The "Auto-Z" makes use of this charge curve to measure the capacity of a capacitor. By applying a pulsating DC voltage to the capacitor under test and measuring the time on its RC charge curve, the capacity of the capacitor can be determined very accurately.

Capacitor Types

There are many different types of capacitors, using different types of dielectrics, each with its own best capability. When replacing capacitors, it is best to replace with a capacitor having not only the same capacity and tolerance, but the same type of dielectric and temperature characteristics as well. This will insure of continued performance equal to the original.

The capacitor is often named according to the type of dielectric which is used, such as paper, mylar, ceramic, mica or aluminum electrolytic.

Paper and mica were the standard dielectric materials used in capacitors for years. Ceramic became popular due to its stability and controlled characteristics and lower cost over mica. Today, there are many dielectrics with different ratings and uses in capacitors. Plastic films of polyester, polycarbonate, polystyrene, polypropylene, and polysulfone are used in many of the newer large value, small size capacitors. Each film has its own special characteristics and is chosen to be used in the circuit for this special feature. Some of the plastic films are also metalized by vacuum plating the film with a metal. These are generally called self-healing type capacitors and should not be replaced with any other type.

Ceramics

Ceramic dielectric is the most versatile of all. Many variations of capacity can be created by altering the ceramic material. Capacitors that increase, stay the same value, or decrease value with temperature changes can be made. If a ceramic disc is marked with a letter P such as P100, then the value of the capacitor will increase 100 parts per million per degree centigrade increase in temperature. If the capacitor is marked NPO or COG, then the value of capacity will remain constant with an increase in the temperature.

Ceramic disc capacitors marked with an N such as N1500 will decrease in capacity as the temperature increases. The negative temperature coefficient is important in many circuits such as the tuned circuits of the radio and television IF. The temperature coefficient of an inductor is positive and the inductance will increase as the temperature rises. If the tuning capacitor across the coil is a negative coefficient, then the net result will be a zero or very little change.

General type ceramic discs are often marked with such letters as Z5U, Z5F, Y5V, X5V, and so forth. This indicates the type of temperature curve for the particular capacitor. Ceramic capacitors that are not NPO or rated with N or P type characteristics will have wider temperature variations and can vary both positive and nega-

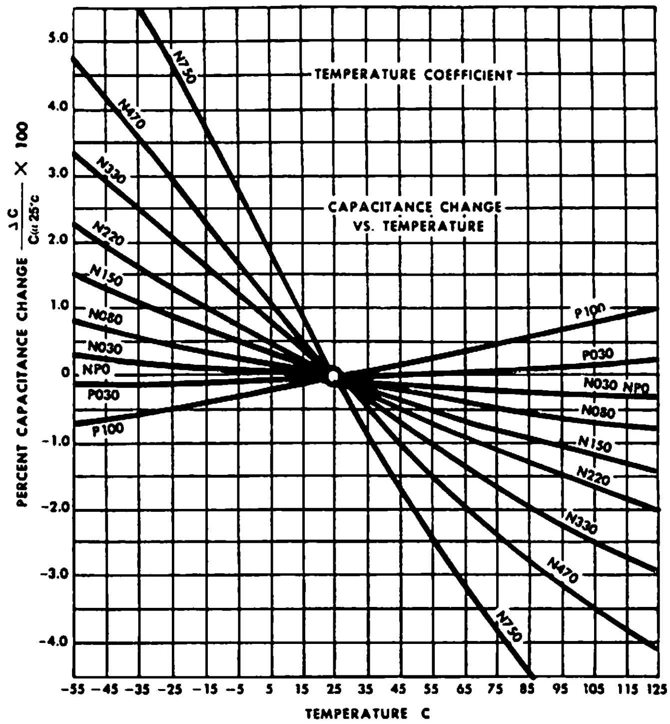


Fig. D — Temperature change versus capacity change of P100 to N750 temperature compensated ceramic disc capacitors.

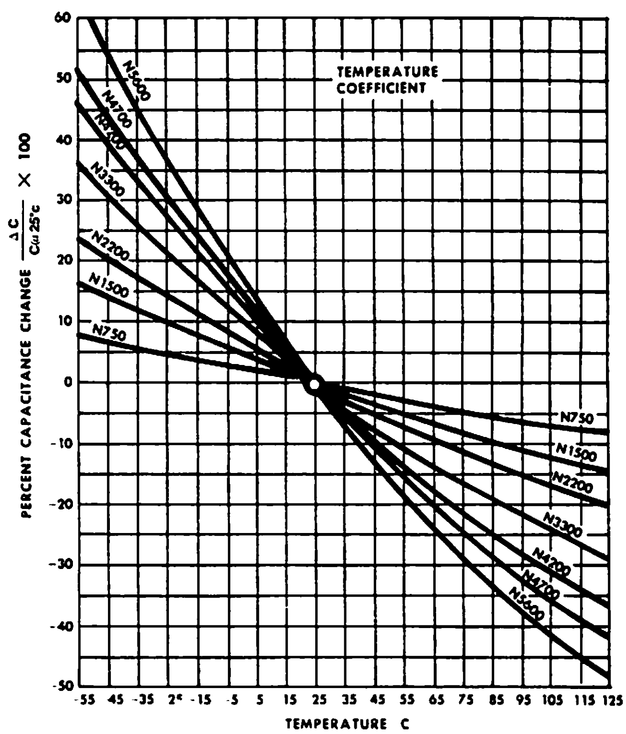


Fig. E — Temperature change versus capacity change of N750 to N5600 temperature compensated ceramic disc capcitors.

tive with temperature changes. The Z5U probably has the greatest change and will only be found in non-critical applications such as B+ power supply decoupling. These type of capacitors should not be used in critical applications such as oscillator and timing circuits.

