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SPECIFICATION FOR APPROVAL

DATE :

CUSTOMER :

PART NAME :

Thick Film Automotive Chip Resistors

CUSTOMER'S DWG. NO. :

CUSTOMER'S PART NO. :

PDC PART NO. :

FWF-S SERIES APPROVED

DESCRIPTION. :

RESULT	ACTION	"V"	CUSTOMER'S SIGNATURE	NOTE
FULL APPROVED				
CONDITIONAL APPROVED				
REJECTED				

OUR ACTION	SIGNATURE
PREPARED By	Jenny Tseng
CHECKED By	Tony Chou
APPROVED By	Byron Tsai

CUSTOMER SIGNATURE FOR
ACCEPTANCE

Contents.

Descriptions	Pages
01. Features	2
02. Applications	2
03. Dimension and construction	2
04. Power Derating Curve	2
05. Rating	3
06. Part Number	4
07. Marking / Soldering / Surge	5
08. Reliability Performance	7
09. Packing Information	9
10. Storage / Handling	10
11. Appendix	11



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FWF-S series. (AEC-Q200) Automotive Grade &. Anti-Sulfur Thick-film Lead Free Chip Resistors

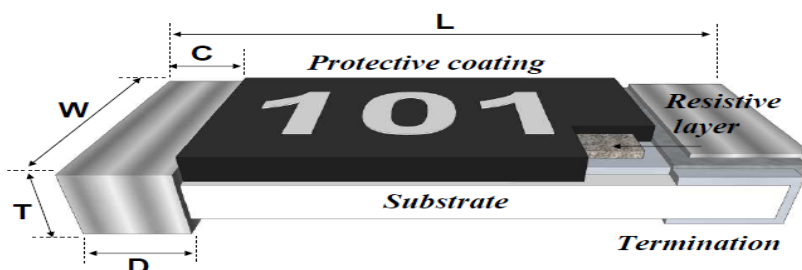
1. Features

- Meet AEC-Q200 test for Automotive industry.
- Suitable for lead free soldering.
- Compatible with wave and reflow soldering.
- Anti-sulfur products and 100% CCD inspection.
- RoHS compliant &. Halogen free.

2. Applications

- Automotive industry.
- Digital meter, Consumer electronics, M/B.
- Motor control, Power supply.

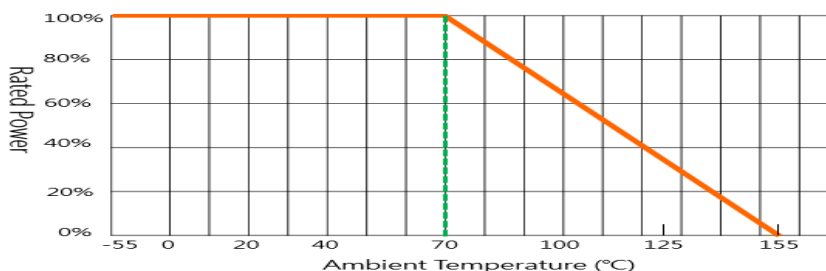
3.Dimension and Construction



Type	Size	L	W	T	C	D	Unit : mm
FWF01	0201	0.60±0.03	0.30±0.03	0.23±0.03	0.10±0.05	0.15±0.05	
FWF02	0402	1.00±0.05	0.50±0.05	0.35±0.05	0.20±0.10	0.25±0.10	
FWF03	0603	1.60±0.10	0.80±0.10	0.45±0.15	0.30±0.10	0.30±0.15	
FWF05	0805	2.00±0.10	1.25±0.10	0.50±0.15	0.40±0.20	0.40±0.20	
FWF06	1206	3.10±0.10	1.60±0.10	0.60±0.15	0.50±0.20	0.45±0.20	
FWF12	1210	3.10±0.10	2.60±0.10	0.55±0.10	0.50±0.20	0.50±0.20	
FWF20	2010	5.00±0.20	2.50±0.20	0.55±0.10	0.65±0.25	0.60±0.25	
FWF25	2512	6.40±0.20	3.20±0.20	0.60±0.10	0.65±0.25	0.90±0.25	

