Capacitor code guide pdf

[Previous Chapter] [Summary] [Subsequent Chapter] Dept. of Health, Education and Wellness Public Health Service Food and Drug Administration * Time / Gold / Deio / IB * Date: 10/23/87 Number: 50 sectors of the related program: Medical devices, Radiological Health ITG Subject: Condenser The purpose of this ITG is to know the investigator with the condenser. Only the basics will be discussed, since it is at the purpose of this ITG to get into great detail. It is stressed that there is no single capacitor that performs all the others, as each condenser is designed to perform a specific task. This ITG will explain the theory of the capacitor operation, the various types of capacitors, physical and electrical capacitors of condensers, the failure mode of the various types, design considerations and environmental effects. The theory is electrically, "capacitance" is present between two adjacent conductors. A condenser is composed of two conductors, usually parallel metal plates, separated by a dielectric or vacuum material so as to keep a large electric charge in a small volume. Depending on the proposed application, the dielectric can be air, gas, paper, organic film, mica, glass or ceramic. The operation of a condenser is similar to explode a balloon and release the air from it. Imagine blowing a balloon, pinching the air nozzle for a few seconds, then releasing the air nozzle so that the air can flow. Similarly, a condenser (blown) is charged to some voltages (air pressure) from an AC or DC voltage source (Air Blower). Once the voltage source is removed, the condenser holds the voltage for some time (pinching the air nozzle) and then start getting rid of the electricity (releasing the air nozzle). The speed with which the condenser drains depend on how much resistance The unloading current meets. More resistance You have the slowest, the current will be downloaded from the condenser. Thinking in terms of balloons, we can say that the closer pinching the air nozzle (resistance) plus air flows (current discharge). If a large piece of metal is placed through the two condenser terminals, the condenser will be discharged instantly and sparks will occur. This is due to the sudden flow of the exhaust current through a negligent resistance. This phenomenon is similar to ticking a balloon where the non-insisted air flow through the Foroinhole is so beautiful that the balloon explodes. The basic equations governing the operation of a condenser are: (1) capacity (c) = charge (q) = ke a ------------ --- voltage (v) D where c It is in Farads Unit (F), Q is in Coulombs (C), and V is in volt (V). A capacitor possesses a capacity Farada if his potential is raised a volt when he receives a charge of a coulomb. On the right side of the equation, K is the dielectric constant (without a unit), eo is the air pressure (8.85 x 10 -1 2 f / cm), a is the area of one of the plates Condensers (cm 2), and D is the separation distance between the two plates (cm). Capacity is more commonly expressed in 10 6 subdivisions called microFarads (UF). (2) Energy (J) = 1/2 capacity (C) X voltage 2 (V) = QV - 2 where J is in watt-seconds or joule units. The equation (1) shows that the ability can be increased in different ways; By reducing the voltage, obtaining a dielectric with a upper K, increasing the area of the condenser plate or decreasing the distance between the condenser plates. The equation (2) shows that energy experiences its largest increase if the voltage has increased. Capacitors are mainly used as energy storage devices; Ie, they preserve electricity until energy is necessary to enter Which uses the condenser. The capacitors are now widely used to keep the DC current from the entrance of a part of a circuit (block), freeing an unwanted noise circuit or distortion (filtering), combining the desired frequencies to resonate in a circuit (coupling), ed Excluding some frequencies from resonance in in Circuit (bypassing). The types of condensers are generally available in two types; Fixed and variable. Fixed capacitors are manufactured to possess a specific capacity that cannot be modified and variable capacitors are manufactured to allow variability to be variable on a wide range. The capacitors are also classified into two generic categories; Electrostatic and electrolytic. Electrostatic capacitors are full of dielectrics composed of a gas, liquid, solid or combination of these. The electrolytic capacitors are characterized by a very thin metal oxide dielectric film size on the surface of one or more electrodes. A. Fixed capacitors with ceramic capacitors - these are a unique family of capacitors with dielectric constants ranging from 6-10,000. They can be easily manufactured for the desired physical and electrical characteristics by applying ceramic chemistry. Ceramic capacitors are so widely used that they are available in three classes. Class I ceramics are used for resonant circuits and