A ceramic capacitor marked GMV means that the value marked on the capacitor is the Guaranteed Minimum Value of capacity at room temperature. The actual value of the capacitor can be much higher. This type

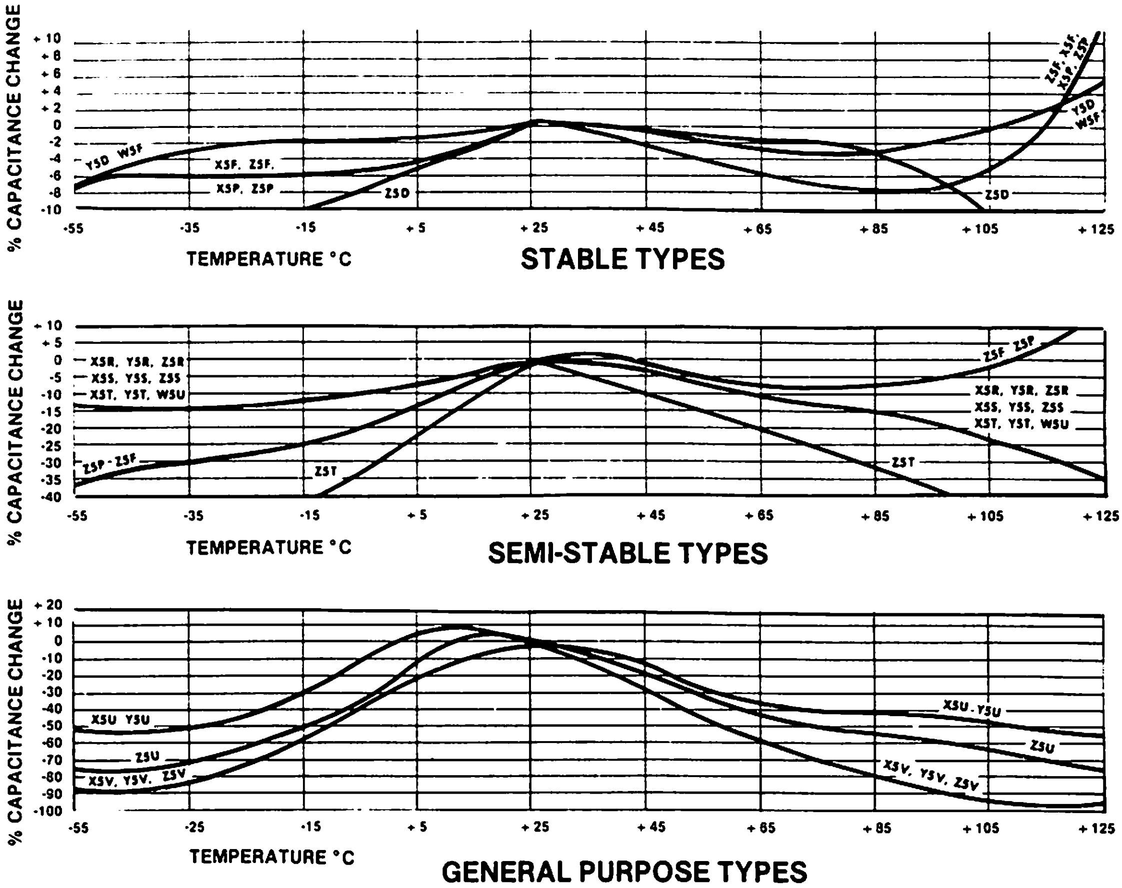


Fig. F — Temperature change versus capacity change of non-temperature compensated ceramic disc capacitors.

of capacitor is used in bypass applications where the actual value of capacity is not critical.

Ceramic capacitors have been the most popular capacitors in electronics because of the versatility of the different temperature coefficients and the cost. When replacing a ceramic disc capacitor, be sure to replace the defective capacitor with one having the same characteristics and voltage rating.

Aluminum Electrolytics

The aluminum electrolytic capacitor or "Lytic" is a very popular component. Large value capacity in a relatively small case with a fairly high voltage rating can be obtained quite easily. The aluminum lytic is used in power supply filtering, audio and video coupling and in bypass applications.

The aluminum lytic is made by using a pure aluminum foil wound with a paper soaked in a liquid electrolyte. When a voltage is applied to the combination, a thin layer of oxide film forms on the pure aluminum forming the dielectric. As long as the electrolyte remains liquid, the capacitor is good or can be reformed after sitting for a while. When the electrolyte drys out the leakage goes up and the capacitor loses capacity. This can happen to aluminum lytics just sitting on the shelf. When an aluminum lytic starts drying out, the capacitor begins to show dielectric absorption. Excessive ESR is also a common failure condition for aluminum lytic capacitors.

Tantalum Electrolytics

The tantalum electrolytic capacitor is becoming very popular. While the leakage in the aluminum lytic is very high due to the nature of its construction, leakage in tantalum capacitors is very low. In addition, tantalum capacitors can be constructed with much tighter tolerances than the aluminum lytic. The tantalum is much smaller in size for the same capacity and working voltage than an aluminum lytic. Tantalum lytics are popular in circuits where high capacity and low leakage is required. The capacity and voltage rating of the tantalum lytic is limited, and for extremely large values of capacity and higher voltages in power supply filtering, the aluminum lytic is still the first choice.

