

Electronic component

电子元器件

Valley Tang



Component Family

元器件族系

Electronic component 电子元件

Passive component 被动元件

Active component 主动元件

Electromagnetic component 电磁元件

Electromechanical component 机电元件

Electro-optic component 光电元件

Printed board 印制电路板

Wire and cable 线材

Passive Component Sub-family

被动元件子族系

- Passive Component Sub-family
被动元件子族系
 - Resistor电阻器
 - Capacitor电容器
 - Inductor电感器（在电磁元件里介绍）
 - Resonator谐振器
 - Crystal & Ceramic Filter晶体/陶瓷滤波器

Passive Components Sub-family

被动元件子族系

Passive Component 被动元件

Resistor 电阻器

Capacitor 电容器

Resonator 谐振器

Crystal & Ceramic Filter 晶体/陶瓷滤波器

Resistor group 电阻器分类

- Resistor 电阻器
- Resistor basic knowledge 电阻器基础知识
 - 在电路中具有电阻性能的实体元件称之为电阻器 (Resistor)
 - 电阻值的符号为R
 - 基本单位为欧姆或简称欧，以希腊字母 Ω /Ohm (Omega) 表示
 - 单位换算： $10E-3$ ($m\Omega$ /毫欧) = 1 (Ω /欧)
= $10E+3$ ($k\Omega$ /千欧) = $10E+6$ ($M\Omega$ /兆欧)

Resistor group 电阻器分类

- Resistor group 电阻器分类
 - Fixed resistor 固定电阻器
 - Trimmed resistor 可调/变电阻器
 - Nonlinear resistor/Sensitive resistor 非线性电阻器/
敏感电阻器

Resistor group 电阻器分类

Fixed resistor 固定电阻器

- Fixed resistor 固定电阻器
- Definition by material construction 根据材料构造可分为
 - Thin film resistor 薄膜电阻器
 - Thick film resistor 厚膜电阻器
 - Wound wire resistor 绕线电阻器
 - Composition resistor 实芯电阻器
 - Network resistor/Array resistor 网络电阻器/排阻

Resistor group 电阻器分类

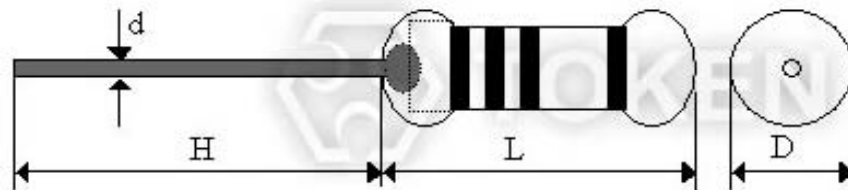
Fixed resistor 固定电阻器

- Thin film resistor 薄膜电阻器
 - 薄膜是在真空中采用蒸发和溅射等工艺将电阻性材料淀积在绝缘基体工艺（真空镀膜技术）制成。
 - Carbon film resistor 碳膜电阻器
 - Metal film resistor 金属膜电阻器
 - Metal oxide film resistor 金属氧化膜电阻器
 - MELF resistor 晶圆电阻器
 - Chip resistor 晶片电阻器

Resistor group 电阻器分类

Fixed resistor 固定电阻器

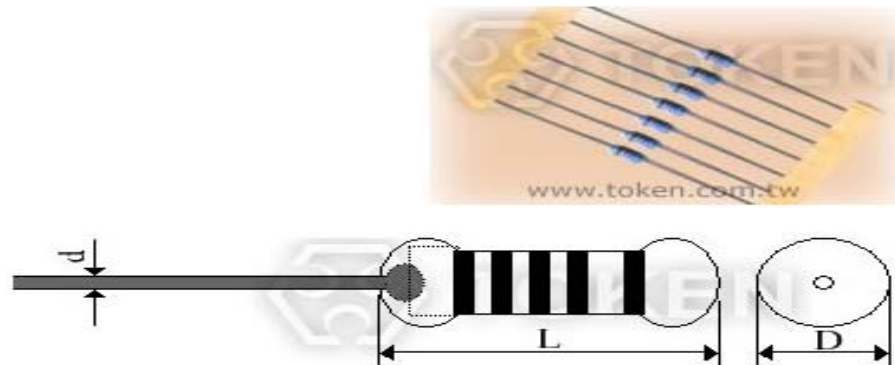
- Carbon film resistor 碳膜电阻器
 - 它是采用高温真空镀膜技术将碳紧密附在瓷棒表面形成碳膜，然后加适当接头切割，并在其表面涂上环氧树脂密封保护而成的。



Resistor group 电阻器分类

Fixed resistor 固定电阻器

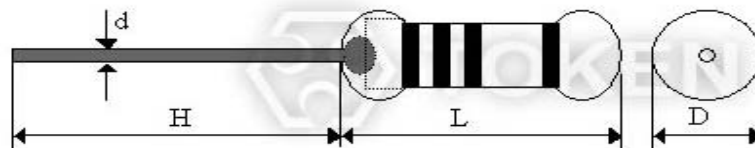
- Metal film resistor 金属膜电阻器
 - 它是采用高温真空镀膜技术将镍铬或类似的合金紧密附在瓷棒表面形成皮膜，经过切割调试阻值，以达到最终要求的精密阻值，然后加适当接头切割，并在其表面涂上环氧树脂密封保护而成的。



Resistor group 电阻器分类

Fixed resistor 固定电阻器

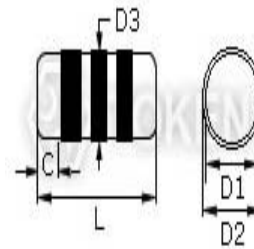
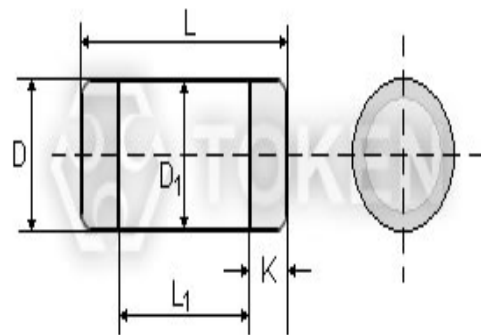
- Metal oxide film resistor 金属氧化膜电阻器
 - 它是采用高温真空镀膜技术将金属氧化物紧密附在瓷棒表面形成碳膜，然后加适当接头切割，并在其表面涂上环氧树脂密封保护而成的。



Resistor group 电阻器分类

Fixed resistor 固定电阻器

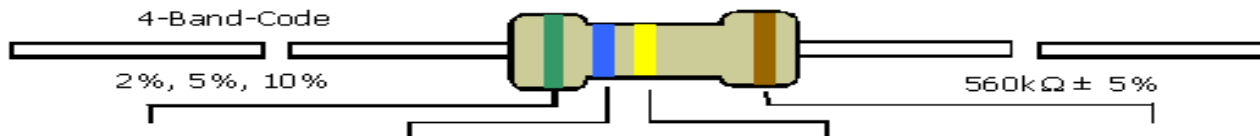
- MELF resistor 晶圆电阻器
 - 碳膜、金属膜、金属氧化膜电阻器的无引线封装形式。



