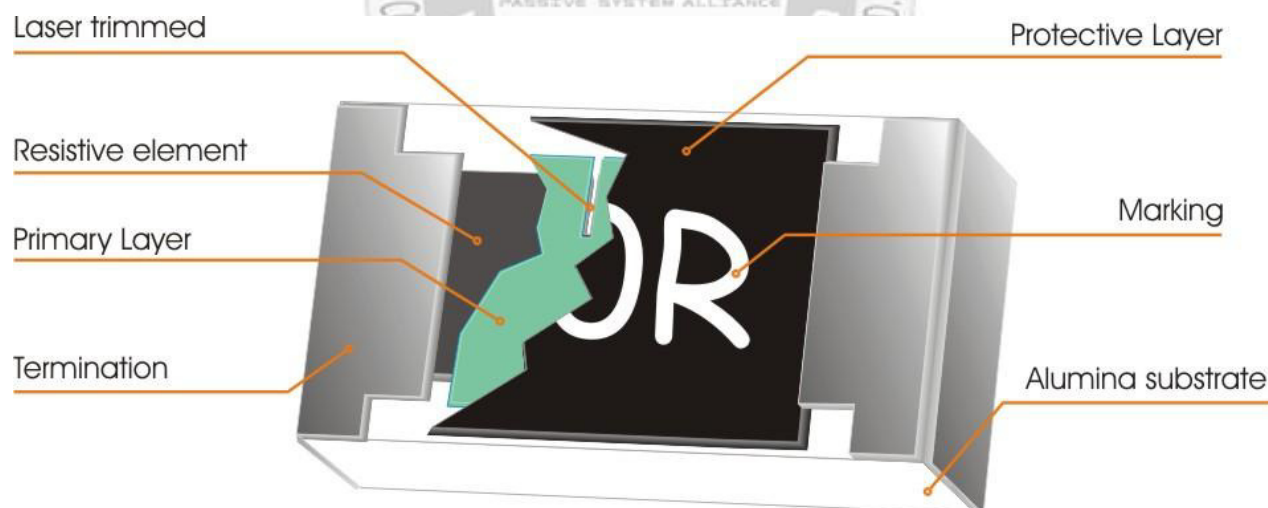


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification						
Series No.	WF25P	WF20P	WF10P	WF12P	WF08P	WF06P	WF04P
Size code	2512 (6432)	2010 (5025)	1210 (3225)	1206 (3216)	0805 (2012)	0603 (1608)	0402 (1005)
Resistance Tolerance	$\pm 1\%$, $\pm 0.5\%$, $\pm 0.1\%$ (E24+E96), $\pm 5\%$ (E24)						
Resistance Range	0 Ω , 1 Ω ~ 1M Ω			0 Ω , 1 Ω ~ 10M Ω		0 Ω , 1 Ω ~ 1M Ω	
TCR (ppm/°C) 10.2 Ω ~ 1M Ω < 10 Ω	± 100 ± 100	± 100 ± 100	± 100 ± 100	± 100 ± 200	± 100 ± 150	± 100 ± 150	± 100 -200/+400
Max. dissipation at T _{amb} =70°C	2 W	1 W	1/2 W	1/2W	1/4 W	1/8 W	1/8 W
Max. Operation Voltage	300V	200V	200V	200V	150V	50V	50V
Max. Overload Voltage	500V	400V	400V	400V	300V	100V	100V
Operation Temperature	- 55/+155°C						

Note :

- This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
- Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}}$$
or Max. RCWV listed above, whichever is lower.
- 2W loading with total solder-pad and trace size of 300 mm²

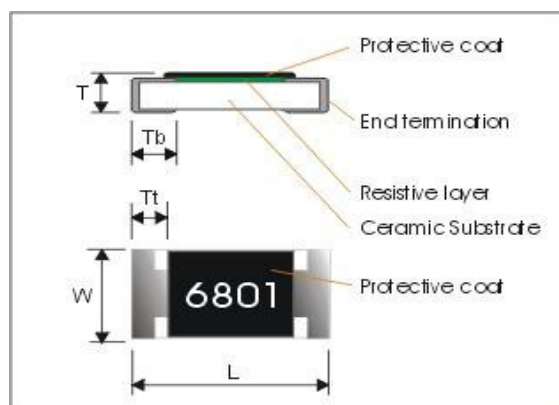
TEST CONDITION FOR JUMPER (0 Ω)

Item	WF25P	WF20P	WF10P	WF12P	WF08P	WF06P	WF04P
Power Rating	2W	1W	1/2W	1/2W	1/4W	1/8W	1/8W
Resistance	Max. 20m Ω	Max. 20m Ω	Max. 20m Ω	Max. 20m Ω	Max. 20m Ω	Max. 20m Ω	Max. 50m Ω
Rated Current	10A	7A	5A	5A	4A	2A	1.5A
Peak Current	25A	17.5A	12.5A	12.5A	10A	5A	3.8A
Operating Temperature	-55 ~ +155°C						

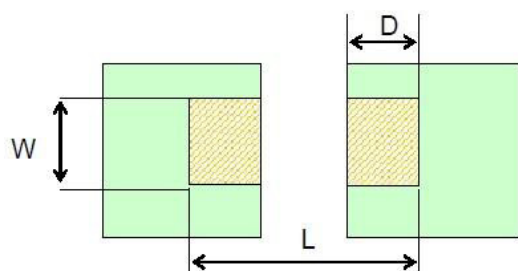
MECHANICAL DATA

Unit: mm

Symbol	WF25P	WF20P	WF12P	WF10P	WF08P	WF06P	WF04P
L	6.30 ± 0.20	5.00 ± 0.20	3.10 ± 0.15	3.10 ± 0.15	2.00 ± 0.10	1.60 ± 0.10	1.00 ± 0.05
W	3.10 ± 0.20	2.50 ± 0.20	1.60 ± 0.15	2.50 ± 0.15	1.25 ± 0.10	0.80 ± 0.10	0.50 ± 0.05
T	0.60 ± 0.15	0.60 ± 0.10	0.55 ± 0.10	0.55 ± 0.10	0.50 ± 0.15	0.45 ± 0.15	0.35 ± 0.05
Tt	0.60 ± 0.25	0.60 ± 0.25	0.50 ± 0.25	0.50 ± 0.25	0.40 ± 0.20	0.30 ± 0.10	0.20 ± 0.10
Tb	1.80 ± 0.25	0.60 ± 0.25	0.50 ± 0.25	0.50 ± 0.25	0.40 ± 0.20	0.30 ± 0.15	0.25 ± 0.10



Recommended Solder Pad Dimensions



Type	W	D	L
WF25P	3.7mm	2.45mm	7.6mm

MARKING

For 0603 above size, each resistor is marked with a four-digit for 1% tolerance and three-digit for 5% tolerance on the protective coating to designate the nominal resistance value.

For 0603, each resistor is marked with a three-digit!

For 0402, no marking !

For Jumper, 2512/2010 defines 0000, 1206/0805/0603 defines 000.

Example:

102 = 1k Ω



16R0 = 16 Ω



FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96 & E24 series for resistors with a tolerance of $\pm 5\%$ & $\pm 1\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Derating curve

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

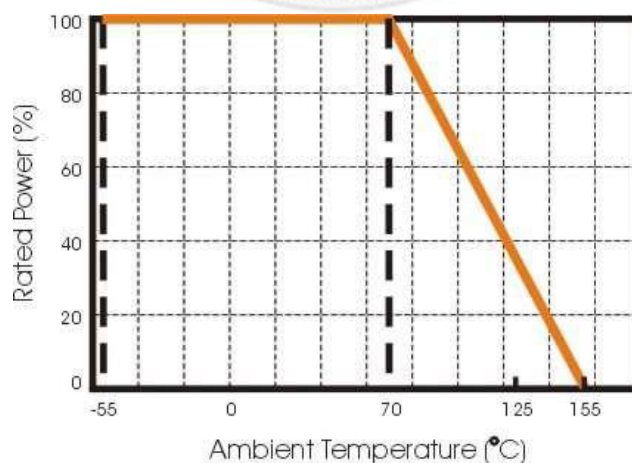


Figure 2 Maximum dissipation in percentage of rated power as a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

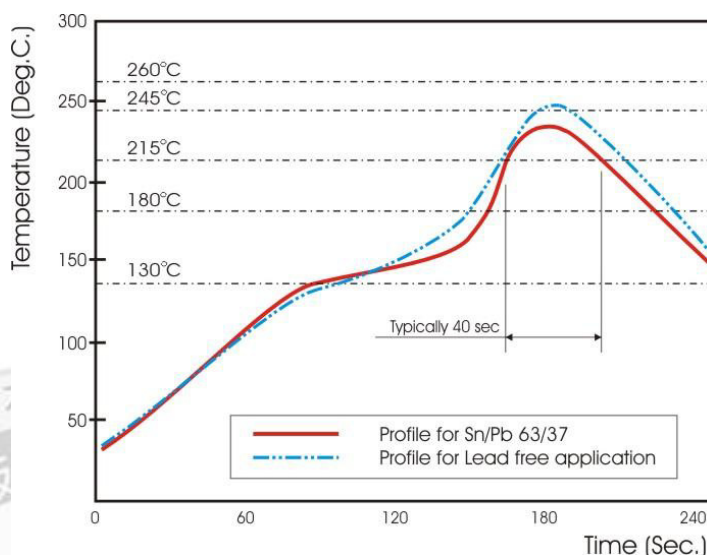


Fig 3. Infrared soldering profile for Chip Resistors

CATALOGUE NUMBERS

The resistors have a catalogue number starting with .

WF25	P	102_	J	T	L
Size code	Type code	Resistance code	Tolerance	Packaging code	Termination code
WF25 : 2512	P :Power	5% E24: 2 significant digits followed by No. of zeros and a blank e.g.: 3ohm =3R0_ 10ohm =100_ 56Kohm =563_ (" _ " means a blank)	J : ±5% F : ±1% D : ±0.5% B : ±0.1% P : Jumper	T : 7" Reel taping	L = Sn base (lead free)
WF20 : 2010	2512 size = 2W				
WF12 : 1206	2010 size = 1W				
WF10 : 1210	1206 size = 1/2W				
WF08 : 0805	1210 size = 1/2W				
WF06 : 0603	0805 size = 1/4W				
WF04 : 0402	0603 size = 1/8W				
	0402 size = 1/8W				
		1% E24+E96: 3 significant digits followed by No. of zeros 100Ω =1000 37.4KΩ =3742			

Tape packaging WF12, WF10, WF08, WF06 : 8mm width paper taping 5,000pcs per reel.

WF04: 8mm width paper taping 10,000pcs per reel.

WF25, WF20: 12mm width plastic taping 4,000pcs per reel.

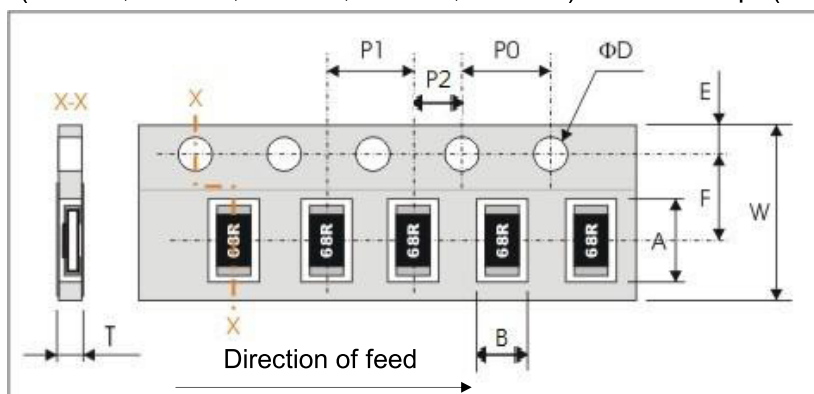
TEST AND REQUIREMENTS

Basic specification : JIS C 5201-1 : 1998

TEST	PROCEDURE	REQUIREMENT
Clause 4.8 Temperature Coefficient of Resistance (TCR)	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/}^\circ\text{C)}$ R ₁ : Resistance at reference temperature R ₂ : Resistance at test temperature t ₁ : 20°C+5°C-1°C	Refer to quick reference data for T.C.R specification
Clause 4.13 Short time overload	5.0× Rated power or Max. Overload Voltage for 5 sec. Measure resistance after 30 minutes..	ΔR/R max. J: ≤ ±(2%+0.1Ω) B,D, F: ≤ ±(1%+0.05Ω)
Clause 4.18 Resistance to soldering heat	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260°C±5°C	No visible damage ΔR/R max. J: ≤ ±(1%+0.1Ω) B,D, F: ≤ ±(0.5%+0.05Ω)
Clause 4.17 Solderability	Un-mounted chips completely immersed for 2±0.5 second in a SAC solder bath at 235°C±5°C	Good tinning (>95% covered) No visible damage
Clause 4.18 Leach Test	Un-mounted chips completely immersed for 60±1second in a solder bath at 260°C±5°C	Ditto
Clause 4.19 Temperature cycling	30 minutes at -55°C±3°C, 2~3 minutes at 20°C+5°C-1°C, 30 minutes at +155°C±3°C, 2~3 minutes at 20°C+5°C-1°C, total 5 continuous cycles	No visible damage ΔR/R max. J ≤ ±(1%+0.1Ω) B,D,F ≤ ±(0.5%+0.05Ω)
Clause 4.25 Load life (endurance)	1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller 70±2°C, 1.5 hours on and 0.5 hours off	No visible damage ΔR/R max. J ≤ ±(3%+0.1Ω) B,D,F ≤ ±(1%+0.05Ω)
Clause 4.24 Load life in Humidity	1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at 40°C±2°C and 90~95% relative humidity, 1.5hours on and 0.5 hours off	No visible damage ΔR/R max. J ≤ ±(3%+0.1Ω) B,D,F ≤ ±(1%+0.05Ω)
Clause 4.33 Bending strength	Resistors mounted on a 90mm glass epoxy resin PCB(FR4); bending : 2 mm(2512;2010) 3mm(1206), once for 10 seconds	No visible damage ΔR/R max. J ≤ ±(1%+0.1Ω) B,D,F ≤ ±(0.5%+0.05Ω)
Clause 4.32 Adhesion	Pressurizing force: 5N, Test time: 10±1sec	No remarkable damage or removal of the terminations
Insulation Resistance Clause 4.6	Apply the maximum overload voltage (DC) for 1minute	R ≥ 10GΩ
Dielectric Withstand Voltage Clause 4.7	Apply the maximum overload voltage (AC) for 1 minute	No breakdown or flashover

PACKAGING

Paper Tape(WF12P, WF10P, WF08P, WF06P, WF04P) & Plastic Tape(WF25P;WF20P)

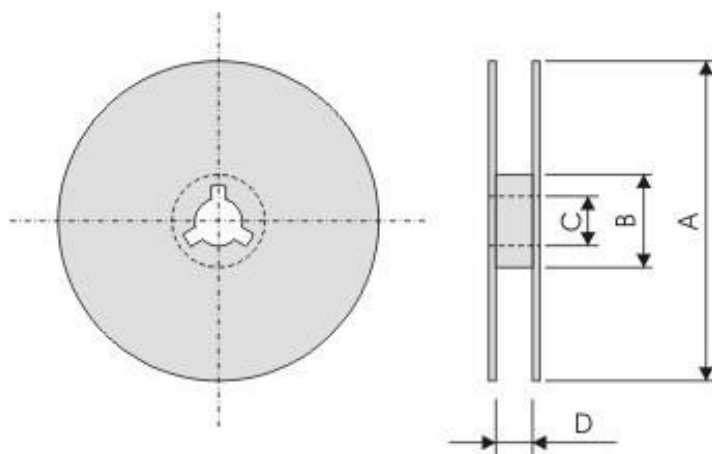


(unit :mm)

Series No.	A	B	W	F	E
WF25P	6.90±0.20	3.60±0.20	12.00±0.30	5.50±0.10	1.75±0.10
WF20P	5.50±0.20	2.80±0.20			
WF12P	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF10P	3.60±0.20	3.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF08P	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF06P	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF04P	1.20±0.10	0.70±0.10	8.00±0.30	3.50±0.20	1.75±0.10

Series No.	P1	P0	P2	ΦD	T
WF25P	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.2
WF20P					Max. 1.0
WF12P					
WF10P	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.0
WF08P	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.0
WF06P	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.65±0.05
WF04P	2.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.40±0.05

Reel dimensions



(unit : mm)

Reel / Tape	A	B	C	D
7" reel for 12mm tape	$\Phi 178.0 \pm 2.0$	$\Phi 60.0 \pm 1.0$	13.0 $\pm$ 0.2	12.4 $\pm$ 1.0
7" reel for 8mm tape				9.0 $\pm$ 0.5



APPROVAL SHEET

WF25S, WF20S, WF12S, WF08S, WF06S

$\pm 5\%$, $\pm 10\%$, $\pm 20\%$

Size 2512 , 2010 , 1206 , 0805 , 0603

Power Surge Chip Resistors

RoHS 2 Compliant with exemption 7C-1

Halogen free



FEATURE

1. Power rating and compact size
2. High reliability and stability
3. Reduced size of final equipment
4. Surge protection
5. RoHS 2 Compliant with exemption 7C-1 and Halogen free products

APPLICATION

- Power supply
- Measurement instrument
- Automotive industry
- Medical or Military equipment

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to request resistance to nominal value within tolerance which controlled by printing process in this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (Pb free) alloy.

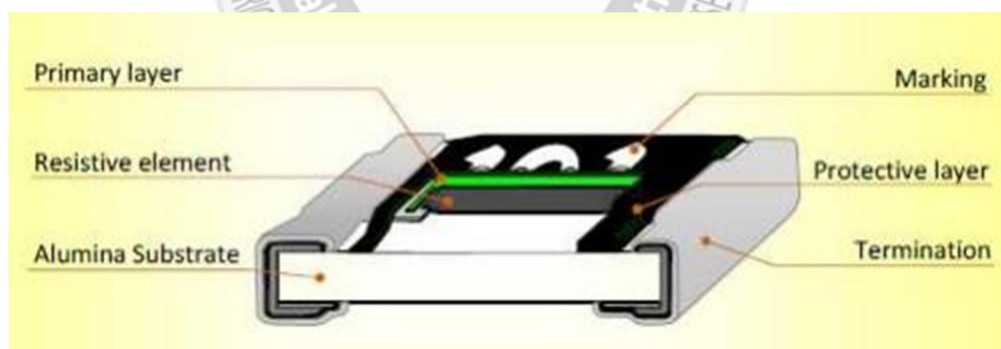


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

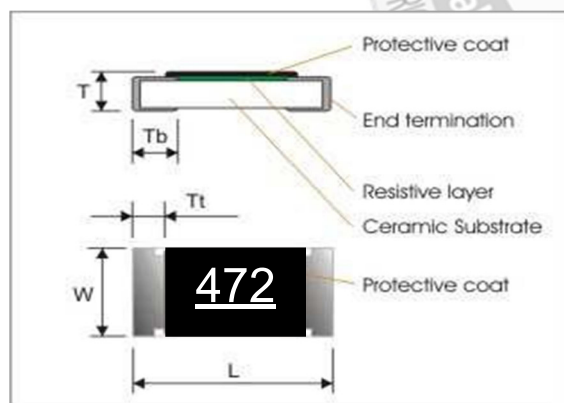
Item	General Specification				
Series No.	WF25S	WF20S	WF12S	WF08S	WF06S
Size code	2512(6432)	2010 (5025)	1206 (3216)	0805 (2012)	0603 (1608)
Resistance Tolerance	$\pm 5\% \pm 10\% \pm 20\%$ (E24)				
Resistance Range	$1\Omega \sim 1M\Omega$				
TCR (ppm/°C)	$\pm 100 \text{ ppm } / ^\circ\text{C}$				
Max. dissipation at $T_{\text{amb}}=70^\circ\text{C}$	1 W	1/2W	1/4W	1/8W	1/10 W
Max. Operation Voltage (DC or RMS)	200V	200V	200V	150V	50V
Max. Overload Voltage (DC or RMS)	400V	400V	400V	300V	100V
Climatic category (IEC 60068)	55/155/56				

Note :

- This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
- Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$\text{RCWV} = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \quad \text{or} \quad \text{Max. RCWV listed above, whichever is lower.}$$

MECHANICAL DATA(unit : mm)

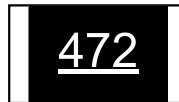


Symbol	WF25S	WF20S	WF12S	WF08S	WF06S
L	6.30±0.20	5.00±0.20	3.10±0.15	2.00±0.15	1.60 ± 0.10
W	3.10±0.20	2.50±0.20	1.60±0.15	1.20±0.15	0.80 ± 0.10
T	0.60±0.15	0.60±0.10	0.55±0.10	0.50±0.10	0.45 ± 0.15
Tt	0.60±0.25	0.60±0.25	0.50±0.25	0.40±0.20	0.30 ± 0.15
Tb	0.60±0.25	0.60±0.25	0.50±0.25	0.40±0.20	0.30 ± 0.10

MARKING

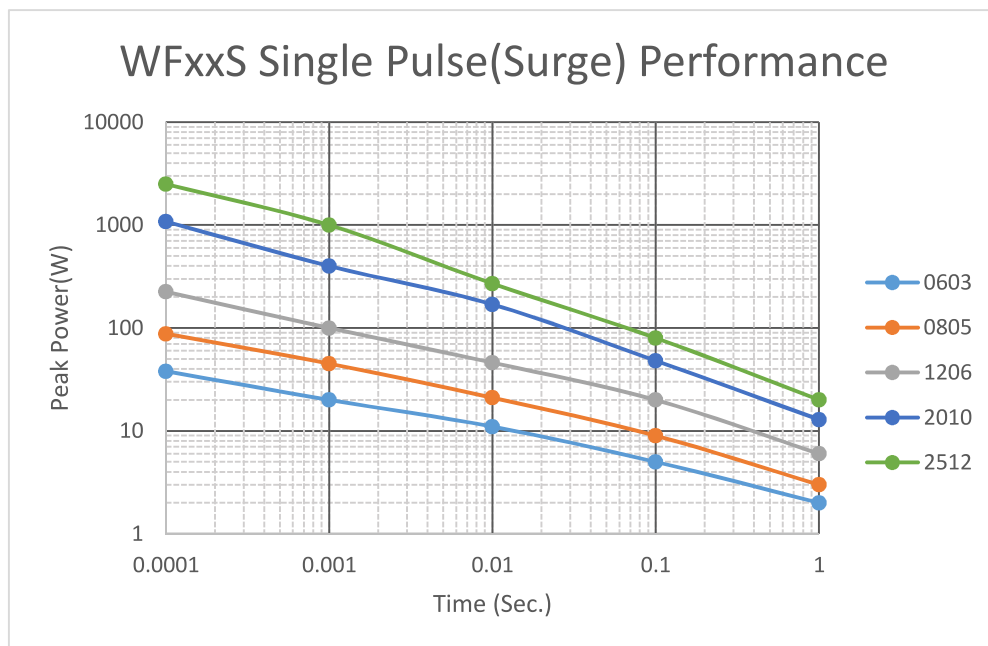
1. Each resistor is marked with a three-digit code on the protective coating to designate the nominal resistance value.
2. Surge Resistor is prints underline on three-digit code for identification

Example:



$$472 = 4700\Omega$$

Single Pulse(Surge) Chart



De-rating curve

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

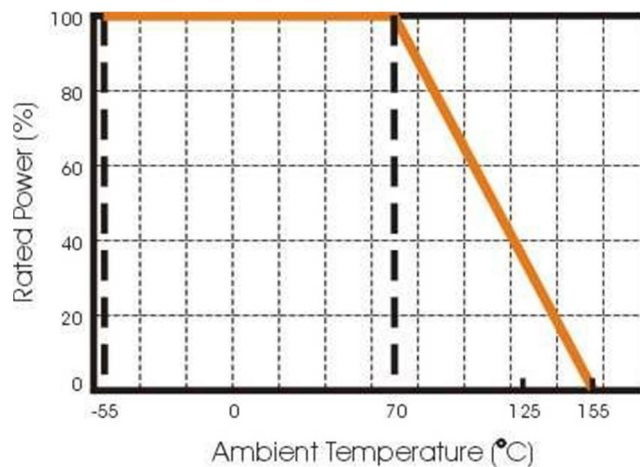


Fig.2 Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

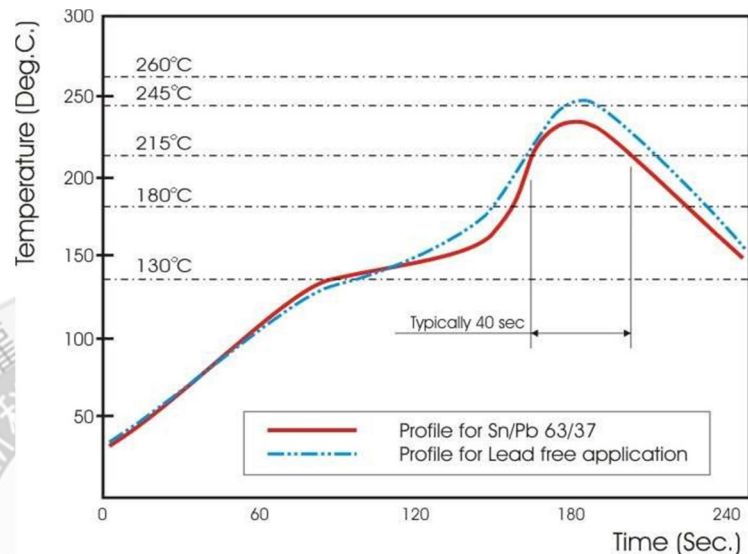


Fig 3. Infrared soldering profile for Chip Resistors WFxxS

CATALOGUE NUMBERS

The resistors have a catalogue number starting with

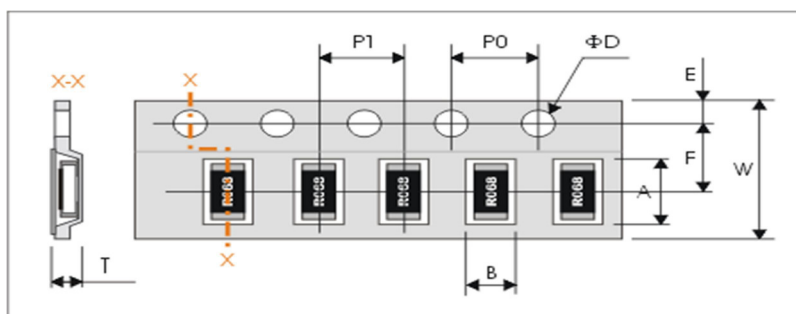
WF20	S	472_	J	T	L
Size code	Type code	Resistance code	Tolerance	Packaging code	Termination code
WF25 : 2512	S : surge	E24 : 3 significant digits followed by no. of zeros and a blank 472 = 4K7	J: $\pm 5\%$	T : 7" Reeled taping	L = Sn base (lead free)
WF20 : 2010			K: $\pm 10\%$		
WF12 : 1206			M: $\pm 20\%$		
WF08 : 0805					
WF06 : 0603					

TEST AND REQUIREMENTS(JIS C 5201-1 : 1998)

TEST	PROCEDURE	REQUIREMENT
Temperature Coefficient of Resistance(T.C.R) Clause 4.8	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/}^\circ\text{C)}$ $t : 20^\circ\text{C}+5^\circ\text{C}-1^\circ\text{C}$ R₁ : Resistance at reference temperature R₂ : Resistance at test temperature	Refer to "QUICK REFERENCE DATA"
Short time overload (S.T.O.L) Clause 4.13	Permanent resistance change after a 5second application of a voltage 2.5 times RCWV or the maximum overload voltage specified in the above list, whichever is less.	$\Delta R/R \text{ max. } \pm(1\%+0.1\Omega)$
Resistance to soldering heat(R.S.H) Clause 4.18	Un-mounted chips completely immersed for 10±1second in a solder bath at 260°C±5°C	no visible damage $\Delta R/R \text{ max. } \pm(1\%+0.05\Omega)$
Solderability Clause 4.17	Un-mounted chips completely immersed for 2±0.5second in a solder bath at 235°C±5°C	good tinning (>95% covered) no visible damage
Temperature cycling Clause 4.19	30 minutes at -55°C±3°C, 2~3 minutes at 20°C+5°C-1°C, 30 minutes at +155°C±3°C, 2~3 minutes at 20°C+5°C-1°C, total 5 cycles	no visible damage $\Delta R/R \text{ max. } \pm(1\%+0.05\Omega)$
Load life (endurance) Clause 4.25	70±2°C, 1000 hours, loaded with RCWV or Vmax,1.5 hours on and 0.5 hours off	$\Delta R/R \text{ max. } \pm(3\%+0.1\Omega)$
Load life in Humidity Clause 4.24	1000 hours, at rated continuous working voltage in humidity chamber controller at 40°C±2°C and 90~95% relative humidity, 1.5hours on and 0.5 hours off	$\Delta R/R \text{ max. } \pm(3\%+0.1\Omega)$
Bending strength Clause 4.33	Resistors mounted on a 90mm glass epoxy resin PCB(FR4); bending : 2 mm, once for 10 seconds	$\Delta R/R \text{ max. } \pm(1\%+0.05\Omega)$
Adhesion Clause 4.32	Pressurizing force: 5N, Test time: 10±1sec.	No remarkable damage or removal of the terminations
Insulation Resistance Clause 4.6	Apply the maximum overload voltage (DC) for 1minute	$R \geq 10G\Omega$
Dielectric Withstand Voltage Clause 4.7	Apply the maximum overload voltage (AC) for 1 minute	No breakdown or flashover

PACKAGING

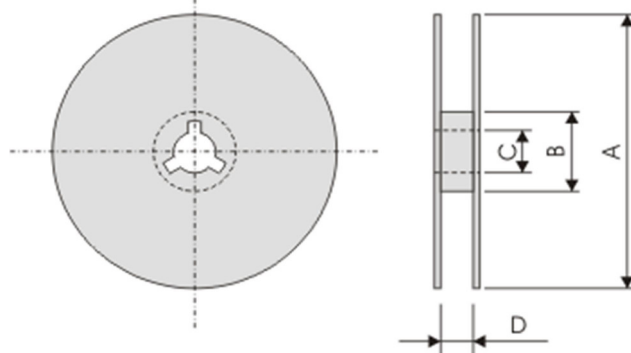
Plastic Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF25S	6.70±0.20	3.50±0.20	12.00±0.30	5.50±0.05	1.75±0.10
WF20S	5.50±0.20	2.80±0.20			
WF12S	3.57±0.20	2.00±0.20	8.00±0.30	3.50±0.05	1.75±0.10
WF08S	2.40±0.20	1.65±0.20			
WF06S	1.90±0.20	1.10±0.20			

Series No.	P1	P0	ΦD	T
WF25S	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.2
WF20S				Mx. 1.0
WF12S				
WF08S				
WF06S				0.65±0.05

Reel dimensions



Reel / Tape	A	B	C	D
7" reel for 8mm tape	178.0±2.0	60.0±1.0	13.0±0.2	9.00±0.50
7" reel for 12mm tape				12.4±1.00

Taping quantity

- 1206 0805 0603 Chip resistors 5,000 pcs per reel.
- 2010 2512 Chip resistors 4,000 pcs per reel.

