AGTF SERIES
AUTOMOTIVE GRADE THIN FILM RESISTORS

VENKEL LTD.

FEATURES:

- AEC-Q200 certified/qualified
- Advanced thin film technology
- Special materials, design, and processing for high sulfur applications
- Test proven immunity to humidity, moisture, and sulfur

RoHS Compliant | REACH Compliant | HF Halogen FREE | Conflict Minerals FREE 3TG

PART NUMBER STRUCTURE

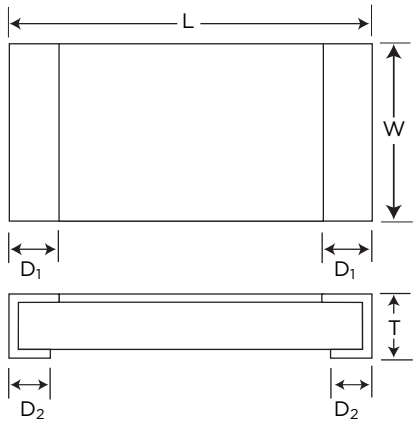
AGTF	1206	-	R	C	-	1001	A	T
Series	**Size**		**Power Rating**	**TCR**		**Resistance Value**	**Resistance Tolerance**	**Packaging**
	0402		P = 1/16W	N = ±10ppm/°C		10R0 = 10Ω	A = ±0.05%	T = Tape & Reel
	0603		Q = 1/10W	Z = ±15ppm/°C		10R2 = 10.2Ω	B = ±0.1%	
	0805		R = 1/8W	E = ±25ppm/°C		1000 = 100Ω	C = ±0.25%	
	1206		T = 1/4W	C = ±50ppm/°C		1001 = 1KΩ	D = ±0.50%	
	1210		Y = 1/3W			1004 = 1MΩ	F = ±1%	
	2010		V = 1/2W					
	2512							

Example P/N: AGTF1206-RC-1001AT

Standard Termination is 100% matte Tin over Nickel.

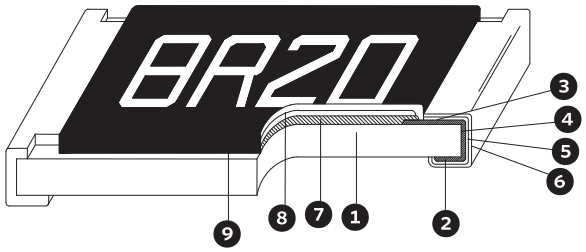
DIMENSIONS

Unit: inches (mm)



SIZE	L	W	T	D1	D2	WEIGHT (g) (1000pcs)
0402	0.040 ± 0.002 (1.00±0.05)	0.020 ± 0.002 (0.50±0.05)	0.012 ± 0.002 (0.30±0.05)	0.008 ± 0.004 (0.20±0.10)	0.008 ± 0.004 (0.20±0.10)	0.54
0603	0.061 ± 0.004 (1.55±0.10)	0.031 ± 0.004 (0.80±0.1)	0.018 ± 0.004 (0.45±0.10)	0.012 ± 0.008 (0.30±0.20)	0.012 ± 0.008 (0.30±0.20)	1.83
0805	0.079 ± 0.006 (2.00±0.15)	0.049± 0.006 (1.25±0.15)	0.022 ± 0.004 (0.55±0.10)	0.012 ± 0.008 (0.30±0.20)	0.016 ± 0.010 (0.40±0.20)	4.71
1206	0.120 ± 0.006 (3.05±0.15)	0.061 ± 0.006 (1.55±0.15)	0.022 ± 0.004 (0.55±0.10)	0.017 ± 0.008 (0.42±0.20)	0.014 ± 0.010 (0.35±0.25)	9.02
1210	0.122 ± 0.006 (3.10±0.15)	0.094 ± 0.006 (2.40±0.15)	0.022 ± 0.004 (0.55±0.10)	0.016 ± 0.010 (0.40±0.20)	0.022 ± 0.010 (0.55±0.25)	10
2010	0.192 ± 0.006 (4.90±0.15)	0.094 ± 0.006 (2.40±0.15)	0.022 ± 0.004 (0.55±0.10)	0.024 ± 0.012 (0.60±0.30)	0.020 ± 0.010 (0.50±0.25)	23.61
2512	0.248 ± 0.006 (6.30±0.15)	0.122 ± 0.006 (3.10±0.15)	0.022 ± 0.004 (0.55±0.10)	0.024 ± 0.012 (0.60±0.30)	0.020 ± 0.010 (0.50±0.25)	38.06