Resistor group 电阻器分类

Fixed resistor 固定电阻器

- Resistor color code guide 电阻器色环码识别



COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE
Black	0	0	0	1Ω	
Brown	1	1	1	10Ω	± 1% (F)
Red	2	2	2	100Ω	± 2% (G)
Orange	3	3	3	1KΩ	
Yellow	4	4	4	10KΩ	
Green	5	5	5	100KΩ	± 0.5% (D)
Blue	6	6	6	1MΩ	± 0.25% (C)
Violet	7	7	7	10MΩ	± 0.10% (B)
Grey	8	8	8		± 0.05%
White	9	9	9		
Gold				0.1	± 5% (J)
Silver				0.01	± 10% (K)



Resistor group 电阻器分类

Fixed resistor 固定电阻器

- Thick film resistor 厚膜电阻器
 - 厚膜是采用丝网印刷将电阻性材料淀积在绝缘基体（例如玻璃或氧化铝陶瓷）上，然后烧结形成。
 - Metal glaze film resistor 金属玻璃釉膜电阻器
 - Chip resistor 晶片电阻器

Resistor group 电阻器分类

Fixed resistor 固定电阻器

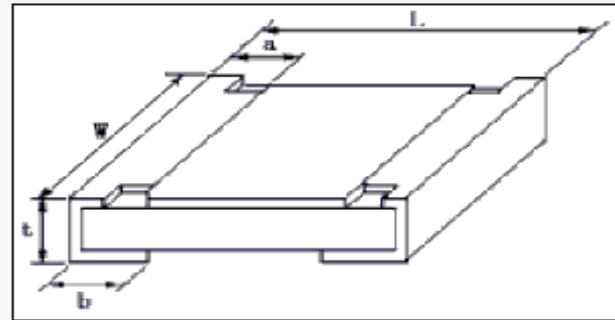
- Metal glaze film resistor 金属玻璃釉膜电阻器
 - 将金属粉和玻璃釉粉混合，采用丝网印刷法印在基板上。



Resistor group 电阻器分类

Fixed resistor 固定电阻器

- Chip resistor 晶片电阻器
 - Thick film chip resistor 薄膜晶片电阻器
 - Thin film chip resistor 厚膜晶片电阻器

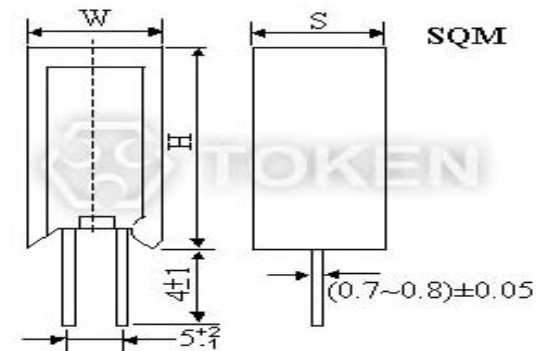
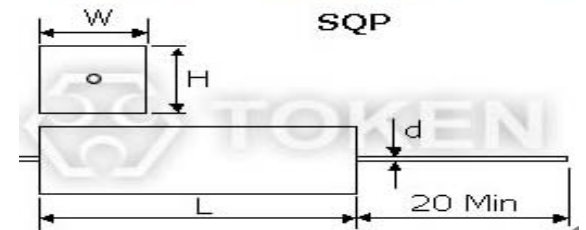
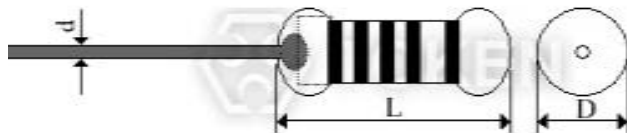


英制 (mil)	公制 (mm)	长(L) (mm)	宽(W) (mm)	高(t) (mm)	a (mm)	b (mm)
0201	0603	0.60±0.05	0.30±0.05	0.23±0.05	0.10±0.05	0.15±0.05
0402	1005	1.00±0.10	0.50±0.10	0.30±0.10	0.20±0.10	0.25±0.10
0603	1608	1.60±0.15	0.80±0.15	0.40±0.10	0.30±0.20	0.30±0.20
0805	2012	2.00±0.20	1.25±0.15	0.50±0.10	0.40±0.20	0.40±0.20
1206	3216	3.20±0.20	1.60±0.15	0.55±0.10	0.50±0.20	0.50±0.20
1210	3225	3.20±0.20	2.50±0.20	0.55±0.10	0.50±0.20	0.50±0.20
1812	4832	4.50±0.20	3.20±0.20	0.55±0.10	0.50±0.20	0.50±0.20
2010	5025	5.00±0.20	2.50±0.20	0.55±0.10	0.60±0.20	0.60±0.20
2512	6432	6.40±0.20	3.20±0.20	0.55±0.10	0.60±0.20	0.60±0.20

Resistor group 电阻器分类

Fixed resistor 固定电阻器

- Wound wire resistor 绕线电阻器
 - 用高阻合金线绕在绝缘骨架上制成，外面涂有耐热的釉绝缘层或绝缘漆。

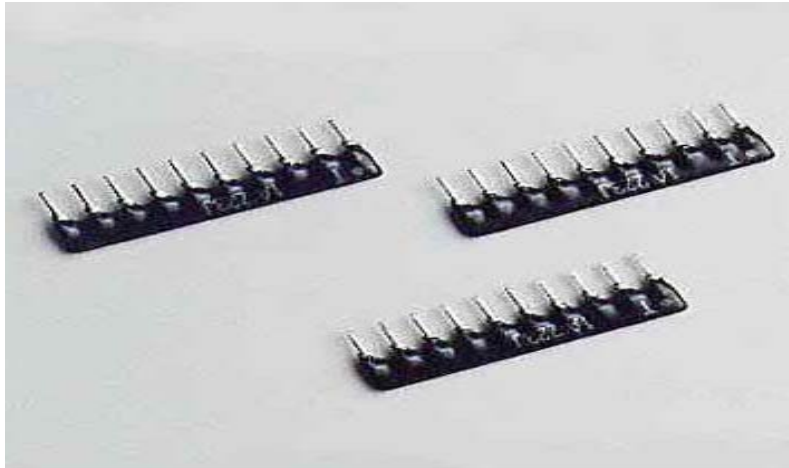


Resistor group 电阻器分类

Fixed resistor 固定电阻器

- Network resistor/Array resistor
网络电阻器/排阻

- THT
- SMT



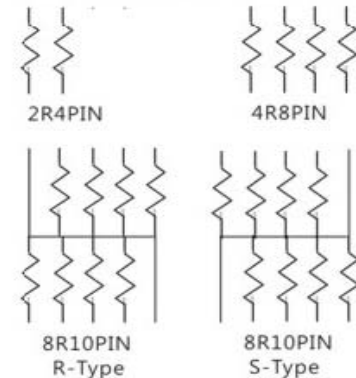
Chip Resistor Array - RA Series

规格型号:
022R (0402) 2R4P
024R (0402) 4R8P
028R (0402) 8R10P
032R (0603) 2R4P
034R (0603) 4R8P
034C (0603) 4R8P
064R (1206) 4R8P
阻值范围:
10R - 1M ohm
误差范围
Tolerance: +/-2, +/-5%