APPROVAL SHEET

WF25V, WF20V, WF12V, WF08V, WF06V

±1%, ±5%

Thick Film High Voltage Chip Resistors

Size 2512,2010,1206, 0805, 0603

RoHS 2 Compliant with exemption 7C-I

Halogen free



*Contents in this sheet are subject to change without prior notice

FEATURES

1. Special material and design for high working voltage require.
2. Compatible with flow and reflow soldering
3. Suitable for lead free soldering.

APPLICATIONS

- Power supply
- Automotive industry
- Measurement instrument
- Back light inverter
- Medical or Military equipment

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

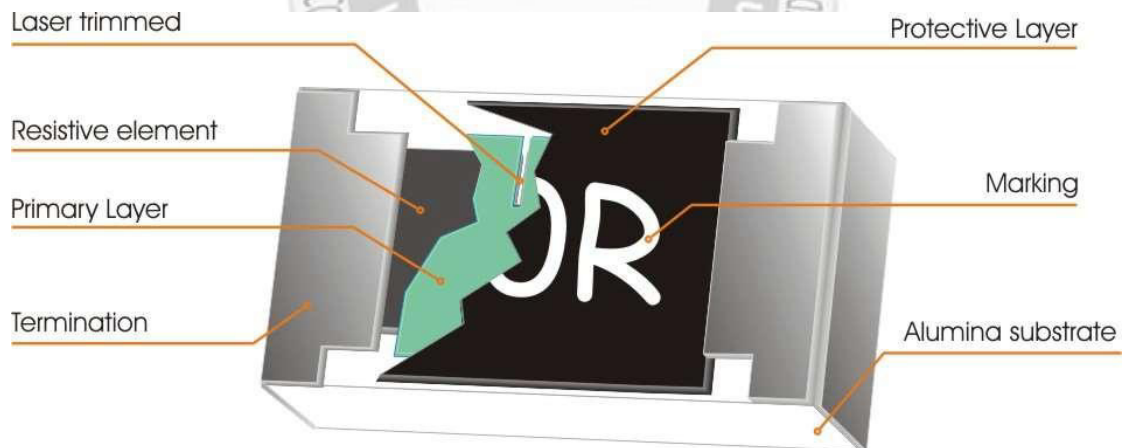


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification				
Series No.	WF25V	WF20V	WF12V	WF08V	WF06V
Size code	2512 (6432)	2010 (5025)	1206 (3216)	0805 (2012)	0603 (1608)
Resistance Tolerance	±1% (E96/E24) , ±5% (E24)				
Resistance Range	±1%: 47Ω ~10MΩ (E96/E24) 11MΩ ~22MΩ (E24) ±5%: 47Ω ~100MΩ(E24)			±1%: 47Ω ~10MΩ (E96/E24) ±5%: 100KΩ ~22MΩ (E24)	±1%: 47Ω ~10MΩ (E96/E24) ±5%: 100KΩ ~10MΩ (E24)
TCR (ppm/°C)	±1%: 47Ω ~10MΩ ±100ppm/°C ±1%: 11MΩ ~22MΩ ±200ppm/°C ±5%: ±200ppm/°C				
Max. Dissipation at T _{amb} =70°C	1 W	1/2 W	1/4 W	1/8 W	1/10 W
Max. Operation Voltage (DC or RMS)	3000V	2000V	800V	400V	200V
Max. Overload Voltage (DC or RMS)	4000V	3000V	1600V	800V	400V
Climatic category (IEC 60068)	55/155/56				

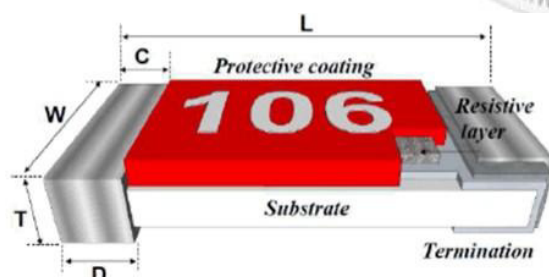
Note:

1. This is the maximum voltage that may be continuously supplied to the resistor element, see “IEC publication 60115-8”
2. Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

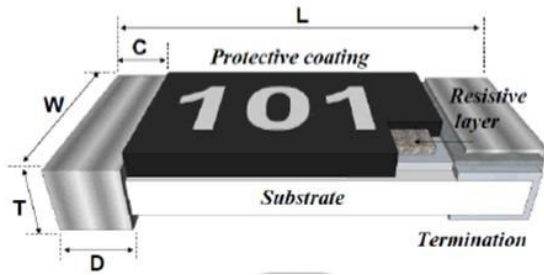
MECHANICAL DATA

R value ≥ 100KΩ



Series No.	WF25V	WF20V	WF12V	WF08V	WF06V
L	6.40 ± 0.20	5.00 ± 0.20	3.10 ± 0.10	2.00 ± 0.10	1.60 ± 0.10
W	3.20 ± 0.20	2.50 ± 0.20	1.60 ± 0.10	1.25 ± 0.10	0.80 ± 0.10
C	0.65 ± 0.25	0.65 ± 0.25	0.50 ± 0.20	0.40 ± 0.20	0.30 ± 0.20
D	0.90 ± 0.25	0.60 ± 0.25	0.50 ± 0.20	0.40 ± 0.20	0.30 ± 0.20
T	0.60 ± 0.15	0.60 ± 0.10	0.55 ± 0.10	0.50 ± 0.10	0.45 ± 0.10

R value < 100K Ω



Series No.	WF25V	WF20V	WF12V	WF08V	WF06V
L	6.40 $\pm$ 0.20	5.00 $\pm$ 0.20	3.10 $\pm$ 0.10	2.00 $\pm$ 0.10	1.60 $\pm$ 0.10
W	3.10 $\pm$ 0.20	2.50 $\pm$ 0.20	1.60 $\pm$ 0.10	1.25 $\pm$ 0.10	0.80 $\pm$ 0.10
C	0.60 $\pm$ 0.25	0.65 $\pm$ 0.25	0.50 $\pm$ 0.25	0.40 $\pm$ 0.20	0.30 $\pm$ 0.20
D	1.80 $\pm$ 0.25	0.60 $\pm$ 0.25	0.50 $\pm$ 0.25	0.40 $\pm$ 0.20	0.30 $\pm$ 0.20
T	0.60 $\pm$ 0.15	0.60 $\pm$ 0.10	0.55 $\pm$ 0.10	0.50 $\pm$ 0.10	0.45 $\pm$ 0.10

CATALOGUE NUMBERS

The resistors have a catalogue number starting with .

WF25	V	1004	F	T	L
Size code	Type code	Resistance code	Tolerance	Packaging code	Termination code
WF25 : 2512 WF20 : 2010 WF12 : 1206 WF08 : 0805 WF06 : 0603	V : High Voltage	$\pm 5\%$ E24: 2 significant digits followed by no. of zeros and a blank $47\Omega = 470_$ $680\Omega = 681_$ $750K\Omega = 754_$ $1M\Omega = 105_$ $100M\Omega = 107_$ (" _ " means a blank) $\pm 1\%$, E24+E96: 3 significant digits followed by no. of zeros $47\Omega = 47R0$ $680\Omega = 6800$ $750K\Omega = 7503$ $1M\Omega = 1004$ $22M\Omega = 2205$	J : $\pm 5\%$ F : $\pm 1\%$	T : 7" Reel taping Q : 10" Reel taping G : 13" Reel taping	L = Sn base (lead free)

Tape packaging:

1206, 0805: 0603: 8mm width paper taping 5Kpcs per 7" reel, 10Kpcs per 10" reel, 20Kpcs per 13" reel
2512, 2010: 12mm width plastic taping 4Kpcs per 7" reel, 8Kpcs per 10" reel, 16Kpcs per 13" reel

MARKING

R value $\geq 100\text{K}\Omega$, Overcoat Color is "Red"

R value $< 100\text{K}\Omega$, Overcoat Color is "Black"

E24 series $\pm 5\%$:

Each resistor is marked with a three-digit code on the protective coating to designate the nominal resistance value.

0603/0805/1206/2010/2512:



$$104 \rightarrow 10 \times 10^4 = 100 \text{ K}\Omega$$

E24/E96 series $\pm 1\%$:

Each resistor is marked with a four-digit code on the protective coating to designate the nominal resistance value.

0805/1206/2010/2512:



$$1001 \rightarrow 100 \times 10^1 = 1 \text{ K}\Omega$$

E24 series $\pm 1\%$:

Each resistor is marked with a three-digit code on the protective coating to designate the nominal resistance value.

0603:

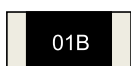


$$915 \rightarrow 91 \times 10^5 = 9.1 \text{ M}\Omega$$

E96 series $\pm 1\%$:

Each resistor is marked with a three-digit code on the protective coating to designate the nominal resistance value.

0603:



$$01\text{B} \rightarrow \text{Refer 0603 1\% E96 CODE table} = 1 \text{ K}\Omega$$

The 1st two digit codes are referring to the CODE on the table, the 3rd code is the index of resistance value. The markings for the overlap values between E24 and E96 series are based on the E96 CODE table.

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

Example

RESISTANCE	1.78 Ω	17.8 Ω	178 Ω	1K78	17K8	178K	1M78	10M0
3 digits marking	25Y	25X	25A	25B	25C	25D	25E	01F

0603 1% E96 CODE table:

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

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of $\pm 1\%$, $\pm 5\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Derating curve

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

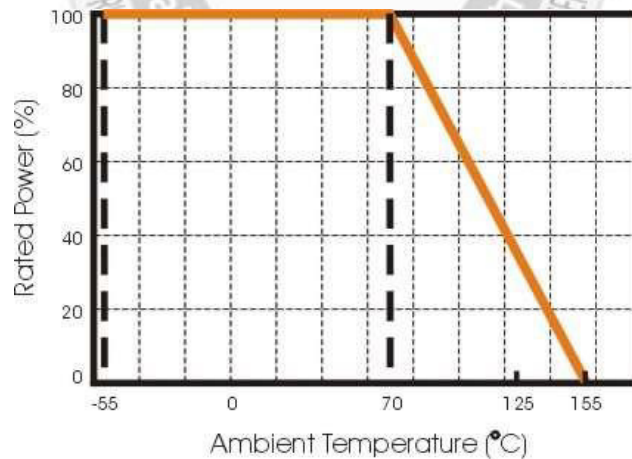


Figure 2 Maximum dissipation in percentage of rated power as a function of the ambient temperature

MOUNTING

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

Storage and Handling Conditions:

1. Products are recommended to be used up within two years since operation date as ensured shelf life. Check solderability in case shelf life extension is needed.
2. To store products with following condition:
 - Temperature :5 to 40°C
 - Humidity :20 to 70% relative humidity
3. Caution:
 - a. Don't store products in a corrosive environment such as sulfide, chloride gas, or acid.
It may cause oxidation of electrode, which easily be resulted in poor soldering.
 - b. To store products on the shelf and avoid exposure to moisture.
 - c. Don't expose products to excessive shock, vibration, direct sunlight and so on

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

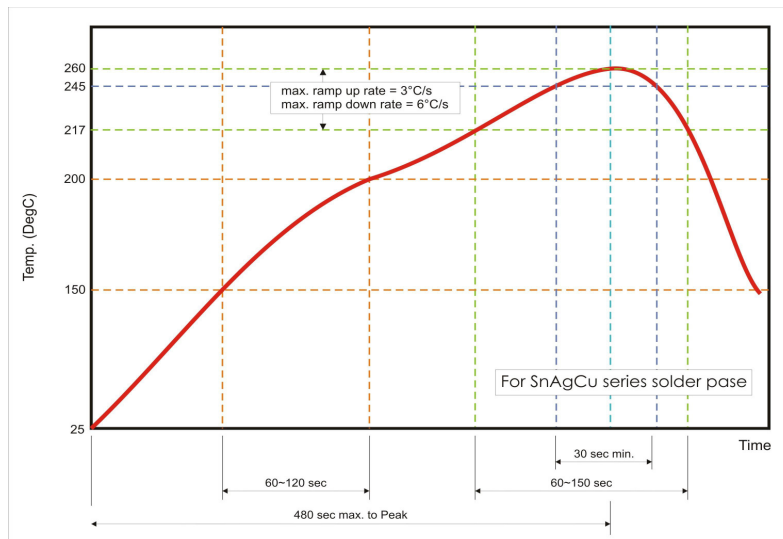
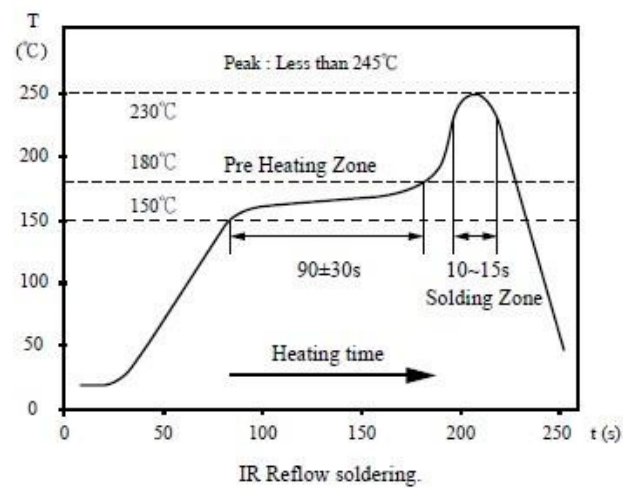
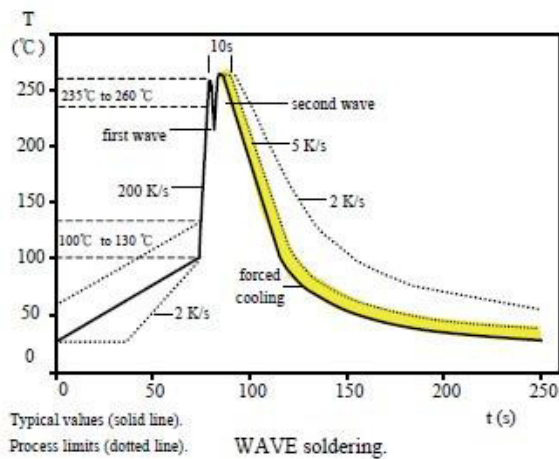
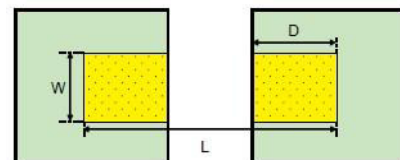


Fig 3. Infrared soldering profile

Recommend Solder Pad Dimensions

Type	W	D	L
WF06V	0.90	1.00	3.00
WF08V	1.30	1.15	3.50
WF12V	1.80	1.30	4.70
WF20V	3.00	1.50	6.80
WF25V	3.70	1.60	7.60
WF25V <100KΩ	3.70	1.60	7.60

Unit:mm



TESTS AND REQUIREMENTS (JIS C 5201-1 : 1998)

Essentially all tests are carried out according to the schedule of IEC publication 115-8, category **LCT/UCT/56**(rated temperature range : Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days). The testing also meets the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 68, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to IEC 60068-1, subclause 5.3. Unless otherwise specified, the following value supplied :

Temperature: 15°C to 35°C.

Relative humidity: 45% to 75%.

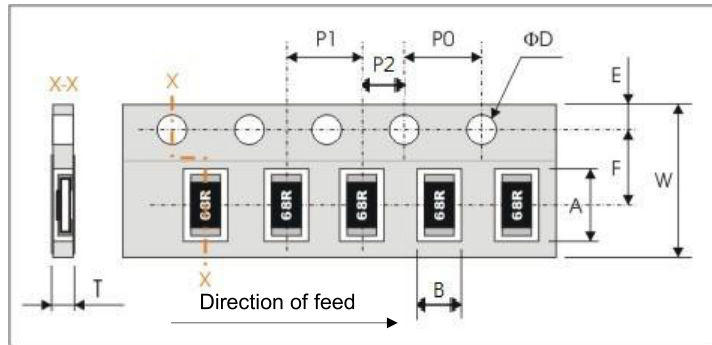
Air pressure: 86kPa to 106 kPa (860 mbar to 1060 mbar).

All soldering tests are performed with mildly activated flux.

TEST	PROCEDURE (IEC 60115)	REQUIREMENT
DC Resistance	IEC 60115-1 / JIS C 5201-1 , Clause 4.5 Measure the resistance Value.	F:±1%, J:±5%
Temperature Coefficient of Resistance(T.C.R) Clause 4.8	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/°C)}$ R ₁ : Resistance at reference temperature R ₂ : Resistance at test temperature t ₁ : 25°C t ₂ : -55~+155°C	Refer to "QUICK REFERENCE DATA"
Short time overload (S.T.O.L) Clause 4.13	5×Rated power or Max. Overload voltage for 5 sec. Measure the resistance after 30 minutes	J: ΔR/R max.±(2%+0.1Ω) F: ΔR/R max.±(1%+0.1Ω)
Resistance to soldering heat(R.S.H) Clause 4.18	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260°C ±5°C	ΔR/R max. ±(1%+0.1Ω) no visible damage
Solderability Clause 4.17	Un-mounted chips completely immersed for 2±0.5second in a SAC solder bath at 245°C±2°C	good tinning (>95% covered) no visible damage
Temperature cycling Clause 4.19	30 minutes at -55°C±3°C, 2~3 minutes at 20°C+5°C-1°C, 30 minutes at +155°C±3°C, 2~3 minutes at 20°C+5°C-1°C, total 5 continuous cycles	ΔR/R max. ±(1%+0.1Ω) no visible damage
Load life (endurance) Clause 4.25	1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller 70±2°C, 1.5 hours on and 0.5 hours off	J: ΔR/R max.±(3%+0.1Ω) F: ΔR/R max.±(1%+0.1Ω)
Load life in Humidity Clause 4.24	1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at 40°C±2°C and 90~95% relative humidity, 1.5hours on and 0.5 hours off	J: ΔR/R max.±(3%+0.1Ω) F: ΔR/R max.±(1%+0.1Ω)
Insulation Resistance Clause 4.6	Test voltage : 100±15V	Between termination and coating must over 1000MΩ
Bending strength Clause 4.33	Resistors mounted on a 90mm glass epoxy resin PCB(FR4), bending 2mm: 2512,2010,1206, 3mm: 0805,0603 once for 10 seconds	ΔR/R max. ±(0.5%+0.05Ω)
Voltage Coefficient of Resistance (VCR)	IEC 60115-1, Clause 4.11 Max. test voltage : 500V V _L : 10% RCWV or Max. RCWV V _H : 100% RCWV or Max. RCWV	100KΩ~≤1MΩ : ±100ppm >1MΩ : ±200ppm ≥10MΩ : ±300ppm

PACKAGING

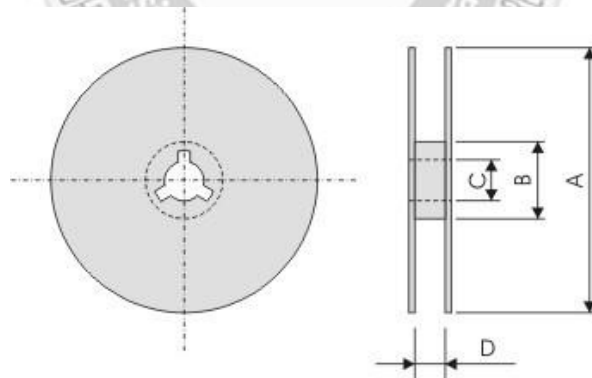
Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF25V	6.90±0.20	3.60±0.20	12.00±0.30	5.50±0.10	1.75±0.10
WF20V	5.50±0.20	2.80±0.20			
WF12V	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF08V	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF06V	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.20	1.75±0.10

Series No.	P1	P0	P2	ΦD	T
WF25V	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.2
WF20V					Max. 1.0
WF12V					
WF08V					
WF06V					

Reel dimensions



(unit : mm)

Size	Reel	Packaging Q'ty	A	B	C	D
0603 0805 1206	7" Reel for 8mm tape	5Kpcs/reel	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	10.00±1.5
	10" reel for 8mm tape	10Kpcs/reel	Φ254.0±2.0	Φ100.0±1.0	13.0±0.2	10.00±1.5
	13" reel for 8mm tape	20Kpcs/reel	Φ330.0±2.0	Φ100.0±1.0	13.0±0.2	10.00±1.5
2010 2512	7" Reel for 12mm tape	4Kpcs/reel	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	13.8±1.5
	10" Reel for 12mm tape	8Kpcs/reel	Φ254.0±2.0	Φ100.0±1.0	13.0±0.2	13.8±1.5
	13" Reel for 12mm tape	16Kpcs/reel	Φ330.0±2.0	Φ100.0±1.0	13.0±0.2	13.8±1.5

APPROVAL SHEET

WK12M / WK08M / WK06M

0/-20%, 0/-30%

Trimmable chip resistors

Size 1206, 0805, 0603,

Customer : _____

Approval No : _____

Issue Date : _____

Customer Approval :

FEATURE

1. Reduced size of final equipment
2. Lower assembly costs
3. Higher component and equipment reliability
4. Improved performance at high frequency
5. Low noise, when not trimmed
6. RoHS compliant and Lead free termination

APPLICATION

- Consumer electrical equipment
- Automotive application
- EDP, Computer application
- Telecom application

DESCRIPTION

The resistors are constructed on a high-grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste, which is applied to the substrate. The composition of the paste is adjusted to give the approximate resistance required.

The resistive layer is covered with a transparent protective coating. Finally the two external end terminations are added. For case of soldering the outer of these end terminations is a Tin (lead free) alloy.

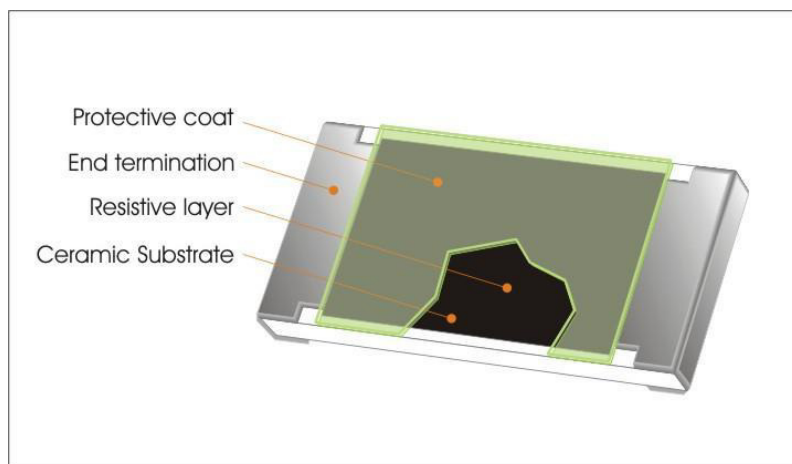


Fig 1. Construction of Trimmable Chip-R

QUICK REFERENCE DATA

Item	General Specification		
Series No.	WK12M	WK08M	WK06M
Size code	1206 (3216)	0805 (2012)	0603 (1608)
Resistance Range	1Ω ~ 4.7MΩ	1Ω ~ 4.7MΩ	10Ω ~ 4.7MΩ
Tolerance	0/-20% and 0/-30% (E24 series)		
TCR (ppm/°C)			
≥10Ω	≤ ± 200 ppm/°C	≤ ± 200 ppm/°C	≤ ± 200 ppm/°C
<10Ω	-200~+500 ppm/°C	-200~+500 ppm/°C	
Max. dissipation at T _{amb} =70°C	1/8 W	1/10W	1/16W
Max. Operation Voltage (DC or RMS)	200V	150V	50V
Climatic category (IEC 60068)	55/125/56		

Note :

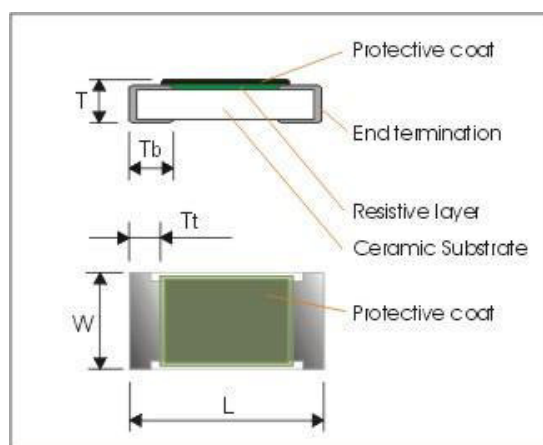
1. This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
2. Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

Dimensions

	WK12M
L	3.20 ± 0.15
W	1.60 ± 0.15
T	0.55 ± 0.10
Tb	1.30 ± 0.10
Tt	0.50 ± 0.25

	WK08M	WK06M
L	2.00 ± 0.10	1.60 ± 0.10
W	1.25 ± 0.10	0.80 ± 0.10
T	0.55 ± 0.10	0.45 ± 0.10
Tb	0.66 ± 0.10	0.30 ± 0.10
Tt	0.40 ± 0.20	0.30 ± 0.10



MARKING

No marking for Trimmable Chip Resistor

TRIMMING INTRODUCTIONS

Typical value for a YAG-laser;

cutting speed : 10-200 mm/sec,

laser power : 1-6 Watt,

bite size : 3~10 μ m (= speed / Q_rate , Bite Size is the distance each laser spot moving and influence the trimming accuracy)

maximum trimming length : 60% of resistive film width, minimum distance from end termination to trimming cut : 0.20mm, minimum distance between cuts (double-cut) : 0.5mm

Protection of the laser cut

by epoxy-fenol lacquers, epoxy resins or silicon alkyd-resins.

This is necessary for humidity test and stability under loaded.

