

APPROVAL SHEET

WF25N, WF20N, WF12N, WF08N, WF06N
±1%, ±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.

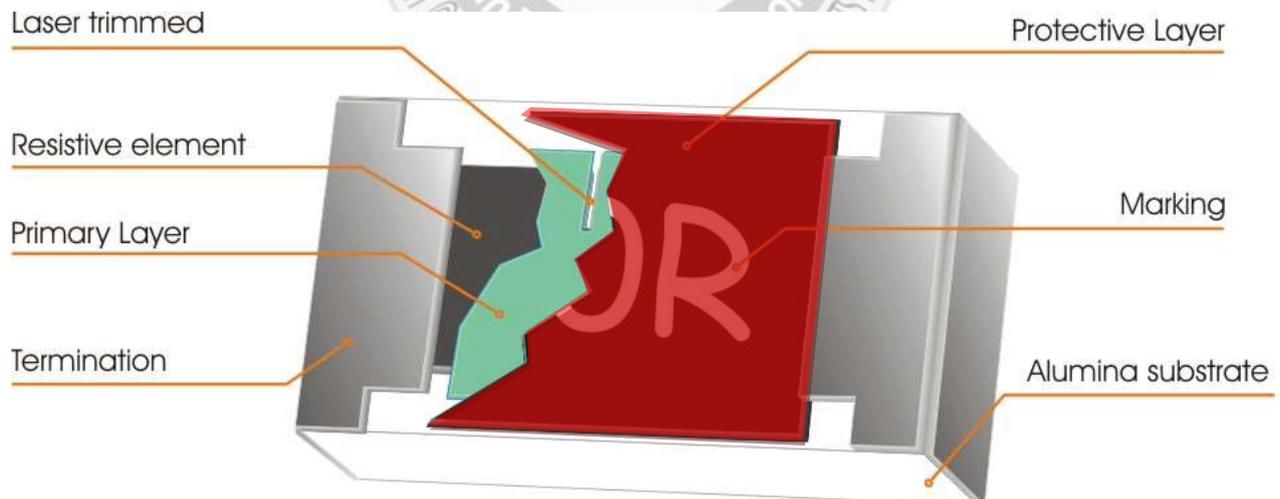


Fig 1. Construction of Chip-R

QUICK REFERENCE DATA

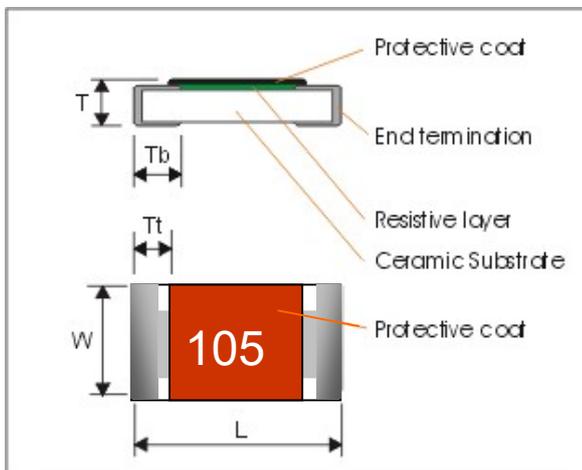
Type	Size	Power Rating at 70°C	Max. RCWV	Max. Overload Voltage	Resistance Tolerance	Temperature Coefficient (ppm/°C)	Resistance Range		Standard Resistance Values
							Min.	Max.	
WF06N	0603	1/10W	200V	400V	±1%(F)	±100	100KΩ	10MΩ	E96/E24
					±5%(J)	±200	100KΩ	22MΩ	E24
WF08N	0805	1/8W	400V	800V	±1%(F)	±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:

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



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

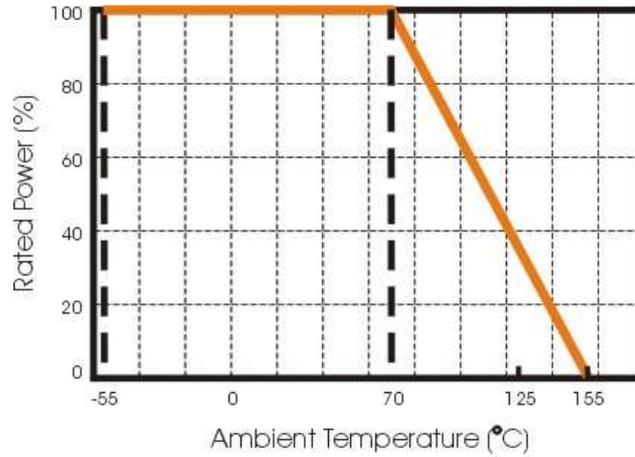


Figure 2 Maximum dissipation in percentage of rated power as a function of the ambient temperature

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.