#Picture-CR-RA-003



Chip Array Network Resistor



Resistor group 电阻器分类

Fixed resistor 固定电阻器

- Preferred number series for resistors and capacitors 电阻器和电容器优先数系
 - E系列
 - E系列也是一种由几何级数构成的数列。E系列首先在英国的电工工业中应用，故采用Electricity的第一个字母E标志这一系列，
 - 它是以 $6\sqrt{10}$ 、 $12\sqrt{10}$ 、 $24\sqrt{10}$ 、 $96\sqrt{10}$ 为公比的几何级数，分别称为E6系列、E12系列、E24系列和E96系列。
 - E6系列适用于允差±20%的数值
 - E12系列适用于允差±10%的数值
 - E24系列适用于允差±5%的数值
 - E96系列适用于允差±1%的数值

Series	Common ratio	Remarks
E6	$6\sqrt{10} \approx 1.46$	Rounded off to a 2-digit figure.
E12	$12\sqrt{10} \approx 1.21$	
E24	$24\sqrt{10} \approx 1.10$	
E96	$96\sqrt{10} \approx 1.02$	Rounded off to a 3-digit figure.

Resistor group 电阻器分类

Fixed resistor 固定电阻器

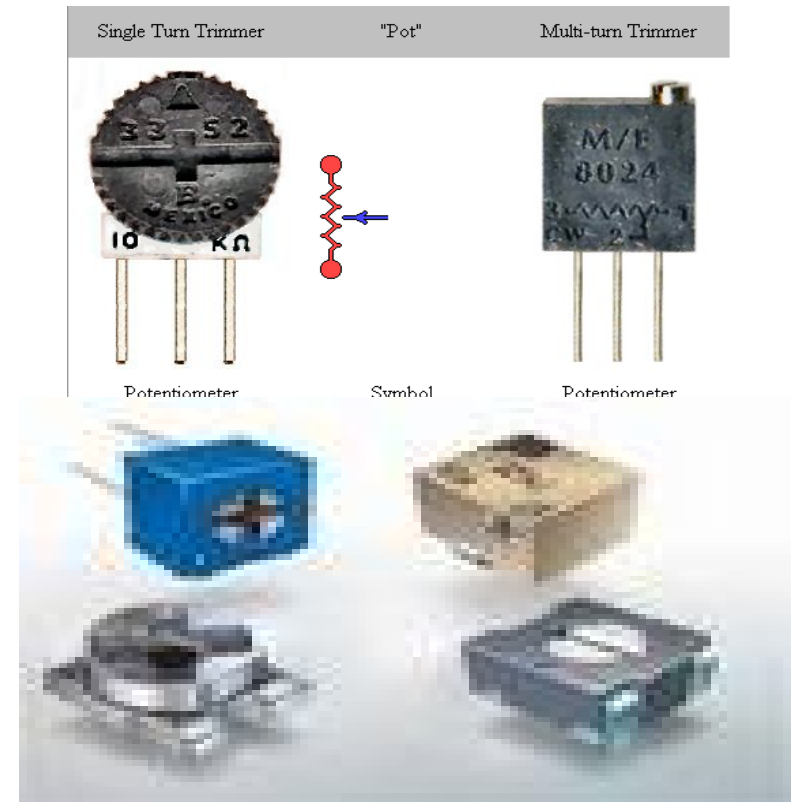
- Preferred number series 优先数系

E3	10				22				47			
E6	10		15		22		33		47		68	
E12	10	12	15	18	22	27	33	39	47	56	68	82
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
E96	100	102	105	107	110	113	115	118	121	124	127	130
	133	137	140	143	147	150	154	158	162	165	169	174
	178	182	187	191	196	200	205	210	215	221	226	232
	237	243	249	255	261	267	274	280	287	294	301	309
	316	324	332	340	348	357	365	374	383	392	402	412
	422	432	442	453	464	475	487	499	511	523	536	549
	562	576	590	604	619	634	649	665	681	698	715	732
	750	768	787	806	825	845	866	887	909	931	953	976

Resistor group 电阻器分类

Trimmed resistor 可调电阻器

- Trimmed resistor 可调电阻器
 - Single turn 单圈
 - Multi-turn 多圈



Resistor group 电阻器分类

Non-linear resistor 非线性电阻器

- Non-linear resistor 非线性电阻器
- Also named sensitive resistor 也即敏感电阻器
- 它是传感器中的一种。
 - 敏感电阻器是指元件特性对温度,电压,湿度,光照,气体,磁场,压力等作用敏感的电阻器。
 - Variable resistor/Varistor 压敏电阻器
 - Thermal resistor/Thermistor 热敏电阻器
 - 还有湿敏电阻器、光敏电阻器、气敏电阻器、力敏电阻器

Resistor group 电阻器分类

Non-linear resistor 非线性电阻器

- Varistor 压敏电阻器

- 压敏电阻器 (Varistor) 是由 **variable resistors** 两字合并而来, 所以也称其为可变电阻器。它是一种因外加电压的改变而呈现非线性电阻变化的电阻器, 具有双向、对称的 V/I 特性。
- 金属氧化物压敏电阻器简称为 **MOV**, 是一种以氧化锌为主体, 添加多种金属氧化物, 经典型的电子陶瓷工艺制成的多晶半导体陶瓷元件。
- 多层片式压敏电阻器 (MLV) 是一种浪涌电压抑制器。它是采用先进的叠层片式化技术制造的半导体陶瓷元件。