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of 0/-20%, and 0/-30%. The values of the E24 series are in accordance with "IEC publication 60063"

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

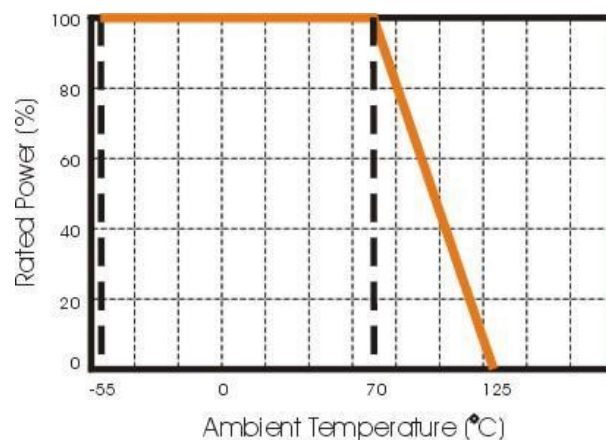


Figure 2 Maximum dissipation in percentage of rated power as a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

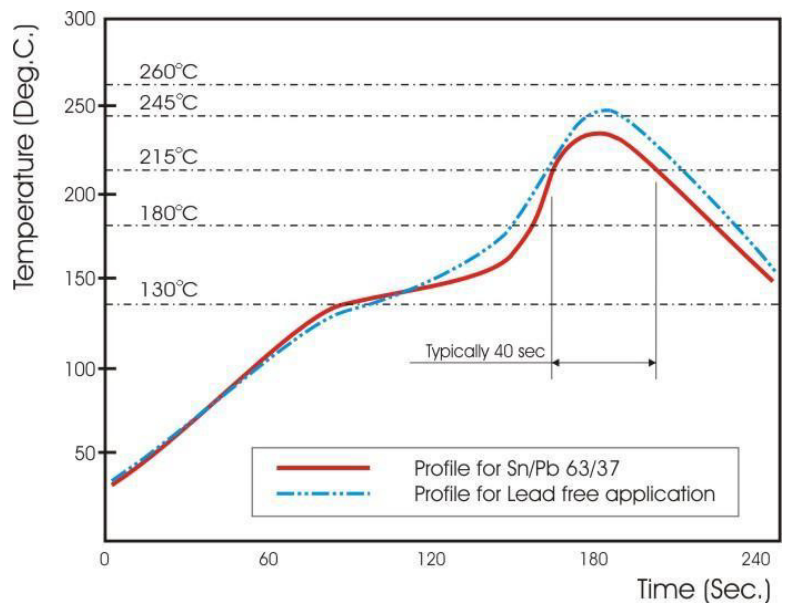


Fig 3. Infrared soldering profile for Chip Resistors

CATALOGUE NUMBERS

The resistors have a catalogue number starting with :

WK12	M	472_	X	T	L
Size code	Type code	Resistance code	Tolerance	Packaging code	Termination code
WK12 : 1206	M : Trimmable	E24 : 2 significant digits followed by no. of zeros and a blank	X : 0/-30%	T : 7" Reeled taping	L = Sn base (lead free)
WK08 : 0805		4.7Ω =4R7_	Y : 0/-20%	B : Bulk	
WK06 : 0603		10Ω =100_			
		220Ω =221_			
		("_" means a blank)			

1. Reeled tape packaging : WK12M / WK08M / WK06M - 8mm width paper taping 5000pcs per reel.
Bulk packaging : WK12M / WK08M / WK06M - 5000pcs per poly bag

TEST AND REQUIREMENTS (JIS C 5201-1 : 1998)

No.	Test items	Condition of test (JIS C 5201-1)	Performance requirements
1	Visual examination	Sub-clause 4.4.1 Checked by visual examination.	As in 4.4.1
2	Dimension Resistance	Sub-clause 4.4.2 Sub-clause 4.5	As specified in Table-3 of this specification. As in 4.5.2 The resistance value shall correspond with the rated resistance taking into account the specified tolerance.
3	Voltage proof	Sub-clause 4.7 Method: 4.6.1.4(See Figure-5) Test voltage: Alternating voltage with a peak value of 1.42 times the insulation voltage. Duration: 60 s ± 5 s Insulation resistance Test voltage: Insulation voltage Duration: 1 min.	No breakdown or flash over R ≥ 1 GΩ
4	Solderability	Sub-clause 4.17 Without ageing Flux: The resistors shall be immersed in a non-activated soldering flux for 2s. Bath temperature: 235 °C ± 5 °C Immersion time: 2 s ± 0.5 s	As in 4.17.4.5 The terminations shall be covered with a smooth and bright solder coating.
5	Mounting Overload (in the mounted state)	Sub-clause 4.31 Substrate material: Epoxide woven glass Test substrate: Figure-3 Sub-clause 4.13 The applied voltage shall be 2.5 times the rated voltage or twice the limiting element voltage, whichever is the less severe. Duration: 2 s Visual examination Resistance	No visible damage ΔR ≤ ± (1%+0.05Ω)

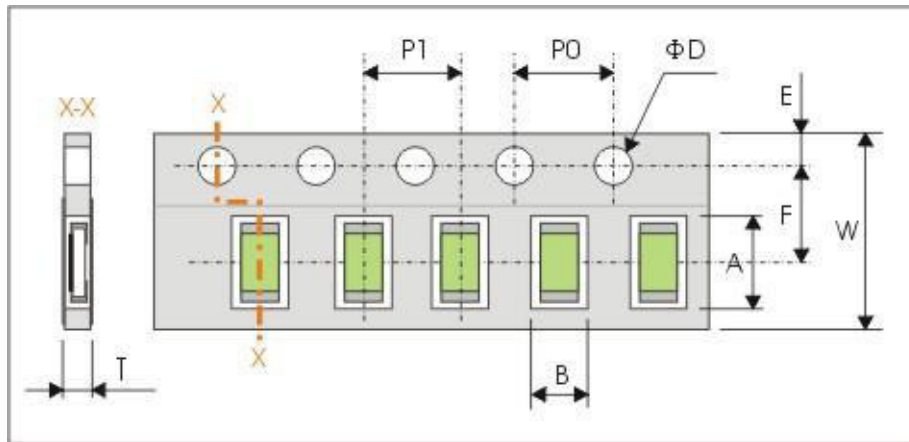
No	Test items	Condition of test (JIS C 5201-1)	Performance requirements
6	Mounting Bond strength of the end face plating Final measurements	Sub-clause 4.31 Substrate material: Epoxide woven glass Test substrate: Figure-4 Sub-clause 4.33 Bent value: 3 mm Resistance Sub-clause 4.33.6 Visual examination	$\Delta R \leq \pm (1\% + 0.05\Omega)$ No visible damage
7	Resistance to soldering heat	Sub-clause 4.18 Solder temperature: $260\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ Immersion time: $10\text{ s} \pm 0.5\text{ s}$ Visual examination	As in 4.18.3.4 No sign of damage such as cracks. $\Delta R \leq \pm (1\% + 0.05\Omega)$
8	Mounting Adhesion Rapid change temperature	Sub-clause 4.31 Substrate material: Epoxide woven glass Test substrate: Figure-3 Sub-clause 4.32 Force: 5 N Duration: $10\text{ s} \pm 1\text{ s}$ Visual examination Sub-clause 4.19 Lower category temperature: $-55\text{ }^{\circ}\text{C}$ Upper category temperature: $+125\text{ }^{\circ}\text{C}$ Duration of exposure at each temperature: 30 min. Number of cycles: 5 cycles. Visual examination Resistance	No visible damage No visible damage $\Delta R \leq \pm (1\% + 0.05\Omega)$

No	Test items	Condition of test (JIS C 5201-1)	Performance requirements
9			
10	Mounting Endurance at 70 °C	Sub-clause 4.31 Substrate material: Epoxide woven glass (FCR1 may use Alumina substrate.) Test substrate: Figure-3 Sub-clause 4.25.1 Ambient temperature: 70 °C ± 2 °C Duration: 1000 h The voltage shall be applied in cycles of 1.5 h on and 0.5 h. The applied voltage shall be the rated voltage or the limiting element voltage whichever is the smaller. Examination at 48 h , 500 h and 1000 h: Visual examination Resistance	No visible damage $\Delta R \leq \pm (5\% + 0.1\Omega)$

No	Test items	Condition of test (JIS C 5201-1)	Performance requirements
11	Mounting Variation of resistance with temperature	Sub-clause 4.31 Substrate material: Epoxide woven glass Test substrate: Figure-3 Sub-clause 4.8 - 55 °C / + 20 °C + 20 °C / + 125°C	As in Table-1
12	Mounting Damp heat, steady state	Sub-clause 4.31 Substrate material: Epoxide woven glass Test substrate: Figure-3 Sub-clause 4.24 Ambient temperature: 40 °C ± 2 °C Relative humidity : $93 \pm 3\%$ a) 1st group: without voltage applied. b) 2nd group: The d. c. voltage shall be applied continuously. The voltage shall be accordance with Sub-clause 4.24.2.1 b). without polarizing voltage [4.24.2.1, c)] Visual examination Resistance	No visible damage $\Delta R \leq \pm (5\% + 0.1\Omega)$
13	Dimensions (detail)	Sub-clause 4.4.3	As in Table-3

PACKAGING

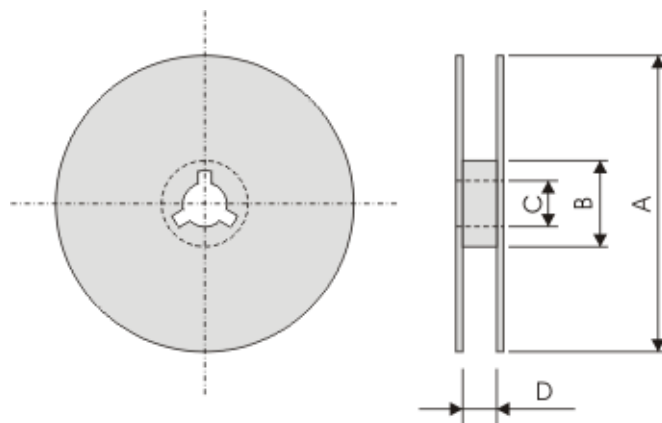
Paper Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WK12M	3.60±0.20	2.00±0.15	8.00±0.20	3.50±0.05	1.75±0.10
WK08M	2.50±0.20	1.65±0.15			
WK06M	1.90±0.20	1.15±0.15			

Series No.	P1	P0	ΦD	T
WK12M / WK08M	4.0±0.10	4.0±0.10	1.50±0.10	Max. 1.0
WK06M				Max. 0.8

Reel dimensions



Symbol (unit : mm)	A	B	C	D
WK12M / WK08M / WK06M	Φ180-1.5	Φ60.0+1.0	13.0±0.2	9.0+1.0

APPROVAL SHEET

WF25H, WF20H

$\pm 0.1\%$, $\pm 0.5\%$

Thick Film High Precision Chip Resistors

Size 2512, 2010

RoHS 2 Compliant with exemption 7C-I

Halogen free

*Contents in this sheet are subject to change without prior notice.

FEATURE

1. High power rating and compact size
2. High reliability and stability
3. Reduced size of final equipment
4. High precision of resistance
5. RoHS 2 Compliant with exemption 7C-I and Halogen free products

APPLICATION

- Power supply
- PDA
- Digital meter
- Computer
- Battery charger
- DC-DC power converter

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is Tin (lead free) alloy.

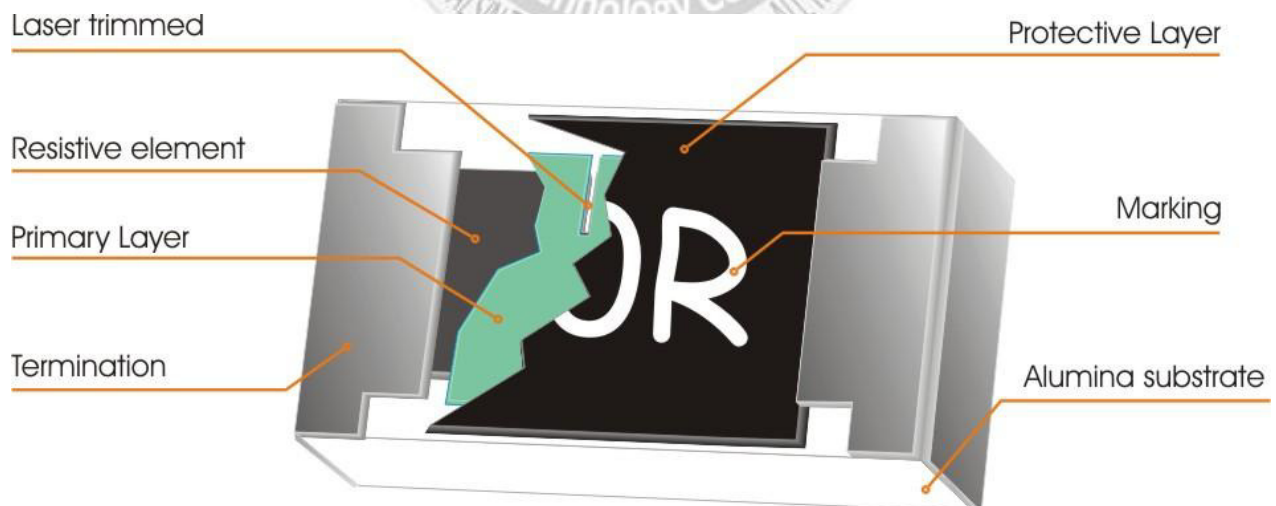


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification	
Series No.	WF25H	WF20H
Size code	2512 (6432)	2010 (5025)
Resistance Tolerance	$\pm 0.5\%$; $\pm 0.1\%$ (E24+E96)	
Resistance Range	$1\Omega \sim 10M\Omega$,	
TCR (ppm/°C) $1\Omega \leq R_n \leq 10\Omega$ $10\Omega < R_n \leq 10M\Omega$	± 200 ppm/°C	
	± 100 ppm/°C	
Max. dissipation at $T_{amb}=70^\circ C$	1 W	0.5W
Max. Operation Voltage (DC or RMS)	250V	200V
Max. Overload Voltage (DC or RMS)	500V	400V
Climatic category (IEC 60068)	55/155/56	

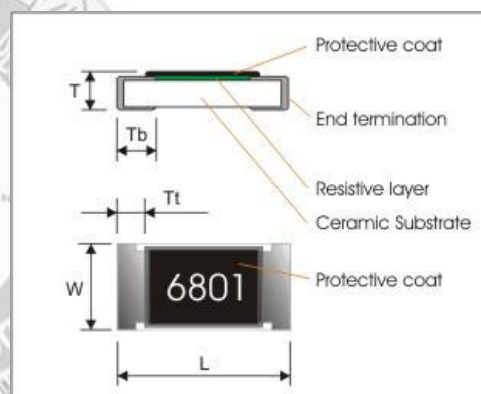
Note :

1. This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
2. Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

MECHANICAL DATA(unit : mm)

Series No.	WF25H	WF20H
L	6.40 ± 0.20	5.00 ± 0.20
W	3.20 ± 0.20	2.50 ± 0.20
T	0.60 ± 0.10	0.55 ± 0.10
Tt	0.65 ± 0.25	0.65 ± 0.25
Tb	0.90 ± 0.25	0.60 ± 0.25



CATALOGUE NUMBERS

The resistors have a catalogue number starting with :

WF25	H	1000	B	T	L
Size code WF25 : 2512 WF20 : 2010	Type code H : Thick film, High precision <1%	Resistance code E24+E96; 3 significant digits followed by no. of zeros $102\Omega = 1020$ $37.4K\Omega = 3742$	Tolerance B : $\pm 0.1\%$ D : $\pm 0.5\%$	Packaging code T : 7" Reel taping	Termination code L = Sn base (lead free)

MARKING

Each resistor is marked with a four-digit code on the protective coating to designate the nominal resistance value.
Example:

RESISTANCE	10Ω	12Ω	100Ω	6800Ω	47000Ω
4 digits marking	10R0	12R0	1000	6801	4702

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96 & E24 series for resistors with a tolerance of $\pm 0.5\%$ & $\pm 0.1\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Derating curve

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

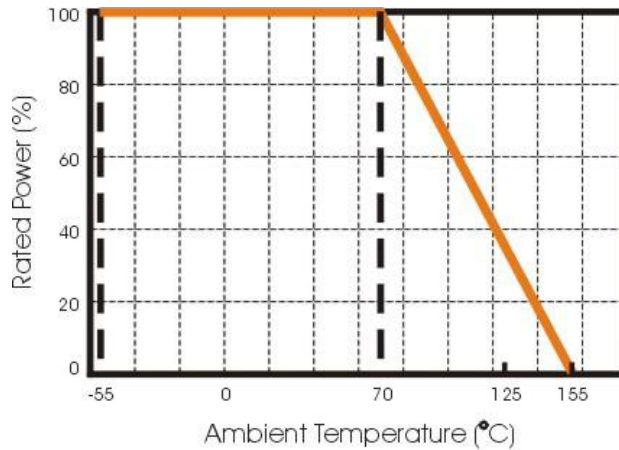


Fig.2 Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

Storage and Handling Conditions:

1. Products are recommended to be used up within two years since operation date as ensured shelf life. Check solderability in case shelf life extension is needed.
2. To store products with following condition:
 - Temperature :5 to 40°C
 - Humidity :20 to 70% relative humidity
3. Caution:
 - a. Don't store products in a corrosive environment such as sulfide, chloride gas, or acid.
It may cause oxidation of electrode, which easily be resulted in poor soldering.
 - b. To store products on the shelf and avoid exposure to moisture.
 - c. Don't expose products to excessive shock, vibration, direct sunlight and so on.

SOLDERING CONDITION follows J-STD-020D

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260 °C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235 °C during 2 seconds. The test condition for no leaching is 260 °C for 30 seconds.

Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3

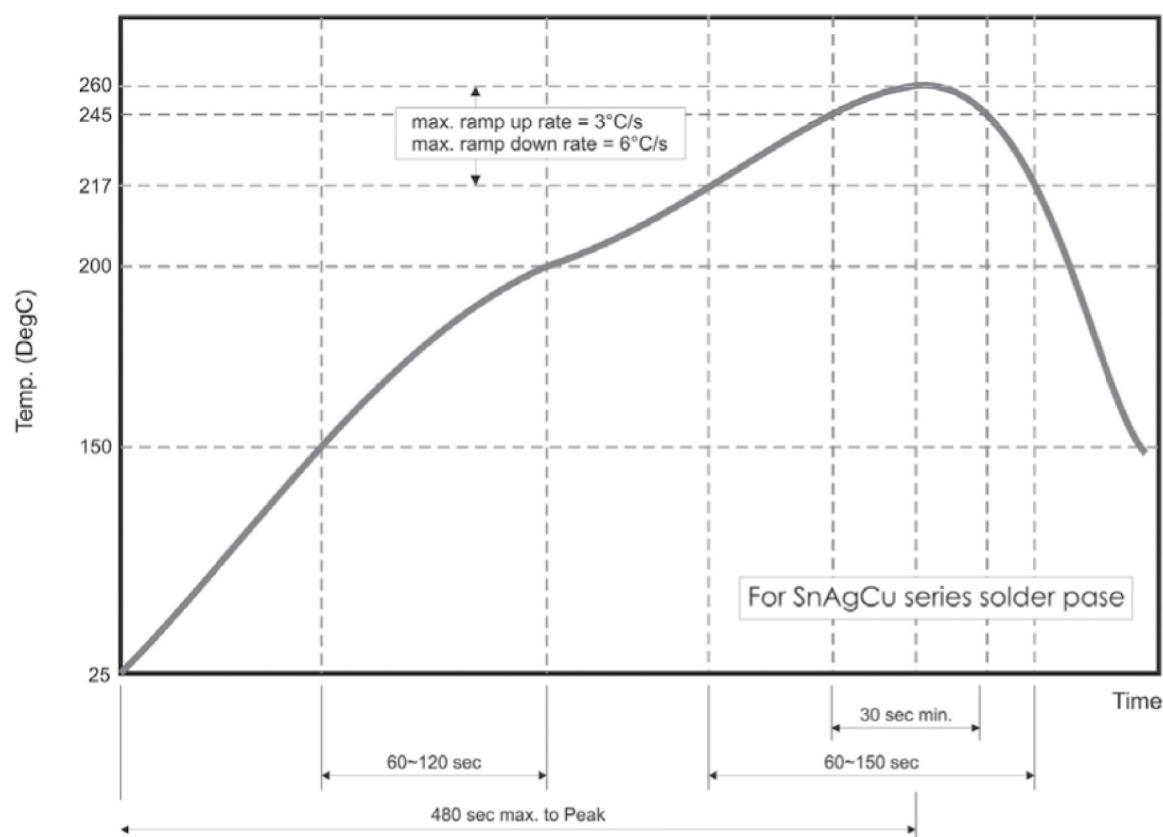


Fig 3. Recommended IR reflow soldering profile for
SMT process with SnAgCu series solder paste

TEST AND REQUIREMENTS (JIS C 5201-1 : 1998)

Essentially all tests are carried out according to the schedule of IEC publication 115-8, category **LCT/UCT/56** (rated temperature range : Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days). The testing also meets the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 68, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to IEC 60068-1, subclause 5.3. Unless otherwise specified, the following value supplied :

Temperature: 15°C to 35°C.

Relative humidity: 45% to 75%.

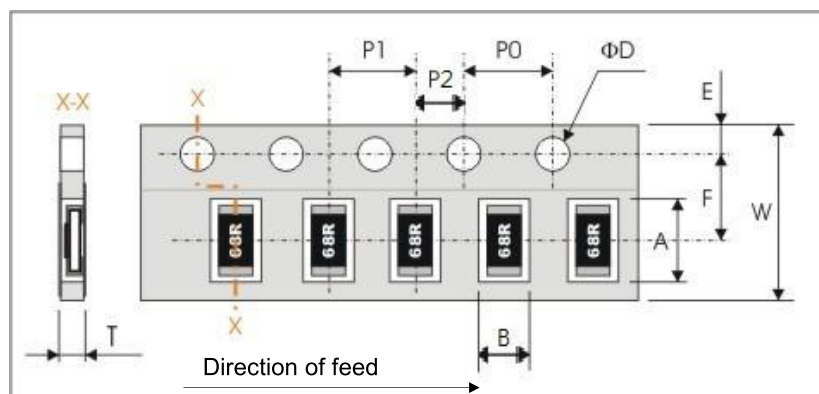
Air pressure: 86kPa to 106 kPa (860 mbar to 1060 mbar).

All soldering tests are performed with midly activated flux.

TEST	PROCEDURE	REQUIREMENT
Electrical Characteristics JISC5201-1: 1998 Clause 4.8	DC resistance values measurement Temperature Coefficient of Resistance (T.C.R) Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/°C)}$ $t_1 : 20^\circ\text{C}+5^\circ\text{C}-1^\circ\text{C}$ $R_1 : \text{Resistance at reference temperature (20}^\circ\text{C}+5^\circ\text{C}-1^\circ\text{C)}$ $R_2 : \text{Resistance at test temperature (-55}^\circ\text{C or +155}^\circ\text{C)}$	Within the specified tolerance Refer to "QUICK REFERENCE DATA"
Short time overload (STOL) Clause 4.13	Permanent resistance change after a 5second application of a voltage 2.5 times RCWV or the maximum overload voltage specified in the above list, whichever is less.	$\Delta R/R$ max. $\pm(1\%+0.05\Omega)$
Resistance to soldering heat Clause 4.17	Un-mounted chips 10 ± 1 seconds, in a SAC solder bath at $260 \pm 5^\circ\text{C}$	no visible damage $\Delta R/R$ max. $\pm(1\%+0.05\Omega)$
Solderability Clause 4.18	Un-mounted chips completely immersed for 2 ± 0.5 sec. in a SAC solder bath at $235 \pm 5^\circ\text{C}$	good tinning (>95% covered) no visible damage
Temperature cycling Clause 4.19	1. 30 minutes at $-55^\circ\text{C} \pm 3^\circ\text{C}$, 2. 2~3 minutes at $20^\circ\text{C}+5^\circ\text{C}-1^\circ\text{C}$, 3. 30 minutes at $+155^\circ\text{C} \pm 3^\circ\text{C}$, 4. 2~3 minutes at $20^\circ\text{C}+5^\circ\text{C}-1^\circ\text{C}$, Total 5 continuous cycles	no visible damage $\Delta R/R$ max. $\pm(1\%+0.05\Omega)$
Load life (endurance) Clause 4.25	1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller $70 \pm 2^\circ\text{C}$, 1.5 hours on and 0.5 hours off	$\Delta R/R$ max. $\pm(3\%+0.1\Omega)$
Load life in Humidity Clause 4.24	1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at $40^\circ\text{C} \pm 2^\circ\text{C}$ and 90~95% relative humidity, 1.5hours on and 0.5 hours off	$\Delta R/R$ max. $\pm(3\%+0.1\Omega)$
Bending strength JISC5201-1: 1998 Clause 4.33	Resistors mounted on a 90mm glass epoxy resin PCB(FR4), bending once 2mm for 10sec,	$\Delta R/R$ max. $\pm(1\%+0.05\Omega)$
Adhesion JISC5201-1: 1998 Clause 4.32	Pressurizing force: 5N, Test time: 10 ± 1 sec.	No remarkable damage or removal of the terminations
Insulation Resistance Clause 4.6	Apply the maximum overload voltage (DC) for 1minutes	$R \geq 10G\Omega$
Dielectric Withstand Voltage Clause 4.7	Apply the maximum overload voltage (AC) for 1 minutes	No breakdown or flashover

PACKAGING

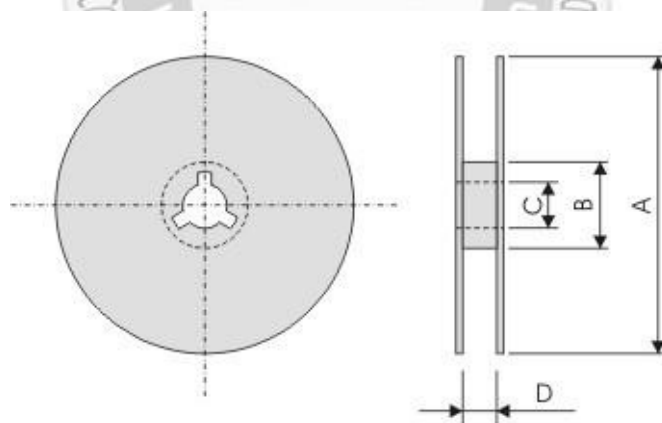
Plastic tape specifications (unit :mm)



Type	A	B	W	F	E
2512	6.90±0.20	3.60±0.20	12.00±0.30	5.50±0.1	1.75±0.10
2010	5.50±0.20	2.80±0.20	12.00±0.30	5.50±0.1	1.75±0.10

Type	P1	P0	P2	ΦD	T
2512	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.2
2010	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.2

Reel dimensions



Symbol	A	B	C	D
(unit : mm)	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	14.0±0.2

Taping quantity

- Chip resistors 4,000 pcs per reel.

APPROVAL SHEET

**WF25A, WF20A, WF10A,
WF12A, WF08A, WF06A, WF04A**

$\pm 1\%$, $\pm 5\%$, Jumper

Thick Film Triple Power Chip Resistors

Size 2512 3W, 2010 1.5W, 1210 3/4W

1206 3/4W, 0805 1/2W, 0603 1/3W, 0402 1/5W

RoHS 2 Compliant with exemption 7C-I

Halogen free

*Contents in this sheet are subject to change without prior notice.

FEATURE

1. Small size and light weight
2. High reliability and stability
3. Reduced size of final equipment
4. High power
5. RoHS 2 Compliant with exemption 7C-I and Halogen free products
6. Flammability against UL94-V0
7. Automotive AECQ-200 Qualified

APPLICATION

- High accuracy dc-power supply
- Digital multi-meter
- Telecommunication
- Computer
- Automotive industry
- Medical and military equipment

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

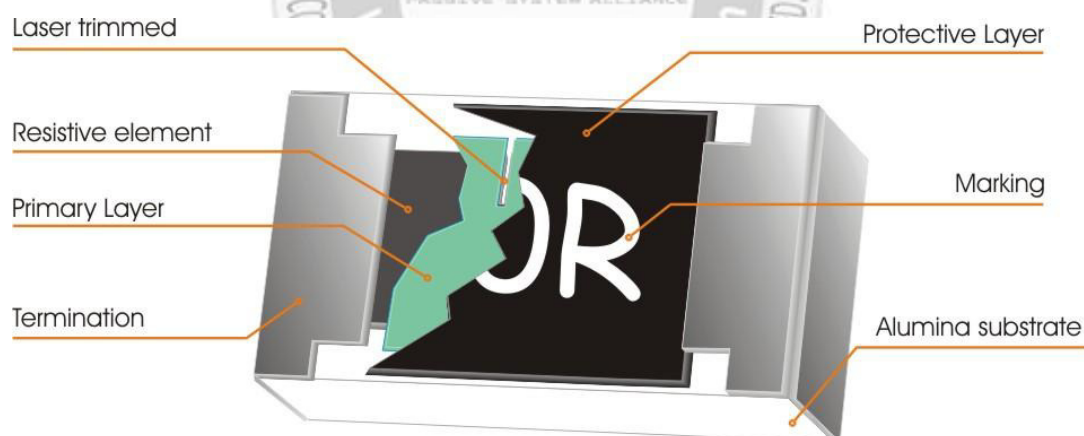


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification						
Series No.	WF25A	WF20A	WF10A	WF12A	WF08A	WF06A	WF04A
Size code	2512 (6432)	2010 (5025)	1210 (3225)	1206 (3216)	0805 (2012)	0603 (1608)	0402 (1005)
Resistance Tolerance	±1% (E24+E96) ±5% (E24)						
Resistance Range	1Ω ~ 1MΩ						10Ω ~ 1M2Ω
TCR (ppm/°C)							
1% 10Ω~1M2Ω	±100	±100	±100	±100	±100	±100	±100
1% 1~9.76Ω	±100	±100	±100	±200	±150	±200	
TCR (ppm/°C)							
5% 1~1M2Ω	±200	±200	±200	±200	±200	±200	±100
Max. dissipation at T _{amb} =70°C	3 W	1.5 W	3/4 W	3/4 W	1/2 W	1/3 W	1/5 W
Max. Operation Voltage	250V	250V	250V	250V	200V	75V	50V
Max. Overload Voltage	500V	500V	500V	500V	300V	125V	100V
Operation Temperature	- 55~+155°C						

Notes:

1. RCWV is Rated Voltage, $V = \sqrt{P \cdot R}$ or Max. Working Voltage whichever is lower.
2. V : Working Voltage(V) , P : Rated Power (W) , R : Resistance Value(Ω)
3. Please consider the resistance variance from soldering pad/trace/amount, and keep the surface temperature do not exceed 105°C when working.