STRUCTURE



1	Alumina Substrate	6	External Electrode
2	Bottom Electrode	7	Resistor Layer
3	Top Electrode	8	Overcoat
4	Edge Electrode	9	Marking
5	Barrier Layer		

ELECTRICAL SPECIFICATION & RANGE

	SIZE	0402	0603		0805	
	Power Rating at 70°C (W)	0.0625W (1/16W)	0.0625W (1/16W)	0.10W (1/10W)	0.10W (1/10W)	0.125W (1/8W)
	Max. Working Voltage	25V	50V	75V	100V	150V
	Max. Overload Voltage	50V	100V	150V	200V	300V
	Operating Temp. Range	-55°C to +155°C	-55°C to +155°C		-55°C to +155°C	
Tol.	TCR	Resistance Range	Resistance Range		Resistance Range	
±0.05% (A)	±10ppm	-	-	10Ω - 49.9KΩ	-	10Ω - 100KΩ
	±15ppm	-	-	10Ω - 49.9KΩ	-	10Ω - 100KΩ
	±25ppm	49.9Ω - 10KΩ	10Ω - 49.9KΩ	10Ω - 49.9KΩ	10Ω - 100KΩ	10Ω - 100KΩ
	±50ppm	49.9Ω - 10KΩ	10Ω - 49.9KΩ	10Ω - 49.9KΩ	10Ω - 100KΩ	10Ω - 100KΩ
±0.1% (B)	±10ppm	-	-	10Ω - 332KΩ	-	10Ω - 511KΩ
	±15ppm	-	-	10Ω - 332KΩ	-	10Ω - 1MΩ
	±25ppm	49.9Ω - 100KΩ	10Ω - 332KΩ	10Ω - 332KΩ	10Ω - 1MΩ	10Ω - 1MΩ
	±50ppm	49.9Ω - 100KΩ	10Ω - 332KΩ	10Ω - 332KΩ	10Ω - 1MΩ	10Ω - 1MΩ
±0.25% (C)	±10ppm	-	-	10Ω - 332KΩ	-	10Ω - 511KΩ
	±15ppm	-	-	10Ω - 332KΩ	-	10Ω - 1MΩ
	±25ppm	49.9Ω - 100KΩ	10Ω - 332KΩ	10Ω - 332KΩ	10Ω - 1MΩ	10Ω - 1MΩ
	±50ppm	49.9Ω - 100KΩ	10Ω - 332KΩ	10Ω - 332KΩ	10Ω - 1MΩ	10Ω - 1MΩ
±0.5% (D)	±10ppm	-	-	10Ω - 332KΩ	-	10Ω - 511KΩ
	±15ppm	-	-	10Ω - 332KΩ	-	10Ω - 1MΩ
	±25ppm	49.9Ω - 100KΩ	10Ω - 332KΩ	10Ω - 332KΩ	10Ω - 1MΩ	10Ω - 1MΩ
	±50ppm	49.9Ω - 100KΩ	10Ω - 332KΩ	10Ω - 332KΩ	10Ω - 1MΩ	10Ω - 1MΩ
±1% (F)	±10ppm	-	-	10Ω - 332KΩ	-	10Ω - 511KΩ
	±15ppm	-	-	10Ω - 332KΩ	-	10Ω - 1MΩ
	±25ppm	49.9Ω - 100KΩ	10Ω - 332KΩ	10Ω - 332KΩ	10Ω - 1MΩ	10Ω - 1MΩ
	±50ppm	49.9Ω - 100KΩ	10Ω - 332KΩ	10Ω - 332KΩ	10Ω - 1MΩ	10Ω - 1MΩ

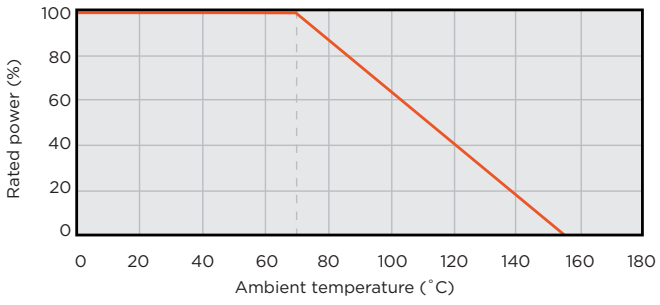
NOTE: Operating Voltage = $(P*R)^{1/2}$ or Max. overload voltage listed above, whichever is lower.
Overload Voltage = $2.5*(P*R)^{1/2}$ or Max. overload voltage listed above, whichever is lower.