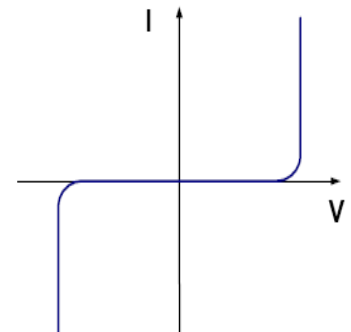


Resistor group 电阻器分类

Non-linear resistor 非线性电阻器

● 特性

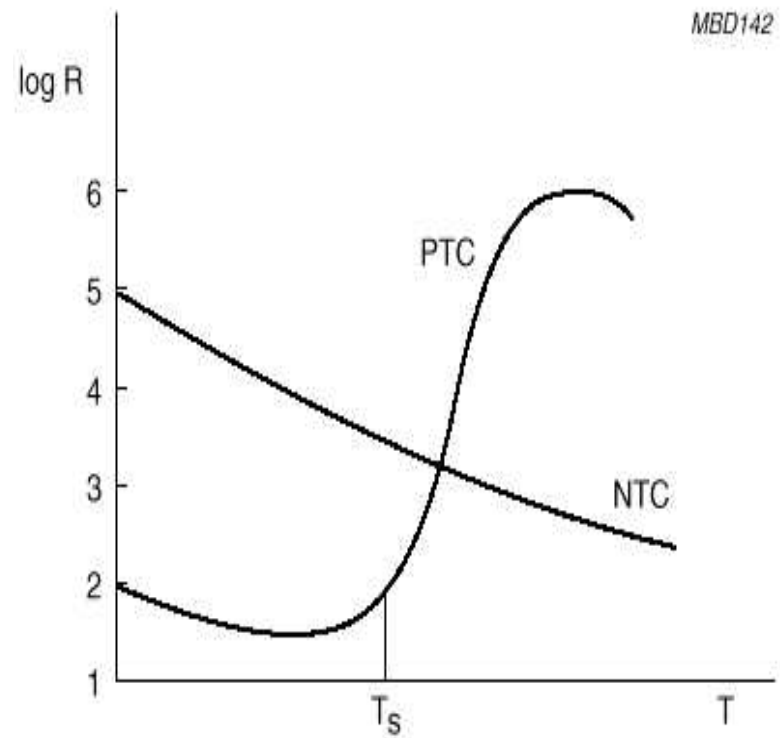
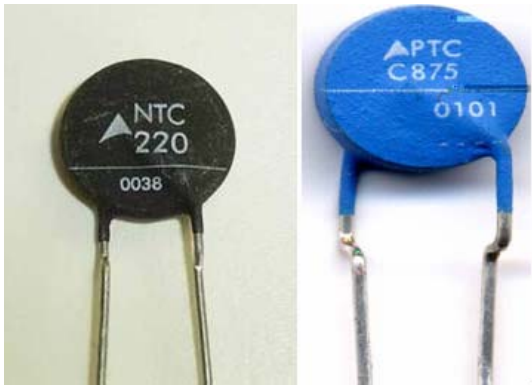
- 压敏电阻器的电压与电流不遵守欧姆定律，而成特殊的非线性关系。
- 当两端所加电压低于标称额定电压值时，压敏电阻器的电阻值接近无穷大，内部几乎无电流流过；
- 当两端所加电压略高于标称额定电压值时，压敏电阻器将迅速击穿导通，并由高阻状态变为低阻状态，工作电流也急剧增大；
- 当两端所加电压低于标称额定电压值时，压敏电阻器又恢复为高阻状态；
- 当两端所加电压超过最大限制电压值时，压敏电阻器将完全击穿损坏，无法再自行恢复。



Resistor group 电阻器分类

Non-linear resistor 非线性电阻器

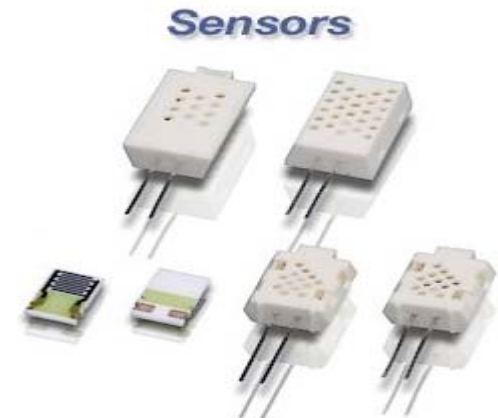
- Thermistor 热敏电阻器
 - NTC
 - PTC



Resistor group 电阻器分类

Non-linear resistor 非线性电阻器

- Humidity sensor 湿敏电阻器
- 湿敏电阻是利用湿敏材料吸收空气中的水分而导致本身电阻值发生变化这一原理而制成的。
 - 半导体陶瓷湿敏元件
 - 氯化锂湿敏电阻
 - 有机高分子膜湿敏电阻



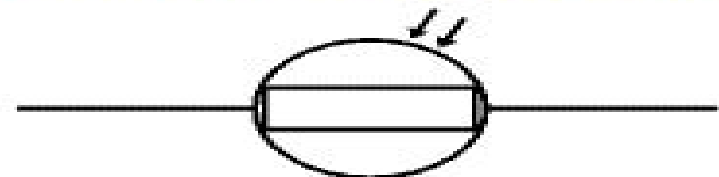
Resistor group 电阻器分类

Non-linear resistor 非线性电阻器

- light dependent resistor
光敏电阻器



Photograph © [Rapid Electronics](#)



circuit symbol

Capacitor group 电容器分类

- Capacitor 电容器
- Capacitor basic knowledge 电容器基础知识
 - 电容器（Capacitor）是由中间夹有电介质的两个导体所构成的元件
 - 电容量的符号为C
 - 基本单位为法拉或简称法，以字母F（Farad）表示
 - 单位换算：1（F/法）=10E+3（mF/毫法）=10E+6（uF/微法）=10E+9（nF/纳法）=10E+12（pF/皮法）

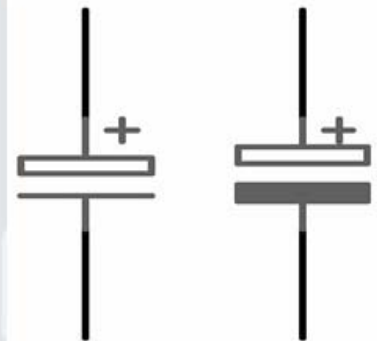
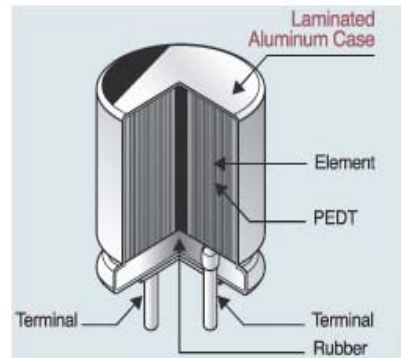
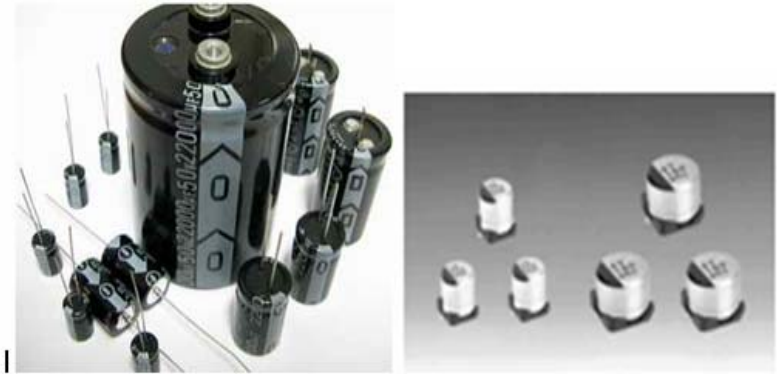
Capacitor group 电容器分类