bypass and high frequency coupling. These capacitors have a broader temperature range than class II and class III capacitors. Class II ceramics are used where miniaturization is required to circumvent radiofrequencies, filtering and interstaglia coupling. Class III ceramics are used where low voltage and bypassing couplings are needed in transistor circuits. Vacuum capacitors - These capacitors have the lowest possible dielectric constant and are limited to the capacities of 10 3 pf (10- 3 UF), up to 50 kV (50x10 3 volts) can be available and can carry huge currents up to 100 amp. Vacuum capacitors are extremely useful because their life, tearing any particle contamination in the vacuum chamber, is indefinite. Condensers Mica: These capacitors find their use in such applications such as high frequency filtering, bypassing, block, buffering, coupling and fixed tuning. Metallized paper and cinematographic capacitors - The use of this class of condensers is ideal where large amounts of heat will be present in a circuit. These capacitors possess a unique self-healing property for which they eliminate momentary short circuits induced in their dielectrics caused by surrounding circumstant circuit elements. Once the condenser becomes too hot, the localized heat generated is sufficient to vaporize the thin electrode in the area of possible breakdown. Auto-care capacity allows these capacitors to have higher voltage assessments for a given thickness. Radiofrequency interference capacitors (RFI) - RFI capacitors are ideal for suppressing unwanted noise from electronic circuits. This minimizes the amount of noise that passes from one circuit phase to another, so improving the overall performance of the circuit. Cinematographic capacitors - These capacitors are widely used where circuits will experience exposure to humidity. Their resistance to the penetration of humidity is by far superior. The cinematographic capacitors are applied in circuits that require block, buffering, bypassing, coupling, tuning and timing. Electrolytic capacitors - The electrolytic capacitors are very different from those previously mentioned as electrolytics are usually polarized. This means that the polarity of the applied voltage must correspond to the polarity of the condenser or the intense heating occurs and the condenser will be burned. Electrolytics meet the design requirements for low-frequency filtering, long-term timing, And decoupling and some bypass applications that require high values of capacities and small volumes. Other condensers commonly used as fixed capacitors are air, glass and paper types. These are the first capacitors to use and still find use in general cases. B. Variable capacitors with variable capacitors, also called trimmers, are invaluable in the design of electronic equipment. Variable capacitors are generally used to provide a range of capacities and are commonly used in applications where exact capacity values cannot be obtained using normal design procedures. These these They are usually built in such a way that the capacity vary is obtained by adjusting the metal plates in the condenser. Screws on these capacitors increase or decrease the actual plate area causing this increase or decrease in capacity. (The inspection of the equation (1) shows this.) The most widely used trimmers are ceramic, glass, air, plastic and mica. C. Special condensers with feeding capacitors - These capacitors are used in cases where conventional capacitors are not effective for high radio frequency filtering. The power capacitors are three terminal devices that do not show the serial-resonant characteristic of the conventional condenser. This allows them to suppress radio frequency interference on a wide range of frequencies and are particularly valuable in filtering the power wiring and control circuit in high frequency screen equipment. High energy storage capacitors: these capacitors are constructed with paper impregnated oil and / or film dielectric. Their main use is for the forming networks of the wrists that use voltages above 1000 volts. Special electrolytic capacitors can be used for slightly lower voltages. Switching capacitors - these are built with impregnated petroleum paper and film dielectric. They are mainly used in triggering circuits because they are characterized by rapid increase times (time takes the capacitor to rise from 10% to 90% of its maximum voltage) and high-current transient and peak voltages associated with switching. Packaging - Capacitors are available in a wide variety of packaging styles. The most common styles are shaped, in glass enclosed, chip, in vase, coated and dual-in-line packaging (DIP). Modeled capacitors are chip rectangular condensers that can be molded in radial or axial rectangular packages or axial lead cylindrical packages. The condensers collected in glass can be single or multilayer chips with axial cables attached in a glass tube. These seem a lot like molded