HINTS ON READING CAPACITOR CODES

Readers who have occasion to handle imported electronic equipment should appreciate the tabulated information given in this article. It is reproduced from "Service Scope," a publication issued by Tektronix Inc., for their customers and service agents.

As far as possible, Australian capacitor manufacturers tend to favour the practice of making capacitor values and ratings directly on the body of the component. Where a color or letter code is used, it is normally no great problem to verify it by reference to local manufacturer's literature.

The real problem arises with capacitors found in imported equipment and marked only with a series of letters, numbers or colour dots, for which there is no related literature. One may guess at the significance of some of the markings but there is always the possibility that the guess may be wrong. And there are often other markings, the meaning of which is unknown.

The problem with the marking of capacitors arises largely from the fact that there is so much information which needs to be encoded, the capacitance value being only one of the things a customer needs to know. Almost certainly, he will need to be informed about other parameters such as tolerance, temperature coefficient and voltage rating. What is more, the need for such data varies with the type of capacitor involved.

With electrolytic capacitors, tolerance and temperature coefficient are seldom important, but peak and working voltage ratings are, even related in some cases to temperature.

Voltage rating and tolerance are important for ceramic capacitors intended for bypass functions; temperature coefficient is less so. For coupling and trimming functions, involving ceramic capacitors of a different type, the emphasis shifts away from voltage rating towards the details of tolerance and temperature coefficient. Thus, temperature coefficient will seldom, if ever, be found on electrolytic capacitors but will amost invariably appear on ceramic fixed capacitors and trimmers intended for coupling, alignment and compensation circuits.

Faced with coding problems, manufacturers have often resorted to improvised methods which may cause no great problem to themselves or their immediate customers. The problem arises later when the same capacitors turn up in isolation or in equipment being serviced, with no readily available key to the coding.

It would be a mammoth task to discover and list the coding methods which have been adopted from time to time by individual manufacturers but what follows is a summary of accepted present-day practice.

CERAMIC DISC CAPACITORS

Often called "discaps" (that's the trademark of one manufacturer), ceramic disc capacitors are available in two categories: temperature compensating or class I, and "high-K" or class II. Temperature compensation (Tc) types usually carry the capacitance in pF's directly. Tolerance may be shown in per cent or by letter:

M = ± 20%
K = ± 10%
J = ± 5%
G = ± 2%
F = ± 1%

Temperature coefficient is indicated as the number of parts per million per degree centrigrade by which capacitance will increase with temperature (+) or decrease (—). Thus P100 stands for +100 P/M/° C, N750 for —750 P/M/° C, NPO for 0 P/M/° C, N030 for —30 P/M/° C, etc. All these Tcs have a tolerance, too. NPO is usually ±30 P/M/° C, with looser tolerance on larger Tcs. Tc tolerance is also looser on very low capacitance parts.

"High-K" types list capacitance the same way (or in μF), and in addition sometimes use a multiplier scheme as follows: 102 for 1000 pF, 473 for 47,000 pF, etc. Capacitance tolerance is shown as above, with the addition of P for GMV ("guaranteed minimum value" or —0, +100%), and Z for —20, +80%. The temperature coefficient of these units is usually not linear, so only the maximum capacitance change due to temperature from the 25° C value is given. This is called the "temperature characteristic," a typical case being "Z5U." This table explains the meaning of the more common temperature characteristic designations. Temperature range over which characteristic is effective:

Z5: +10° C to +85° C
Y5: —30° C to +85° C
X5: —55° C to +85° C
W5: —55° C to +125° C

Limits of capacitance change from the room temperature value:

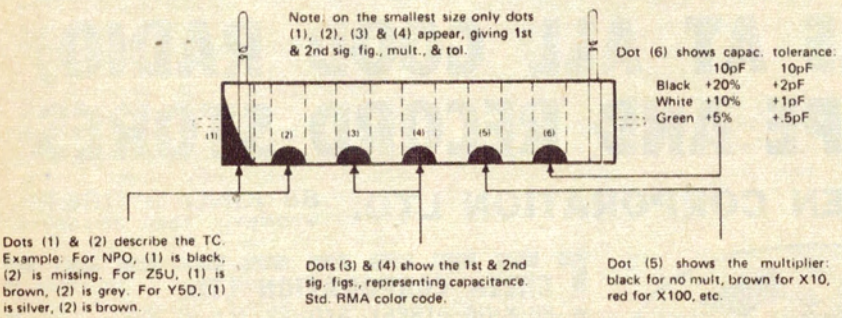
D: ±3.3%
E: ±4.7%
F: ±7.5%
S: ±22%
U: +22, —56%
V: +22, —82%

Thus "Z5U" means that temperature can cause the capacitance to increase a maximum of 22%, or decrease a maximum of 56% from the room temperature value, within the limits of +10° C and +85° C.