4.Power Derating Curve

Operating Temperature Range: -55 to +155°C



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5.Rating

5.1 General Resistance

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.	
FWF01	0201	1/20W	25V	50V	±1%(F) ±5%(J)	±200	>1MΩ	10MΩ	E-96(F) E-24(J)
						±100	51Ω	1MΩ	
						±200	10	49.9Ω	
						-200~+600	1Ω	9.76Ω	
FWF02	0402	1/10W	50V	100V	±1%(F) ±5%(J)	±200	>1MΩ	10MΩ	E-96(F) E-24(J)
						±100	>10Ω	1MΩ	
						-200~+400	1Ω	10Ω	
FWF03	0603	1/8W	75V	150V	±1%(F) ±5%(J)	±200	>1MΩ	10MΩ	E-96(F) E-24(J)
						±100	>10Ω	1MΩ	
						-200~+400	1Ω	10Ω	
FWF05	0805	1/4W	150V	300V	±1%(F) ±5%(J)	±200	>1MΩ	10MΩ	E-96(F) E-24(J)
						±100	>10Ω	1MΩ	
						-200~+400	1Ω	10Ω	
FWF06	1206	1/4W	200V	400V	±1%(F) ±5%(J)	±200	>1MΩ	10MΩ	E-96(F) E-24(J)
						±100	>10Ω	1MΩ	
						-200~+400	1Ω	10Ω	
FWF12	1210	1/2W	200V	400V	±1%(F) ±5%(J)	±200	>1MΩ	10MΩ	E-96(F) E-24(J)
						±100	>10Ω	1MΩ	
						-200~+400	1Ω	10Ω	
FWF20	2010	3/4W	200V	400V	±1%(F) ±5%(J)	±200	>1MΩ	10MΩ	E-96(F) E-24(J)
						±100	>10Ω	1MΩ	
						±200	1Ω	10Ω	
FWF25	2512	1 W	250V	500V	±1%(F) ±5%(J)	±200	>1MΩ	10MΩ	E-96(F) E-24(J)
						±100	>10Ω	1MΩ	
						±200	1Ω	10Ω	



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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 keep the surface temperature do not exceed 105°C when working.

5.2 0 Ohm, Jumper

Type	Size	Rating @ 70°C	Rated Current	Peak Current	Resistance
FWF01	0201	1/20W	≤ 1A	≤ 2.5A	< 50mΩ
FWF02	0402	1/16W	≤ 1A	≤ 2A	< 50mΩ
FWF03	0603	1/10W	≤ 1A	≤ 3A	< 50mΩ
FWF05	0805	1/8W	≤ 1.5A	≤ 3.5A	< 50mΩ
FWF06	1206	1/4W	≤ 2A	≤ 5A	< 50mΩ
FWF12	1210	1/2W	≤ 3A	≤ 7.5A	< 50mΩ
FWF20	2010	3/4W	≤ 3.2A	≤ 8A	< 50mΩ
FWF25	2512	1W	≤ 4.5A	≤ 11A	< 50mΩ

Notes:

1. Please consider keep the surface temperature do not exceed 105°C when working.

6.Part Number

Type	Size	Tolerance	Packing	Watt	R Value (GM)	TCR	Special Code
FWF	01 :0201 02 :0402 03 :0603 05 :0805 06 :1206 12 :1210 20 :2010 25 :2512	F :±1% J :±5%	Paper Tape : 0402,0603 0805,1206 T : 5Kpcs V : 10Kpcs(0402) U : 15Kpcs(0201) W : 20Kpcs Plastic Tape : 2010,2512 P : 4Kpcs X : 8Kpcs Y : 16Kpcs	As Rating Info	XXXX XXX 5%: 3 digits 1%: 4 digits	As Rating Info	S : Anti-Sulfur ASTM-B809 60°C, 500 hrs



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Example :

FWF05FT-1004-S

→ 0805 size, tolerance 1%, paper tape, 1/8W, 1 MΩ.

FWF25JP-102 -S

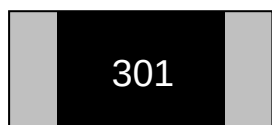
→ 2512 size, tolerance 5%, plastic tape, 1W, 1 KΩ.