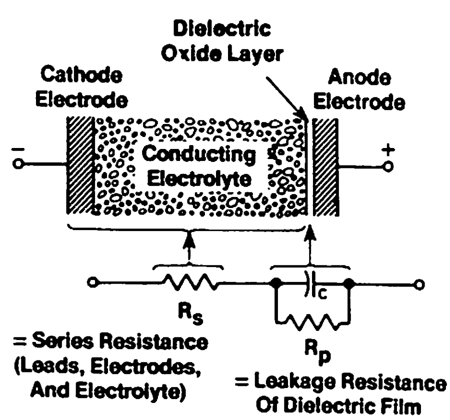


Fig. G — Construction of an electrolytic capacitor and its equivalent circuit.

A Capacitor Is More Than A Capacitor

An ideal capacitor is defined as "a device consisting of two electrodes, separated by a dielectric, for introducing capacitance into an electric circuit." Unfortunately, we don't work with ideal components. The capacitors we encounter every day in our service work are much more complex than this simple definition. In an actual capacitor, a certain amount of current leaks through the dielectric or the insulation. Capacitors have internal series resistances, can exhibit an effect called dielectric absorption, and the capacitance can change in value. If we were to draw a circuit to represent an actual capacitor, it might look like the circuit in Figure H.

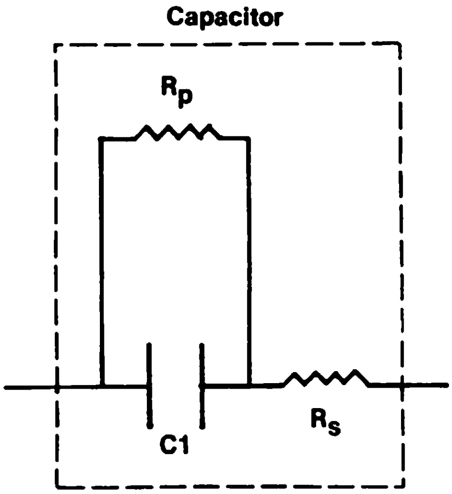


Fig. H — Equivalent circuit of a practical capacitor.

The capacitor C1 represents the true capacitance, the resistance Rp represents the leakage path through the capacitor, and the resistance Rs, called the Effective Series Resistance (ESR) represents all of the combined internal series resistances in the capacitor.

Leakage

One of the most common capacitor failures is caused by current leaking through the capacitor. Some capacitors will show a gradual increase in leakage, while others will change rapidly and even short out entirely. In order to effectively test a capacitor for leakage, it is necessary to test the capacitor at its rated voltage.

When a DC voltage is applied to a capacitor, a certain amount of current will flow through the capacitor. This current is called the leakage current and is the result of imperfections in the dielectric. Whenever this leakage current flows through an electrolytic capacitor, normal chemical processes take place to repair the damage done by the current flow. Heat will be generated from the leakage current flowing through the capacitor and will speed up the chemical repair processes.

As the capacitor ages, the amount of water remaining in the electrolyte will decrease, and the capacitor will be less capable of healing the damage done by the various leakage paths through the dielectric. Thus, as the amount of water in the electrolyte decreases, the capacitor will be less capable of healing the leakage paths and the overall leakage current in the capacitor will ultimately increase. The increase in leakage current will generate additional heat, which will speed up the chemical processes in the capacitor. This process, of course, will use up more water and the capacitor will eventually go into a run-away mode. At some point, the leakage current will finally get large enough to adversely affect the circuit the capacitor is used in.

Dielectric Absorption

One of the most common types of failures of electrolytic capacitors is dielectric absorption. Dielectric absorption is the result of a capacitor remembering a charge that is placed on it. The capacitor cannot be completely discharged and a voltage will reappear after the capacitor has been discharged. Another name for dielectric absorption is battery effect. As this name implies, a capacitor with excessive dielectric absorption will act like a battery in the circuit. This will upset the circuit by changing bias levels. A capacitor with excessive dielectric absorption will also have a different effective capacitance when it is operating in a circuit. Dielectric absorption will not normally show up in film or ceramic capacitors, but if the "Auto-Z" test does indicate dielectric absorption the capacitor is likely to fail in use. Dielectric absorption in these capacitors will generally be associated with a high leakage as well.

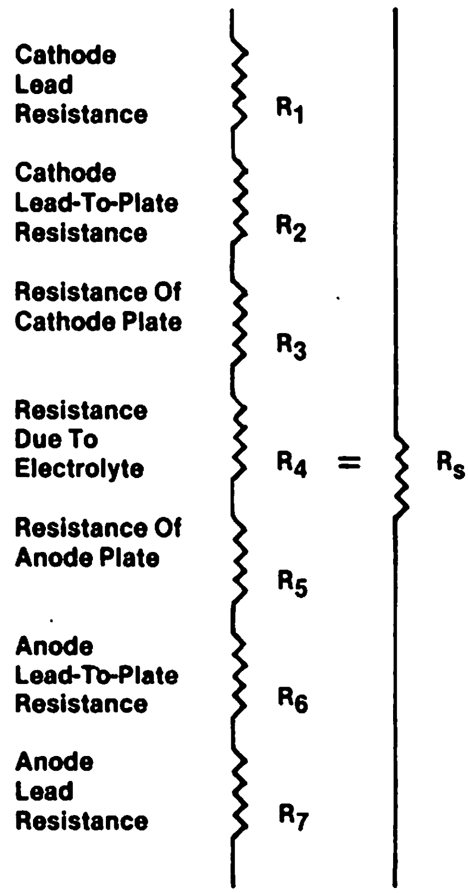


Fig. I — The Effective Series Resistance (ESR) is composed of all the combined internal resistances in the capacitor.