ELECTRICAL SPECIFICATION & RANGE

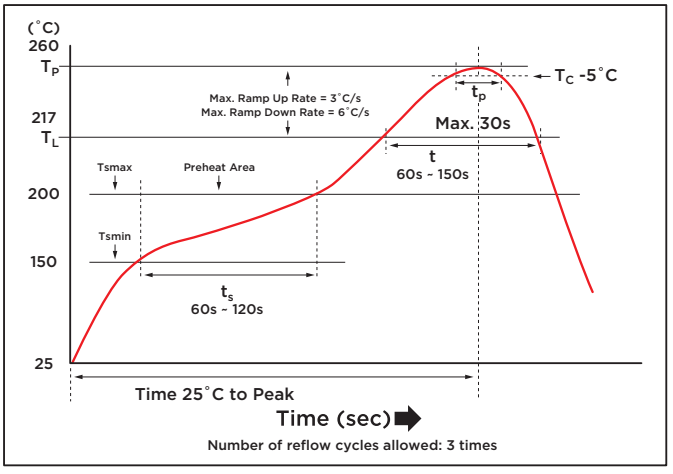
	SIZE	1206		1210		2010		2512
	Power Rating at 70°C (W)	0.125W (1/8W)	0.25W (1/4W)	0.25W (1/4W)	0.33W (1/3W)	0.25W (1/4W)	0.33W (1/3W)	0.50W (1/2W)
	Max. Working Voltage	150V	200V	150V	200V	150V	200V	150V
	Max. Overload Voltage	300V	400V	300V	400V	300V	400V	300V
	Operating Temp. Range	-55°C to +155°C		-55°C to +155°C		-55°C to +155°C		-55°C to +155°C
Tol.	TCR	Resistance Range		Resistance Range		Resistance Range		Resistance Range
±0.05% (A)	±10ppm	-	10Ω - 200KΩ	-	10Ω - 499KΩ	-	10Ω - 499KΩ	-
	±15ppm	-	10Ω - 200KΩ	-	10Ω - 499KΩ	-	10Ω - 499KΩ	-
	±25ppm	10Ω - 200KΩ	10Ω - 200KΩ	10Ω - 499KΩ	10Ω - 499KΩ	10Ω - 499KΩ	10Ω - 499KΩ	10Ω - 499KΩ
	±50ppm	10Ω - 200KΩ	10Ω - 200KΩ	10Ω - 499KΩ	10Ω - 499KΩ	10Ω - 499KΩ	10Ω - 499KΩ	10Ω - 499KΩ
±0.1% (B)	±10ppm	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-
	±15ppm	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-
	±25ppm	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ
	±50ppm	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ
±0.25% (C)	±10ppm	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-
	±15ppm	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-
	±25ppm	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ
	±50ppm	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ
±0.5% (D)	±10ppm	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-
	±15ppm	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-
	±25ppm	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ
	±50ppm	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ
±1% (F)	±10ppm	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-
	±15ppm	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-	10Ω - 1MΩ	-
	±25ppm	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ
	±50ppm	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ	10Ω - 1MΩ

NOTE: **Operating Voltage** = $(P*R)^{1/2}$ or Max. overload voltage listed above, whichever is lower.
Overload Voltage = $2.5*(P*R)^{1/2}$ or Max. overload voltage listed above, whichever is lower.

DERATING CURVE



SOLDERING CONDITION



MARKING

0603: 3 Digit Marking
Example:
14C=13K7Ω
13C=13K3Ω
68B=4.99KΩ
68X=49.9Ω

0603 3digit marking for E24 **Example: 101=100Ω 102=1KΩ**

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

0805 ~ 2512: 4 Digit Marking **Example:**

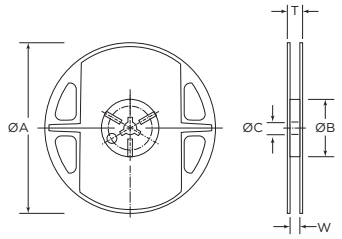
RESISTANCE	100Ω	2.2KΩ	10KΩ	49.9KΩ	100KΩ
MARKING	1000	2201	1002	4992	1003

MARKING TABLE

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

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

REEL SPECIFICATIONS



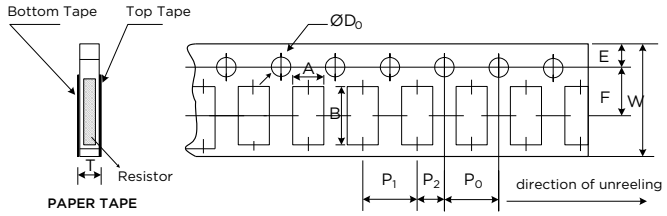
Minimum of 30 empty pockets at the beginning of reel, 65 minimum empty pockets at the end.