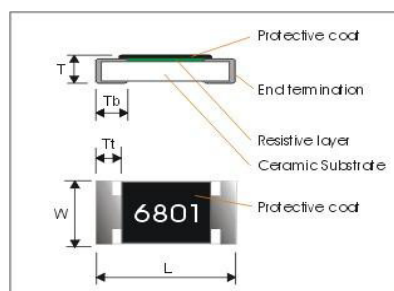
High Current Power Jumpers (0Ω)

Item	General Specification						
Series No.	WF25A	WF20A	WF10A	WF12A	WF08A	WF06A	WF04A
Size code	2512 (6432)	2010 (5025)	1210 (3225)	1206 (3216)	0805 (2012)	0603 (1608)	0402 (1005)
Resistance Range	≤ 10mΩ	≤ 10mΩ	≤ 10mΩ	≤ 10mΩ	≤ 10mΩ	≤ 10mΩ	≤ 20mΩ
TCR (ppm/°C)	TCR is not applicable for Jumper product						
Max. dissipation @ T _{amb} =70°C	3 W	1.5 W	3/4 W	3/4 W	1/2 W	1/3 W	1/5 W
Max Rated Current	14 A	12 A	9 A	9 A	7 A	6 A	3 A
Max Overload Current	28 A	24 A	18 A	18 A	14 A	12 A	6 A
Operation temperature	- 55~+155°C						

Notes:

Max.rated (Rated Current) /Overload current (Peak Current) and resistance listed above, TCR is not applicable of Jumper products, and keep the surface temperature do not exceed 105°C when working.

DIMENSIONS (unit : mm)



Series	WF25A	WF20A	WF10A	WF12A	WF08A	WF06A	WF04A
L	6.40 ± 0.20	5.00 ± 0.20	3.10 ± 0.10	3.10 ± 0.10	2.00 ± 0.10	1.60 ± 0.10	1.00 ± 0.05
W	3.20 ± 0.25	2.50 ± 0.20	2.60 ± 0.10	1.60 ± 0.10	1.25 ± 0.10	0.80 ± 0.10	0.50 ± 0.05
T	1.10 ± 0.20	0.60 ± 0.10	0.55 ± 0.10	0.55 ± 0.10	0.50 ± 0.10	0.45 ± 0.10	0.35 ± 0.05
Tt	0.45 ± 0.25	0.65 ± 0.25	0.50 ± 0.25	0.50 ± 0.25	0.40 ± 0.20	0.30 ± 0.20	0.20 ± 0.10
Tb	1.80 ± 0.25	0.60 ± 0.25	0.50 ± 0.25	0.50 ± 0.25	0.40 ± 0.20	0.30 ± 0.20	0.25 ± 0.10

CATALOGUE NUMBERS

The resistors have a catalogue number starting with.

WF06	A	510_	J	T	L	J
Size code	Type code	Resistance code	Tolerance	Packaging code	Termination code	Special code
WF25: 2512	A : Triple Power	5% E24:	J : ±5%	T : 7" Reeled taping	L = Sn base	J =
WF20: 2010	2512 = 3W	2 significant digits	F : ±1%	Z : 7" Reeled taping	(lead free)	AECQ-200
WF10: 1210	2010 = 1.5W	followed by No. of zeros	P : Jumper	(WF25A)		qualified
WF12: 1206	1210 = 3/4W	& a blank				
WF08: 0805	1206 = 3/4W	e.g.:				
WF06: 0603	0805 = 1/2W	3ohm =3R0_				
WF04: 0402	0603 = 1/3W	10ohm =100_				
	0402 = 1/5W	56Kohm =563_				
		("_" means a blank)				
		1% E24+E96:				
		3 significant digits				
		followed by No. of zeros				
		100Ω =1000				
		37.4KΩ =3742				

■ Reeled packaging

WF25A 12mm width pc emboss taping 3,000pcs per 7" reel

WF20A 12mm width pc emboss taping 4,000pcs per 7" reel

WF10A, WF12A, WF08A, WF06A 8mm width paper taping 5,000pcs per 7" reel

WF04A 8mm width paper taping 10,000pcs per 7" reel

MARKING

Size \ Nr. Of digit of code\tolerance	$\pm 1\%, \pm 5\%$
2512/2010/1210/1206/0805	$\pm 1\%$: 4 digits marking; $\pm 5\%$: 3 digits marking
0603	3 digits marking
0402	No marking

Size \ Nr. Of digit of code\tolerance	Jumper (0 Ω)
2512/2010	4 digits marking
1210/1206/0805/0603	3 digits marking
0402	No marking

3 digits marking ($\pm 5\%$ 2512,2010,1210,1206,0805,0603)

Each resistor is marked with a three digits code on the protective coating to designate the nominal resistance value.

3 digits marking ($\pm 1\%$ 0603)

Nominal resistance	Description																																						
1.E24 series	2 significant digits followed by No. of zeros .As 0603 WR06X ±5% Example <table><tr><td>RESISTANCE</td><td>4.7Ω</td><td>47Ω</td><td>470Ω</td><td>4K70</td><td>47K0</td><td>470K</td><td>4M70</td></tr><tr><td>3 digits marking</td><td>4R7</td><td>470</td><td>471</td><td>472</td><td>473</td><td>474</td><td>475</td></tr></table>	RESISTANCE	4.7Ω	47Ω	470Ω	4K70	47K0	470K	4M70	3 digits marking	4R7	470	471	472	473	474	475																						
RESISTANCE	4.7Ω	47Ω	470Ω	4K70	47K0	470K	4M70																																
3 digits marking	4R7	470	471	472	473	474	475																																
2.E96 series	The 1st two digit codes are referring to the CODE on the table, the 3rd code is the index of resistance value. Repeat values between E24 and E96 series, whose marking are based on the E96 CODE table. <table><tr><td>Code</td><td>Z</td><td>Y</td><td>X</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr><tr><td>Multiplier</td><td>10⁻³</td><td>10⁻²</td><td>10⁻¹</td><td>10⁰</td><td>10¹</td><td>10²</td><td>10³</td><td>10⁴</td><td>10⁵</td><td>10⁶</td></tr></table> Example <table><tr><td>RESISTANCE</td><td>1.78Ω</td><td>17.8Ω</td><td>178Ω</td><td>1K78</td><td>17K8</td><td>178K</td><td>1M78</td></tr><tr><td>3 digits marking</td><td>25Y</td><td>25X</td><td>25A</td><td>25B</td><td>25C</td><td>25D</td><td>25E</td></tr></table>	Code	Z	Y	X	A	B	C	D	E	F	G	Multiplier	10 ⁻³	10 ⁻²	10 ⁻¹	10 ⁰	10 ¹	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁶	RESISTANCE	1.78Ω	17.8Ω	178Ω	1K78	17K8	178K	1M78	3 digits marking	25Y	25X	25A	25B	25C	25D	25E
Code	Z	Y	X	A	B	C	D	E	F	G																													
Multiplier	10 ⁻³	10 ⁻²	10 ⁻¹	10 ⁰	10 ¹	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁶																													
RESISTANCE	1.78Ω	17.8Ω	178Ω	1K78	17K8	178K	1M78																																
3 digits marking	25Y	25X	25A	25B	25C	25D	25E																																
3. Remark	There is no marking for the items not under E24 and E96 series.																																						

E96 CODE table:

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

4 digits marking ($\pm 1\%$ 2512,2010,1210,1206,0805)

Each resistor is marked with a four digits code on the protective coating to designate the nominal resistance value. For values below 97 Ω 6 the R is used as a digit. For values of 100 Ω or greater, the first 3 digits are significant, and the fourth digit indicates the number of multiple to follow.

Example

RESISTANCE	Jumper (0 Ω)	4.7 Ω	10 Ω	12 Ω	100 Ω	6800 Ω	47000 Ω	470000 Ω
3 digits marking $\pm 5\%$ 2512,2010,1210,1206,0805,0603 Jumper 1210,1206, 0805, 0603	000	4R7	100	120	101	682	473	474
4 digits marking $\pm 1\%$ 2512,1210,1206,0805 Jumper 2512,2010	0000	4R70	10R0	12R0	1000	6801	4702	4703

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96&E24 series for resistors with a tolerance of $\pm 1\%$, $\pm 5\%$. The values of the E96/E24 series are in accordance with "IEC publication 60063".

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

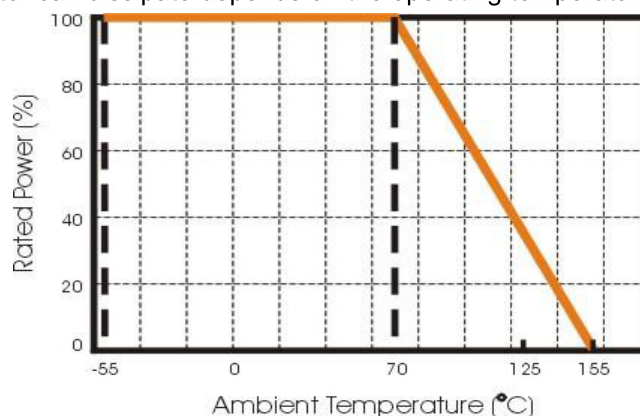


Fig.2 Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

Storage and Handling Conditions:

- Products are recommended to be used up within two years since operation date as ensured shelf life. Check solderability in case shelf life extension is needed.
- To store products with following condition:
 - Temperature :5 to 40°C
 - Humidity :20 to 70% relative humidity
- Caution:
 - Don't store products in a corrosive environment such as sulfide, chloride gas, or acid.
It may cause oxidation of electrode, which easily be resulted in poor soldering.
 - To store products on the shelf and avoid exposure to moisture.
 - Don't expose products to excessive shock, vibration, direct sunlight and so on

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

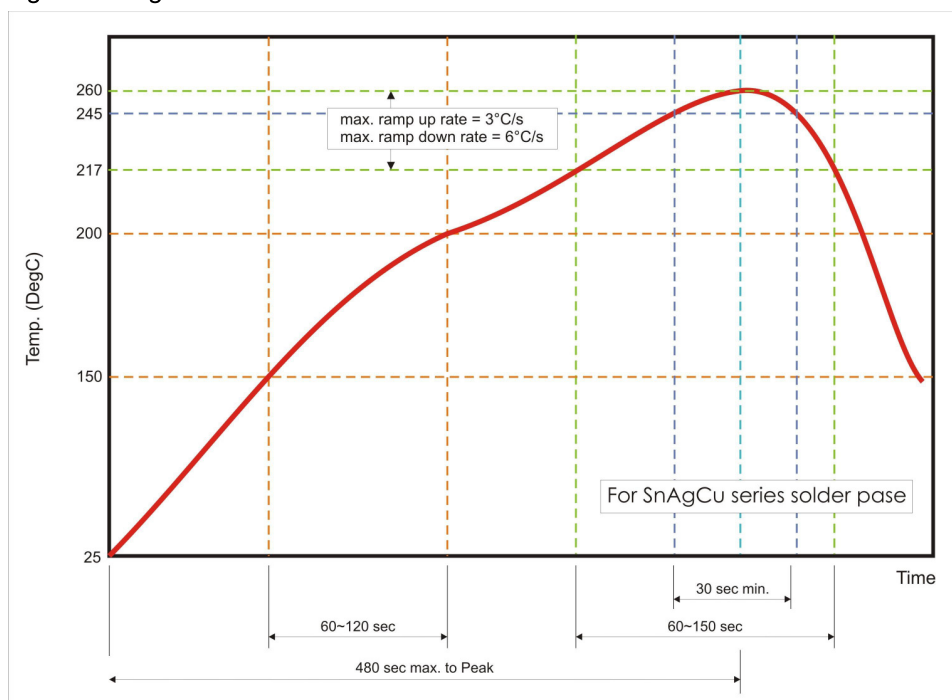
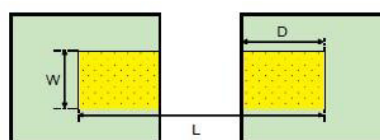


Fig 3. Recommended IR reflow soldering profile for SMT process with SnAgCu series solder paste

RECOMMENDED SOLDERING PAD DIMENSIONS:

Series No.	W	D	L
WF25A	3.70	2.45	7.60
WF20A	3.00	1.50	6.80
WF10A	3.00	1.30	4.70
WF12A	1.80	1.30	4.70
WF08A	1.30	1.15	3.50
WF06A	0.90	1.00	3.00
WF04A	0.60	0.50	1.50

Unit: mm



TEST AND REQUIREMENTS

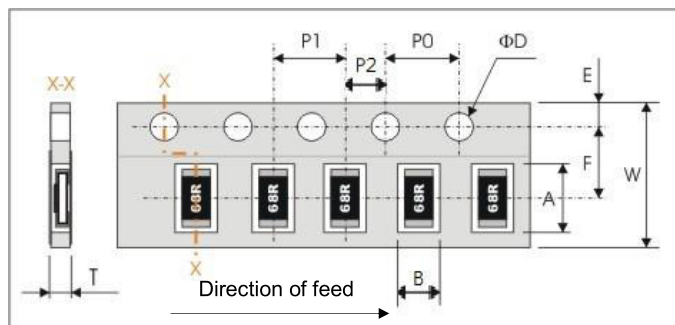
Basic Specification: AEC Q-200; IEC-60115

TEST	PROCEDURE	REQUIREMENT
Clause 4.8 Temperature Coefficient of Resistance (TCR)	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/}^\circ\text{C)}$ R ₁ : Resistance at reference temperature R ₂ : Resistance at test temperature t ₁ : 25°C +1°C -1°C.	Refer to quick reference data for T.C.R specification
AEC-Q200 TABLE 7.3 High Temperature Exposure	1000 hrs. @ T=155°C. Unpowered. Measurement at 24 ±2 hours after test conclusion.	No visible damage $\Delta R/R \text{ max. : } \leq \pm(1\%+0.05\Omega)$ 0402 Jumper : $\leq 20\text{m}\Omega$ Others Jumper : $\leq 10\text{m}\Omega$
AEC-Q200 TABLE 7.4 Temperature cycling	1000 Cycles (-55°C to +155°C). Measurement at 24±2 hours after test conclusion.	No visible damage $\Delta R/R \text{ max. : } \leq \pm(0.5\%+0.05\Omega)$ 0402 Jumper : $\leq 20\text{m}\Omega$ Others Jumper : $\leq 10\text{m}\Omega$
AEC-Q200 TABLE 7. Moisture Resistance	Test 65°C /80~100%RH/10Cycles. Measurement at 24±2 hours after test conclusion. (t=24hrs/cycle).	No visible damage $\Delta R/R \text{ max. : } \leq \pm(0.5\%+0.05\Omega)$ 0402 Jumper : $\leq 20\text{m}\Omega$ Others Jumper : $\leq 10\text{m}\Omega$
AEC-Q200 TABLE 7.7 Bias Humidity	1000 hours 85 °C /85%RH. 10% of operating power. Measurement at 24 ±2 hours after test conclusion.	No visible damage $\Delta R/R \text{ max. : } \leq \pm(1\%+0.05\Omega)$ 0402 Jumper : $\leq 20\text{m}\Omega$ Others Jumper : $\leq 10\text{m}\Omega$
AEC-Q200 TABLE 7.8 Operation life (endurance)	Test 1000hr @ TA=125°C at specified rated power. Measurement at 24±2 hours after test conclusion.	No visible damage $\Delta R/R \text{ max. : } \leq \pm(1\%+0.05\Omega)$ 0402 Jumper : $\leq 20\text{m}\Omega$ Others Jumper : $\leq 10\text{m}\Omega$
AEC-Q200 TABLE 7.9 External Visual	Inspect device construction, marking and workmanship.	No visual damage and refer marking code.
AEC-Q200 TABLE 7.10 Physical Dimension	Verify physical dimensions to the applicable device detail specification.	Within the spec.
AEC-Q200 TABLE 7.13 Mechanical shock	Test Peak value:100g's,Wave:Hail-sine, Duration:6ms,Velocity:12.3ft/sec.	Within product specification tolerance and no visible damage.
AEC-Q200 TABLE 7.14 Vibration	5 g's for 20 min., 12 cycles each of 3 orientations. Test from 10-2000 Hz.	No visible damage $\Delta R/R \text{ max. : } \leq \pm(1\%+0.05\Omega)$ 0402 Jumper : $\leq 20\text{m}\Omega$ Others Jumper : $\leq 10\text{m}\Omega$

TEST	PROCEDURE	REQUIREMENT
AEC-Q200 TABLE 7.15 Resistance to soldering heat (R.S.H)	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 270°C ±5°C.	No visible damage $\Delta R/R$ max. : $\leq \pm(0.5\%+0.05\Omega)$ 0402 Jumper : $\leq 20m\Omega$ Others Jumper : $\leq 10m\Omega$
AEC-Q200 TABLE 7.16 Thermal shock	-55 to 155 °C / dwell time 15min/ Max transfer time 20sec/ 300cycles.	No visible damage $\Delta R/R$ max. : $\leq \pm(0.5\%+0.05\Omega)$ 0402 Jumper : $\leq 20m\Omega$ Others Jumper : $\leq 10m\Omega$
AEC-Q200-002 ESD	Test contact min. 1KV. (0.5KV for 0402 only)	No visible damage $\Delta R/R$ max. : $\leq \pm(1\%+0.1\Omega)$ 0402 Jumper : $\leq 20m\Omega$ Others Jumper : $\leq 10m\Omega$
AEC-Q200 TABLE 7.18 Solderability	a)Baking 155°C 4H, dipping 235°C 5s b)Steam 8H, dipping 215°C 5s c)Steam 8H, dipping 260°C 7s.	Good tinning (>95% covered) No visible damage
AEC-Q200 TABLE 7.20 Flammability	UL-94 V-0 or V-1 are acceptable	Refer UL-94.
AEC-Q200 TABLE 7.21 Board flex	Resistors mounted on a 90mm glass epoxy resin PCB(FR4); bending 2mm 2512.2010.1210.1206, 3mm 0805.0603,0402	No visible damage $\Delta R/R$ max. : $\leq \pm(0.5\%+0.05\Omega)$ 0402 Jumper : $\leq 20m\Omega$ Others Jumper : $\leq 10m\Omega$
AEC-Q200 TABLE 7.22 Terminal strength	Force 1.8 Kg (0402 for 1.0kg) for 60 seconds.	No mechanical damage

PACKAGING

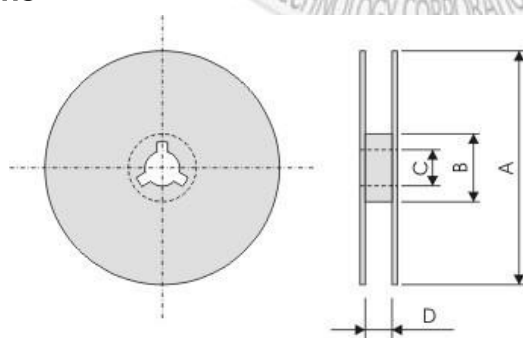
Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF25A	6.70±0.20	3.50±0.20	12.00±0.30	5.50±0.05	1.75±0.10
WF20A	5.50±0.20	2.80±0.20	12.00±0.30	5.50±0.05	1.75±0.10
WF10A	3.60±0.20	3.00±0.20	8.00±0.30	3.50±0.05	1.75±0.10
WF12A	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.05	1.75±0.10
WF08A	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.05	1.75±0.10
WF06A	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.05	1.75±0.10
WF04A	1.20±0.10	0.70±0.10	8.00±0.30	3.50±0.20	1.75±0.10

Series No.	P1	P0	P2	ΦD	T
WF25A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.50
WF20A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.00
WF10A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.00
WF12A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.00
WF08A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.00
WF06A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 0.80
WF04A	2.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.40±0.05

Reel dimensions



unit: mm

Symbol	A	B	C	D
7" 8mm tape	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	9.0+1/-0
7" 12mm tape	Φ178.0±2.0	Φ60.0±1.0	13.0±0.5	13.8±1.5

APPROVAL SHEET

**WF25A, WF20A, WF10A,
WF12A, WF08A, WF06A, WF04A**

$\pm 1\%$, $\pm 5\%$, Jumper

Thick Film Triple Power Chip Resistors

Size 2512 3W, 2010 1.5W, 1210 3/4W

1206 3/4W, 0805 1/2W, 0603 1/3W, 0402 1/5W

RoHS 2 Compliant with exemption 7C-I

Halogen free

*Contents in this sheet are subject to change without prior notice.

FEATURE

1. Small size and light weight
2. High reliability and stability
3. Reduced size of final equipment
4. High power
5. RoHS 2 Compliant with exemption 7C-I and Halogen free products
6. Flammability against UL94-V0

APPLICATION

- High accuracy dc-power supply
- Digital multi-meter
- Telecommunication
- Computer
- Automotive industry
- Medical and military equipment

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

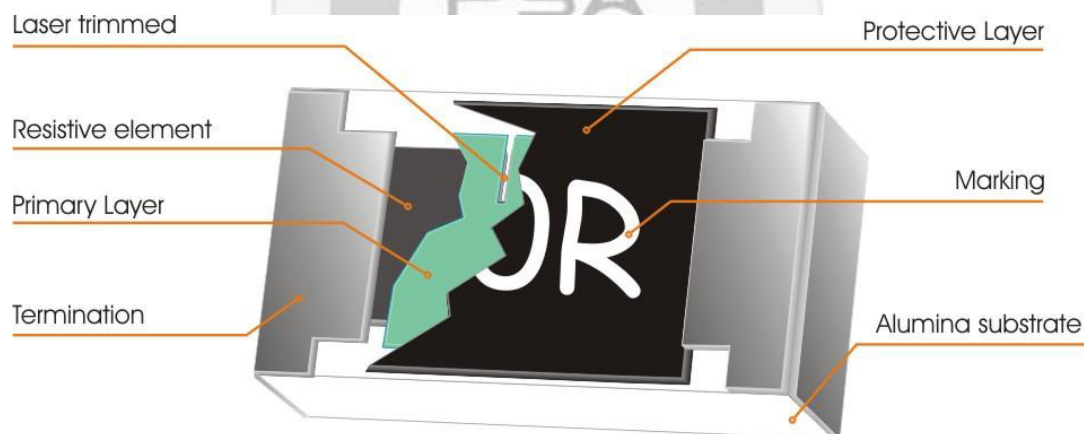


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification						
Series No.	WF25A	WF20A	WF10A	WF12A	WF08A	WF06A	WF04A
Size code	2512 (6432)	2010 (5025)	1210 (3225)	1206 (3216)	0805 (2012)	0603 (1608)	0402 (1005)
Resistance Tolerance	±1% (E24+E96) ±5% (E24)						
Resistance Range	1Ω ~ 1MΩ						10Ω ~ 1M2Ω
TCR (ppm/°C)							
1% 10Ω~1M2Ω	±100	±100	±100	±100	±100	±100	±100
1% 1~9.76Ω	±100	±100	±100	±200	±150	±200	
TCR (ppm/°C)							
5% 1~1M2Ω	±200	±200	±200	±200	±200	±200	±100
Max. dissipation at T _{amb} =70°C	3 W	1.5 W	3/4 W	3/4 W	1/2 W	1/3 W	1/5 W
Max. Operation Voltage	250V	250V	250V	250V	200V	75V	50V
Max. Overload Voltage	500V	500V	500V	500V	300V	125V	100V
Operation Temperature	- 55~+155°C						

Notes:

1. RCWV is Rated Voltage, $V = \sqrt{P \cdot R}$ or Max. Working Voltage whichever is lower.
2. V : Working Voltage(V) , P : Rated Power (W) , R : Resistance Value(Ω)
3. Please consider the resistance variance from soldering pad/trace/amount, and keep the surface temperature do not exceed 105°C when working.

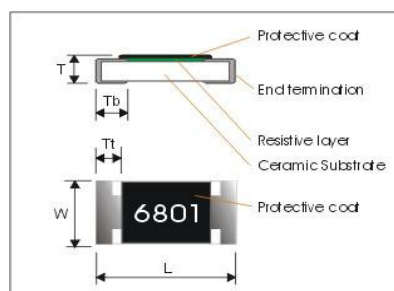
High Current Power Jumpers (0Ω)

Item	General Specification						
Series No.	WF25A	WF20A	WF10A	WF12A	WF08A	WF06A	WF04A
Size code	2512 (6432)	2010 (5025)	1210 (3225)	1206 (3216)	0805 (2012)	0603 (1608)	0402 (1005)
Resistance Range	≤ 10mΩ	≤ 10mΩ	≤ 10mΩ	≤ 10mΩ	≤ 10mΩ	≤ 10mΩ	≤ 20mΩ
TCR (ppm/°C)	TCR is not applicable for Jumper product						
Max. dissipation @ T _{amb} =70°C	3 W	1.5 W	3/4 W	3/4 W	1/2 W	1/3 W	1/5 W
Max Rated Current	14 A	12 A	9 A	9 A	7 A	6 A	3 A
Max Overload Current	28 A	24 A	18 A	18 A	14 A	12 A	6 A
Operation temperature	- 55~+155°C						

Notes:

Max.rated (Rated Current) /Overload current (Peak Current) and resistance listed above, TCR is not applicable of Jumper products, and keep the surface temperature do not exceed 105°C when working.

DIMENSIONS (unit : mm)



Series	WF25A	WF20A	WF10A	WF12A	WF08A	WF06A	WF04A
L	6.40 ± 0.20	5.00 ± 0.20	3.10 ± 0.10	3.10 ± 0.10	2.00 ± 0.10	1.60 ± 0.10	1.00 ± 0.05
W	3.20 ± 0.25	2.50 ± 0.20	2.60 ± 0.10	1.60 ± 0.10	1.25 ± 0.10	0.80 ± 0.10	0.50 ± 0.05
T	1.10 ± 0.20	0.60 ± 0.10	0.55 ± 0.10	0.55 ± 0.10	0.50 ± 0.10	0.45 ± 0.10	0.35 ± 0.05
Tt	0.45 ± 0.25	0.65 ± 0.25	0.50 ± 0.25	0.50 ± 0.25	0.40 ± 0.20	0.30 ± 0.20	0.20 ± 0.10
Tb	1.80 ± 0.25	0.60 ± 0.25	0.50 ± 0.25	0.50 ± 0.25	0.40 ± 0.20	0.30 ± 0.20	0.25 ± 0.10

CATALOGUE NUMBERS

The resistors have a catalogue number starting with.

WF06	A	510_	J	T	L
Size code WF25: 2512 WF20: 2010 WF10: 1210 WF12: 1206 WF08: 0805 WF06: 0603 WF04: 0402	Type code A : Triple Power 2512 = 3W 2010 = 1.5W 1210 = 3/4W 1206 = 3/4W 0805 = 1/2W 0603 = 1/3W 0402 = 1/5W	Resistance code 5% E24: 2 significant digits followed by No. of zeros & a blank e.g.: 3ohm = 3R0_ 10ohm = 100_ 56Kohm = 563_ (" " means a blank) 1% E24+E96: 3 significant digits followed by No. of zeros 100Ω = 1000 37.4KΩ = 3742	Tolerance J : ±5% F : ±1% P : Jumper	Packaging code T : 7" Reeled taping Z : 7" Reeled taping (WF25A)	Termination code L = Sn base (lead free)

■ Reeled packaging

WF25A 12mm width pc emboss taping 3,000pcs per 7" reel

WF20A 12mm width pc emboss taping 4,000pcs per 7" reel

WF10A, WF12A, WF08A, WF06A 8mm width paper taping 5,000pcs per 7" reel

WF04A 8mm width paper taping 10,000pcs per 7" reel

MARKING

Size \ Nr. Of digit of code\tolerance	$\pm 1\%, \pm 5\%$
2512/2010/1210/1206/0805	$\pm 1\%$: 4 digits marking; $\pm 5\%$: 3 digits marking
0603	3 digits marking
0402	No marking

Size \ Nr. Of digit of code\tolerance	Jumper (0 Ω)
2512/2010	4 digits marking
1210/1206/0805/0603	3 digits marking
0402	No marking

3 digits marking ($\pm 5\%$ 2512,2010,1210,1206,0805,0603)

Each resistor is marked with a three digits code on the protective coating to designate the nominal resistance value.

3 digits marking ($\pm 1\%$ 0603)

Nominal resistance	Description																																						
1.E24 series	2 significant digits followed by No. of zeros .As 0603 WR06X ±5% Example <table><tr><td>RESISTANCE</td><td>4.7Ω</td><td>47Ω</td><td>470Ω</td><td>4K70</td><td>47K0</td><td>470K</td><td>4M70</td></tr><tr><td>3 digits marking</td><td>4R7</td><td>470</td><td>471</td><td>472</td><td>473</td><td>474</td><td>475</td></tr></table>	RESISTANCE	4.7Ω	47Ω	470Ω	4K70	47K0	470K	4M70	3 digits marking	4R7	470	471	472	473	474	475																						
RESISTANCE	4.7Ω	47Ω	470Ω	4K70	47K0	470K	4M70																																
3 digits marking	4R7	470	471	472	473	474	475																																
2.E96 series	The 1st two digit codes are referring to the CODE on the table, the 3rd code is the index of resistance value. Repeat values between E24 and E96 series, whose marking are based on the E96 CODE table. <table><tr><td>Code</td><td>Z</td><td>Y</td><td>X</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr><tr><td>Multiplier</td><td>10⁻³</td><td>10⁻²</td><td>10⁻¹</td><td>10⁰</td><td>10¹</td><td>10²</td><td>10³</td><td>10⁴</td><td>10⁵</td><td>10⁶</td></tr></table> Example <table><tr><td>RESISTANCE</td><td>1.78Ω</td><td>17.8Ω</td><td>178Ω</td><td>1K78</td><td>17K8</td><td>178K</td><td>1M78</td></tr><tr><td>3 digits marking</td><td>25Y</td><td>25X</td><td>25A</td><td>25B</td><td>25C</td><td>25D</td><td>25E</td></tr></table>	Code	Z	Y	X	A	B	C	D	E	F	G	Multiplier	10 ⁻³	10 ⁻²	10 ⁻¹	10 ⁰	10 ¹	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁶	RESISTANCE	1.78Ω	17.8Ω	178Ω	1K78	17K8	178K	1M78	3 digits marking	25Y	25X	25A	25B	25C	25D	25E
Code	Z	Y	X	A	B	C	D	E	F	G																													
Multiplier	10 ⁻³	10 ⁻²	10 ⁻¹	10 ⁰	10 ¹	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁶																													
RESISTANCE	1.78Ω	17.8Ω	178Ω	1K78	17K8	178K	1M78																																
3 digits marking	25Y	25X	25A	25B	25C	25D	25E																																
3. Remark	There is no marking for the items not under E24 and E96 series.																																						

E96 CODE table:

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

4 digits marking ($\pm 1\%$ 2512,2010,1210,1206,0805)

Each resistor is marked with a four digits code on the protective coating to designate the nominal resistance value. For values below 97 Ω 6 the R is used as a digit. For values of 100 Ω or greater, the first 3 digits are significant, and the fourth digit indicates the number of multiple to follow.