Equivalent Series Resistance

Another problem which develops in capacitors is high Equivalent Series Resistance (ESR). All capacitors have a certain amount of ESR. Sources that contribute to ESR include lead resistance, dissipation in the dielectric material, and foil resistance. Small, non-electrolytic capacitors should have extremely small amounts of ESR. An electrolytic capacitor which has excessive ESR will develop internal heat which greatly reduces the life of the capacitor. In addition, ESR changes the impedance of the capacitor in circuit since it has the same effect as adding an external resistor in series with the component.

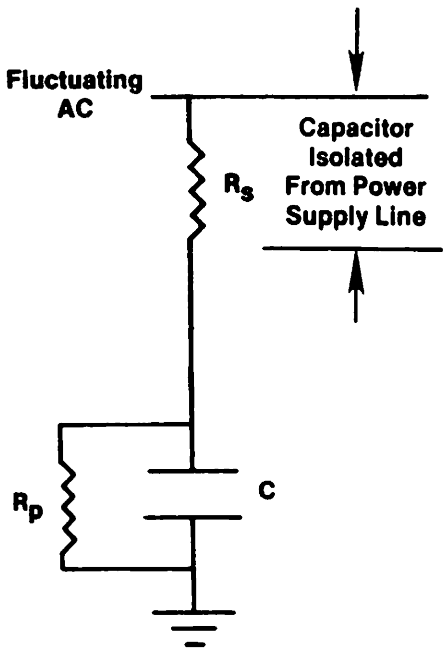


Fig. J — The Equivalent Series Resistance has the result of isolating the capacitor from the power supply line, reducing its filtering capabilities.

Value Change

Capacitors can change value. On some multi-layer foil capacitors, poor welding or soldering of the foil to the leads can cause an open to one of the foils to develop due to stress of voltage or temperature. This can result in a loss of almost one-half of the capacitor's marked capacity. Ceramic disc capacitors can also change value due to fissures or cracks. Small fissures or cracks in the ceramic insulating material can be created by thermal stress from exposure to heat and cold. Sometimes very small fissures develop which do not effect the capacitor until much later. The crack will reduce the capacitor to a smaller value. Although the ceramic is still connected to the leads, the actual value of capacity could be a very small portion of the original value depending upon where the crack occurs. The "Auto-Z" will let you know what the value of the capacitor is regardless of its marked value.

Electrolytic capacitors are another example of capacitors that can change value in circuit or on the shelf. As these capacitors dry out, they eventually lose their capacitance due to the failure of the aluminum oxide film making up the dielectric. A change in value in an aluminum electrolytic will often also be preceded by other defects, such as high leakage, high dielectric absorption and/or high internal resistances.

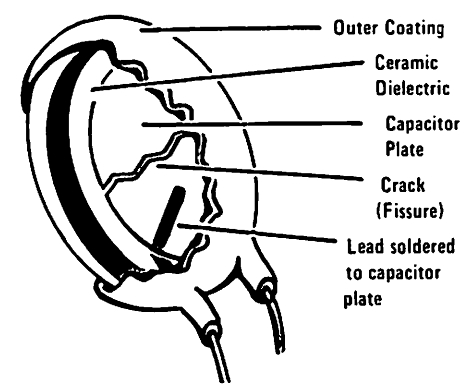


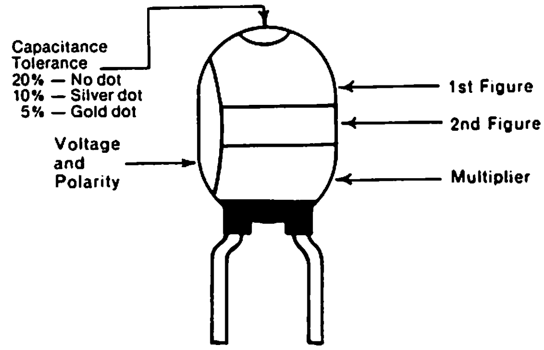
Fig. K — A ceramic disc is made of a silver coated ceramic dielectric which is coated with a protective coating. Large cracks or fissures in the dielectric may develop which change the capacitance value.

As Figure L shows, the ESR is the combined resistances of the connecting leads, the electrode plates, the resistance of the lead to plate connections, and the losses associated with the dielectric. All capacitors have some ESR. Normal amounts of ESR are tolerated by the capacitor and the circuit it is used in. Defects can occur, however, in the capacitor which will increase the ESR in the capacitor. Any increase in ESR can affect the circuit in which the capacitor is used, as well as the capacitor itself.

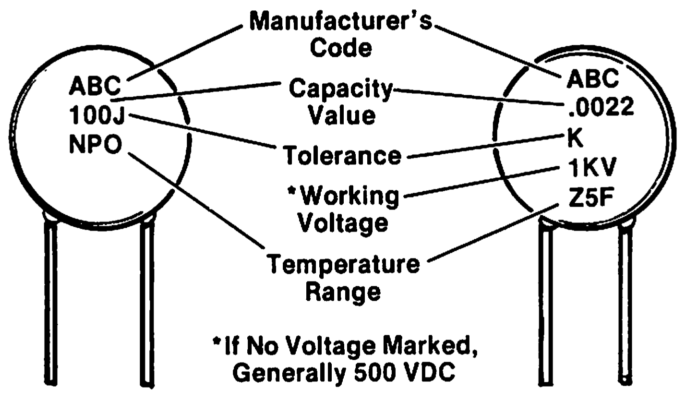
Excessive ESR caused heat to build up within the capacitor, causing it to fail at an accelerating rate. ESR also reduces the ability of a capacitor to filter AC. As the model in Figure M shows, the series resistance RS isolates the capacitor from the AC it is to filter.