Unit: mm

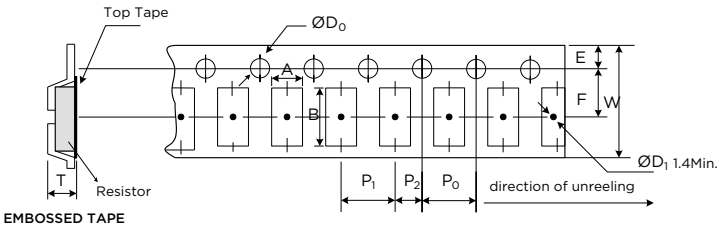
TYPE	Ø A	ØB	ØC	W	T	PAPER TAPE (EA)	EMBOSSED PLASTIC TAPE (EA)
0402	178.0±1.0	60.0+1.0	13.5±0.7	9.5±1.0	11.5±1.0	10,000	-
0603	178.0±1.0	60.0+1.0	13.5±0.7	9.5±1.0	11.5±1.0	5,000	-
0805	178.0±1.0	60.0+1.0	13.5±0.7	9.5±1.0	11.5±1.0	5,000	-
1206	178.0±1.0	60.0+1.0	13.5±0.7	9.5±1.0	11.5±1.0	5,000	-
1210	178.0±1.0	60.0±1.0	13.5±0.7	9.5±1.0	11.5±1.0	5,000	-
2010	178.0±1.0	60.0+1.0	13.5±0.7	13.5±1.0	15.5±1.0	-	4,000
2512	178.0±1.0	60.0+1.0	13.5±0.7	13.5±1.0	15.5±1.0	-	4,000

TAPE SPECIFICATIONS

Units: mm.



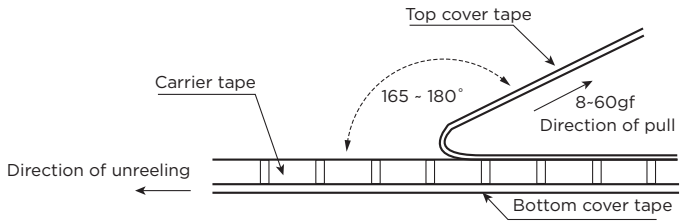
PAPER TAPE



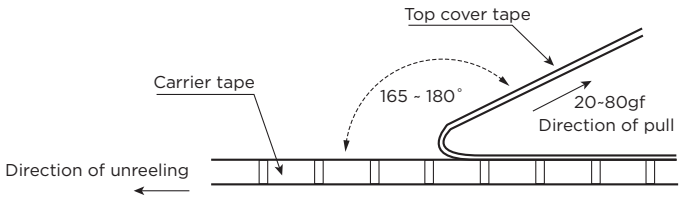
EMBOSSED TAPE

TAPE	SIZE (inches)	A	B	W	E	F	P_0	P_1	P_2	$ØD_0$	T
Paper	0402	0.70±0.05	1.16±0.05	8.00±0.10	1.75±0.05	3.5±0.05	4.00±0.10	2.00±0.05	2.00±0.05	1.55±0.05	0.40±0.03
	0603	1.10±0.05	1.90±0.05	8.00±0.10	1.75±0.05	3.5±0.05	4.00±0.10	4.00±0.10	2.00±0.05	1.55±0.05	0.60±0.03
	0805	1.60±0.05	2.37±0.05	8.00±0.10	1.75±0.05	3.5±0.05	4.00±0.10	4.00±0.10	2.00±0.05	1.55±0.05	0.75±0.05
	1206	2.00±0.05	3.55±0.05	8.00±0.10	1.75±0.05	3.5±0.05	4.00±0.10	4.00±0.10	2.00±0.05	1.55±0.05	0.75±0.05
	1210	2.75±0.05	3.40±0.05	8.00±0.10	1.75±0.05	3.5±0.05	4.00±0.05	4.00±0.10	2.00±0.05	1.60±0.10	0.75±0.05
Embossed	2010	2.85±0.10	5.45±0.10	12.0±0.10	1.75±0.10	5.5±0.05	4.00±0.05	4.00±0.10	2.00±0.05	1.50+0.10	1.00±0.20
	2512	3.40±0.10	6.65±0.10	12.0±0.10	1.75±0.10	5.5±0.05	4.00±0.05	4.00±0.10	2.00±0.05	1.50+0.10	1.00±0.20