Example

RESISTANCE	Jumper (0 Ω)	4.7 Ω	10 Ω	12 Ω	100 Ω	6800 Ω	47000 Ω	470000 Ω
3 digits marking $\pm 5\%$ 2512,2010,1210,1206,0805,0603 Jumper 1210,1206, 0805, 0603	000	4R7	100	120	101	682	473	474
4 digits marking $\pm 1\%$ 2512,1210,1206,0805 Jumper 2512,2010	0000	4R70	10R0	12R0	1000	6801	4702	4703

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96&E24 series for resistors with a tolerance of $\pm 1\%$, $\pm 5\%$. The values of the E96/E24 series are in accordance with "IEC publication 60063".

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

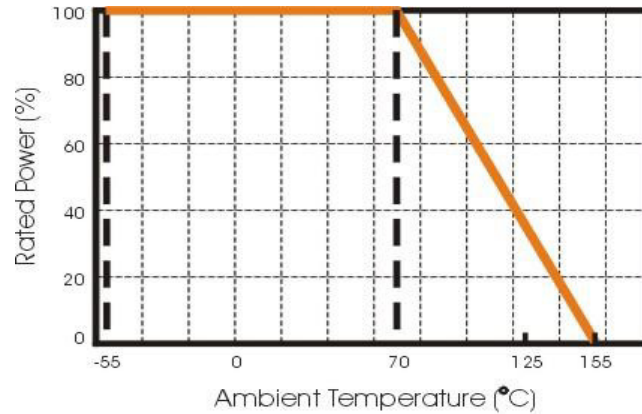


Fig.2 Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

Storage and Handling Conditions:

- Products are recommended to be used up within two years since operation date as ensured shelf life. Check solderability in case shelf life extension is needed.
- To store products with following condition:
 - Temperature :5 to 40°C
 - Humidity :20 to 70% relative humidity
- Caution:
 - Don't store products in a corrosive environment such as sulfide, chloride gas, or acid.
It may cause oxidation of electrode, which easily be resulted in poor soldering.
 - To store products on the shelf and avoid exposure to moisture.
 - Don't expose products to excessive shock, vibration, direct sunlight and so on

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

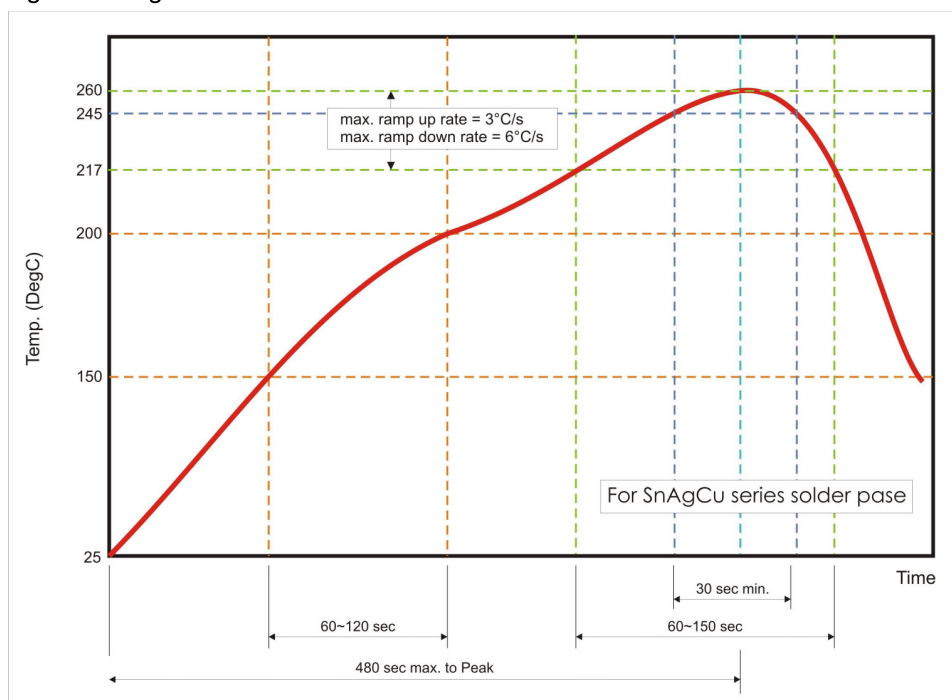
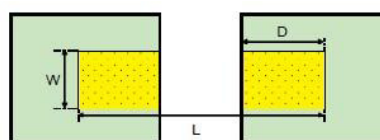


Fig 3. Recommended IR reflow soldering profile for SMT process with SnAgCu series solder paste

RECOMMENDED SOLDERING PAD DIMENSIONS:

Series No.	W	D	L
WF25A	3.70	2.45	7.60
WF20A	3.00	1.50	6.80
WF10A	3.00	1.30	4.70
WF12A	1.80	1.30	4.70
WF08A	1.30	1.15	3.50
WF06A	0.90	1.00	3.00
WF04A	0.60	0.50	1.50

Unit: mm



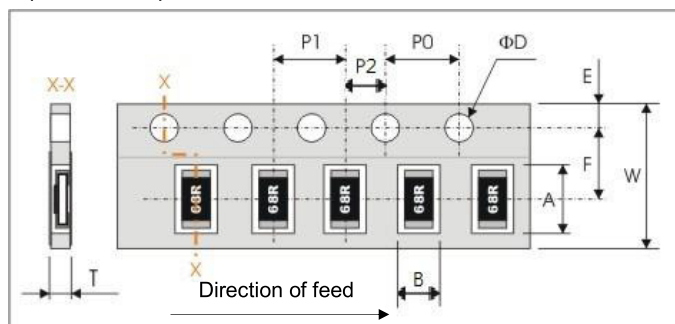
TEST AND REQUIREMENTS

Basic specification : JIS C 5201-1 : 1998

TEST	PROCEDURE	REQUIREMENT
Clause 4.8 Temperature Coefficient of Resistance (TCR)	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/}^\circ\text{C)}$ R ₁ : Resistance at reference temperature R ₂ : Resistance at test temperature t ₁ : 25°C +1°C -1°C.	Refer to quick reference data for T.C.R specification
Clause 4.18 Resistance to soldering heat(R.S.H)	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260°C±5°C.	No visible damage J: ΔR/R max. : ≤ ±(1%+0.05Ω) F: ΔR/R max. : ≤ ±(0.5%+0.05Ω) 0402 Jumper : ≤ 20mΩ Others Jumper : ≤ 10mΩ
Clause 4.17 Solderability	Un-mounted chips completely immersed for 3±0.5 second in a SAC solder bath at 245°C±2°C.	Good tinning (>95% covered) No visible damage
Clause 4.33 Bending strength	Resistors mounted on a 90mm glass epoxy resin PCB(FR4); bending : 0402: 3 mm once for 10 seconds. Others: 2 mm, once for 10 seconds.	No visible damage J: ΔR/R max. : ≤ ±(1%+0.05Ω) F: ΔR/R max. : ≤ ±(0.5%+0.05Ω) 0402 Jumper : ≤ 20mΩ Others Jumper : ≤ 10mΩ
Clause 4.13 Short time overload	5 × Rated power for 5 sec. Measure resistance after 30 minutes.	J: ΔR/R max.: ≤ ±(2%+0.05Ω) F: ΔR/R max. : ≤ ±(1%+0.05Ω) 0402 Jumper : ≤ 20mΩ Others Jumper : ≤ 10mΩ
Clause 4.25 Load life (endurance)	1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller 70±2°C, 1.5 hours on and 0.5 hours off.	No visible damage J: ΔR/R max. : ≤ ±(3%+0.05Ω) F: ΔR/R max. : ≤ ±(1%+0.05Ω) 0402 Jumper : ≤ 20mΩ Others Jumper : ≤ 10mΩ
Clause 4.24 Load life in Humidity	1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at 40°C±2°C and 90~95% relative humidity, 1.5 hours on and 0.5 hours off.	No visible damage J: ΔR/R max. : ≤ ±(3%+0.05Ω) F: ΔR/R max. : ≤ ±(1%+0.05Ω) 0402 Jumper : ≤ 20mΩ Others Jumper : ≤ 10mΩ
Clause 4.19 Temperature cycling	1. 30 minutes at -55°C±3°C, 2. 2~3 minutes at 25°C+5°C-1°C, 3. 30 minutes at +155°C±3°C, 4. 2~3 minutes at 25°C+5°C-1°C, Total 5 continuous cycles.	No visible damage J: ΔR/R max. : ≤ ±(1%+0.05Ω) F: ΔR/R max. : ≤ ±(0.5%+0.05Ω) 0402 Jumper : ≤ 20mΩ Others Jumper : ≤ 10mΩ
Clause 4.6 Insulation Resistance	Apply the insulation voltage 100+15Vdc for 1minute.	R ≥ 1GΩ

PACKAGING

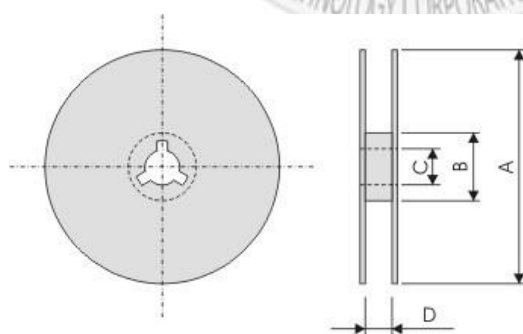
Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF25A	6.70±0.20	3.50±0.20	12.00±0.30	5.50±0.05	1.75±0.10
WF20A	5.50±0.20	2.80±0.20	12.00±0.30	5.50±0.05	1.75±0.10
WF10A	3.60±0.20	3.00±0.20	8.00±0.30	3.50±0.05	1.75±0.10
WF12A	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.05	1.75±0.10
WF08A	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.05	1.75±0.10
WF06A	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.05	1.75±0.10
WF04A	1.20±0.10	0.70±0.10	8.00±0.30	3.50±0.20	1.75±0.10

Series No.	P1	P0	P2	ΦD	T
WF25A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.50
WF20A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.00
WF10A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.00
WF12A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.00
WF08A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.00
WF06A	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 0.80
WF04A	2.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.40±0.05

Reel dimensions



unit: mm

Symbol	A	B	C	D
7" 8mm tape	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	9.0+1/-0
7" 12mm tape	Φ178.0±2.0	Φ60.0±1.0	13.0±0.5	13.8±1.5

APPROVAL SHEET

WF12G, WF08G, WF06G, WF04G

$\pm 1\%$, $\pm 5\%$, $11\text{M}\Omega \sim 100\text{M}\Omega$

High ohm chip resistors

Size 1206, 0805, 0603, 0402

*Contents in this sheet are subject to change without prior notice

FEATURE

1. Small size and light weight
2. High reliability and stability
3. Reduced size of final equipment
4. Higher component and equipment reliability
5. RoHS compliant and lead free products.

APPLICATION

- Power supply
- PDA
- Digital meter
- Computer
- Palmtop computers

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is Tin (lead free) alloy.

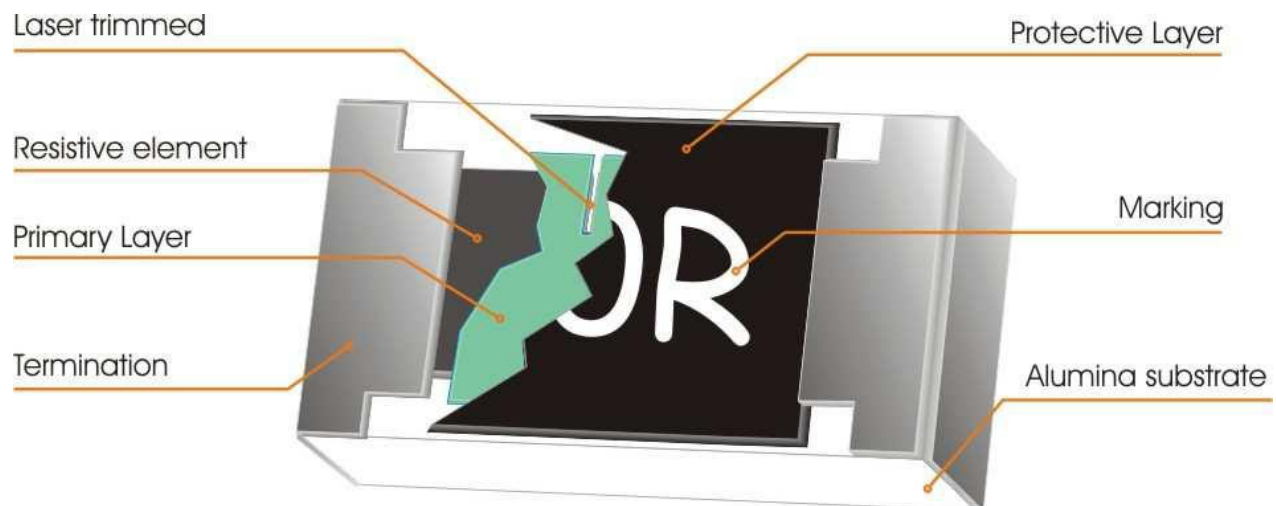


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification			
Series No.	WF12G	WF08G	WF06G	WF04G
Size code	1206 (3216)	0805 (2125)	0603 (1608)	0402 (1005)
Resistance Tolerance	$\pm 1\%, \pm 5\%$			
Resistance Range	$10\text{M}\Omega < R \leq 100\text{M}\Omega$			$10\text{M}\Omega < R \leq 30\text{M}\Omega$ (E24 series)
TCR (ppm/°C)	$\leq \pm 200 \text{ ppm/}^\circ\text{C}$			$\leq \pm 300 \text{ ppm/}^\circ\text{C}$
Max. dissipation at $T_{\text{amb}}=70^\circ\text{C}$	1/4 W	1/8 W	1/10 W	1/16W
Max. Operation Voltage (DC or RMS)	200V	150V	50V	50V
Climatic category (IEC 60068)	55/155/56			

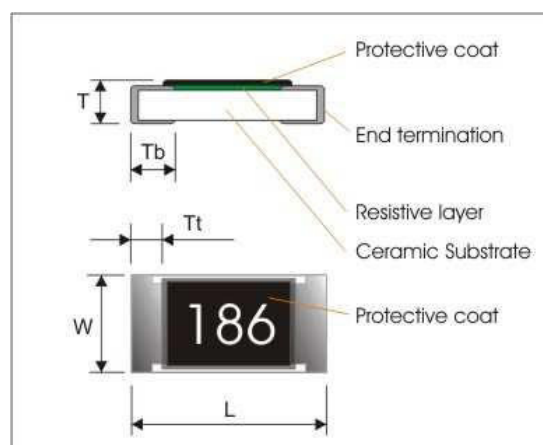
Note :

- This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
- Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$\text{RCWV} = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

DIMENSIONS(unit : mm)

series	WF12G	WF08G	WF06G	WF04G
L	3.10 ± 0.15	2.00 ± 0.10	1.60 ± 0.10	1.00 ± 0.05
W	1.60 ± 0.15	1.25 ± 0.10	0.80 ± 0.10	0.50 ± 0.05
Tt	0.50 ± 0.25	0.40 ± 0.20	0.30 ± 0.10	0.20 ± 0.10
Tb	0.50 ± 0.25	0.40 ± 0.20	0.30 ± 0.15	0.25 ± 0.10
T	0.55 ± 0.10	0.50 ± 0.15	0.45 ± 0.15	0.35 ± 0.05

**MARKING****3-digits marking**

Each resistor is marked with a three digits code on the protective coating to designate the nominal resistance value.

Example

$$\begin{aligned} 306 &= 30 \text{ M}\Omega \\ 186 &= 18 \text{ M}\Omega \end{aligned}$$

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96 & E24 series for resistors with a tolerance of $\pm 1\%$, $\pm 5\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

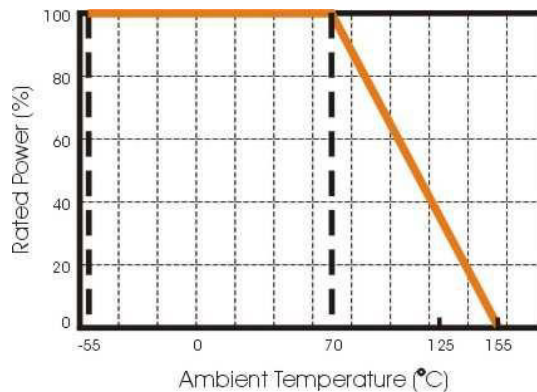


Figure 2. Maximum dissipation in percentage of rated power
As a function of the ambient temperature

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in below. WF04G is not guaranteed with wave soldering process due to its 0402 size.

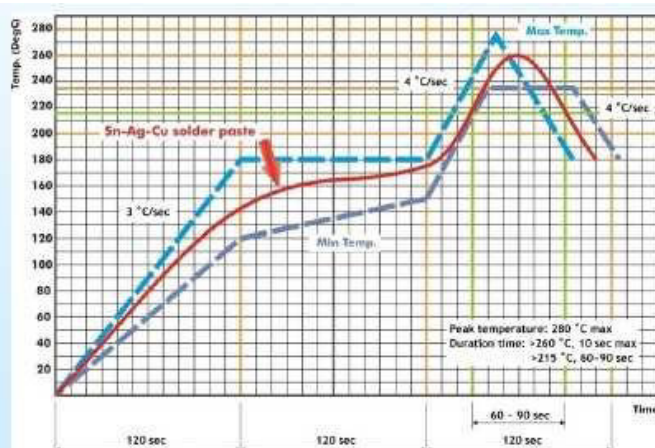


Fig. 1 Recommended IR reflow soldering profile for SMT process with SnAgCu series solder paste.

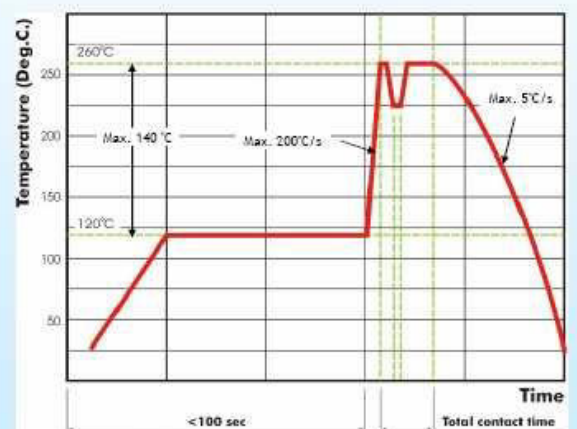


Fig. 2 Recommended wave soldering profile for SMT process with SnAgCu series solder.

CATALOGUE NUMBERS

The resistors have a catalogue number starting with :

WF06	G	226_	J	T	L
Size code	Type code	Resistance code	Tolerance	Packaging code	Termination code
WF12 : 1206	G : High ohmic >10MΩ	5% E24: 2 significant digits followed by no. of zeros and a blank	J : ±5%	T : 7" Reeled taping	L = Sn base (lead free)
WF08 : 0805	1206 size=0.25W	11MΩ =116_	F : ±1%	B : Bulk	
WF06 : 0603	0805 size=0.125W	22MΩ =226_			
WF04 : 0402	0603 size=0.10W	30MΩ =306_			
		("_" means a blank)			
		1%, E24+E96: 3 significant digits followed by no. of zeros			
		100Ω =1000			
		37.4KΩ =3742			

1. Reeled tape packaging : 8mm width paper taping 5000pcs per 7" reel for 1206, 0805, 0603 (10,000pcs for 0402)
2. Bulk packaging : 5000pcs per polybag

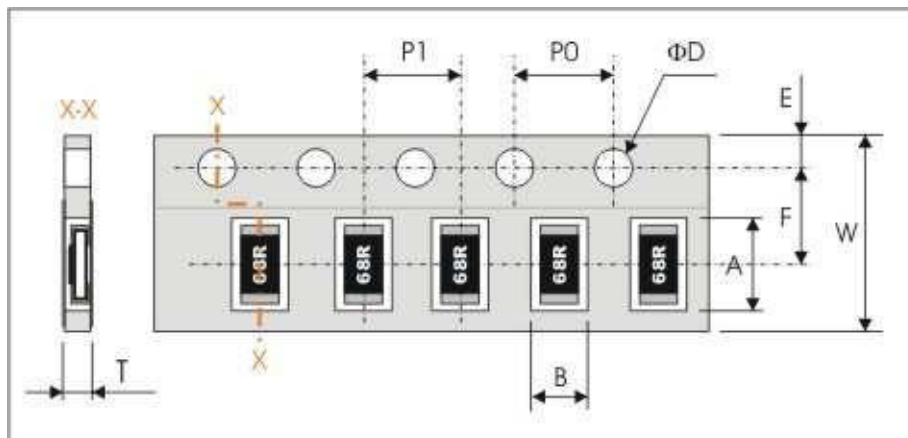
TEST AND REQUIREMENTS(JIS C 5201-1 : 1998)

TEST	PROCEDURE	REQUIREMENT
Temperature Coefficient of Resistance (T.C.R) Clause 4.8	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/°C)}$ R ₁ : Resistance at reference temperature R ₂ : Resistance at test temperature t ₁ : 20°C±5°C-1°C t ₂ : Test temperature.	Refer to quick reference data for T.C.R specification.
Short time overload (S.T.O.L) Clause 4.13	Permanent resistance change after a 5 second application of a voltage 2.5xU _R or max. Overload voltage, whichever is less.	No visible damage. $\Delta R/R \text{ max. J: } \leq \pm(2\%+0.1\Omega)$ $F: \leq \pm(1\%+0.05\Omega)$
Solderability Clause 4.17	Un-mounted chips completely immersed for 2±0.5 second in a SAC solder bath at 235°C±5°C.	good tinning (>95% covered) no visible damage
Resistance to soldering heat(R.S.H) Clause 4.18	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260°C±5°C	No visible damage. $\Delta R/R \text{ max. J: } \leq \pm(1\%+0.1\Omega)$ $F: \leq \pm(0.5\%+0.05\Omega)$

TEST	PROCEDURE	REQUIREMENT
Temperature cycling Clause 4.19	1. 30 minutes at $-55^{\circ}\text{C} \pm 3^{\circ}\text{C}$, 2. 2~3 minutes at $20^{\circ}\text{C} + 5^{\circ}\text{C} - 1^{\circ}\text{C}$, 3. 30 minutes at $+155^{\circ}\text{C} \pm 3^{\circ}\text{C}$, 4. 2~3 minutes at $20^{\circ}\text{C} + 5^{\circ}\text{C} - 1^{\circ}\text{C}$, Total 5 continuous cycles.	No visible damage. $\Delta R/R$ max. $J \leq \pm(1\% + 0.1\Omega)$ $F \leq \pm(0.5\% + 0.05\Omega)$
Load life (endurance) Clause 4.25	1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller $70 \pm 2^{\circ}\text{C}$, 1.5 hours on and 0.5 hours off	No visible damage. $\Delta R/R$ max. $J \leq \pm(3\% + 0.1\Omega)$ $F \leq \pm(1\% + 0.05\Omega)$
Load life in Humidity Clause 4.24	1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and 90~95% relative humidity, 1.5hours on and 0.5 hours off	No visible damage. $\Delta R/R$ max. $J \leq \pm(3\% + 0.1\Omega)$ $F \leq \pm(1\% + 0.05\Omega)$
Bending strength Clause 4.33	Resistors mounted on a 90mm glass epoxy resin PCB(FR4); bending : 3 mm, once for 10 seconds	$\Delta R/R$ max. $\pm(1\% + 0.10\Omega)$
Adhesion Clause 4.32	Pressurizing force: 5N, Test time: 10 ± 1 sec.	No remarkable damage or removal of the terminations.
Insulation Resistance Clause 4.6	Apply the maximum overload voltage (DC) for 1minute	$R \geq 10\text{G}\Omega$
Dielectric Withstand Voltage Clause 4.7	Apply the maximum overload voltage (AC) for 1 minute	No breakdown or flashover

PACKAGING

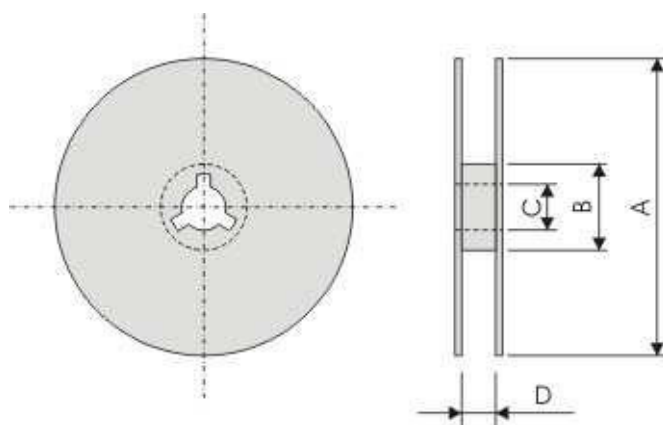
Paper Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF12G	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF08G	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF06G	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF04G	1.20±0.10	0.70±0.10	8.00±0.30	3.50±0.2	1.75±0.10

Series No.	P1	P0	ΦD	T
WF12G	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.0
WF08G	4.00±0.10	4.00±0.10		0.65±0.1
WF06G	4.00±0.10	4.00±0.10		0.40±0.05
WF04G	2.00±0.10	4.00±0.10		

Reel dimensions



Symbol	A	B	C	D
(unit : mm)	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	9.0±0.5

Taping quantity

- Chip resistors 5,000 pcs/reel for 1206, 0805, 0603 (10,000 pcs/reel for 0402)

APPROVAL SHEET

**WF10H_J, WF12H_J, WF08H_J,
WF06H_J, WF04H_J**

$\pm 0.5\%$, $\pm 0.1\%$

Thick Film High Precision Chip Resistors

Size 1210, 1206, 0805, 0603, 0402

Automotive AEC Q200 Qualified

RoHS 2 Compliant with exemption 7C-I

Halogen free

*Contents in this sheet are subject to change without prior notice.

FEATURE

1. Automotive grade AEC Q-200 compliant
2. 100% CCD inspection
3. RoHS compliant with exemption 7C-I and Halogen free products
4. High precision $\pm 0.5\%$, $\pm 0.1\%$

APPLICATION

- Automotive application
- Consumer electrical equipment
- EDP, Computer application
- Telecom application

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.



Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification				
Series No.	WF10H	WF12H	WF08H	WF06H	WF04H
Size code	1210 (3225)	1206 (3216)	0805 (2125)	0603 (1608)	0402 (1005)
Resistance Range	47Ω ~ 1MΩ (E96+E24 series)				
Resistance Tolerance	±0.5%, ±0.1%				
TCR (ppm/°C) 10Ω ≤ R ≤ 1MΩ	≤ ± 100 ppm/°C				
Max. dissipation at T _{amb} =70°C	1/2 W	1/4 W	1/8 W	1/10 W	1/16W
Max. Operation Voltage (DC or RMS)	200V	200V	150V	75V	50V
Max. overload voltage (DC or RMS)	400V	400V	300V	150V	100V
Climatic category	55/155/56				

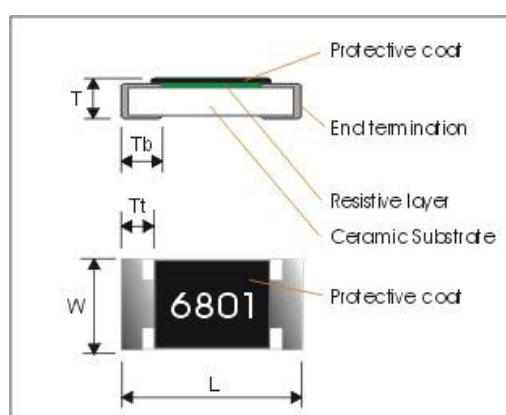
Note :

- This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
- Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$
- Non E96 series resistance upon requested.