- Capacitor 电容器
 - EL capacitor 铝电解电容器
 - Tan capacitor 钽电容器
 - Film capacitor 有机薄膜电容器
 - Ceramic capacitor 陶瓷电容器
 - Safety standard approved capacitor 安规电容器

Capacitor group 电容器分类

EL capacitor 铝电解电容器

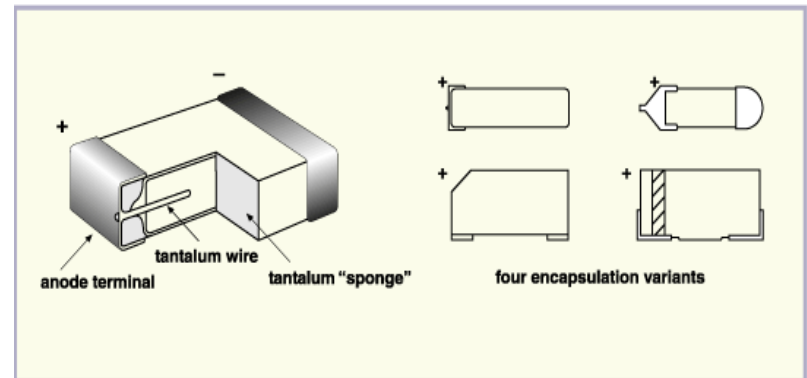
- EL capacitor 铝电解电容器
 - Characteristics is to pass AC but block DC signal 主要特性是隔直流通交流
 - Polarity component 铝电解电容器是有极性的元件
 - Marking is negative pole 标识在负极
 - No marking for bi-polarity 双极性的无极性标识
 - SMT and THT assembly 插件和贴片封装



Capacitor group 电容器分类

Tan capacitor 铝电解电容器

- Tan capacitor 钽电容器
 - Polarity component 钽电容器是有极性的元件
 - Marking is positive pole 标识在正极
 - No marking for bi-polarity 双极性的无极性标识
 - Size for SMT 尺寸
 - A-3216
 - B-3528
 - C-6032
 - D-7343



Capacitor group 电容器分类

Film capacitor 铝电解电容器

- Film capacitor 有机薄膜电容器

- Polyester film cap 聚酯薄膜电容器
- Polypropylene film cap 聚丙烯薄膜电容器
- Metallized PE film cap 金属化聚酯薄膜电容器
- Metallized PP film cap 金属化聚丙烯薄膜电容器
- Standard approved film cap 安规认证电容器



Capacitor group 电容器分类

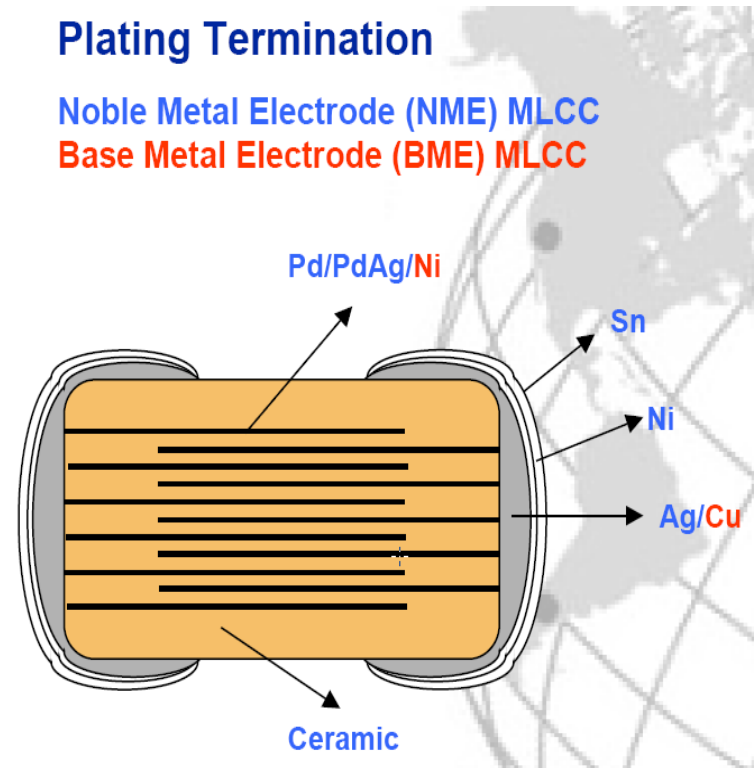
Ceramic capacitor 陶瓷电容器

- Ceramic capacitor 陶瓷电容器
 - Multilayer ceramic cap 多层瓷介电容器
 - Ceramic disc cap 瓷片电容器
 - Safety standard approved cap 安规安证电容器
 - Network capacitor 网络电容器

Capacitor group 电容器分类

Multilayer ceramic cap 多层瓷介电容器

- Multilayer ceramic cap 多层瓷介电容器
 - Preferred number series please view resistor group above 优先数系见电阻器类
 - Inner and outer electrode 内外电极材料
 - NME 贵金属电极
 - BME 贱金属电极



Capacitor group 电容器分类

Multilayer ceramic cap 多层瓷介电容器

- 1 Tolerance 允许偏差

EIA Tolerance Codes		
A = +/-0.05pF *	H = +/-2.5%	Q = -10%/+30%
B = +/-0.1pF *	J = +/-5%	S = +/-22%
C = +/-0.25pF *	K = +/-10%	T = -10%/+50%
D = +/-0.5pF *	L = +/-15%	U = -10%/+75%
E = +/-0.5%	M = +/-20%	W = -10%/+100%
F = +/-1.0%	N = +/-30%	Y = -20%/+5%
G = +/-2%	P = -0/+100%	Z = -20%/+80%
* - these tolerances apply to capacitors below 10pF [Common "PREFERRED" Tolerances in BLUE]		

Capacitor group 电容器分类

Multilayer ceramic cap 多层瓷介电容器

- 2 temperature characteristic 温度特性
 - Class 1 ceramic capacitor I类陶瓷电容器

C0G=NP0
 N: Negative
 P: Positive
 0: +/-0

Significant figure of temp. coeff. of cap. (ppm/°C)	Symbol	Multiplier applied to significant figure	Symbol	Tolerance of temp. coeff. (ppm)	Symbol
0	C	-1	0	±30	G
0.3	B	-10	1	±60	H
0.8	L	-100	2	±120	J
0.9	A	-1000	3	±250	K
1.0	M	-10000	4	±500	L
1.5	P	1	5	±1000	M
2.2	R	10	6	±2500	N
3.3	S	100	7		
4.7	T	1000	8		
5.6	V	10000	9		
7.5	U				