capacitors. Chip capacitors are thin rectangular condensers and lead-free dishes or body wiring so that they can be placed in microelectronic circuits. Potted capacitors, in many ways, are synonymous with modeled capacitors. The only difference is that pot capacitors are protected as a bakery. Coated capacitors, more commonly known as diving capacitors, are available in rectangular styles and discs with radial cables and are immersed in the liquid resin. Coated capacitors find great use in which exact dimensions can be compromised. Diving capacitors are single or multilayer capacitors treated in integrated packages. The mica chips are available in buttons styles. This package is composed of a stack of silvered mica discs connected in parallel. Figures 1, 2 and 3 show some of the various types and packaging styles of condensers. Figure 1a (image size 29kb) shows the immersion lead capacitors (top) and with printed axial capacitors (lowered group); Figure 1b (image size 29kb) shows glass angle axial capacitors (a), chip condensers (B & C), molded lead capacitors (D), axial condensers printed and lead capacitor capacitors (f); Figure 1C (image size 29kb) shows the various styles of feeding capacitors; and Figure 1D (image size 29kb) Show radial-lead condensers (upper and lower left), printed axial condensers (lower right group), button capacitors (medium-medium group) and Fixed terminals (Top Central and top right). Figure 2a-C (13KB image size) shows various types of trimmer capacitors. Figure 3 (image size 7kb) (figure shows (a) mica; (b) glass; (c) ceramic; (d) ceramic for generic use; (e) solid electrolyte tantanum; (f) foil tantalum; (g) -Through Button Mica and Ceramica; (h) Plastic film for generic use; and (i) generic paper. Physical and electrical specifications There are numerous criteria that the designer uses to choose the capacitor that will improve a specific task. List Here are some of the specifications Most important important In the assessment of condenser performance. Dissipation factor (DF) - This is a measure of loss in a condenser. Sometimes this is interchanged with a loss measure called power factor (PF). Lands in large reel and AC paper capacitors are DF, while losses in most capacitors used in CC or low-level condensers are PF. The current ideal should bring the voltage of 90 into a condenser, but due to the production processes, the current brings the voltage by an angle A. The DF = tan (90 -a) and PF = sin (90 -A)). Lower is the DF, the better the condenser. Resistance to the equivalent series (ESR) - In the capacitors, this is defined as the AC resistance (R) of a condenser that expresses the loss at a certain frequency (F). The ESR is related to the PF with the relation: R = PF X 10 6 --- 2 FC in OHMS units. Insulation resistance (IR) - This is resistance through the terminals of a condenser. IR is inversely proportional to capacity and temperature so that capacity (or temperature) increases IR will decrease. Dielectric strength: corresponds to the maximum voltage that a dielectric material can withstand without breaking. Electrostatic capacitors are often specified by their dielectric resistant to tension (DWV) and this is synonymous with dielectric resistance. The dielectric resistance is usually specified in Volt per mil at constant temperature. Dielectric absorption: This is the property of an imperfect dielectric in which all electrical accusations within the body of the material caused by an electric field are not returned to that field. Dielectric absorption is measured by determining the "reappearance voltage" which appears through a condenser at a certain point in time after the condenser was completely unloaded in short-circuit conditions. It is expressed as the ratio of reappearing to the charging voltage. Volumetric efficiency: this is obtained by obtaining most of the capacities of the smallest possible volume. The volume is a function of dielectric material used and the construction method. Capacitors with high volumetric efficiency are the most applicable in most new projects of integrated circuit electronic equipment. Temperature coefficient (TC) - TC is the change in the capacity to measure degree of temperature variation. It can be positive, negative or even zero and is expressed in parts per million per degree Celsius (ppm / 0c). The equation that determines the TC is: TC = C1-C 2 x 10 6 ------ (T 1-T 2) C 1 where C 1 EC 2 are the initial and final capabilities and T 1 and T 2 are the initial and final temperatures. Voltage ratings - There are two types of voltage evaluations to be considered when evaluating the condenser performance; DC voltage and overvoltage and AC voltage. In the case of Voltage Ratings DC and Surge, the thickness of the dielectric determines the maximum overvoltage and DC voltages that can be applied. AC voltage ratings are usually specified for ceramic capacitors. This assessment corresponds to the required AC voltage to make