DIMENSIONS(unit : mm)

Series No.	WF10H	WF12H	WF08H	WF06H	WF04H
L	3.10 ± 0.10	3.10 ± 0.1	2.0 ± 0.10	1.60 ± 0.10	1.00±0.05
W	2.60 ± 0.10	1.60 ± 0.1	1.25 ± 0.10	0.80 ± 0.10	0.50±0.05
Tt	0.50 ± 0.20	0.50 ± 0.2	0.40 ± 0.20	0.30 ± 0.10	0.20±0.10
Tb	0.50 ± 0.20	0.45 ± 0.2	0.40 ± 0.20	0.30 ± 0.20	0.25±0.10
T	0.55 ± 0.10	0.65 ± 0.15	0.5 ± 0.15	0.45 ± 0.15	0.35±0.05



CATALOGUE NUMBERS

The resistors have a catalogue number starting with :

WF06	H	3742	D	T	L	J
Size code WF10 : 1210 WF12 : 1206 WF08 : 0805 WF06 : 0603 WF04 : 0402	Type code H : Thick film High precision, <1%,	Resistance code E96+E24: 3 significant digits followed by no. of zeros 102Ω =1020 37.4KΩ =3742 220Ω =2200	Tolerance D : ±0.5% B : ±0.1%	Packaging code T : 7" Reeled taping	Termination code L = Sn base (lead free)	Special code J = Automotive grade

- Reeled tape packaging : 8mm width paper taping 5000pcs per 7" reel for 1206/0805/0603
10000pcs per 7" reel for 0402

MARKING

- No marking code for 0402 size.
- 3 digits marking for 0603 size:

WFxxH has same marking rule as WR ±1%

Nominal resistance	Description																																						
1.E24 series	2 significant digits followed by No. of zeros .As 0603 WR06X ±5% Example <table><tr><td>RESISTANCE</td><td>4.7Ω</td><td>47Ω</td><td>470Ω</td><td>4K70</td><td>47K0</td><td>470K</td><td>4M70</td></tr><tr><td>3 digits marking</td><td>4R7</td><td>470</td><td>471</td><td>472</td><td>473</td><td>474</td><td>475</td></tr></table>	RESISTANCE	4.7Ω	47Ω	470Ω	4K70	47K0	470K	4M70	3 digits marking	4R7	470	471	472	473	474	475																						
RESISTANCE	4.7Ω	47Ω	470Ω	4K70	47K0	470K	4M70																																
3 digits marking	4R7	470	471	472	473	474	475																																
2.E96 series	The 1st two digit codes are referring to the CODE on the table, the 3rd code is the index of resistance value. Repeat values between E24 and E96 series, whose marking are based on the E96 CODE table. <table><tr><td>Code</td><td>Z</td><td>Y</td><td>X</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr><tr><td>Multiplier</td><td>10⁻³</td><td>10⁻²</td><td>10⁻¹</td><td>10⁰</td><td>10¹</td><td>10²</td><td>10³</td><td>10⁴</td><td>10⁵</td><td>10⁶</td></tr></table> Example <table><tr><td>RESISTANCE</td><td>1.78Ω</td><td>17.8Ω</td><td>178Ω</td><td>1K78</td><td>17K8</td><td>178K</td><td>1M78</td></tr><tr><td>3 digits marking</td><td>25Y</td><td>25X</td><td>25A</td><td>25B</td><td>25C</td><td>25D</td><td>25E</td></tr></table>	Code	Z	Y	X	A	B	C	D	E	F	G	Multiplier	10 ⁻³	10 ⁻²	10 ⁻¹	10 ⁰	10 ¹	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁶	RESISTANCE	1.78Ω	17.8Ω	178Ω	1K78	17K8	178K	1M78	3 digits marking	25Y	25X	25A	25B	25C	25D	25E
Code	Z	Y	X	A	B	C	D	E	F	G																													
Multiplier	10 ⁻³	10 ⁻²	10 ⁻¹	10 ⁰	10 ¹	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁶																													
RESISTANCE	1.78Ω	17.8Ω	178Ω	1K78	17K8	178K	1M78																																
3 digits marking	25Y	25X	25A	25B	25C	25D	25E																																
3. Remark	There is no marking for the items not under E24 and E96 series.																																						

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

4 digits marking (±1% : 1210,1206,0805)

Each resistor is marked with a four digits code on the protective coating to designate the nominal resistance value. For values below 97Ω6 the R is used as a digit. For values of 100Ω or greater, the first 3 digits are significant, and the fourth digit indicates the number of multiple to follow.

Example

RESISTANCE	10Ω	12Ω	100Ω	6800Ω	47000Ω	470000Ω
4 digits marking	10R0	12R0	1000	6801	4702	4703

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96 & E24 series for resistors with a tolerance of $\pm 0.5\%$, $\pm 0.1\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

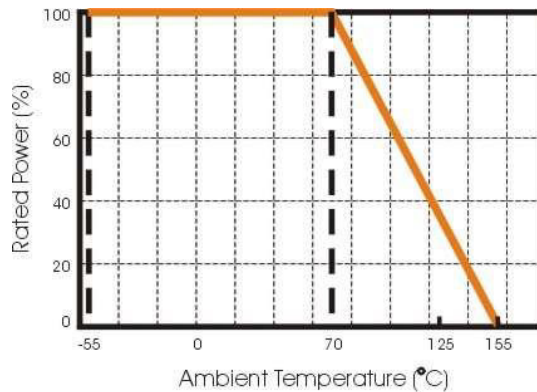


Figure 2. Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

Storage and Handling Conditions:

- Products are recommended to be used up within two years since operation date as ensured shelf life. Check solderability in case shelf life extension is needed.
- To store products with following condition:
 - Temperature :5 to 40°C
 - Humidity :20 to 70% relative humidity
- Caution:
 - Don't store products in a corrosive environment such as sulfide, chloride gas, or acid.
It may cause oxidation of electrode, which easily be resulted in poor soldering.
 - To store products on the shelf and avoid exposure to moisture.
 - Don't expose products to excessive shock, vibration, direct sunlight and so on.

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

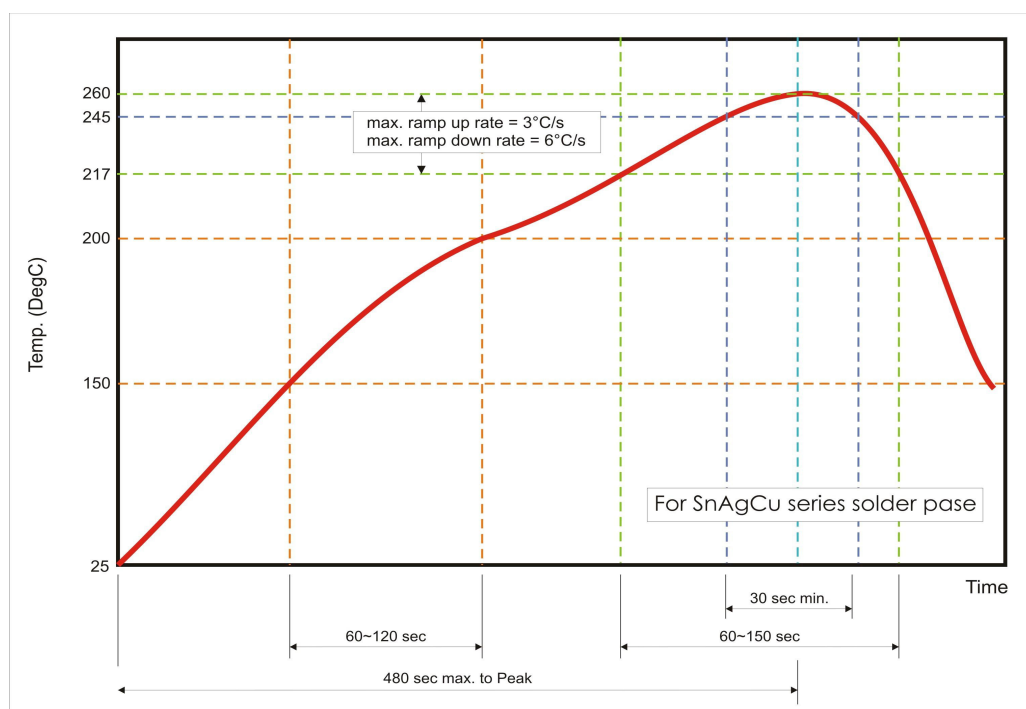


Fig 3. Recommended IR reflow soldering profile for
SMT process with SnAgCu series solder paste

TEST AND REQUIREMENTS

Essentially all tests are carried out according to the schedule of IEC publication 115-8, category **LCT/UCT/56**(rated temperature range : **Lower Category Temperature, Upper Category Temperature**; damp heat, long term, 56 days). The testing also meets the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 68, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to IEC 60068-1, subclause 5.3. Unless otherwise specified, the following value supplied :

Temperature: 15°C to 35°C.

Relative humidity: 45% to 75%.

Air pressure: 86kPa to 106 kPa (860 mbar to 1060 mbar).

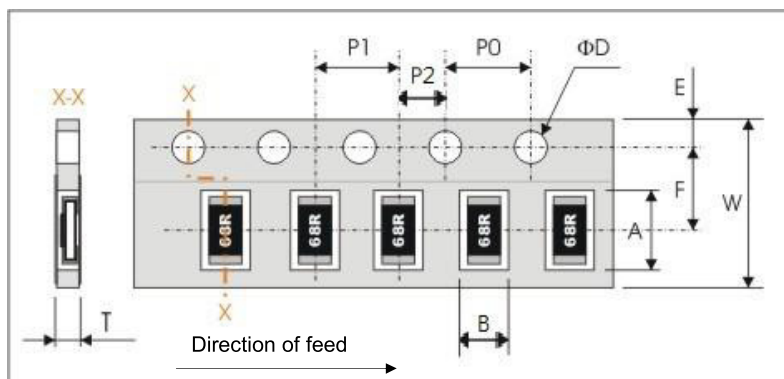
All soldering tests are performed with mildly activated flux.

TEST	PROCEDURE / TEST METHOD	REQUIREMENT
		Resistor
Electrical Characteristics JISC5201-1: 1998 Clause 4.8	- DC resistance values measurement - Temperature Coefficient of Resistance (T.C.R) Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/}^\circ\text{C)}$ $t_1: 20^\circ\text{C} \pm 5^\circ\text{C} - 1^\circ\text{C}$ R_1 : Resistance at reference temperature R_2 : Resistance at test temperature	Within the specified tolerance Refer to "QUICK REFERENCE DATA"
Resistance to soldering heat(R.S.H) MIL-STD-202 method 210	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 270°C ±5°C	ΔR/R max. ±(1.0%+0.05Ω) no visible damage
Solderability J-STD-002	a) Bake the sample for 155°C dwell time 4hrs/ solder dipping 235°C / 5sec. b) Steam the sample dwell time 1 hour/ solder dipping 260°C / 7sec.	95% coverage min., good tinning and no visible damage
Temperature cycling JESD22 Method JA-104	1000 cycles, -55°C ~ +155°C, dwell time 5~10min	ΔR/R max. ±(1.0%+0.05Ω) No visible damage
Moisture Resistance MIL-STD-202 method 106	65±2°C, 80~100% RH, 10 cycles, 24 hours/ cycle	ΔR/R max. ±(1.0%+0.05Ω) No visible damage
Bias Humidity MIL-STD-202 method 103	1000+48/-0 hours; 85°C, 85% RH, 10% of operation power	ΔR/R max. ±(2.0%+0.10Ω) No visible damage
Operational Life MIL-STD-202 method 108	1000+48/-0 hours; 35% of operation power, 125±2°C	ΔR/R max. ±(2.0%+0.1Ω) No visible damage

TEST	PROCEDURE / TEST METHOD	REQUIREMENT
		Resistor
High Temperature Exposure MIL-STD-202 Method 108	1000+48/-0 hours; without load in a temperature chamber controlled 155±3°C	$\Delta R/R$ max. $\pm(2.0\%+0.10\Omega)$ No visible damage
Board Flex AEC-Q200-005	Resistors mounted on a 90mm glass epoxy resin PCB(FR4),bending once 2mm for 10sec.	$\Delta R/R$ max. $\pm(1.0\%+0.05\Omega)$ No visible damage
Terminal strength AEC-Q200-006	Pressurizing force: 1Kg, Test time: 60±1sec.	No remarkable damage or removal of the terminations
Thermal shock MIL-STD-202 method 107	Test -55 to 155°C / dwell time 15min/ Max transfer time 20sec 300cycles	$\Delta R/R$ max. $\pm(1.0\%+0.05\Omega)$ No visible damage
ESD AEC-Q200-002	Test contact 1.0KV (0.5KV for 0402 only)	$\Delta R/R$ max. $\pm(1.0\%+0.05\Omega)$ No visible damage
Short Time Overload JISC5201-1: 1998 Clause 4.13	2.5 times RCWV or max. overload voltage, for 5seconds	$\Delta R/R$ max. $\pm(2.0\%+0.10\Omega)$ No visible damage
Load life in Humidity JISC5201-1: 1998 Clause 4.24	1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at 40°C±2°C and 90~95% relative humidity, 1.5hours on and 0.5 hours off	$\Delta R/R$ max. $\pm(2\%+0.10\Omega)$ No visible damage
Load life (endurance) JISC5201-1: 1998 Clause 4.25	1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller 70±2°C, 1.5 hours on and 0.5 hours off	$\Delta R/R$ max. $\pm(2\%+0.10\Omega)$ No visible damage

PACKAGING

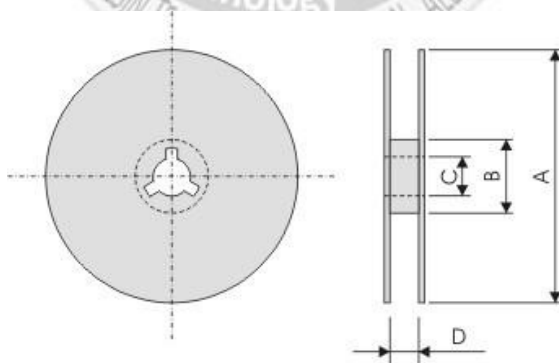
Paper Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF10H	3.60±0.20	2.90±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF12H	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF08H	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF06H	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF04H	1.20±0.10	0.7±0.10	8.00±0.30	3.50±0.05	1.75±0.10

Series No.	P1	P0	P2	ΦD	T
WF10H	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.65±0.1
WF12H	4.00±0.10	4.00±0.10	2.00±0.10		0.65±0.1
WF08H	4.00±0.10	4.00±0.10	2.00±0.10		0.65±0.1
WF06H	4.00±0.10	4.00±0.10	2.00±0.10		0.65±0.1
WF04H	2.00±0.10	4.00±0.10	2.00±0.10		0.40±0.05

Reel dimensions



Symbol	A	B	C	D
(unit : mm)	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	9.0±0.5

Taping quantity

- Chip resistors 5,000 pcs/reel for WF10H, WF12H, WF08H, WF06H.
- Chip resistors 10,000 pcs/reel for WF04H.

APPROVAL SHEET

WF10H, WF12H, WF08H, WF06H, WF04H

$\pm 0.5\%$, $\pm 0.1\%$

Thick Film High Precision Chip Resistors

Size 1210, 1206, 0805, 0603, 0402

RoHS 2 Compliant with exemption 7C-I

Halogen free



*Contents in this sheet are subject to change without prior notice.

FEATURE

1. Small size and light weight
2. High reliability and stability
3. Reduced size of final equipment
4. High precision
5. Higher component and equipment reliability
6. RoHS 2 Compliant with exemption 7C-I and Halogen free products

APPLICATION

- Power supply
- PDA
- Digital meter
- Computer
- Palmtop computers

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

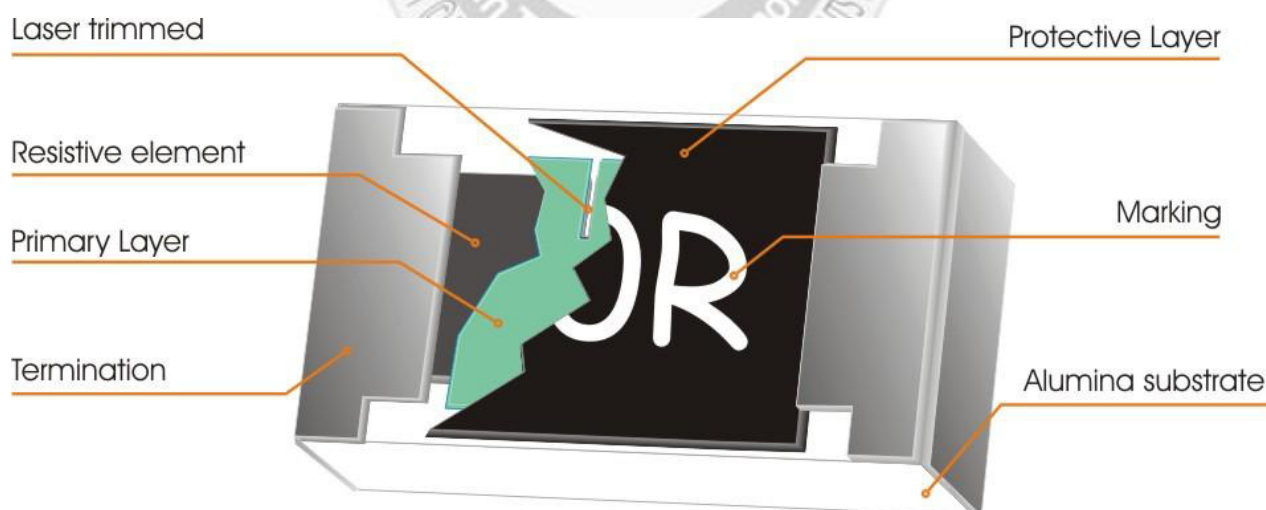


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification				
Series No.	WF10H	WF12H	WF08H	WF06H	WF04H
Size code	1210 (3226)	1206 (3216)	0805 (2125)	0603 (1608)	0402 (1005)
Resistance Range	10Ω ~ 1MΩ (E96+E24 series)				
Resistance Tolerance	±0.5%, ±0.1%				
TCR (ppm/°C) 10Ω ≤ R ≤ 1MΩ	≤ ± 100 ppm/°C				
Max. dissipation at T _{amb} =70°C	1/2 W	1/4 W	1/8 W	1/10 W	1/16W
Max. Operation Voltage (DC or RMS)	200V	200V	150V	75V	50V
Max. overload voltage (DC or RMS)	400V	400V	300V	150V	100V
Climatic category	55/155/56				

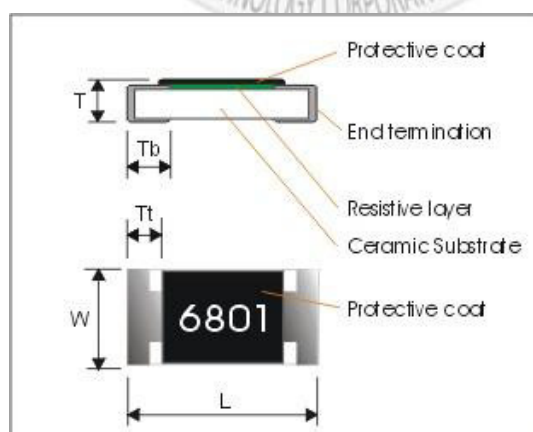
Note :

1. This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
2. Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

DIMENSIONS(unit : mm)

Series No.	WF10H	WF12H	WF08H	WF06H	WF04H
L	3.10 ± 0.10	3.10 ± 0.1	2.0 ± 0.10	1.60 ± 0.10	1.00±0.05
W	2.60 ± 0.10	1.60 ± 0.1	1.25 ± 0.10	0.80 ± 0.10	0.50±0.05
Tt	0.50 ± 0.20	0.50 ± 0.2	0.40 ± 0.20	0.30 ± 0.10	0.20±0.10
Tb	0.50 ± 0.20	0.45 ± 0.2	0.40 ± 0.20	0.30 ± 0.20	0.25±0.10
T	0.55 ± 0.10	0.65 ± 0.15	0.5 ± 0.15	0.45 ± 0.15	0.35±0.05



CATALOGUE NUMBERS

The resistors have a catalogue number starting with :

WF06	H	3742	D	T	L
Size code	Type code	Resistance code	Tolerance	Packaging code	Termination code
WF10: 1210 WF12 : 1206 WF08 : 0805 WF06 : 0603 WF04 : 0402	H : High precision, <1%	E96+E24: 3 significant digits followed by no. of zeros 102Ω =1020 37.4KΩ =3742 220Ω =2200	D : ±0.5% B : ±0.1%	T : 7" Reeled taping	L = Sn base (lead free)

- Reeled tape packaging: 8mm width paper taping 5,000pcs per 7" reel for 1210/1206/0805/0603,
10,000pcs per 7" reel for 0402.

MARKING

- No marking code for 0402 size.
- 3 digits marking for 0603 size:

WFxxH has same marking rule as WR ±1%

Nominal resistance	Description																																						
1.E24 series	2 significant digits followed by No. of zeros .As 0603 WR06X ±5% Example <table><tr><td>RESISTANCE</td><td>4.7Ω</td><td>47Ω</td><td>470Ω</td><td>4K70</td><td>47K0</td><td>470K</td><td>4M70</td></tr><tr><td>3 digits marking</td><td>4R7</td><td>470</td><td>471</td><td>472</td><td>473</td><td>474</td><td>475</td></tr></table>	RESISTANCE	4.7Ω	47Ω	470Ω	4K70	47K0	470K	4M70	3 digits marking	4R7	470	471	472	473	474	475																						
RESISTANCE	4.7Ω	47Ω	470Ω	4K70	47K0	470K	4M70																																
3 digits marking	4R7	470	471	472	473	474	475																																
2.E96 series	The 1st two digit codes are referring to the CODE on the table, the 3rd code is the index of resistance value. Repeat values between E24 and E96 series, whose marking are based on the E96 CODE table. <table><tr><td>Code</td><td>Z</td><td>Y</td><td>X</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr><tr><td>Multiplier</td><td>10⁻³</td><td>10⁻²</td><td>10⁻¹</td><td>10⁰</td><td>10¹</td><td>10²</td><td>10³</td><td>10⁴</td><td>10⁵</td><td>10⁶</td></tr></table> Example <table><tr><td>RESISTANCE</td><td>1.78Ω</td><td>17.8Ω</td><td>178Ω</td><td>1K78</td><td>17K8</td><td>178K</td><td>1M78</td></tr><tr><td>3 digits marking</td><td>25Y</td><td>25X</td><td>25A</td><td>25B</td><td>25C</td><td>25D</td><td>25E</td></tr></table>	Code	Z	Y	X	A	B	C	D	E	F	G	Multiplier	10 ⁻³	10 ⁻²	10 ⁻¹	10 ⁰	10 ¹	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁶	RESISTANCE	1.78Ω	17.8Ω	178Ω	1K78	17K8	178K	1M78	3 digits marking	25Y	25X	25A	25B	25C	25D	25E
Code	Z	Y	X	A	B	C	D	E	F	G																													
Multiplier	10 ⁻³	10 ⁻²	10 ⁻¹	10 ⁰	10 ¹	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁶																													
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3 digits marking	25Y	25X	25A	25B	25C	25D	25E																																
3. Remark	There is no marking for the items not under E24 and E96 series.																																						

E96 CODE table:

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

4 digits marking (±1% : 1210,1206,0805)

Each resistor is marked with a four digits code on the protective coating to designate the nominal resistance value. For values below 97Ω the R is used as a digit. For values of 100Ω or greater, the first 3 digits are significant, and the fourth digit indicates the number of multiple to follow.

Example

RESISTANCE	10Ω	12Ω	100Ω	6800Ω	47000Ω	470000Ω
4 digits marking	10R0	12R0	1000	6801	4702	4703

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96 & E24 series for resistors with a tolerance of $\pm 0.5\%$, $\pm 0.1\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

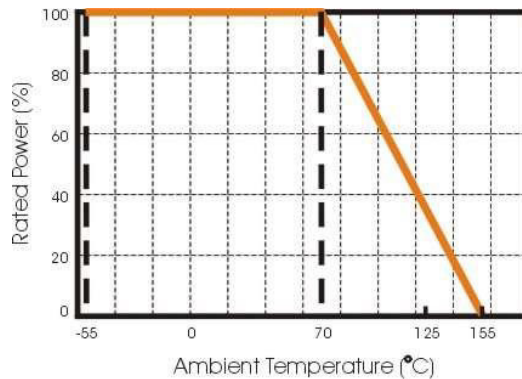


Figure 2. Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

Storage and Handling Conditions:

1. Products are recommended to be used up within two years since operation date as ensured shelf life. Check solderability in case shelf life extension is needed.
2. To store products with following condition:
 - Temperature :5 to 40°C
 - Humidity :20 to 70% relative humidity
3. Caution:
 - a. Don't store products in a corrosive environment such as sulfide, chloride gas, or acid.
It may cause oxidation of electrode, which easily be resulted in poor soldering.
 - b. To store products on the shelf and avoid exposure to moisture.
 - c. Don't expose products to excessive shock, vibration, direct sunlight and so on.

SOLDERING CONDITION follows J-STD-020D

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds.

Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3

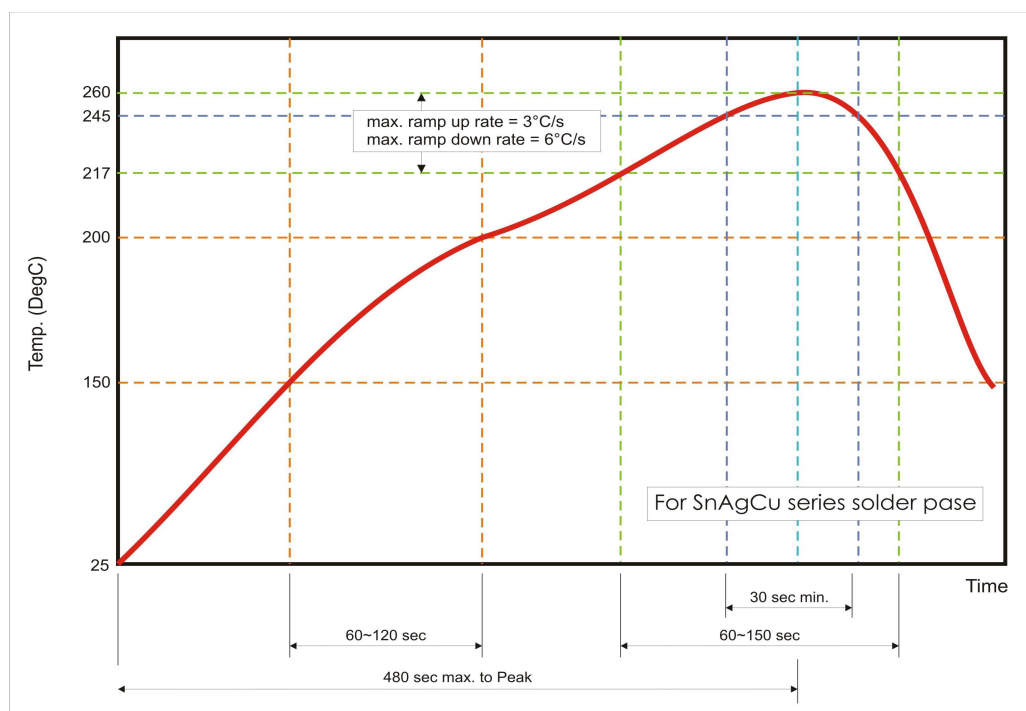


Fig 3. Recommended IR reflow soldering profile for
SMT process with SnAgCu series solder paste

TEST AND REQUIREMENTS (JIS C 5201-1 : 1998)

Essentially all tests are carried out according to the schedule of IEC publication 115-8, category **LCT/UCT/56**(rated temperature range : **Lower Category Temperature, Upper Category Temperature**; damp heat, long term, 56 days). The testing also meets the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 68, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to IEC 60068-1, subclause 5.3. Unless otherwise specified, the following value supplied :

Temperature: 15°C to 35°C.

Relative humidity: 45% to 75%.

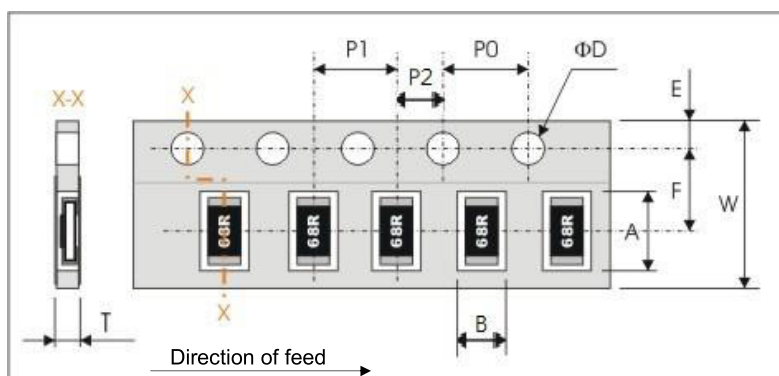
Air pressure: 86kPa to 106 kPa (860 mbar to 1060 mbar).

All soldering tests are performed with mildly activated flux.