Capacitor group 电容器分类

Multilayer ceramic cap 多层瓷介电容器

Low temp. (°C)	Symbol	High temp. (°C)	Symbol	Max. Cap. change over temp. range (%)	Symbol
+10	Z	+45	2	±1.0	A
-30	Y	+65	4	±1.5	B
-55	X	+85	5	±2.2	C
		+105	6	±3.3	D
		+125	7	±4.7	E
		+150	8	±7.5	F
		+200	9	±10	P
				±15	R
				±22	S
				+22 to -33	T
				+22 to -56	U
				+22 to -82	V

Capacitor group 电容器分类

Multilayer ceramic cap 多层瓷介电容器

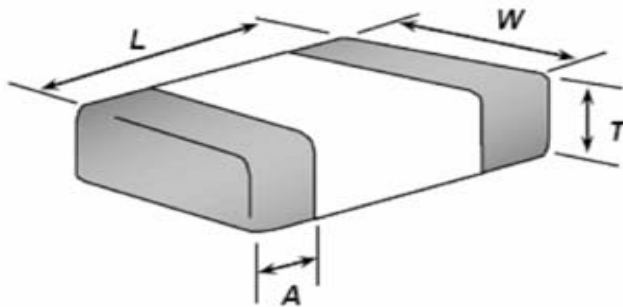
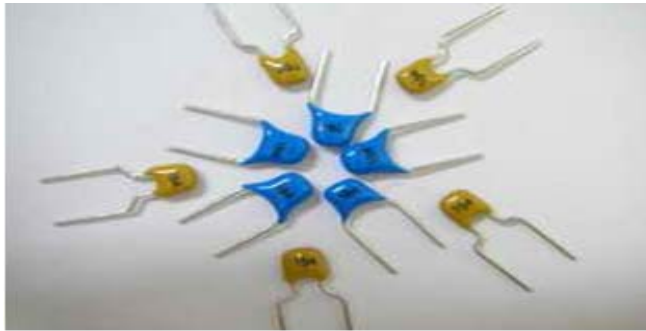
- Rate voltage 额定电压

EIA Voltage Codes		
0G = 4.0VDC	1J = 63VDC	2D = 200VDC
0L = 5.5VDC	1K = 80VDC	2P = 220VDC
0J = 6.3VDC	2A = 100VDC	2E = 250VDC
1A = 10VDC	2Q = 110VDC	2F = 315VDC
1C = 16VDC	2B = 125VDC	2V = 350VDC
1E = 25VDC	2C = 160VDC	2G = 400VDC
1H = 50VDC	2Z = 180VDC	2W = 450VDC
Common "PREFERRED" Voltage Ratings in BLUE		

Capacitor group 电容器分类

Multilayer ceramic cap 多层瓷介电容器

- Size for SMT 尺寸

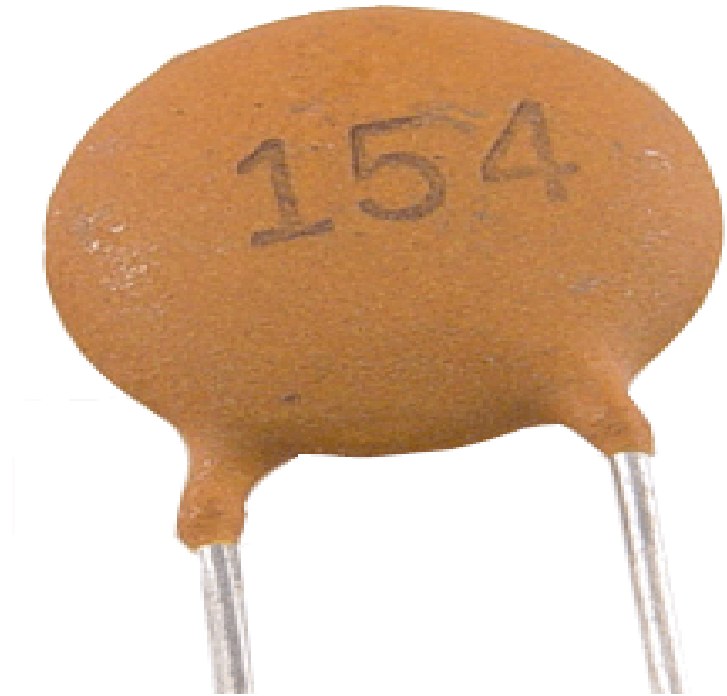


- 01005 - 0.01" X 0.005" (0.3 mm X 0.15mm)
- 0201 - 0.02" X 0.01" (0.6 mm X 0.3 mm)
- 0402 - 0.04" X 0.02" (1.0 mm X 0.5 mm)
- 0603 - 0.06" X 0.03" (1.5 mm X 0.8 mm)
- 0805 - 0.08" X 0.05" (2.0 mm X 1.3 mm)
- 1206 - 0.12" X 0.06" (3.0 mm X 1.5 mm)
- 1812 - 0.18" X 0.12" (4.6 mm X 3.0 mm)