Dipped Tantalum Capacitors

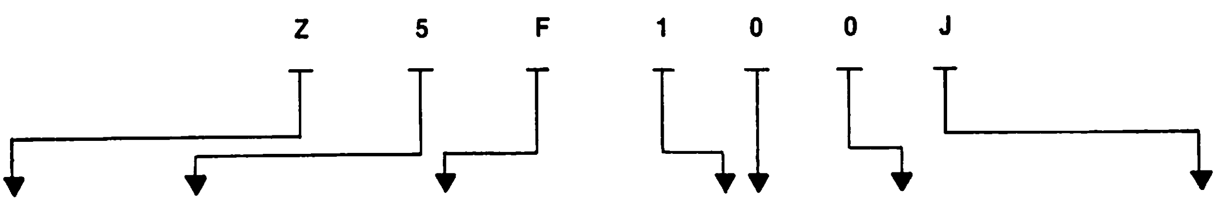
Color	Rated Voltage	Capacitance in Picofarads 1st Figure	2nd Figure	Multiplier
Black	4	0	0	—
Brown	6	1	1	—
Red	10	2	2	—
Orange	15	3	3	—
Yellow	20	4	4	10,000
Green	25	5	5	100,000
Blue	35	6	6	1,000,000
Violet	50	7	7	10,000,000
Gray	—	8	8	—
White	3	9	9	—



Ceramic Disc Capacitors



Typical Ceramic Disc Capacitor Markings



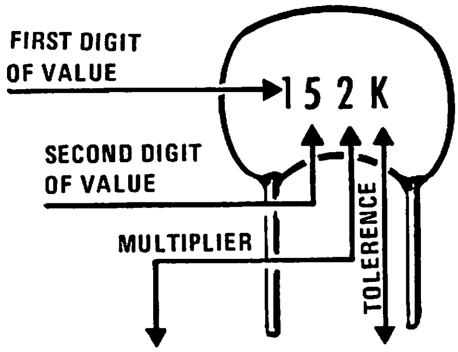
Low Temp.	Letter Symbol	High Temp.	Numerical Symbol	Max. Capac. Change Over Temp. Range	Letter Symbol
+10°C	Z	+45°C	2	+1.0%	A
-30°C	Y	+65°C	4	±1.5%	B
-55°C	X	+85°C	5	±1.1%	C
		+105°C	6	±3.3%	D
		+125°C	7	±4.7%	E
				±7.5%	F
				±10.0%	P
				±15.0%	R
				±22.0%	S
				+22%, -33%	T
				+22%, -56%	U
				+22%, -82%	V

Temperature Range Identification of Ceramic Disc Capacitors

1st & 2nd Fig. of Capacitance	Multiplier	Numerical Symbol	Tolerance on Capacitance	Letter Symbol
	1	0		
	10	1		
	100	2	±5%	J
	1,000	3	±10%	K
	10,000	4	±20%	M
	100,000	5	+100%, -0%	P
		—	+80%, -20%	Z
		—		
	.01	8		
	.1	9		

Capacity Value and Tolerance of Ceramic Disc Capacitors

Film Type Capacitors

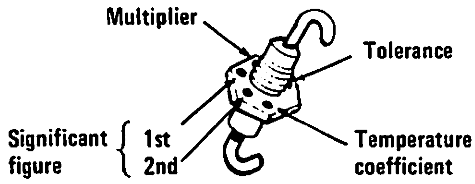


MULTIPLIER		TOLERANCE OF CAPACITOR		
For the Number	Multiplier	Letter	10 pF or Less	Over 10 pF
0	1	B	±0.1 pF	
1	10	C	±.25 pF	
2	100	D	±0.5 pF	
3	1,000	F	±1.0 pF	± 1%
4	10,000	G	±2.0 pF	± 2%
5	100,000	H		± 3%
		J		± 5%
8	0.01	K		±10%
9	0.1	M		±20%

EXAMPLES:
152K = 15 x 100 = 1500 pF or .0015 uF, ±10%
759J = 75 x 0.1 = 7.5 pF, ±5%

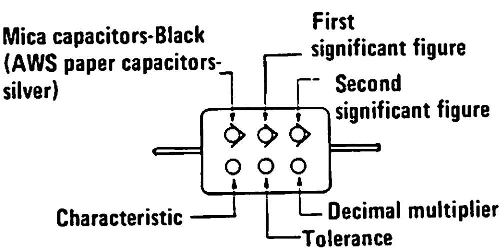
NOTE: The letter "R" may be used at times to signify a decimal point; as in: 2R2 = 2.2 (pF or uF).