TEST	PROCEDURE	REQUIREMENT
DC resistance Clause 4.5	DC resistance values measured at the test voltages specified below : <10Ω@0.1V, <100Ω@0.3V, <1KΩ@1.0V, <10KΩ@3V, <100KΩ@10V, <1MΩ@25V, <10MΩ@30V	Within the specified tolerance
Temperature Coefficient of Resistance(T.C.R) Clause 4.8	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6$ (ppm/°C) ; t1 : 20°C+5°C-1°C R1 : Resistance at reference temperature R2 : Resistance at test temperature	Refer to "QUICK REFERENCE DATA"
Short time overload (S.T.O.L) Clause 4.13	Permanent resistance change after a 5second application of a voltage 2.5 times RCWV or the maximum overload voltage specified in the above list, whichever is less.	ΔR/R max. ±(0.25%+0.05Ω)
Resistance to soldering heat(R.S.H) Clause 4.18	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260 °C ±5°C	no visible damage Δ R/R max. ±(0.25%+0.05Ω)
Solderability Clause 4.17	Un-mounted chips completely immersed for 2±0.5 second in a SAC solder bath at 235°C±5°C	good tinning (>95% covered) no visible damage
Temperature cycling Clause 4.19	30 minutes at -55°C±3°C, 2~3 minutes at 20°C+5°C-1°C, 30 minutes at +155°C±3°C, 2~3 minutes at 20°C+5°C-1°C, total 5 continuous cycles	no visible damage ΔR/R max. ±(0.25%+0.05Ω)
Load life (endurance) Clause 4.25	1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller 70±2°C, 1.5 hours on and 0.5 hours off	ΔR/R max. ±(1%+0.1Ω)
Load life in Humidity Clause 4.24	1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at 40°C±2°C and 90~95% relative humidity, 1.5hours on and 0.5 hours off	ΔR/R max. ±(1%+0.1Ω)
Bending strength Clause 4.33	Resistors mounted on a 90mm glass epoxy resin PCB(FR4); bending : 3 mm, once for 10 seconds	ΔR/R max. ±(0.25%+0.05Ω)
Adhesion Clause 4.32	Pressurizing force: 5N, Test time: 10±1sec.	No remarkable damage or removal of the terminations.
Insulation Resistance Clause 4.6	Apply the maximum overload voltage (DC) for 1minute	R ≥ 10GΩ
Dielectric Withstand Voltage Clause 4.7	Apply the maximum overload voltage (AC) for 1 minute	No breakdown or flashover

PACKAGING

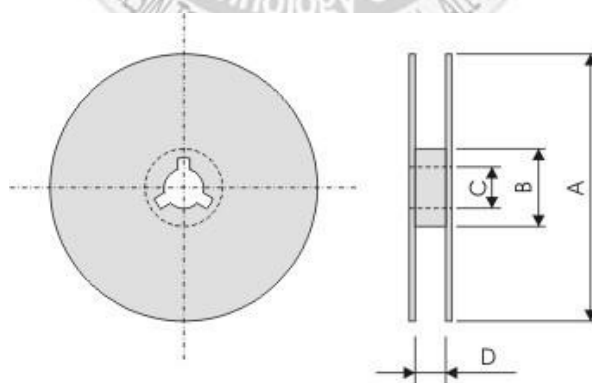
Paper Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF10H	3.60±0.20	3.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF12H	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF08H	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF06H	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF04H	1.20±0.10	0.7±0.10	8.00±0.30	3.50±0.05	1.75±0.10

Series No.	P1	P0	P2	ΦD	T
WF10H	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.0
WF12H	4.00±0.10	4.00±0.10	2.00±0.10		0.65±0.1
WF08H	4.00±0.10	4.00±0.10	2.00±0.10		0.65±0.1
WF06H	4.00±0.10	4.00±0.10	2.00±0.10		0.65±0.1
WF04H	2.00±0.10	4.00±0.10	2.00±0.10		0.40±0.05

Reel dimensions



Symbol	A	B	C	D
(unit : mm)	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	9.0±0.5

Taping quantity

- Chip resistors 5,000 pcs/reel for WF10H, WF12H, WF08H, WF06H.
- Chip resistors 10,000 pcs/reel for WF04H.

APPROVAL SHEET

WF12J, WF08J, WF06J

$\pm 0.5\%$, $\pm 0.25\%$, $\pm 0.1\%$

Thick Film High Precision Low TCR Chip
Resistors

Size 1206, 0805, 0603

RoHS 2 Compliant with exemption 7C-I

Halogen free

*Contents in this sheet are subject to change without prior notice.

FEATURE

1. Small size and light weight
2. High precision down to 0.1%
3. Suitable for lead free soldering
4. Compatible with wave and reflow soldering
5. RoHS 2 Compliant with exemption 7C-I and Halogen free products

APPLICATION

- Power supply
- Digital meter, Consumer electronics, M/B
- Portable electronics devices

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

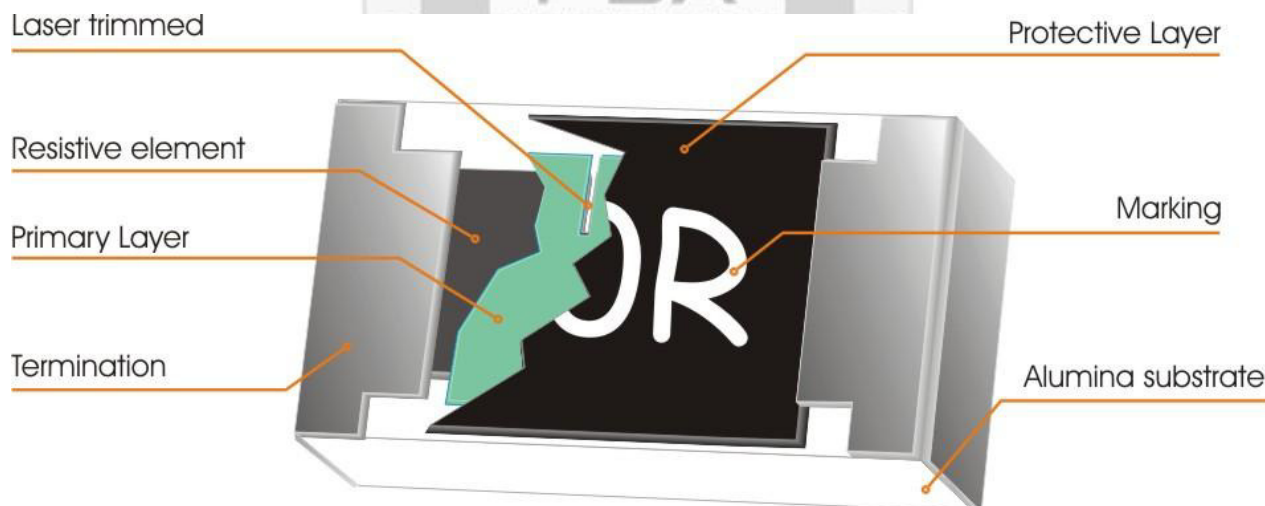


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

Item	General Specification		
Series No.	WF12J	WF08J	WF06J
Size code	1206 (3216)	0805 (2125)	0603 (1608)
Resistance Range	470Ω ~ 470KΩ (E96+E24 series)		
Resistance Tolerance	±0.5%, ±0.25%, ±0.1%		
*TCR (ppm/°C)	≤ ± 25 ppm/°C		
Max. dissipation at T _{amb} =70°C	1/4 W	1/8 W	1/10 W
Max. Operation Voltage (DC or RMS)	200V	150V	75V
Max. overload voltage (DC or RMS)	400V	300V	100V
Climatic category	55/155/56		

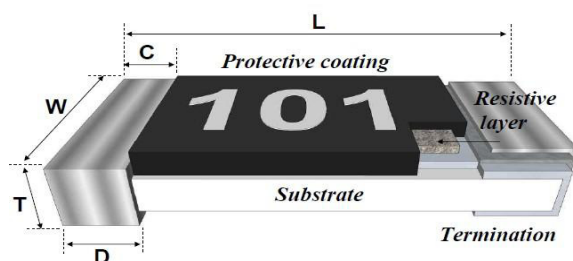
Note :

1. This is the maximum voltage that may be continuously supplied to the resistor element, see “IEC publication 60115-8”
2. Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}}$$
or Max. RCWV listed above, whichever is lower
3. Please consider the resistance variance may from soldering pad/trace/amount influence, and recommend keep the surface temperature do not exceed 105°C when operating
4. *TCR -55~+25°C is 50ppm

DIMENSIONS(unit : mm)

Series No.	WF12J	WF08J	WF06J
L	3.10 ± 0.10	2.00 ± 0.10	1.60 ± 0.10
W	1.60 ± 0.10	1.25 ± 0.10	0.80 ± 0.10
C	0.50 ± 0.20	0.40 ± 0.20	0.30 ± 0.20
D	0.50 ± 0.20	0.40 ± 0.20	0.30 ± 0.20
T	0.55 ± 0.10	0.50 ± 0.10	0.45 ± 0.10



CATALOGUE NUMBERS

The resistors have a catalogue number starting with :

WF06	J	3742	D	T	L
Size code WF12 : 1206 WF08 : 0805 WF06 : 0603	Type code J : High precision, Low TCR 25ppm	Resistance code E96+E24: 3 significant digits followed by no. of zeros 470Ω =4700 3.32KΩ =3321 37.4KΩ =3742 470KΩ =4703	Tolerance B : ±0.10% C : ±0.25% D : ±0.50%	Packaging code T : 7" Reeled taping 5Kpcs Q : 10" Reeled taping 10Kpcs G : 13" Reeled taping 20Kpcs	Termination code L = Sn base (lead free)

MARKING

3 digits marking for 0603 size

Nominal resistance	Description														
1.E24 series	2 significant digits followed by No. of zeros .														
	Example														
	RESISTANCE	4.7Ω	47Ω	470Ω	4K70	47K0	470K	4M70							
	3 digits marking	4R7	470	471	472	473	474	475							
2.E96 series	The 1st two digit codes are referring to the CODE on the table, the 3rd code is the index of resistance value. Repeat values between E24 and E96 series, whose marking are based on the E96 CODE table.														
	Code	Z	Y	X	A	B	C	D	E	F	G				
	Multiplier	10 ⁻³	10 ⁻²	10 ⁻¹	10 ⁰	10 ¹	10 ²	10 ³	10 ⁴	10 ⁵	10 ⁶				
	Example														
	RESISTANCE	1.78Ω	17.8Ω	178Ω	1K78	17K8	178K	1M78							
	3 digits marking	25Y	25X	25A	25B	25C	25D	25E							
3. Remark	There is no marking for the items not under E24 and E96 series.														
E96 CODE table:															
CODE	R value	CODE	R-value	CODE	R-Value	CODE	R-value	CODE	R-value	CODE	R-value	CODE	R-value	CODE	R-value
01	100	13	133	25	178	37	237	49	316	61	422	73	562	85	750
02	102	14	137	26	182	38	243	50	324	62	432	74	576	86	768
03	105	15	140	27	187	39	249	51	332	63	442	75	590	87	787
04	107	16	143	28	191	40	255	52	340	64	453	76	604	88	806
05	110	17	147	29	196	41	261	53	348	65	464	77	619	89	825
06	113	18	150	30	200	42	267	54	357	66	475	78	634	90	845
07	115	19	154	31	205	43	274	55	365	67	487	79	649	91	866
08	118	20	158	32	210	44	280	56	374	68	499	80	665	92	887
09	121	21	162	33	215	45	287	57	383	69	511	81	681	93	909
10	124	22	165	34	221	46	294	58	392	70	523	82	698	94	931
11	127	23	169	35	226	47	301	59	402	71	536	83	715	95	953
12	130	24	174	36	232	48	309	60	412	72	549	84	732	96	976

4 digits marking for 0805, 1206 size:

Each resistor is marked with a four digits code on the protective coating to designate the nominal resistance value. The first 3 digits are significant, and the fourth digit indicates the number of multiple to follow.

Example

RESISTANCE	470Ω	6800Ω	47000Ω	470000Ω
4 digits marking	4700	6801	4702	4703

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E96 & E24 series for resistors with a tolerance of $\pm 0.5\%$, $\pm 0.1\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

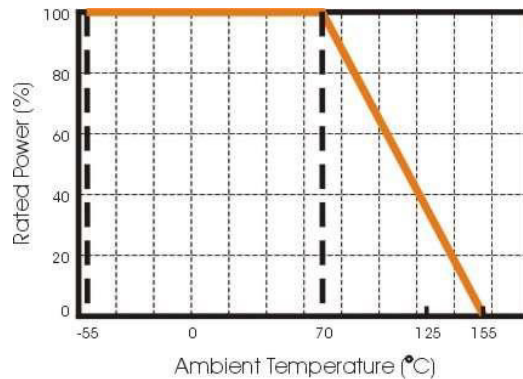


Figure 2. Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

Storage and Handling Conditions:

- Products are recommended to be used up within two years since operation date as ensured shelf life. Check solderability in case shelf life extension is needed.
- To store products with following condition:
 - Temperature :5 to 40°C
 - Humidity :20 to 70% relative humidity
- Caution:
 - Don't store products in a corrosive environment such as sulfide, chloride gas, or acid.
It may cause oxidation of electrode, which easily be resulted in poor soldering.
 - To store products on the shelf and avoid exposure to moisture.
 - Don't expose products to excessive shock, vibration, direct sunlight and so on.

SOLDERING CONDITION follows J-STD-020D

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds. The test condition for no leaching is 260°C for 30 seconds.

Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3

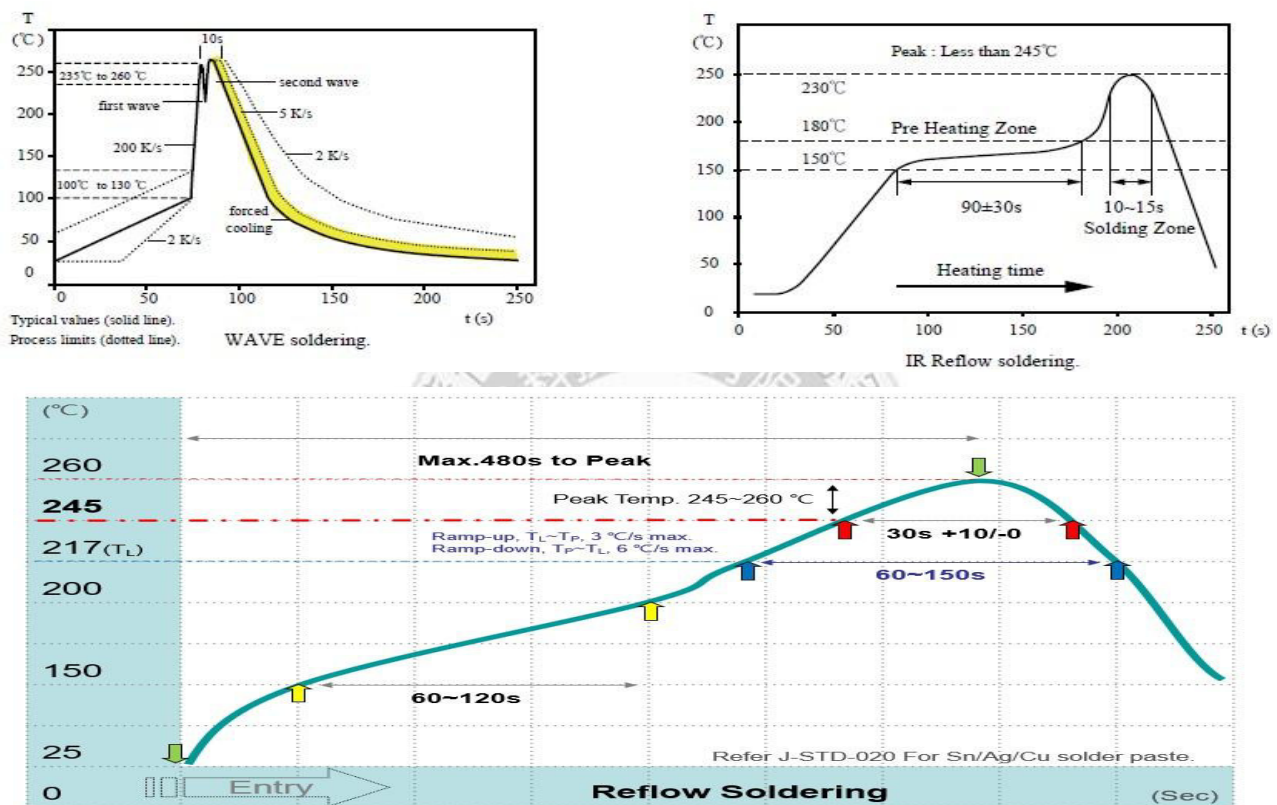
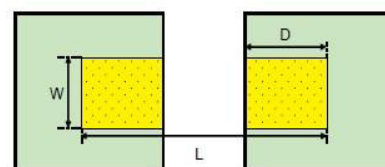


Fig 3. Recommended IR reflow soldering profile for
SMT process with SnAgCu series solder paste

Recommend Solder Pad Dimensions :

Product size	W	D	L
0603	0.90	1.00	3.00
0805	1.30	1.15	3.50
1206	1.80	1.30	4.70



TEST AND REQUIREMENTS (JIS C 5201-1 : 1998)

Essentially all tests are carried out according to the schedule of IEC publication 115-8, category **LCT/UCT/56**(rated temperature range : Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days). The testing also meets the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 68, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to IEC 60068-1, subclause 5.3. Unless otherwise specified, the following value supplied :

Temperature: 15°C to 35°C.

Relative humidity: 45% to 75%.

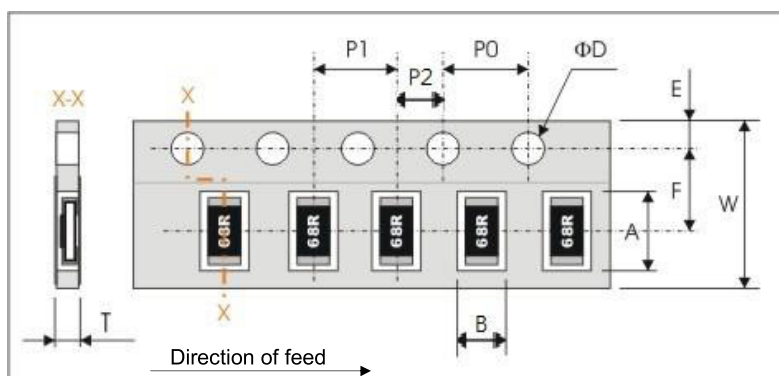
Air pressure: 86kPa to 106 kPa (860 mbar to 1060 mbar).

All soldering tests are performed with mildly activated flux.

TEST	PROCEDURE	REQUIREMENT
DC Resistance	IEC 60115-1 / JIS C 5201-1, Clause 4.5 Measure the resistance Value.	B: $\pm 0.10\%$, C: $\pm 0.25\%$ D: $\pm 0.50\%$
Insulation Resistance	IEC 60115-1, Clause 4.6 Test voltage : 100 $\pm$ 15V	Between termination and coating must over 1000M Ω
Temperature Coefficient of Resistance (TCR)	IEC 60115-1, Clause 4.8 Natural resistance change per change in degree centigrade $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6$ (ppm/°C) t1 : 25°C~ t2 : -55°C (cold)/ +155°C (hot) R1 : Resistance at reference temperature R2 : Resistance at test temperature	Within the spec.
Short Time Overload (STOL)	IEC 60115-1, Clause 4.13 Permanent resistance change after a 5second application of a voltage 2.5 times RCWV or the maximum overload voltage specified in the above list, whichever is less.	D: $\Delta R/R \leq \pm (1.0\% + 0.05\Omega)$ B,C: $\Delta R/R \leq \pm (0.5\% + 0.05\Omega)$
Solder Ability	IEC 60115-1, Clause 4.17 After immersing flux, dip in the 235 $\pm$ 2°C molten solder bath for 3 $\pm$ 0.5 sec.	Over 95% of termination must be covered with solder.
Resistance to Solder Heat (RSH)	IEC 60115-1, Clause 4.18 Un-mounted chips completely immersed for 10 $\pm$ 1second in a SAC solder bath at 260°C $\pm$ 5°C	$\Delta R/R \leq \pm (0.5\% + 0.05\Omega)$
Temperature Cycle	IEC 60115-1, Clause 4.19 Repeat 5 cycles as follows: -55°C (30min) $\rightarrow$ 25°C (2~3min) $\rightarrow$ 155°C (30min) $\rightarrow$ 25°C (2~3min)	$\Delta R/R \leq \pm (0.5\% + 0.05\Omega)$
Load Life Humidity	IEC 60115-1, Clause 4.24 40 $\pm$ 2°C with relative humidity 90% ~ 95%, DC rated voltage for 1.5 hours ON 0.5 hours OFF. Cycle repeated 1000 hours.	D: $\Delta R/R \leq \pm (1.0\% + 0.05\Omega)$ B,C: $\Delta R/R \leq \pm (0.5\% + 0.05\Omega)$
Load Life	EC 60115-1, Clause 4.25 70 $\pm$ 2°C, DC rated voltage for 1.5 hours ON 0.5 hours OFF. Cycle repeated 1000 hours.	D: $\Delta R/R \leq \pm (1.0\% + 0.05\Omega)$ B,C: $\Delta R/R \leq \pm (0.5\% + 0.05\Omega)$
Board Flex (Bending)	IEC 60115-1, Clause 4.33 Resistance change after bended on the 90mm PCB. Bending 0603.0805 3mm, 1206 2mm.	$\Delta R/R \leq \pm (0.5\% + 0.05\Omega)$ No mechanical damage.
High Temperature Exposure	MIL-STD-202 method 108 1000+48/-0 hours; without load in 155°C.	$\Delta R/R \leq \pm (1.0\% + 0.1\Omega)$

PACKAGING

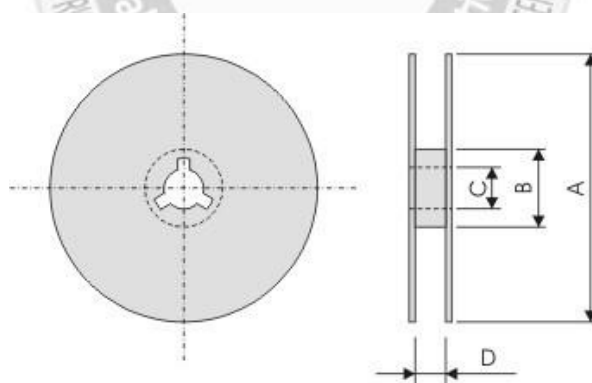
Paper Tape specifications (unit :mm)



Series No.	A	B	W	F	E
WF12J	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF08J	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.2	1.75±0.10
WF06J	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.2	1.75±0.10

Series No.	P1	P0	P2	ΦD	T
WF12J	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.80±0.1
WF08J	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.80±0.1
WF06J	4.00±0.10	4.00±0.10	2.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.65±0.1

Reel dimensions



Product size	Reel	Taping quantity	A	B	C	D
1206	7"	5K	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	9.0±0.5
0805	10"	10K	Φ254.0±2.0	Φ100.0±1.0	13.0±0.2	9.0±0.5
0603	13"	20K	Φ330.0±2.0	Φ100.0±1.0	13.0±0.2	9.0±0.5

APPROVAL SHEET

WF12K, WF08K, WF06K, WF04K

$\pm 1.0\%$, 0.5% , $\pm 0.25\%$, $\pm 0.1\%$

Thick Film TC50

High Precision Thick Film chip resistors

Size 1206, 0805, 0603, 0402

FEATURE

1. SMD Thick film resistor
2. High reliability and stability
3. High performance of TCR: 50 ppm/K
4. High precision
5. RoHS compliant & Lead free

APPLICATION

- Medical equipment
- Measuring instrument
- Communication device
- Computer
- Printer

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive layer that is applied to the top surface of the substrate. The composition of the resistive layer is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For environmental soldering issue, the outer layer of these end terminations is a Lead-free solder .

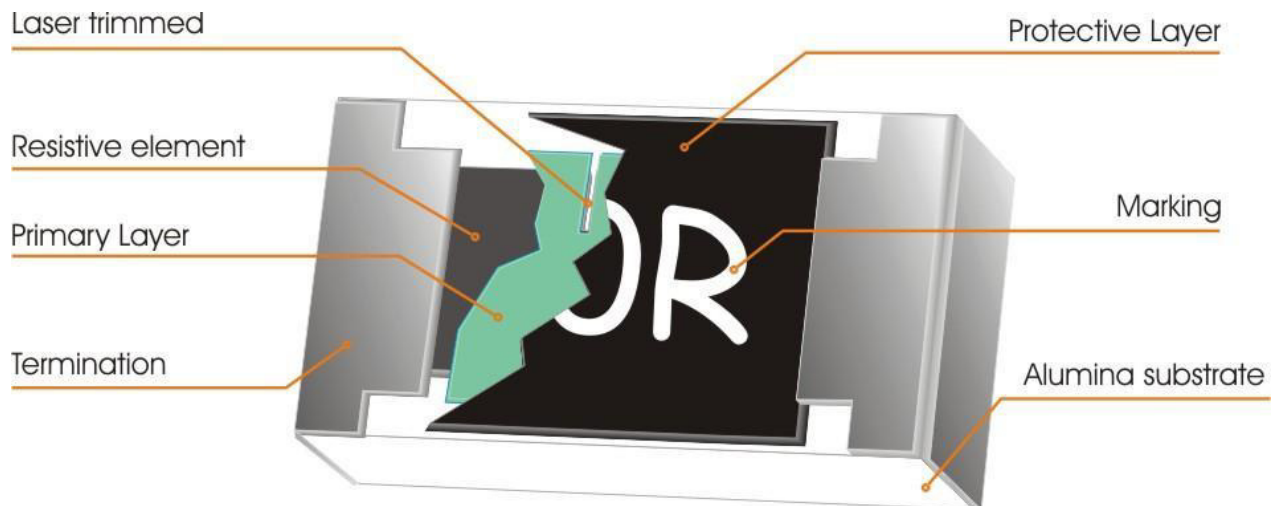


Fig 1. Construction of Chip-R WFxxK

QUICK REFERENCE DATA

Item	General Specification			
Series No.	WF12K	WF08K	WF06K	WF04K
Size code	1206 (3216)	0805 (2012)	0603 (1608)	0402 (1005)
Resistance Tolerance	$\pm 1.0\%$, $\pm 0.5\%$, $\pm 0.25\%$, $\pm 0.1\%$			
Resistance Range	10 Ω ~ 1M Ω (E24 +E96)			100 Ω ~ 1M Ω (E24 +E96)
TCR (ppm/°C)	>10R: ± 50 1-10R: ± 100			
Max. dissipation at T _{amb} =70°C	1/4W	1/8W	1/10W	1/16W
Max. Operation Voltage (DC or RMS)	200V	150V	50V	50V
Max. Overload Voltage (DC or RMS)	400V	300V	100V	100V
Operation temperature	- 55 ~ +155°C			

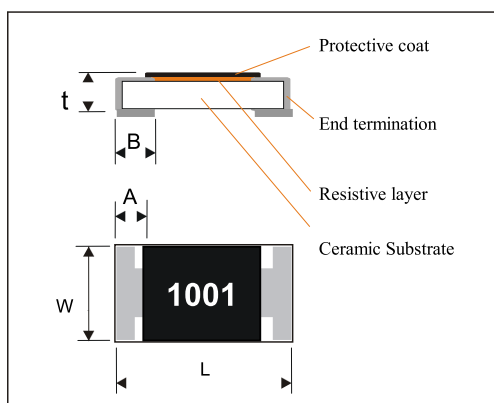
Note :

1. This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8"
2. Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

DIMENSIONS(unit : mm)

Type	WF12K	WF08K	WF06K	WF04K
L	3.10 ± 0.10	2.00 ± 0.10	1.60 ± 0.10	1.00 ± 0.05
W	1.60 ± 0.10	1.25 ± 0.10	0.80 ± 0.10	0.50 ± 0.05
A	0.50 ± 0.20	0.40 ± 0.20	0.30 ± 0.10	0.20 ± 0.10
B	0.45 ± 0.20	0.40 ± 0.20	0.30 ± 0.15	0.25 ± 0.10
t	0.60 ± 0.15	0.50 ± 0.15	0.45 ± 0.10	0.35 ± 0.05



MARKING

- 3-digits marking for 0603 size**

WFxxK has same marking rule as commodity $\pm 1\%$.

3-digits marking ($\pm 1\%$: 0603)

Nominal resistance				Description											
1.E-24 series				As 0603 WR06X ±5%.											
2.E-96 series				The 1st two digit codes are referring to the CODE on the table, the 3rd code is the index of resistance value : Y=10 ⁻² , X=10 ⁻¹ , A=10 ⁰ , B=10 ¹ , C=10 ² , D=10 ³ , E=10 ⁴ , F=10 ⁵ EX: 17.8Ω=25X, 178Ω=25A, 1K78 =25B 17K8=25C, 178K=25D, 1M78=25E											
				3. Remark											
				There is no marking for the items are not under E-24 and E-96 series											
CODE	R_value	CODE	R_value	CODE	R_Value	CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value	CODE	R_value
01	100	13	133	25	178	37	237	49	316	61	422	73	562	85	750
02	102	14	137	26	182	38	243	50	324	62	432	74	576	86	768
03	105	15	140	27	187	39	249	51	332	63	442	75	590	87	787
04	107	16	143	28	191	40	255	52	340	64	453	76	604	88	806
05	110	17	147	29	196	41	261	53	348	65	464	77	619	89	825
06	113	18	150	30	200	42	267	54	357	66	475	78	634	90	845
07	115	19	154	31	205	43	274	55	365	67	487	79	649	91	866
08	118	20	158	32	210	44	280	56	374	68	499	80	665	92	887
09	121	21	162	33	215	45	287	57	383	69	511	81	681	93	909
10	124	22	165	34	221	46	294	58	392	70	523	82	698	94	931
11	127	23	169	35	226	47	301	59	402	71	536	83	715	95	953
12	130	24	174	36	232	48	309	60	412	72	549	84	732	96	976

- 4-digits marking for 1206, 0805 size**

Each resistor is marked with a four digits code on the protective coating to designate the nominal resistance value of E24+E96. For values below 97 Ω 6 the R is used as a digit. For values of 100 Ω or greater, the first 3 digits are significant, the fourth digit indicates the number of multiple to follow.

