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Department of Communications

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TELECOMMUNICATIONS REGULATION CIRCULAR

PRINCIPLES UNDERLYING THE SUPPRESSION OF INDUCTIVE INTERFERENCE AT STANDARD BROADCAST FREQUENCIES

JUNE 1, 1976
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TELECOMMUNICATION REGULATORY SERVICE

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PRINCIPLES UNDERLYING THE SUPPRESSION OF INDUCTIVE INTERFERENCE AT STANDARD BROADCAST FREQUENCIES

1. Interference to radio reception may be caused by surges, sparks, or by the interruption of an electric circuit such as the opening and closing of switches, or motor commutation.

2. There are two components of the interference-producing voltage - namely, (1) the line-to-line component acting between the conductors of the supply line, and (2) the line-to-ground component acting between the line conductors jointly as one node, and ground as the other node. The line-to-ground component usually causes greater interference to radio reception than the line-to-line component.

3. Coupling from Source to Radio Receiver - The interference from electrical apparatus reaches the radio receiver by direct radiation, or conduction along the power lines, or both. The interference may radiate direct from the source, or from wires associated with the source acting as transmitting antennae, or the surge may be conducted along the supply circuit and radiated in the vicinity of the radio receiver or the antenna system.

4. Means of Suppression - Radio interference may be suppressed by any one or more of the following methods:

   (a) Applying a spark eliminator at the source;

   (b) Shielding to prevent direct radiation;

   (c) Capacitors to provide a low impedance by-pass;

   (d) Inductors to provide a high impedance circuit to restrict the interfering surge in the supply circuit;

   (e) Any desirable combination of two or more of the above-mentioned means;

   (f) Resistors to dissipate radio-frequency energy.

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5. Line-to-Line Component - Capacitors should be connected across the supply line according to Figure 1, page 8, in close proximity to the source of interference. These capacitors should, preferably, be non-inductive, have short leads, and be connected close to the source, to ensure that the by-pass circuit through the capacitance has sufficiently low impedance at radio frequency. Where this simple method does not sufficiently suppress the interference, it may be due to the fact that the capacitor circuit is not of sufficiently low impedance compared to that of the supply line, with the result that a considerable part of line-to-line component of the interfering voltage travels along the supply line. This condition may be rectified by inserting inductors as in Figures 2 and 3, in the supply line, to increase its impedance. The best relative position for the inductors depends upon radio frequency characteristics of the supply line, and can be determined by experiment.

5. Line-to-Ground Components

(a) The line-to-ground component usually causes the greater interference to reception, and may be suppressed by connecting capacitors from each line to the frame of the apparatus as shown in Figures 4 and 7. It is essential that the impedance at radio frequency of the capacitor circuit from the source of interference through the capacitor to the frame of the apparatus be kept as low as possible. The capacitors should, therefore, be non-inductively wound, and connected as close as possible to the source, with short leads.

(b) Where the frame of the apparatus is grounded, the capacitors may be connected from each line to the frame, according to Figure 4.

(c) Where the frame of the apparatus is ungrounded, it is necessary that a shock limiting capacitor of low capacitance be connected in the lead to the apparatus frame (Figure 7) in order that the leakage current from the line to the apparatus frame may under no conditions exceed C.S.A. specifications. (For most equipment this is 0.5 milliamperes.)

NOTE: The limit of 0.5 milliamperes refers to the total current to the frame and includes that due to capacitance and leakage of both the apparatus and the suppressor, combined.

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(d) Where the method described above does not satisfactorily suppress the interference, it may be necessary to insert choke coils in the supply leads according to Figures 5, 6, 8, or 9. The best arrangements can be determined by experiment.

7. Connection to Internal Point of Apparatus Circuit - In some cases tests indicate that the interference can best be suppressed by connecting capacitors to some point in the circuit in close proximity to the source, rather than to the apparatus terminals. For example, on large commutator motors and generators, individual capacitors should be connected from each brush holder to frame, with leads as short as possible.