7. Marking/Soldering

Resistance value identify :

E24 ±5% : 3 Digits marking to identify the resistance value

0603/0805/1206/1210

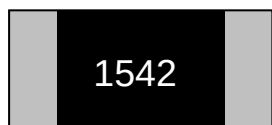


301 → $30 \times 10^1 = 300 \Omega$

E24 ±5% 2010/2512 : 4 Digits marking to identify the resistance value

E24/E96 ±1% : 4 Digits marking to identify the resistance value

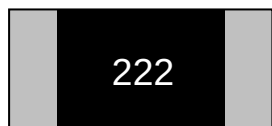
0805/1206/1210/2010/2512



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

E24 ±1% : 3 Digits marking to identify the resistance value

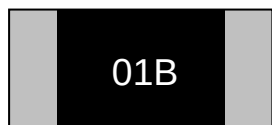
0603



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

E96 ±1% : 3 Digits marking to identify the resistance value

0603



01B → Refer 0603 marking table = 1 KΩ

No marking of 0201/0402 product.



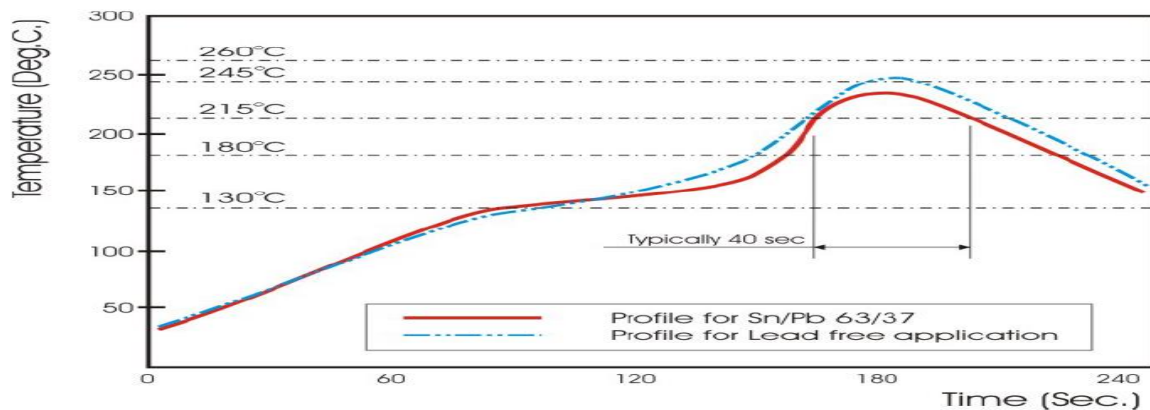
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Soldering Condition

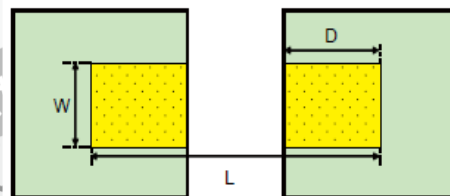
The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs). Surface Mount Resistors are tested for solderability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



Notice. Two times limitations for reflow soldering is highly recommended

Recommend Solder Pad Dimensions :

Type	W	D	L
FWF01 -S	0.30	0.30	0.90
FWF02 -S	0.60	0.50	1.50
FWF03 -S	0.90	0.60	2.10
FWF05 -S	1.30	0.70	2.60
FWF06 -S	1.60	0.90	3.80
FWF12 -S	2.80	0.90	3.80
FWF20 -S	2.80	0.90	5.60
FWF25 -S	3.50	1.60	7.00



Unit. mm

FWF-S series. (AEC-Q200) Automotive Grade &. Anti-Sulfur Thick-film Lead Free Chip Resistors