PEEL BACK FORCE AND DIRECTION DIAGRAM

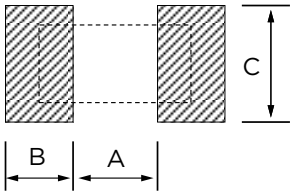


PAPER TAPE
- Peel force of top cover tape
- The peel speed shall be about 300mm/min ± 5%
- The peel force of top cover tape shall be between 8gf to 60gf



EMBOSSED TAPE
- Peel force of top cover tape
- The peel speed shall be about 300mm/min ± 5%
- The peel force of top cover tape shall be between 20gf to 80gf

RECOMMENDED LAND PATTERN



Units: mm.

TYPE	A	B	C
0402	0.50	0.50	0.60±0.2
0603	0.80	1.00	0.90±0.2
0805	1.00	1.00	1.35±0.2
1206	2.00	1.15	1.70±0.2

TYPE	A	B	C
1210	2.00	1.15	2.50±0.2
2010	3.60	1.40	2.50±0.2
2512	4.90	1.60	3.10±0.2

ENVIRONMENTAL CHARACTERISTICS

TEST	REQUIREMENT		TEST METHOD
	Tol. ≤0.05%	Tol. >0.05%	
Temperature Coefficient of Resistance (T.C.R.)	As Spec.		**JIS-C-5201-1 4.8** **IEC-60115-1 4.8** -55˚C~+125˚C, 25˚C is the reference temperature
Short Time Overload	ΔR±0.05%		**JIS-C-5201-1 4.13** RCWV*2.5 or Max. Overload Voltage whichever is lower for 5 seconds
Insulation Resistance	>1000MΩ		**JIS-C-5201-1 4.6** **IEC-60115-1 4.6** Apply 100V_{DC} for 1 minute
Operational Life	ΔR±0.05%	ΔR±0.02%	**MIL-STD-202 Method 108** Condition D Steady State T_A=125˚C at derated power. Measurement at 24±4 hours after test conclusion.
	>7kΩ→ ΔR±0.05%		
	ΔR±0.05% for high power rating		
Biased Humidity	ΔR±0.1%		**MIL-STD-202 Method 103** 1000 hrs 85˚C/85%RH 10% of operating power.
High Temperature Exposure	ΔR±0.02%		**MIL-STD-202 Method 108** at +155°C for 1000 hrs
Temperature Cycling	ΔR±0.01%		**JESD22 Method JA-104** -55˚C to +125˚C, 1000 cycles
Bending Strength (Board Flex)	ΔR±0.1%		**JIS-C-5201-1 4.33** Bending once for 60 seconds **Bending displacement:** 2010 2512 sizes: 2 mm Other sizes: 3 mm
Solderability	95% min. coverage		**JIS-C-5201-1 4.17** **IEC-60115-1 4.17** 245±5°C for 3 seconds
Resistance to Soldering Heat	ΔR±0.05%		**JIS-C-5201-1 4.18** **IEC-60115-1 4.18** 260±5°C for 10 seconds
Teminal Strength	No breakages		**AEC-Q200-006** Force of 1.8kg for 60 seconds.
Mechanical Shock	ΔR±0.05%	ΔR±0.1%	**MIL-STD-202 Method 213** **Wave Form:** Tolerance for half sine shock pulse. Peak value is 100g's. Normal duration (D) is 6.
Vibration	ΔR±0.05%	ΔR±0.1%	**MIL-STD-202 Method 204** 5 g's for 20 min., 12 cycles each of 3 orientations, 10-2000 Hz
ESD	ΔR±0.5%		**AEC-Q200-002** Human body model 0402 / 0603: 0.2KV 0805 / 1206: 1KV 2010 / 2512 / AR13: 2KV
Resistance to solvents	Marking unsmeared		**MIL-STD-202 Method 215** Add Aqueous wash chemical - OKEM Clean or equivalent. Do not use banned solvents.
Sulfur Test	ΔR±1%		**ASTM-B-809-95 Modified** 105±2 °C no power rating for 750 hrs.
Flammability	No ignition of the tissue paper or scorching of the pinewood board		**UL-94** V-0 or V-1 are acceptable. Electrical test not required.

RCWV (Rated continuous working voltage) = √(P*R) or Max operating voltage whichever is lower
Storage Temperature: 15-28˚C; **Humidity** < 80%RH
Shelf Life: 2 years from production date.