Capacitor group 电容器分类

Ceramic disc cap 瓷片电容器

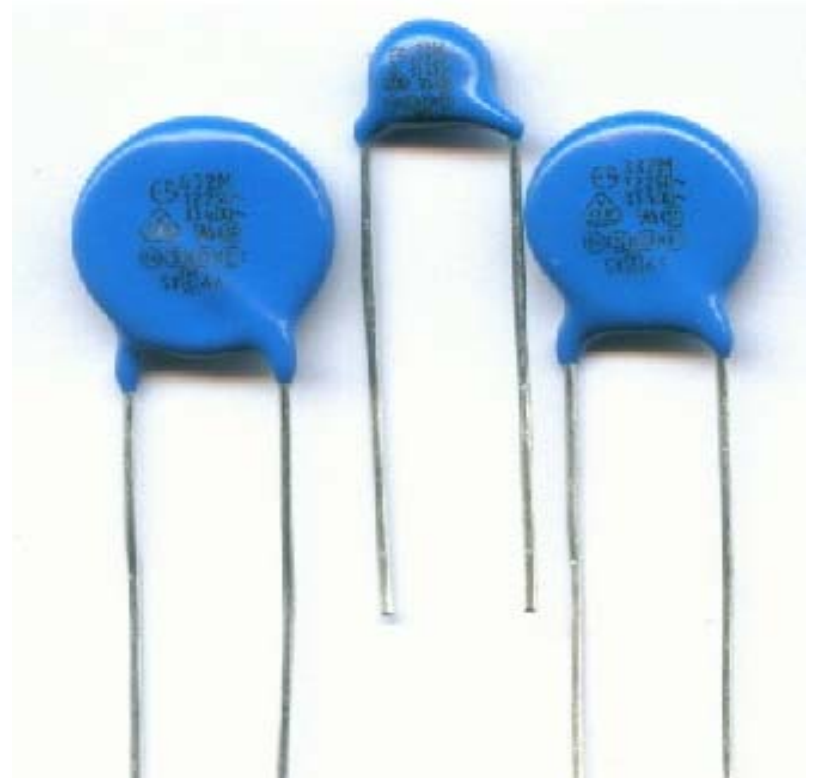
- Ceramic disc cap 瓷片
电容器



Capacitor group 电容器分类

Safety standard approved cap 安规认证电容器

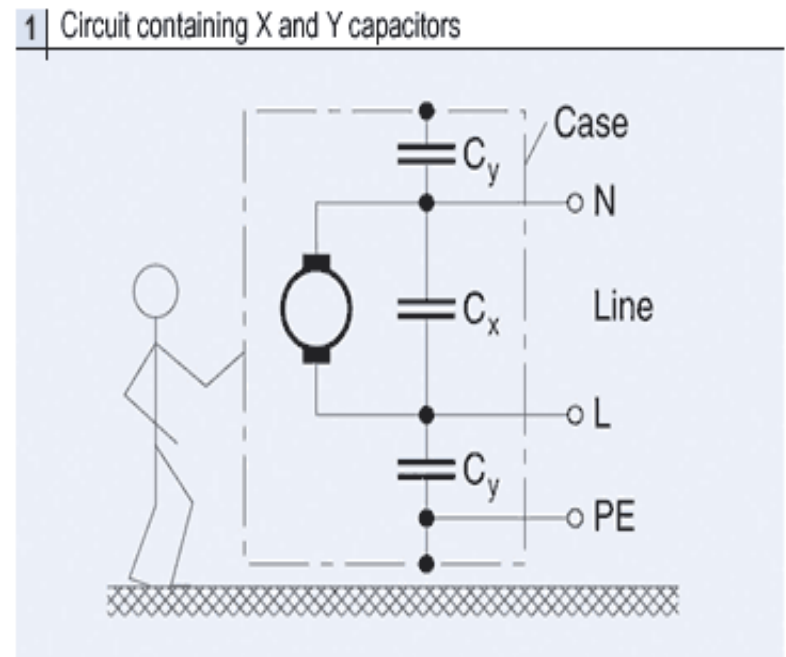
- Safety standard approved cap 安规认证电容器



Capacitor group 电容器分类

Safety standard approved cap 安规认证电容器

- Safety standard approved capacitor 安规电容器
 - X1/X2 Cap: film dielectric 有机薄膜介质
 - Y1/Y2 Cap: ceramic dielectric 陶瓷介质
 - X cap is to connect N and L line X 电容器主要用于零火线之间
 - Y cap is to connect N or L line and ground Y 电容器主要用于零火线与地之间

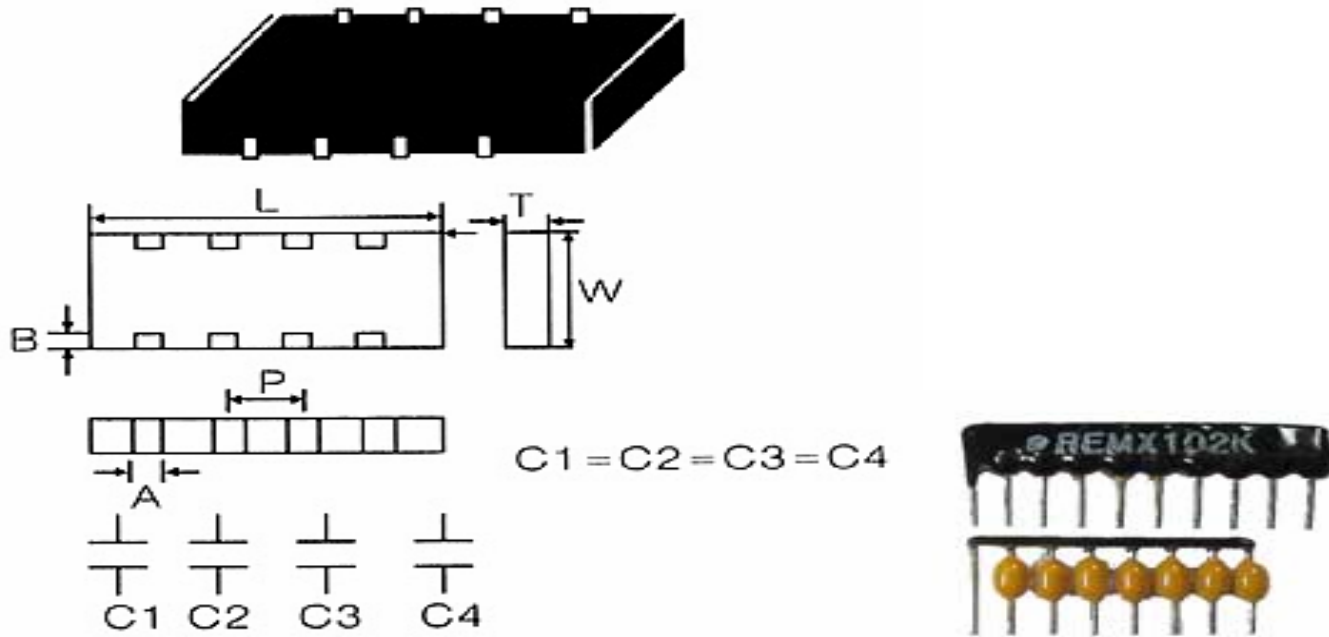


1 The capacitors suppress transients and are vital to protection of people and equipment.

Capacitor group 电容器分类

Network capacitor 网络电容器

- Network capacitor 网络电容器



Capacitor group 电容器分类

Various capacitors comparison 不同类型电容器比较

	Aluminum	Tantalum	Ceramic	Film
Dielectric	Aluminum Oxide (Al ₂ O ₃)	Tantalum Tetroxide (Ta ₂ O ₅)	Titanium Oxide Barium types, etc	Polyester, Polypropylene, etc.
Proportional Dielectric Constant	8 ~ 10	27	1500 ~ 15000 (Titanium Oxide Barium)	2.1 ~ 3.1
Package Style	Screw terminal, Snap-in terminal, Lead terminal, Chip	Chip (main type), dip	Chip (main type), dip	Chip dip (main type), Chip and case
Advantages	<ul style="list-style-type: none"> •Low price •Compact with large capacitance 	<ul style="list-style-type: none"> •Compact with comparatively high electrolytic capacitance •Semi-permanent life 	<ul style="list-style-type: none"> •Compact (especially multilayer types) •No polarity 	<ul style="list-style-type: none"> •Good Characteristics •Can manufacture all voltages—low to high •High reliability
Disadvantages	<ul style="list-style-type: none"> •Short life at high temps •Large capacitance tolerance •Polarity (main type) 	<ul style="list-style-type: none"> •Operation requires study of voltage derating •Polarity 	<ul style="list-style-type: none"> •Large changes in electrolytic capacitance caused by temperature and DC voltage 	<ul style="list-style-type: none"> •Large outside dimensions