8. Reliability Performance (AEC-Q200)

Test Item	Specification	Refer Test Method (AEC-Q200. IEC 60115)
DC Resistance	F : $\pm 1\%$; J : $\pm 5\%$	AEC-Q200 TABLE 7.1, IEC 60115-1 Clause 4.5 Measure the resistance Value.
High Temperature Exposure (Storage)	$\Delta R \leq \pm(1\%+0.05\Omega)$ No visible damage.	AEC-Q200 TABLE 7.3 1000 hrs. @ T=155 $\pm$ 3°C. Unpowered. Measurement at 24 $\pm$ 2 hours after test conclusion.
Temperature Cycling	$\Delta R \leq \pm(0.5\%+0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.4 1000 Cycles (-55°C to +155°C). Measurement at 24 $\pm$ 4 hours after test conclusion.
Moisture Resistance	$\Delta R \leq \pm(0.5\%+0.05\Omega)$	AEC-Q200 TABLE 7.6 Test 65 $\pm$ 2°C/80~100%RH/10Cycles. Measurement at 24 $\pm$ 2 hours after test conclusion. (t=24hrs/cycle).
Biased Humidity	$\Delta R \leq \pm(1\%+0.05\Omega)$	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	$\Delta R \leq \pm(1\%+0.05\Omega)$	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 PDC marking code.	AEC-Q200 TABLE 7.9 Inspect construction, marking and appearance.
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, no visible damage.	AEC-Q200 TABLE 7.13 1/2 Sine Pulse / 1500g Peak / Velocity 15.4ft/sec



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FWF-S series. (AEC-Q200) Automotive Grade &. Anti-Sulfur Thick-film Lead Free Chip Resistors

Test Item	Specification	Refer Test Method (AEC-Q200. IEC 60115)
Vibration	$\Delta R \leq \pm(1\% + 0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.14 Test 5g's for 20min, 12 cycles each of 3 orientations.
Resistance to Solder Heat	$\Delta R \leq \pm(0.5\% + 0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.15 Solder dipping @ 270°C±5°C for 10sec.±1sec.
Thermal Shock	$\Delta R \leq \pm(0.5\% + 0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.16 -55 to 155°C/ dwell time 15min/ Max transfer time 20sec/ 300cycles.
ESD	$\Delta R \leq \pm(1\% + 0.05\Omega)$	AEC-Q200-002 Test contact 0201 0.3kV, 0402 0.5kV, 2010/2512 3.0kV, others 1.0kV
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 260°C 7s
Board Flex	$\Delta R \leq \pm(1\% + 0.05\Omega)$ No mechanical damage.	AEC-Q200 TABLE 7.21 Resistors mounted on a 90mm glass epoxy resin PCB(FR4), bending once 2mm for 10sec.
Terminal Strength	No remarkable damage or removal of the terminations	AEC-Q200 TABLE 7.22 Force 1.8 Kg for 60 sec of 2010/2512, others 1 Kg.
Short Time Overload	J : $\Delta R \leq \pm(2\% + 0.05\Omega)$ F : $\Delta R \leq \pm(1\% + 0.05\Omega)$	IEC 60115-1, Clause 4.13 2.5 times RCWV or max. overload voltage, for 5 seconds.
Temperature Coefficient of Resistance	Within the spec.	IEC 60115-1, Clause 4.8 Test temperature : (T ₁) 25°C ~ (T ₂) -55°C/+155°C TCR(ppm/°C) = (R ₂ -R ₁)/R ₁ x 1/(T ₂ -T ₁) x 10 ⁶
Anti-sulfur Test	$\Delta R \leq \pm(2\% + 0.05\Omega)$	ASTM B-809-95 FOS test 60°C, 500hrs.



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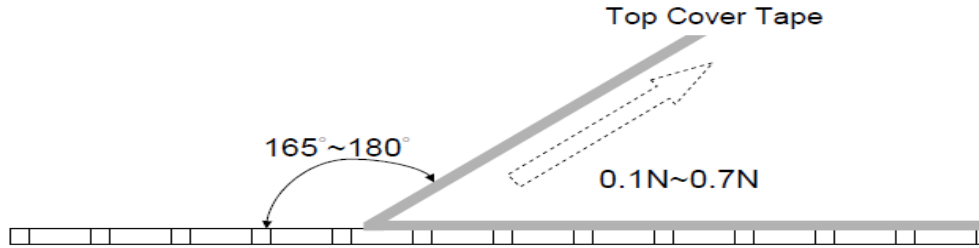