Ceramic Feed Through Capacitors

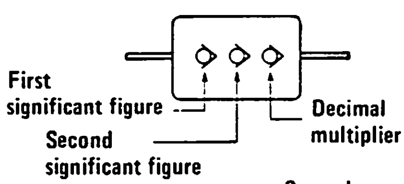


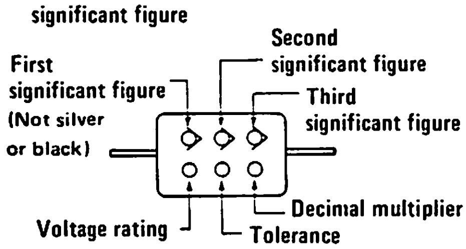
Color	Significant Figure	Multiplier	Tolerance 10 pF or Less	Tolerance Over 10 pF	Temperature Coefficient
Black	0	1	2 pF	20%	0
Brown	1	10	0.1 pF	1%	N30
Red	2	100	—	2%	N60
Orange	3	1,000	—	2.5%	N150
Yellow	4	10,000	—	—	N220
Green	5	—	5 pF	5%	N330
Blue	6	—	—	—	N470
Violet	7	—	—	—	N750
Gray	8	0.001	0.025 pF	—	P30
White	9	0.1	1 pF	10%	+120 to -750 (RETMA) +500 to -330 (JAN)
Gold	—	—	—	—	P100
Silver	—	—	—	—	Bypass or coupling

Postage Stamp Mica Capacitors



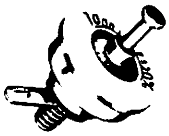
AWS and JAN fixed capacitors
(First dot silver or black)

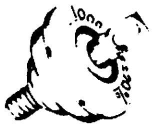


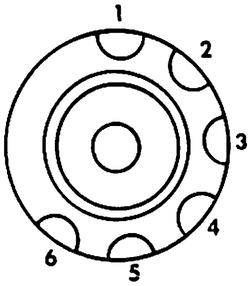


Color	Significant Figure	Multiplier	Tolerance (%)	Voltage Rating
Black	0	1	-	—
Brown	1	10	1	100
Red	2	100	2	200
Orange	3	1,000	3	300
Yellow	4	10,000	4	400
Green	5	100,000	5	500
Blue	6	1,000,000	6	600
Violet	7	10,000,000	7	700
Gray	8	100,000,000	8	800
White	9	1,000,000,000	9	900
Gold	-	0.1	5	1000
Silver	-	0.01	10	2000
No color	-	—	20	500

Standard Button Mica

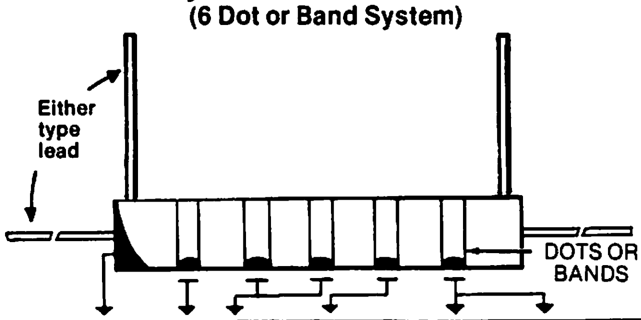






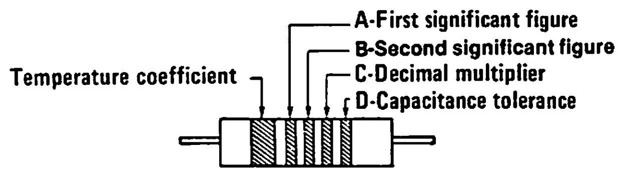
1st DOT	2nd and 3rd DOTS		4th DOT	5th DOT		6th DOT
Identifier	Capacitance in pF		Multiplier	Capacitance Tolerance		Temp. Characteristic
	Color	1st & 2nd Sig. Figs.		Percent	Letter Symbol	
Black	Black	0	1	±20%	F	
	Brown	1	10	± 1%	F	
NOTE: Identifier is omitted if capacitance must be specified to three significant figures.	Red	2	100	±2% or ±1 pF	G or B	
	Orange	3	1000	± 3%	H	
	Yellow	4				+100
	Green	5				
	Blue	6				-20 PPM/°C above 50 pF
	Violet	7				
	Gray	8				±100 PPM/°C below 50 pF
	White	9	0.1			
	Gold			±5%	J	
	Silver			±10%	K	

Radial or Ayial Lead Ceramic Capacitors
(6 Dot or Band System)



Temp. Coefficient			Capacitance			Nominal Capacitance Tolerance		
T.C.	1st Color	2nd Color	1st and 2nd Sig. Fig.	Multiplier	Color	10 pF or Less	Over 10 pF	Color
P100	Red	Violet	0	1	Black	±2.0 pF	±20%	Black
P030	Green	Blue	1	10	Brown	±0.1 pF	± 1%	Brown
NPO	Black		2	100	Red		± 2%	Red
N030	Brown		3	1,000	Orange		± 3%	Orange
N080	Red		4	10,000	Yellow		+100% -0%	Yellow
N150	Orange		5		Green	±0.5 pF	± 5%	Green
N220	Yellow		6		Blue			Blue
N330	Green		7		Violet			Violet
N470	Blue		8	.01	Gray	±0.25 pF	+80% -20%	Gray
N750	Violet		9	.1	White	±1.0 pF	±10%	White
N1500	Orange	Orange						
N2200	Yellow	Orange						
N3300	Green	Orange						
N4200	Green	Green						
N4700	Blue	Orange						
N5600	Green	Black						
N330 ±500	White							
N750 ±1000	Gray							
N3300 ±2500	Gray	Black						