the sum of the DC voltage and the AC voltage below the nominal DC voltage. In addition to these assessments there are some types of electrolytic capacitors in which the voltage applied is primary concern. The electrolytic capacitors are sensitive to the effects of tension because they are highly polarized devices. Even if the voltage applied is lower than the specified maximum voltage, the voltage drop through the condenser ESR will reduce the condenser's life expectancy through an accelerated effect of internal heating. Current evaluations: current evaluations to be considered Loss and ripple currents. The dispersion current is the current DC current of the relatively small value that flows through the condenser when the voltage is applied through the terminals. The ripple current is the AC component of a unidirectional current. For electrolytic capacitors, there is also a maximum allowed charge and discharge the exhaust current. Frequency - Because there is an internal inductance in a condenser there will be a resonant frequency. Dependent employee Type of condenser, this frequency can or can't fall into an interval that is a problem for the designer. This problem arises because the designer would like the condenser to block or minimize the DC current and resonance the internal impedance is a minimum that causes maximum DC current. Driving mode electrolytic capacitors - most faults in electrolytic capacitors results from two cases; O The breaking of the dielectric film due to the low IR or loss of electrolyte due to high IR. Dielectric break is an electrochemical insufficiency caused by the improper chemical composition of the dielectric material used in their manufacture. The addition of contaminants such as chloride is also a predominant factor in dielectric break. The loss of electrolytes is a mechanical insufficiency and is most commonly caused by insufficient compression seal, losses on the welding on the bottom of the cylinder (in axial devices) and leaks around the aluminum terminals or to the tantalum in headers or seals in Plastic (printed). Other fault modes exist in the form of scarce welds or pressure connections by becoming open circuits after a short duration of conservation or operating life. Ceramic capacitors - Most faults in ceramic capacitors is caused by raporous materials used to protect the capacitor and lead group from outdoor environments. Other failures include electrical degradation and intermittent failures. The electrical degradation is caused by thermal expansion of encapsulating and moisture between the section of the coating and the condenser. Intermittent or open failures are caused by bad welding techniques and terminal design that translate into free or detached cables. Paper and cinema capacitors - Paper and film capacitors are subject to the same error methods of electrolytic capacitors with the exception of electrolyte loss. The sealing loss is common in capacitors impregnated in poorly made oil. Mechanical failures are caused by the fracture of the electrode tongue at the connection point to the electrode or the external cable. The rough edges on the electrodes of the sheet sheet cause an early shoring, especially if the lower plate is more thick than the upper. Design considerations The reliability of a condenser depends on the degree of success obtained in the housing of the capacitor element in a mechanically and respectful enclosure of the environment. The capacitors with the construction of internal lead must be mechanically and electrically sounds before the release is applied. The encapsulated capacitors or printed capacitors cannot resist dynamic environments such as high levels of shock and vibrations. For mechanical integrity, metallurgical obligations and reinforcement materials should be used. When considering which capacitor is better executed a specific circuit task there are several options available. These options depend on the cost of the condenser and the condenser's physical and electrical properties with respect to the task that is going to perform. If accuracy is a must, therefore it is recommended that the capacitors mica, glass, ceramics and films (polystyrene) are used. These capacitors possess an exceptional capacity stability compared to temperature, voltage, frequency and waist. The circuits that settle for semiprecision can use paper / plastic film capacitors (with metallic sheet or dielectric sheet) because they are currently a large portion of applications. If precision is of no importance, therefore, general purpose capacitors are recommended. These are the least expensive capacitors and have good performance ratings. Where it is The suppression of radiofrequency interference, RFI and feed-through capacitors are the best equipped. For heavy currents (60-40 Hz power supply), the dielectric card or film capacitors must be used for suppression, ceramic and button-mica capacitors are recommended with low frequency capacitors