9. PACKAGING

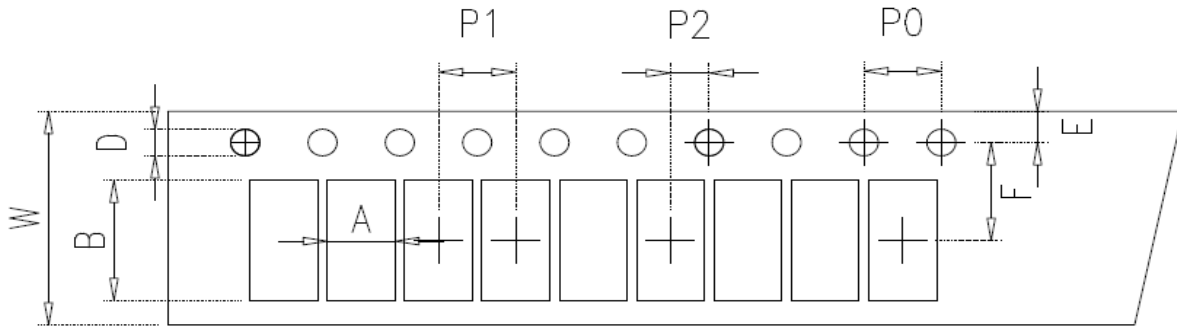
9.1 Peel Strength of Top Cover Tape

The peel speed shall be about 300 mm/min

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



9.2 Tape Packaging Dimensions



unit:mm

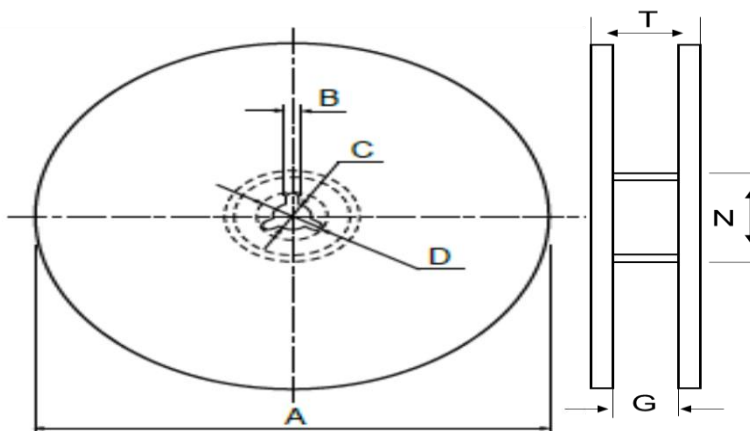
Size	A	B	W	F	E	P1	P2	P0	D
0201	0.37±0.05	0.67±0.05	8.00±0.30	3.50±0.05	1.75±0.10	2.00±0.05	2.00±0.05	4.00±0.10	1.50+0.10/-0
0402	0.70±0.10	1.20±0.10	8.00±0.30	3.50±0.05	1.75±0.10	2.00±0.10	2.00±0.05	4.00±0.10	1.50+0.10/-0
0603	1.10±0.20	1.90±0.20	8.00±0.30	3.50±0.05	1.75±0.10	4.00±0.10	2.00±0.05	4.00±0.10	1.50+0.10/-0
0805	1.65±0.20	2.40±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
1206	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
1210	3.00±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
2010	2.80±0.20	5.50±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
2512	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

unit : mm



FWF-S series. (AEC-Q200) Automotive Grade &. Anti-Sulfur Thick-film Lead Free Chip Resistors

9.3 Reel Dimensions



unit:mm

Size	Packaging Q'ty	A	N	C	D	B	G	T
0201	15kpcs/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.
0402	10kpcs/Reel							
0603	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.
0805	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.
1206	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.
1210								
2010 2512	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.

10. 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 standard AEC-Q200 series resistors are mainly used on general automotive equipment without safety considerations. Please select SAFETY concern type or 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 acknowledgments only used for our parent company, marketing subsidiaries and official marketing agents who purchase our products. Not applicable for the other nonofficial channels.



FWF-S series. (AEC-Q200) Automotive Grade &. Anti-Sulfur Thick-film Lead Free Chip Resistors

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.