5 Dot or Band Ceramic Capacitors
(one wide band)

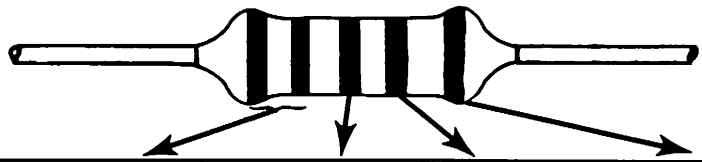


Fixed cermic capacitors, 5 dot or band system

Color Code for Ceramic Capacitors

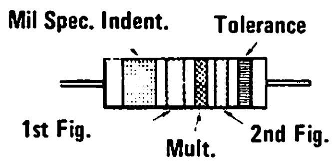
Color	1st & 2nd Significant Figure	Multiplier	Capacitance Tolerance		Temp. Coeff.
			Over 10 pF	10 pF or Less	
Black	0	1	±20%	2.0 pF	0
Brown	1	10	± 1%		N30
Red	2	100	± 2%		N80
Orange	3	1000			N150
Yellow	4				N220
Green	5				N330
Blue	6		± 5%	0.5 pF	N470
Violet	7				N750
Gray	8	0.01		0.25 pF	P 30
White	9	0.1	±10%	1.0 pF	P500

5 Band Ceramic Capacitors
(all bands equal size)



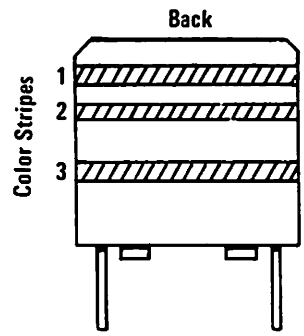
color	1st, 2nd Band	Multiplier	Tolerance	Characteristic
Black	0	1	±20% (M)	NPO
Brown	1	10		Y5S
Red	2	100		Y5T
Orange	3	1K		N150
Yellow	4	10K		N220
Green	5		N330	
Blue	6			N470
Violet	7			N750
Grey	8		±30% (N)	Y5R
White	9		SL (GP)	
Gold	-	0.1	±5% (J)	Y5F
Silver	-	0.01	±10% (K)	Y5P

Tubular Encapsulated RF Chokes



Color	*Figure*	*Multiplier*	*Tolerance*
Black	0	1	
Brown	1	10	
Red	2	100	
Orange	3	1,000	
Yellow	4		
Green	5		
Blue	6		
Violet	7		
Gray	8		
White	9		
None			20%
Silver			10%
Gold			5%

Multiplier is the factor by which the two color figures are multiplied to obtain the inductance value of the choke coil in uH.
Values will be in uH.



"POSTAGE STAMP" FIXED INDUCTORS

Color	1st Digit 1st Strip	2nd Digit 2nd Strip	Multiplier 3rd Strip
Black or (Blank)	0	0	1
Brown	1	1	10
Red	2	2	100
Orange	3	3	1,000
Yellow	4	4	10,000
Green	5	5	100,000
Blue	6	6	
Violet	7	7	
Gray	8	8	
White	9	9	
Gold			X.1
Silver			X.01

GLOSSARY

Aging — operating a component or instrument at controlled conditions for time and temperature to screen out weak or defective units and, at the same time, stabilize the good units.

Anode — the positive electrode of a capacitor or diode.

Capacitance — the measure of the size of a capacitor. Usually expressed in microfarads and picofarads. Determined by the size of the plates, and the dielectric material.

Capacitive reactance — the opposition to the flow of a pulsating DC voltage or AC voltage. Measured in ohms.

Capacitor — an electronic component consisting of two metal plates separated by a dielectric. Can store and release electrical energy, block the flow of DC current or filter out or bypass AC currents.

Cathode — the negative electrode of a capacitor or diode.

Charge — the quantity of electrical energy stored or held in a capacitor.

Clearing — the removal of a flaw or weak spot in the dielectric of a metalized capacitor. The stored energy in the capacitor vaporizes the material in the immediate vicinity of the flaw. Also called self-healing or self-clearing.

COG — same as NPO. Very small capacity charge for large temperature changes.

Coil — an inductor wound in a spiral or circular fashion. Can be wound on a form or without a form such as an air coil.

CV product — the capacitance of a capacitor multiplied by its working voltage. Used when determining the leakage allowable in electrolytic capacitors. The CV product is also equal to the charge that a capacitor can store at its maximum voltage.

Dielectric — the insulating or non-conducting material between the plates of a capacitor where the electric charge is stored. Typical dielectrics include air, impregnated paper, plastic films, oil, mica, and ceramic.

Dielectric absorption — the measure of the inability of a capacitor to completely discharge. The charge that remains after a determined discharge time is expressed in a percentage of the original charge. Also called "Capacitor Memory" or "Battery Action".

Dielectric constant — the ratio of capacitance between a capacitor having a dry air dielectric and the given material. A figure for determining the efficiency of a given dielectric material. The larger the dielectric constant, the greater the capacity with a given size plate.

Disc capacitor — small single layer ceramic capacitor consisting of disc of ceramic dielectric with silver deposited on both sides as the plate. The ceramic material can be of different compositions to give different temperature curves to the capacitor.

Dissipation factor (DF) — the ratio of the effective series resistance of a capacitor compared to its reactance at a given frequency, generally given in percent.

Electrolyte — a current conducting liquid or solid between the plates or electrodes of a capacitor with at least one of the plates having an oxide or dielectric film.

Electrolytic capacitor (aluminum) — a capacitor consisting of two conducting electrodes of pure aluminum, the anode having an oxide film which acts as the dielectric. The electrolyte separates the plates.

Equivalent series resistance (ESR) — All internal series resistances of a capacitor are lumped into one resistor and treated as one resistor at one point in the capacitor.

Farad — the measure or unit of capacity. Too large for electronic use and is generally measured in microfarads or picofarads.

Fissures — cracks in the ceramic dielectric material of disc capacitor, most often caused by thermal shock. Some small fissures may not cause failure for a period of time until exposed to great thermal shock or mechanical vibration for a period of time.

Fixed capacitor — a capacitor designed with a specific value of capacitance that cannot be changed.