for low currents. Ceramic chip capacitors are higher in the list for use in microelectronic circuits. These capacitors are electrically and physically the most suitable for such such If a capacitor is to be used as a transmitter, it is recommended that the gas, the vacuum or the ceramic capacitors are used. These capacitors possess the high capacity radio frequency (rf) power management, high RF current and voltage, low loss, low internal inductance, and very low ESR. Environmental effects The effective function of a capacitor depends very much on the physical environment that surrounds it. Of these many possible effects, those of primary concern regarding medical devices are temperatures, humidity, dynamics, pressure and radiation. Temperature - The maximum operating ambient temperature surrounding a capacitor in an application is critical. At the ambient temperature changes, the dielectric constant and ability to change more capacitors. The useful life of a capacitor decreases if it is subjected to high temperatures for a large amount of time. As the environment temperature surrounding the capacitor increases, the condenser should receive less than the nominally applied peak voltage. On the other part of the spectrum, also the cold temperatures can present problems. electrolytic capacitors change their immensely few degrees capacity once they are exposed to temperatures below 25 aluminum electrolytic C. lose their ability to -55 C and tantalum loses about 20%. The low temperature equipment should be given time to the ability to climb once the equipment is turned on. Humidity (moisture) - An important consideration in the application of a capacitor is to make sure that no moisture penetrates the sealing of the case of the capacitor. The effects of humidity are parametric changes (especially IR), the reduced time duration and serious failure due to severe moisture penetration. Most sensitive to moisture the capacitors are not sealed-sealed dielectric-card. The moisture can easily penetrate into paper and can be trapped during manufacture, penetrate into the capacitor during the duration of the duration, or penetrate into the capacitor when exposed to a damp environment. Dynamic Environments - mechanically dynamic environments can damage or destroy a capacitor. The main dynamic environments are in the form of shock, vibration and acceleration. The movement of a capacitor assembly within a case can cause fluctuations in capacity, attachment errors of the electrodes and dielectrics and insulation failures. The susceptibility of a capacitor to dynamic environments depends on its physical construction; greater of the complex elements in the capacitor, the lower is the frequency response of the elements. Barometric Pressure: the pressure that the altitude in which a hermetically sealed capacitor can work safely. This altitude depends on the design of the wall of the housing for the final seal, the voltage at which the capacitor will be used and the type of impregnating agent used in the dielectric material. While the altitude increases, the dielectric strength through the final bond strength will decrease. If the altitude increases with the reduced barometric pressure, then the pressure inside the capacitor increases the mechanical stress on the case and seal until the occurrence of faults. Radiation - The particles of radiation can degrade the electrical performance of the capacitors. The main cause of radiation-induced defects capacitor's size variations in the interelectrode spacing. This change is due to the evolution of gas and swelling. The changes due to radiation are more pronounced in organic-dielectric capacitors. Capacitors using organic materials such as polystyrene, polyethylene terephthalate, polyethylene are less satisfactory in a radiation environment of about one that these condensers employ inorganic dielectric. The electrolytic capacitors (aluminum and tantalum) are able to exposure to extended radiation with tantalum to be more radiation resistant. Another defect from radiation occurs when the dielectric in the condenser experiences a considerable increase in his own In an ionizing radiation environment. This translates into the very dangerous discharge of a loaded condenser. References Chute, George M., Electronics in the industry. New York: McGraw-Hill Book Company, 1971. Fink, Donald G., Ed., Manual of electronic engineers. New York: McGraw-Hill Book Company, 1975. Fink, Donald G., Ed., Standard Manual for Electrical Engineers. New York: McGraw-Hill Book Company, 1960. Fugiel, Max, Modern Microelectronics. New York: Research and Training Association, 1972. Harper, Charles A., Ed., Manual of Electronic Components. NEW YORK: McGraw-Hill Book Company, 1977. Figure 1 (1a, 1b ,! C ,! (D) are the typical ceramic capacitors (AC) and Micha (D) Figure 2 (2a, 2b, 2c) are the typical Trimmer capacitors Figure 3 common fixed capacitors [previous chapter] [Summary] [Chapter Next] Chapter]