Whether voltage rating appears on a disc depends on the manufacturer's practice. Most do not include it on their "standard" voltage rating, which is 1000V for Sprague and RMC, and 500V for Erie. Other voltage ratings, however, are printed on the capacitor.

High-voltage ceramic discs and plates used at Tektronix are of class II dielectric material, and carry labels similar to the class II discs.

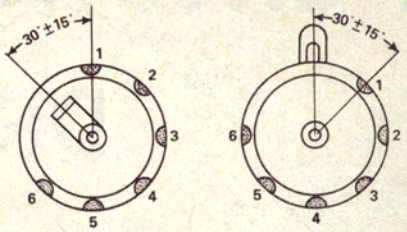
CERAMIC TUBULAR CAPACITORS



These units are usually white enamel coated and have parallel radial leads. "Dog bones" come in both class I and class II dielectrics and in several sizes, at least one being too small for a complete code of any kind. The code consists of colour dots which show temperature coefficient (Tc), capacitance, and tolerance (Tol.). The smallest style shows only capacitance and tolerance, and none can show the capacitance of a close-tolerance part to greater than two significant figures. The more common examples are illustrated above.

BUTTON MICA CAPACITORS

The most difficult aspect of understanding the code on these parts is "where do you begin?" The sketch shows that the first dot is keyed to a centre terminal lug.



Dot Meaning

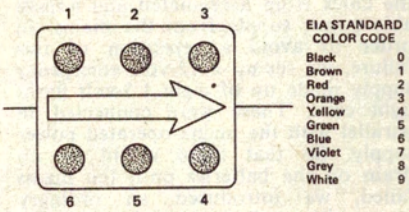
1. Identifier: Black, except omitted where capacitance must be specified to 3 significant figures.
2. Capacitance; 1st significant figure in pF.
3. Capacitance: 2nd significant figure in pF.
4. Multiplier of Capacitance: black = X1, brown = X10, red = X100, etc.
5. Capacitance Tolerance: black = ±20%, silver = ±10%, gold = ±5%.
6. "Characteristic": black means a temperature coefficient falling somewhere between −20 and+100P/M/°C.

Note: The dots always read in a clockwise direction.

If the button has no centre lug terminals, the manufacturer tries to put the dots more on one side than out on the very edge; thus the code can be seen from one side only.

MOULDED MICA CAPACITORS

Colour codes on this type vary, causing much confusion. There are two basically different code schemes, one being "OLD," the other being the EIA/MIL scheme currently in use. The sketch shows the difference.



OLD

Dot Meaning

1. Capacitance: 1st significant figure in pF.
2. Capacitance: 2nd significant figure in pF.
3. Capacitance: 3rd significant figure in pF.
4. Multiplier of capacitance.
5. Tolerance: Black = ±20%, Silver = ±10%, Green = ±5%, Brown = ±1%
6. "Characteristic": Brown = B, Yellow = E, Green = F

EIA/MIL

Dot Meaning

1. Identifier: White if per commercial specification, black if per mil specification.
2. Capacitance: 1st significant figure in pF.
3. Capacitance; 2nd significant figure in pF.
4. Multiplier of capacitance.
5. Tolerance: same as "OLD."
6. "Characteristic": same as "OLD."

Note: "Characteristic" in mica capacitors refers to the temperature coefficient and capacitance drift.

Char.	T_c (P/M/°C)	Drift
B	±500	±3% +1 pF
C	±200	±(0.5% +0.5 pF)
D	±100	±(0.3% +0.1 pF)
E	-20 to +100	±(0.1% +0.1 pF)
F	0 to +70	±(0.05% +0.1 pF)

OTHER TYPES

DIPPED MICA CAPACITORS: These parts carry a printed label much like that on ceramic discs. They may include the characteristic letter explained in the table above.

PAPER AND FILM CAPACITORS, ALUMINIUM AND TANTALUM ELECTROLYTIC CAPACITORS: In almost all cases they carry printed or stamped labels consisting of capacitance, tolerance, and voltage rating. Other characteristics are either unimportant or are reasonably consistent in all capacitors of the same kind.

CERAMIC TRIMMERS: The printed on labels usually show capacitance range and temperature characteristic. Tc reads the same as on ceramic discs. The tolerance on Tc of ceramic trimmer rotors is much looser than on fixed capacitors, for mechanical reasons.

AIR TRIMMERS: The same principle applies as in the case of paper and film capacitors. Only capacitance range need be indicated as Tc is essentially uniform in this type.

(NOTE: Readers may wish to be reminded of the article "Fixed Capacitors —a guide to types and characteristics" which appeared in the May, 1965 issue of "Electronics Australia." Among the subjects discussed in this article are included tolerance, stability, operating frequency, leakage, losses and physical construction. Copies of this article can still be obtained from the Information Service for 20c post free.) ■