Gimmick — a capacitor formed by two wires or other conducting materials twisted together or brought into close proximity of each other.

GMV — Guaranteed Minimum Value. The smallest value this ceramic capacitor will have. Its value could be much higher.

Henry — The unit of the measure of inductance. Also expressed in microhenry and millihenry.

Inductor — a device consisting of one or more windings with or without a magnetic material core or introducing inductance into a circuit.

Inductance — the property of a coil or transformer which induces an electromagnetic force in that circuit or a neighboring circuit upon application of an alternating current.

Inductive reactance — the opposition of an inductor to an alternating or pulsating current.

Impedance — the total opposition of a circuit to the flow of an alternating or pulsating current.

Insulation resistance — the ratio of the DC working voltage and the resulting leakage current through the dielectric. Generally a minimum value is specified, usually in the several thousand megohms range.

Iron core — the central portion of a coil or transformer. Can be a powdered iron core as in small coils used in RF to the large iron sheets used in power transformers.

Leakage current — stray direct current flowing through the dielectric or around it in a capacitor when a voltage is applied to its terminals.

Metalized capacitor — one in which a thin film of metal has been vacuum plated on the dielectric. When a breakdown occurs, the metal film around it immediately burns away. Sometimes called a self-healing capacitor.

Monolithic ceramic capacitor — a small capacitor made up of several layers of ceramic dielectric separated by precious metal electrodes.

Mutual inductance — the common property of two inductors whereby the induced voltage from one is induced into the other. The magnitude is dependent upon the spacing.

NPO — an ultra stable temperature coefficient in a ceramic disc capacitor. Derived from "negative-positive-zero". Does not change capacity with temperature changes.

Padder — a high capacity variable capacitor placed in series with a fixed capacitor to vary the total capacity of the circuit by a small amount.

Power factor — the ratio of the effective resistance of a capacitor to its impedance.

Reactance — the opposition of a capacitor or inductor to the flow of an AC current or a pulsating DC current.

Self-healing — term used with metalized foil capacitors.

Solid tantalum capacitor — an electrolytic capacitor with a solid tantalum electrolyte instead of a liquid. Also called a solid electrolyte tantalum capacitor.

Surge voltage — the maximum safe voltage in peaks to which a capacitor can be subjected to and remain within the operating specifications. This is not the working voltage of the capacitor.

Temperature coefficient (TC) — the changes in capacity per degree change in temperature. It can be positive, negative, or zero. Expressed in parts per million per degree centigrade for linear types. For non-linear types, it is expressed as a percent of room temperature.

Time constant — the number of seconds required for a capacitor to reach 63.2% of its full charge after a voltage is applied. The time constant is the capacity in farads times the resistance in ohms is equal to seconds ($T = RC$).

Trimmer — a low value variable capacitor placed in parallel with a fixed capacitor of higher value so that the total capacity of the circuit may be adjusted to a given value.

Variable capacitor — a capacitor that can be changed in value by varying the distance between the plates or the useful area of its plates.

Voltage rating — see working voltage.

Wet (slug) tantalum capacitor — an electrolytic capacitor having a liquid cathode.

Working voltage — the maximum DC voltage that can be applied to a capacitor for continuous operation at the maximum rated temperature.

SERVICE & WARRANTY

Warranty

Your Sencore instrument has been built to the highest quality standards in the industry. Each unit has been tested, aged under power for at least 24 hours, and then retested on every function and range to insure it met all published specifications after aging. Your instrument is fully portected with a 1 year warranty and Sencore's exclusive 100% Made Right Lifetime Guarantee in the unlikely event a manufacturing defect is missed by these tests. Details are covered in the separate booklet. Read this booklet thoroughly, and keep it in a safe place so you can review it if questions arise later.

Service

The Sencore Factory Service Department provides all in or out-of-warranty service and complete recalibration services for Sencore instruments. NO LOCAL SERVICE CENTERS ARE AUTHORIZED TO REPAIR SENCORE INSTRUMENTS. Factory service assures you of the highest quality work, the latest circuit improvements, and the fastest turnaround time possible because every technician specializes in Sencore instruments. Sencore's Service Department can usually repair your instrument and return it to you faster than a local facility servicing many brands of instruments, even when shipping time is included.

YOU DO NOT NEED AUTHORIZATION TO RETURN AN INSTRUMENT TO SENCORE FOR SERVICE. Be sure you include your name and address along with a description of the symptoms if it should ever be necessary to return your instrument. Ship your instrument by United Parcel Service or air freight if possible. Use parcel post only when absolutely necessary.

BE SURE THE INSTRUMENT IS PROPERLY PACKED. Use the original shipping carton and all packing inserts whenever possible. If the original packing material is not available, make certain the unit is properly packed in a sturdy box with shock-absorbing material on all sides. Sencore suggests insuring the instrument for its full value in case it is lost or damaged in shipment.

A separate schematic and parts list is included if you wish to repair your own instrument. Parts may be ordered directly from the Factory Service Department. Any parts not shown in the parts list may be ordered by description. Maintenance instructions and circuit descriptions may be ordered from the Service Parts Department.

We reserve the right to examine defective components before an in-warranty replacement is issued.

SENCORE FACTORY SERVICE
3200 Sencore Drive
Sioux Falls, SD 57107
(605) 339-0100
TWX: 910-660-0300

Fill in for your records:

Date Purchased: ______________________________

Serial Number ______________________________

Run Number ______________________________

(NOTE: Please refer to the run number if it is necessary to call the Service Department. The run number may be updated when the unit has been returned for service.)

Form 3584

PRINTED IN USA