8. Connection to Supply Lead

(a) In cases where it is more convenient to connect the suppressor to the supply circuit, and where there is no excessive impedance in the part of the circuit between the suppressor and the source, the suppressor may be connected in the supply lead as close as possible to the apparatus.

(b) Where the frame of the apparatus is grounded, the arrangements shown in Figures 1, 2, 3, 4, 5, or 6 may be used.

(c) Where the frame of the apparatus is ungrounded, a shock limiting capacitor is required, as previously described, and the arrangements shown in Figures 1, 2, 3, 7, 8, or 9 may be used.

9. Shielding - Where other methods of suppression fail, thorough shielding of the interfering apparatus may be necessary in addition to one or more of the suppressors previously described. To be effective, shielding must be according to the following specifications:

(a) Material - The material may be solid (either foil or sheet metal), or may be of mesh not greater than 5 mm, provided that the wires of the mesh are thoroughly bonded at each contact, e.g., galvanized steel mesh should be galvanized after weaving.

(b) Bonding - All sections of the shield should be thoroughly bonded at frequent intervals. No gaps should be left around the door openings, unless a liberal overlap is provided and good contact made at frequent intervals.

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(c) Ground - Usually the shielding should be grounded at one point only, with a short low impedance ground. In exceptional cases, however, multiple grounds may prove more satisfactory.

(d) Power Supply Leads - A capacitor must be connected from each conductor to the shield, at the point where the conductor passes through the shield.

(e) Double Shielding - In cases where a single shield provides insufficient suppression, a double shield may be used, provided that the two shields are complete in themselves and they are spaced more than 5 cm apart and bonded together and to the ground at one point only.

10. Sources Requiring Shielding - Typical examples of apparatus requiring shielding are as follows:

(a) All high frequency generators such as used for electro-medical purposes (diathermy, violet ray, etc.).

(b) Ozonators, such as used for purifying air, bleaching flour, etc.

(c) Industrial equipment using high frequency, such as electric welders, induction furnaces, etc.

11. Spark Eliminators and Surge Absorbers

(a) Sparking at contacts may be eliminated or reduced by the application of spark eliminators or surge absorbers according to Figures 10 or 11.

(b) As shown in Figure 10, a resistor in series with a capacitor is connected across the switch or circuit breaker with short leads of low impedance. The value of resistance is just sufficient to limit the current in the capacitor circuit to prevent sparking at the switch.

(c) Where the interference is caused by a voltage surge built up across a coil of high impedance such as relay coils used for elevators, control circuits, signalling, etc., this surge may be reduced or eliminated by a suitable capacitor connected across the coil with short leads.

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(d) It is usually found that the application of spark eliminators of surge absorbers, in addition to reducing radio interference, improves the operation of the associated switches and increases the life of the contacts.

12. Suppression of Interference from Sparks

NOTE: This applies to high voltage sparks such as are used for the ignition of oil-burning furnaces, etc., and for the formation of ozone in devices used for purifying air and bleaching flour.

(a) In order to eliminate interference from high voltage sparks, it is necessary to suppress the radio frequency components of the surge at a point in the circuit as near the spark as possible. This can best be accomplished by inserting a suitable resistor in the spark circuit and constructing the entire high tension part of the circuit with as short leads as possible.

(b) The interference may be further reduced by placing the entire high tension circuit within a grounded shield, which should include an electro-static shield between primary and secondary winding of the transformer. The high tension circuit should be ungrounded unless the centre of the high tension winding of the transformer is grounded. (See Figure 12.)

Values of Components of Suppressors

13. Capacitors

(a) As a general rule the capacitance value of capacitors used for the suppression of radio interference is not critical. The value of all the capacitors marked "C" in Figures 1 to 9 may be of the order of 0.1 μF. In special cases, however, larger capacitors may be required and the value of such can best be determined by experiment.

(b) The special case referred to above occurs when the capacitor and some inductance either in the suppressor or associated electrical apparatus forms an oscillating circuit and thereby increases the intensity of the interference. In such cases the value of the capacitor may be altered or a suitable resistance connected in series with the capacitor.