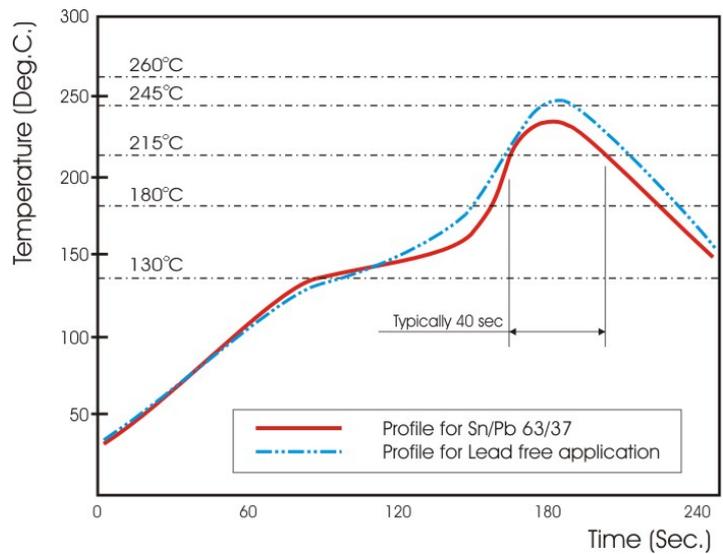


Fig 3. Infrared soldering profile

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 WF20 : 2010 WF12 : 1206 WF08 : 0805 WF06 : 0603	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 0603/0805/1206: paper tape, 5kpcs/reel 2010,2512 : plastic tape, 4kpcs/reel	L = Sn base (lead free)	J = AEC Q200 compliant

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°C ~ -55°C 25°C ~ +155°C TCR(ppm/°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±2°C. Cycle repeated 1000 hours.
*Insulation Resistance	Between termination and coating must over 1000MΩ	IEC 60115-1, Clause 4.6 Test voltage : 100±15V

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.

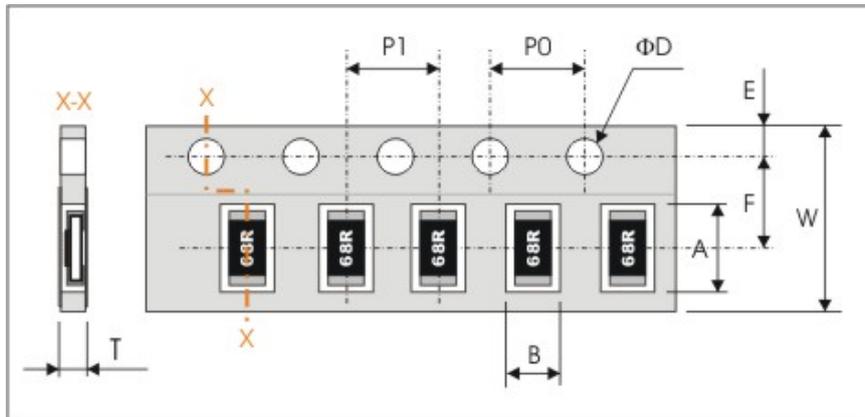
... To store products with following condition:

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



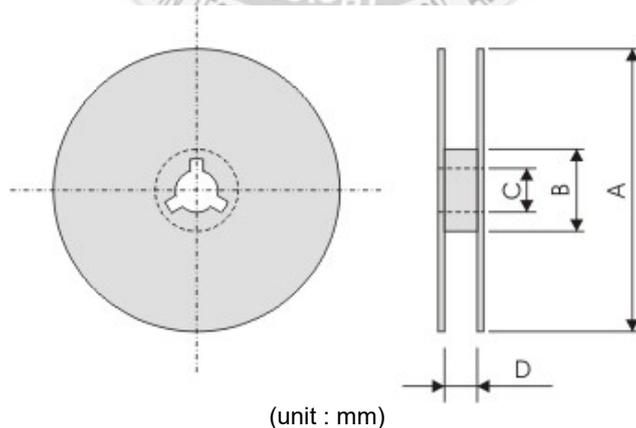
PACKAGING

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



(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									
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.