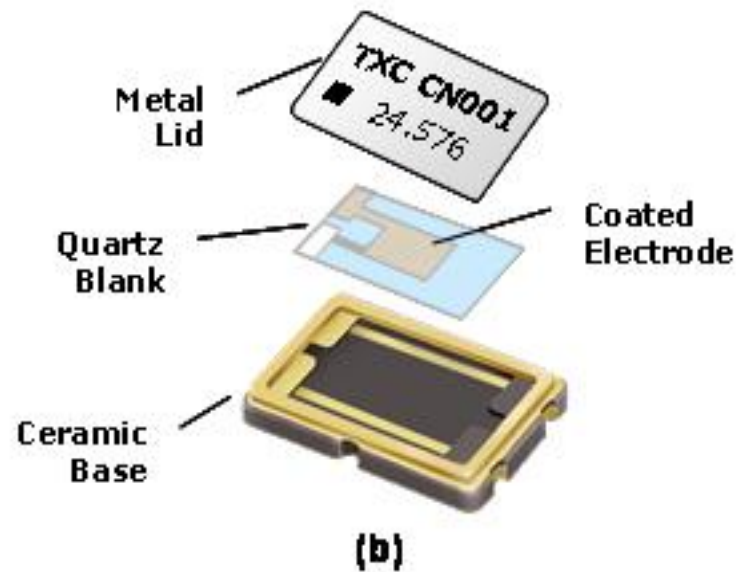
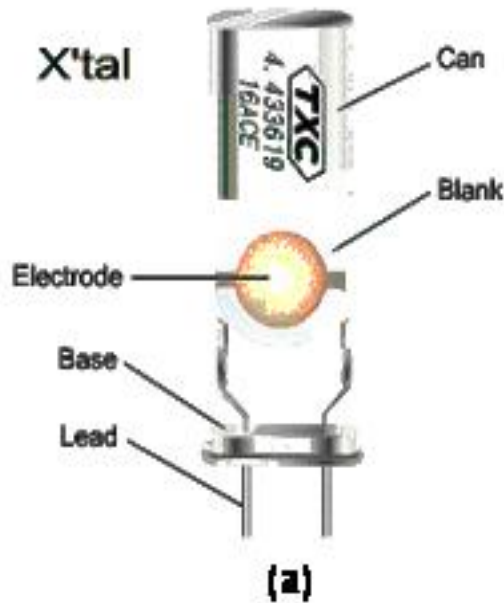
Resonator group 谐振器分类

- Resonator group 谐振器分类
 - Quartz crystal resonator 石英晶体谐振器
 - Ceramic resonator 陶瓷谐振器

Resonator group 谐振器分类

Crystal resonator 晶体谐振器

- Crystal resonator 晶体谐振器
 - Metal can type resonator 金属外壳封装



Resonator group 谐振器分类

Crystal resonator 晶体谐振器

- Technology terminology 技术术语
 - Equivalent circuit 等效工作电路
 - Symbol 电路符号
 - Resonance theory 谐振原理



Fig 1 Equivalent Circuit of Crystal Unit

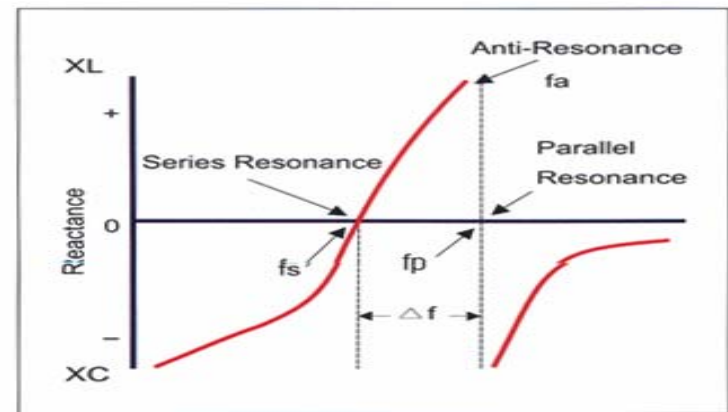
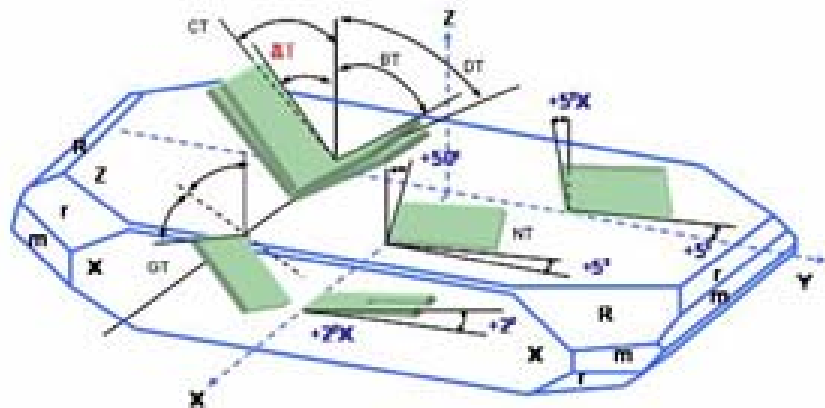
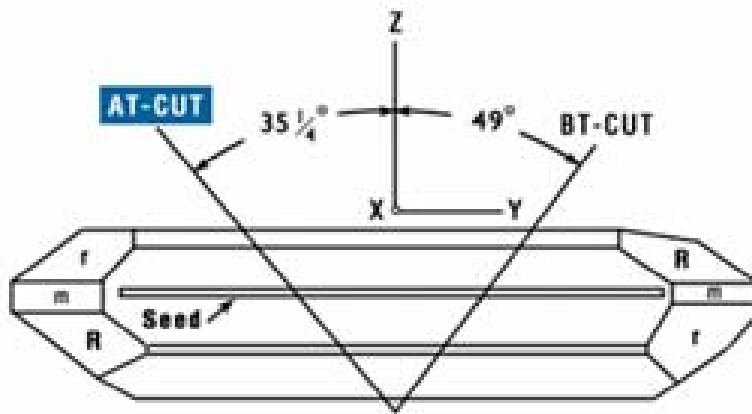


Fig. 6 plot of reactance vs. frequency for a quartz crystal.

Resonator group 谐振器分类

Crystal resonator 晶体谐振器

- Technology terminology 技术术语
 - Cut type 切割类型
 - Mass product/AT 常用AT



(Fig. 3) Orientation angle of a 2-plate quartz crystal.

Resonator group 谐振器分类

Ceramic resonator 陶瓷谐振器

- Ceramic resonator 陶瓷谐振器



Resonator group 谐振器分类

Ceramic resonator 陶瓷谐振器

- Various resonator comparison 多种谐振器比较

Name	Symbol	Price	Size	Adjustment	Initial frequency tolerance	Long-term stability
LC		Inexpensive	Large	Necessary	+/-2.0%	Not so good
CR		Inexpensive	Small	Necessary	+/-2.0%	Not so good
Crystal resonator		Expensive	Large	Unnecessary	+/-0.001%	Excellent
Ceramic resonator		Inexpensive	Small	Unnecessary	+/-0.5%	Excellent

Questions & Answer?

Any question is welcome!