Example

RESISTANCE	10 Ω	12 Ω	100 Ω	6800 Ω	47000 Ω
4-digits marking	10R0	12R0	1000	6801	4702

- No marking code for 0402 size**

FUNCTIONAL DESCRIPTION

Product characterization

Standard values of nominal resistance are taken from the E24 & E96 series for resistors with a tolerance of $\pm 1.0\%$, $\pm 0.5\%$, $\pm 0.25\%$, $\pm 0.1\%$. The values of the E24/E96 series are in accordance with "IEC publication 60063".

Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

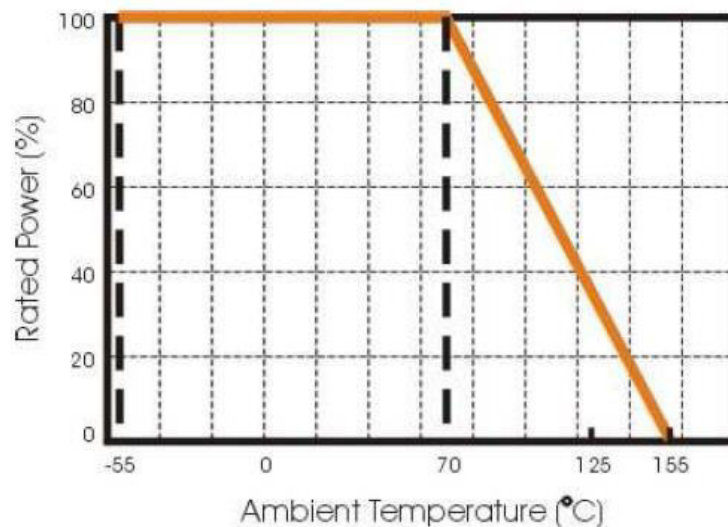


Figure 2. Maximum dissipation in percentage of rated power
As a function of the ambient temperature

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

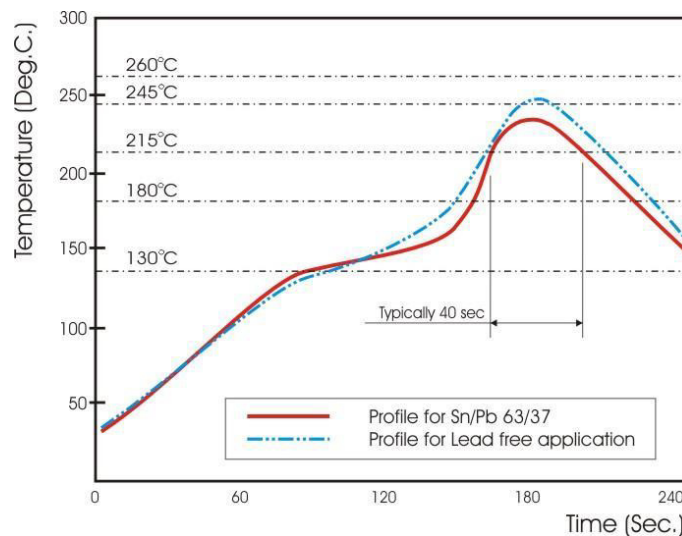
Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds within lead-free solder bath. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.



CATALOGUE NUMBERS

The resistors have a catalogue number starting with .

WF08	K	xxxx	D	T	L
Size code WF12: 1206 WF08: 0805 WF06: 0603 WF04: 0402	Type code TCR 50ppm	Resistance code E24 +E192: R is first code followed by 3 significant digits. E24: 39R0=>39R0 820R =>8200 E96: 49R9 =>49R9 499R =>4990	Tolerance F : ±1.0% D : ±0.5% C: ±0.25% B : ±0.1%	Packaging code T : 7" reel G : 13" reel	Termination code L : lead free

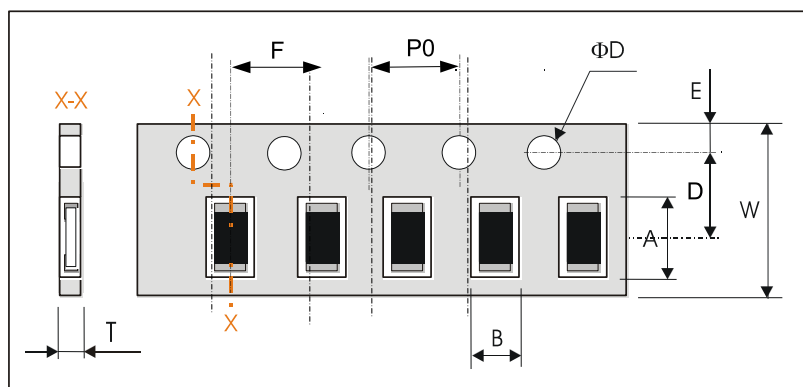
1. Reeled tape packaging: 8mm width paper taping.
for WF12, WF08, WF06, 5,000pcs/ 7" reel; 20kpcs/ 13" reel
for WF04, 10,000pcs/ 7" reel ; 70kpcs/ 13" reel

TEST AND REQUIREMENTS(JIS C 5201-1 : 1998)

TEST	PROCEDURE	REQUIREMENT
		Resistor
DC resistance Clause 4.5	DC resistance values measured <10Ω@0.1V, <100Ω@0.3V, <1KΩ@1.0V, <10KΩ@3V, <100KΩ@10V, <1MΩ@25V, <10MΩ@30V	Within the specified tolerance
Temperature Coefficient of Resistance(T.C.R) Clause 4.8	Natural resistance change per change in degree centigrade. $\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/°C)}$ R ₁ : Resistance at reference temperature R ₂ : Resistance at test temperature t ₁ : 20°C+5°C-1°C	Refer to "QUICK REFERENCE DATA"
Short time overload (S.T.O.L) Clause 4.13	Permanent resistance change after a 5second application of a voltage 2.5 times RCWV or the maximum overload voltage specified in the above list, whichever is less.	ΔR/R max. ±(0.5%+0.05Ω)
Resistance to soldering heat(R.S.H) Clause 4.18	Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260°C±5°C	no visible damage Δ R/R max. ±(0.25%+0.05Ω)
Solderability Clause 4.17	Un-mounted chips completely immersed for 2±0.5 second in a SAC solder bath at 235°C±5°C	good tinning (>95% covered) no visible damage
Temperature cycling Clause 4.19	30 minutes at -55°C±3°C, 2~3 minutes at 20°C+5°C-1°C, 30 minutes at +125°C±3°C, 2~3 minutes at 20°C+5°C-1°C, total 5 continuous cycles	no visible damage ΔR/R max. ±(0.5%+0.05Ω)
Load life (endurance) Clause 4.25	70±2°C, 1000 hours, loaded with RCWV or Vmax, 1.5 hours on and 0.5 hours off	ΔR/R max. ±(1.0%+0.05Ω)
Load life in Humidity Clause 4.24	1000 hours, at rated continuous working voltage in humidity chamber controller at 40°C±2°C and 90~95% relative humidity, 1.5hours on and 0.5 hours off	ΔR/R max. ±(1.0%+0.05Ω)
Bending strength Clause 4.33	Resistors mounted on a 90mm glass epoxy resin PCB(FR4); bending : 3 mm, once for 10 seconds.	ΔR/R max. ±(0.5%+0.05Ω)
Adhesion Clause 4.32	Pressurizing force: 5N, Test time: 10±1sec.	No remarkable damage or removal of the terminations.
Insulation Resistance Clause 4.6	Apply the maximum overload voltage (DC) for 1minute	R ≥ 10GΩ
Dielectric Withstand Voltage Clause 4.7	Apply the maximum overload voltage (AC) for 1 minute	No breakdown or flashover

PACKAGING

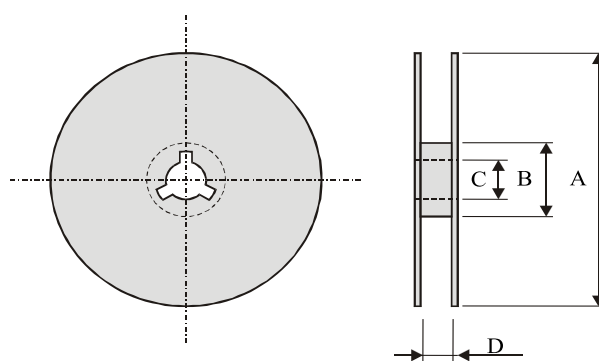
Paper Tape specifications (unit :mm)



Series No.	A	B	W	D	E
WF12	3.60±0.20	2.00±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF08	2.40±0.20	1.65±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF06	1.90±0.20	1.10±0.20	8.00±0.30	3.50±0.20	1.75±0.10
WF04	1.20±0.10	0.7±0.10	8.00±0.20	3.50±0.05	1.75±0.10

Series No.	F	P0	ΦD	T
WF12	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.0
WF08	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	Max. 1.0
WF06	4.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.65±0.05
WF04	2.00±0.10	4.00±0.10	Φ1.50 ^{+0.1} _{-0.0}	0.40±0.05

Reel dimensions



Symbol	A	B	C	D
7" reel	Φ178.0±2.0	Φ60.0±1.0	13.0±0.2	9.0±0.5
13" reel	Φ330.0±2.0	Φ100.0±1.0	13.0±0.2	9.0±0.5

Taping quantity

- Chip resistors 5,000 pcs per 7" reel; 20,000 pcs per 13" reel (WF12, WF08, WF06)
- Chip resistors 10,000 pcs per 7" reel; 70,000 pcs per 13" reel (WF04)

APPROVAL SHEET

WFxxL_J

±1%, ±5%

Thick Film Power Chip Resistor
Wide Termination
Size 0612, 1225

Automotive AEC Q200 Compliant
RoHS 2 Compliant with exemption 7C-I
Halogen free

*Contents in this sheet are subject to change without prior notice.

FEATURE

1. High power rating to 2W and compact size
2. High reliability and high precision (1%)
3. Compatible with wave and reflow soldering
4. Suitable for lead free soldering
5. Automotive AEC-Q200 compliant
6. RoHS 2 compliant with exemption 7C-I and Halogen free products

APPLICATION

- Power supply
- Industry controller
- Digital meter, Consumer electronics, M/B
- LED Lighting
- Automotive devices

DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added at longer sides. For ease of soldering the outer layer of these end terminations is Tin (lead free) alloy.

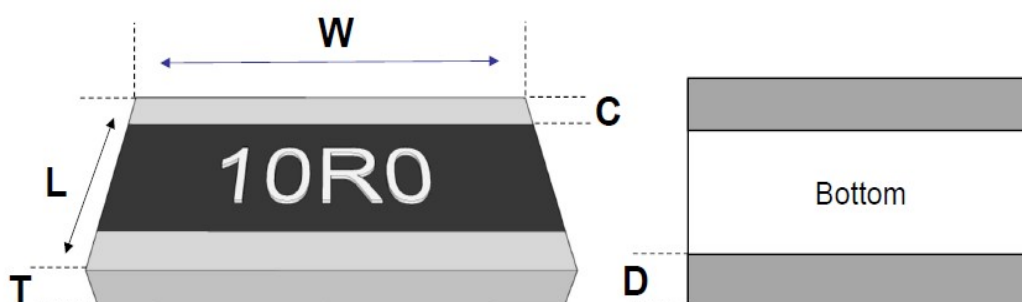


Fig 1. Construction of Chip-R

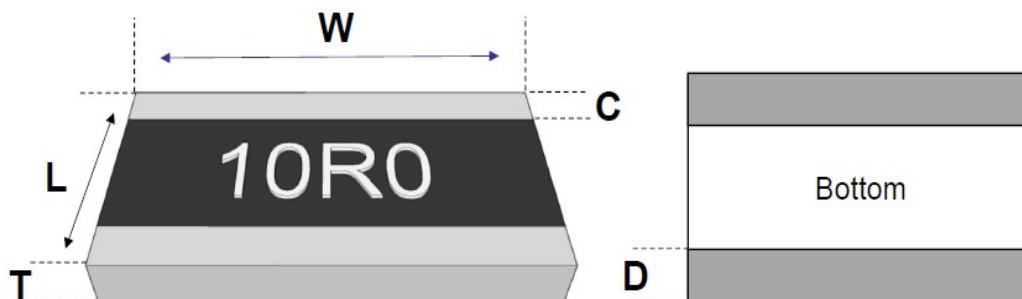
QUICK REFERENCE DATA

Type	Size	Rating at 70°C (W)	Max. Work (V)	Max. Overload (V)	Resistance Tolerance	Temperature Coefficient (ppm/°C)	Resistance		Standard Resistance Values
							Min. (Ω)	Max. (Ω)	
WF25L	1225	2W	200V	400V	±1%(F)	±200	1	4.64	E24/E96
					±1%(F)	±100	4.7	1M	E24/E96
					±5%(J)	±200	1	4.3	E24
					±5%(J)	±100	4.7	1M	E24
WF12L	0612	1W	200V	400V	±1%(F)	±200	1	4.64	E24/E96
					±1%(F)	±100	4.7	1M	E24/E96
					±5%(J)	±200	1	4.3	E24
					±5%(J)	±100	4.7	1M	E24

Note:

- (i) $E = \sqrt{P * R}$ or Max. Working Voltage whichever is lower.
- (ii) E : Working Voltage(V) , P : Rated Power (W) , R : Resistance Value(Ω)
- (iii) Solder-pad and trace size influences should be evaluated, and board surface temperature should keep not exceed 105°C when working

MECHANICAL DATA



Unit : mm

Type	L	W	C	D	T
WF25L	3.10±0.20	6.30±0.20	0.45±0.20	0.75±0.20	0.60±0.15
WF12L	1.60±0.20	3.20±0.20	0.25±0.20	0.40±0.20	0.60±0.15

MARKING

Each resistor is marked with a four-digit code on the protective coating to designate the nominal resistance value

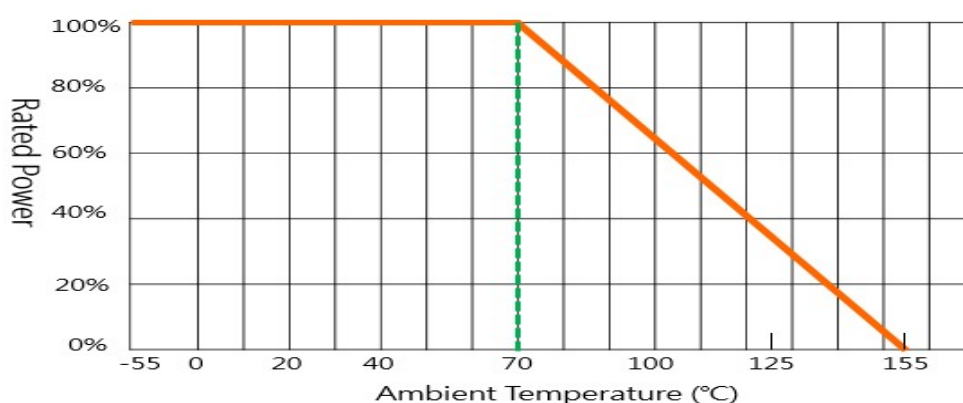
Example : **1000** → $100 \times 10^0 = 100\Omega$

Example : **4R70** → $4.7 \times 10^0 = 4.7\Omega$

FUNCTIONAL DESCRIPTION

Derating curve

The power that the resistor can dissipate depends on the operating temperature.



CATALOGUE NUMBERS

The resistors have a catalogue number starting with

WF12	L	10R0	F	T	L	J
Size code WF25 : 1225 WF12 : 0612	Type code L: wide termination	Resistance code ±5%, E24: 2 significant digits followed by no. of zeros and a blank 220Ω = 221_ (" " means a blank) ±1%, E24+E96: 3 significant digits followed by no. of zeros E24: 102Ω = 1020 E96: 37.4KΩ = 3742	Tolerance J : ±5% F : ±1%	Packaging code T : 7" reeled in tape Q: 10" Reeled taping G: 13" Reeled taping	Termination code L = Sn base (lead free)	Special code J = AEC-Q200 compliant

MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

The end terminations guarantee a reliable contact.

SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 3 seconds. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.

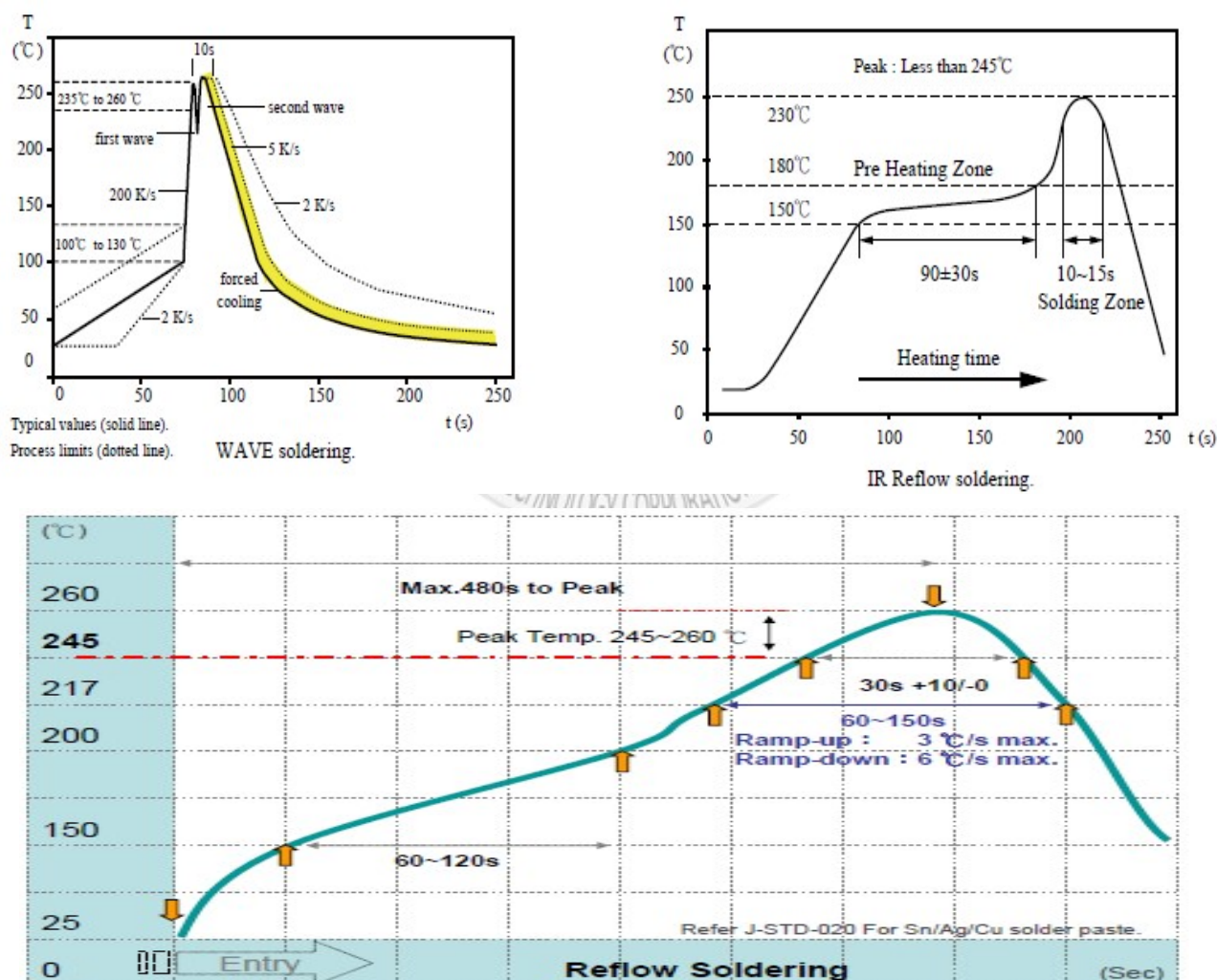


Fig 3. Infrared soldering profile for Chip Resistors

TEST AND REQUIREMENTS (AEC Q200)

Test	Specification	Refer Methods (AEC-Q200. IEC 60115)
DC Resistance	J : $\pm 5\%$ F : $\pm 1\%$	AEC-Q200 TABLE 7.1 IEC 60115-1 / JIS C 5201-1, Clause 4.5 Measure the resistance Value.
High Temperature Exposure (Storage)	J : $\Delta R \leq \pm(3\%+0.1\Omega)$ F : $\Delta R \leq \pm(1\%+0.1\Omega)$	AEC-Q200 TABLE 7.3 1000 hrs. @ T=155°C. Unpowered. Measure at 24 ± 2 hours after test end.
Temperature Cycling	J : $\Delta R \leq \pm(1\%+0.05\Omega)$ F : $\Delta R \leq \pm(0.5\%+0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.4 1000 Cycles (-55°C to +125°C). Measure at 24 ± 2 hours after test end.
Moisture Resistance	J : $\Delta R \leq \pm(1\%+0.05\Omega)$ F : $\Delta R \leq \pm(0.5\%+0.05\Omega)$	AEC-Q200 TABLE 7.6 Test 65°C/80~100%RH/10Cycles. Measure at 24 ± 2 hours after test end. (24hrs/cycle).
Biased Humidity	J : $\Delta R \leq \pm(3\%+0.1\Omega)$ F : $\Delta R \leq \pm(1\%+0.1\Omega)$	AEC-Q200 TABLE 7.7 1000 hours 85°C/85%RH, 10% of operating power. Measure at 24 ± 2 hours after test end.
Operational Life	J : $\Delta R \leq \pm(3\%+0.1\Omega)$ F : $\Delta R \leq \pm(1\%+0.1\Omega)$	AEC-Q200 TABLE 7.8 Test 1000hr @ TA=125°C at specified rated power. Measurement at 24 ± 2 hours after test end.
External Visual	No visual damage and refer marking code.	AEC-Q200 TABLE 7.9 Inspect appearance, marking and workmanship.
Physical Dimension	Within the spec.	AEC-Q200 TABLE 7.10 Verify physical dimensions to the applicable device detail specification.
Mechanical Shock	Within product specification tolerance and no visible damage.	AEC-Q200 TABLE 7.13 Test Peak value: 100g's, Wave: Half-sine, Duration: 6ms, Velocity: 12.3ft/sec.
Vibration	No mechanical damage.	AEC-Q200 TABLE 7.14 5 g's for 20 min., 12 cycles each of 3 orientations. Test from 10-2000 Hz.
Resistance to Solder Heat	J : $\Delta R \leq \pm(1\%+0.05\Omega)$ F : $\Delta R \leq \pm(0.5\%+0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.15 Solder dipping @ 260°C $\pm 5^\circ\text{C}$ for 10sec. ± 1 sec.

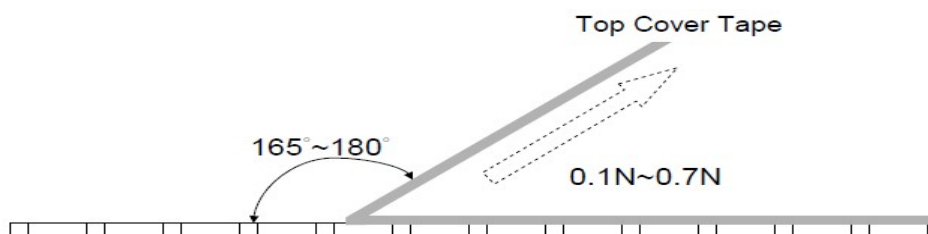
Test	Specification	Refer Methods (AEC-Q200. IEC 60115)
Thermal Shock	J : $\Delta R \leq \pm(1\%+0.05\Omega)$ F : $\Delta R \leq \pm(0.5\%+0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.16 -55 to 155°C, dwell time 15min. Max transfer time 20sec, 300cycles.
ESD	$\Delta R \leq \pm 5\%$ No mechanical damage.	AEC-Q200-002 Test contact min. 2KV.
Solder Ability	Over 95% of termination must be covered with solder.	AEC-Q200 TABLE 7.18 a) Baking 155°C 4H, dipping 235°C 5s b) Steam 1H, dipping 215°C 5s c) Steam 1H, dipping 260°C 7s
Flammability	Refer UL-94.	AEC-Q200 TABLE 7.20 UL-94 V-0 or V-1 are acceptable.
Board Flex	J : $\Delta R \leq \pm(1\%+0.05\Omega)$ F : $\Delta R \leq \pm(0.5\%+0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.21 Bending 2mm.
Terminal Strength	No mechanical damage	AEC-Q200 TABLE 7.22 Force 1.8 Kg for 60 seconds.
Short Time Overload	J : $\Delta R \leq \pm(2\%+0.5m\Omega)$ F : $\Delta R \leq \pm(1\%+0.5m\Omega)$	IEC 60115-1, Clause 4.13 5 × Rated power for 5 seconds
Temperature Coefficient of Resistance	TCR within the spec. (ppm/°C)	IEC 60115-1, Clause 4.8 Test temperature : (T1)25°C ~ (T2)+155°C $TCR(ppm/°C) = (R_2 - R_1) / R_1 \times 1 / (T_2 - T_1) \times 10^6$

PACKAGING

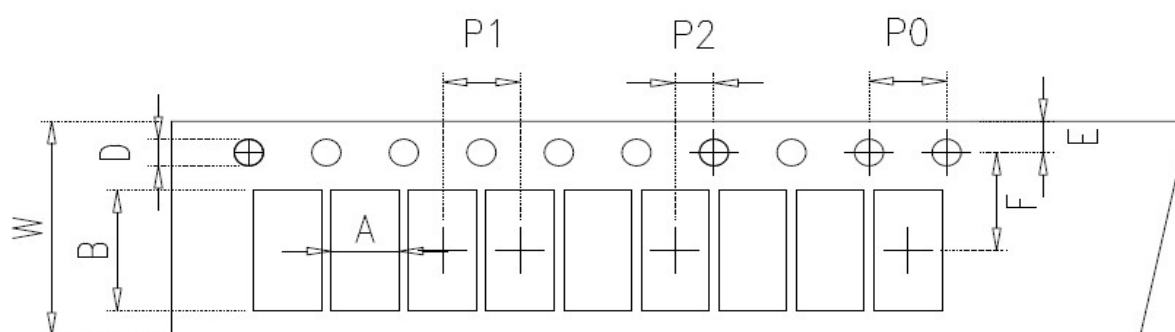
Peel Strength of Top Cover Tape

The peel speed shall be about 300 mm/min

The peel force of top cover tape shall between 0.1 to 0.7N



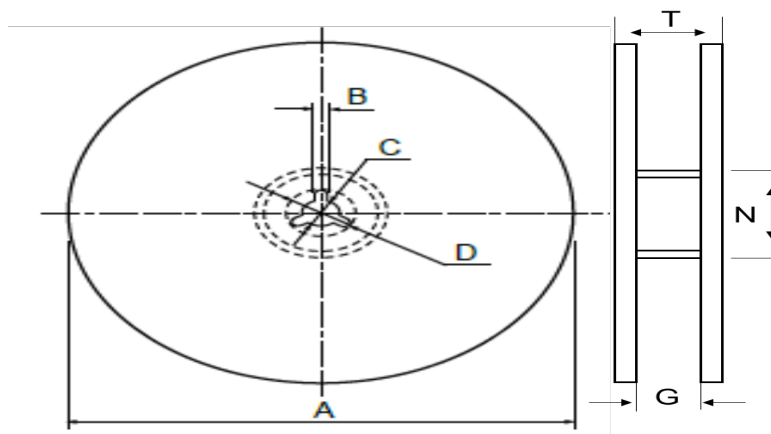
Tape Packaging Dimensions



unit:mm

Size	A	B	W	F	E	P1	P2	P0	D
0612	2.00±0.20	3.60±0.20	8.00±0.30	3.50±0.05	1.75±0.10	4.00±0.10	2.00±0.05	4.00±0.10	1.50+0.10/-0
1225	3.50±0.20	6.70±0.20	12.00±0.30	5.50±0.05	1.75±0.10	4.00±0.10	2.00±0.05	4.00±0.10	1.50+0.10/-0

Reel dimensions



unit:mm

Size	Packaging Q'ty	A	N	C	D	B	G	T
0612	5kpcs/Reel	178.0±2.0	60.0±0.5	13.0±0.5	20(Min.)	2.0±0.5	10.0±1.5	14.9max.
	10kpcs/Reel	254.0±2.0	100.0±1.0	13.5±0.5	20(Min.)	2.0±0.5	10.0±1.5	14.9max.
	20kpcs/Reel	330.0±2.0	100.0±1.0	13.5±0.5	20(Min.)	2.0±0.5	10.0±1.5	14.9max.
1225	4kpcs/Reel	178.0±2.0	60.0±0.5	13.0±0.5	20(Min.)	2.0±0.5	13.8±1.5	16.7max.
	8kpcs/Reel	254.0±2.0	100.0±0.5	13.5±0.5	20(Min.)	2.0±0.5	13.8±1.5	20.0max.
	16kpcs/Reel	330.0±2.0	100.0±1.0	13.5±0.5	20(Min.)	2.0±0.5	13.8±1.5	20.0max.

Storage & Handling

Products are recommended to be used up within one year as ensured shelf life.

Check solder ability in case shelf life extension is needed.

To store products with following condition:

Temperature:5 to 40℃ ; Humidity: 20 to 70% relative humidity.

Precaution for use :

The AEC-Q200 series resistors is mainly used on general automotive equipment without safety considerations. Please contact our company in advanced if you intend to use resistor for designing the equipment which may damage itself and the safety of third party. If necessary, please consider to add the protect circuit in devising process and obtaining fully safety evaluation. The contents of the acknowledgment is only used for our parent company, marketing subsidiaries and official marketing agents who purchase our products. Not applicable for the other nonofficial channels.

※ All product specification and data are subject to change without notice