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(c) In the arrangement shown in Figure 11, the value of the capacitor is not critical, and it is usually found that a capacitance from 0.1 to 1 microfarad is sufficient. The best value depends upon the electrical characteristics of the associated circuits.

(d) The shock limiting capacitors "C_1", Figures 7, 8, & 9 should be of sufficiently low capacitance to limit the current to the frame of ungrounded apparatus to within the C.S.A. specified limit.

(e) A value of 0.01 microfarads is recommended for the shock limiting capacitors when used according to Figures 7, 8, & 9, and connected to 110 V.

(f) The effectiveness of suppressors in eliminating interference would be materially reduced if the shock-limiting capacitor were made much less than the value given above.

14. Inductors

(a) The inductance of inductors shown in Figures 2, 3, 5, 6, 8 & 9 is not critical. (It may be of the order of 1 millihenry.)

(b) It is very important, however, that the distributed capacitance of the inductor should be kept to a minimum in order to ensure high impedance at radio frequency. In cases where the suppressor is desired to suppress the interference at one frequency, or over a narrow frequency band, the inductor may be tuned to have high impedance at such frequency by arranging for the inductance and distributed capacitance to be of suitable values or by tuning the inductor with a suitable capacitor.

(c) The distributed capacitance of the inductors may be kept to a minimum by the type of winding, which may be either single layer, or if desired, to economize space, some form of low capacitance multi-layer winding such as band, honeycomb, or duo-lateral, etc.

15. Resistors

(a) The exact value of resistance is not critical; but as a general rule it should be of the minimum value found by experiment to give satisfactory results. In the arrangement shown in Figure 10, a resistance of 30 to 100 ohms is usually found sufficient.

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(b) According to the arrangement shown in Figure 12, a resistor of 5 to 25 kilohms is usually required. The value of this resistor can best be determined by experiment.

16. Wiring

(a) Leads or connections between the cource of interference on the appliance and the suppressor unit should be kept as short as possible, preferably not longer than a few centimetres. Regarding capacitor filters, this is necessary as the efficiency of such filters depends on the provision of paths from each conductor to the frame or ground and between two conductors whose impedance over the broadcast frequency bands shall be low compared with both the source and the supply line impedances.

(b) Regarding high frequency inductors, short leads or connections are also necessary, as the leads between the source of the interference and the inductors may add to the possibility of the propagation of directly radiated interference from the plant or appliance.

(c) The leads or connections to suppressors should be mechanically strong and installed and maintained at a high standard, at least equivalent to the general requirements of Parts I and II of the C.E. Code.

17. Additional Information - Circulars are available containing detailed information on the suppression of individual types of apparatus. These can be obtained from the nearest Superintendent of Telecommunication Regulation.

for W.J. Wilson,
Director,
Telecommunication Engineering
Branch,
Telecommunication Regulatory Service.

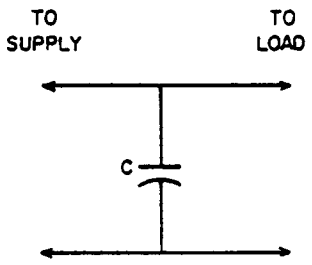

FIG. 1

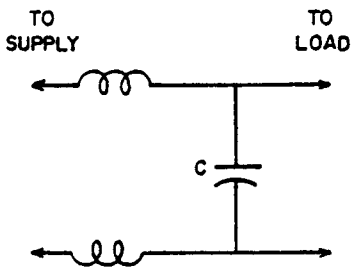

FIG. 2

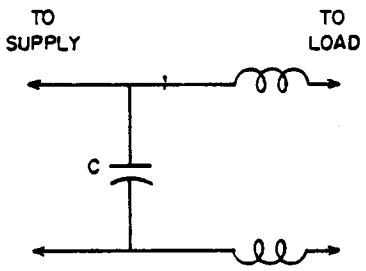

FIG. 3

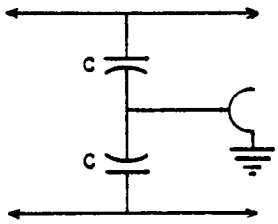

FIG. 4

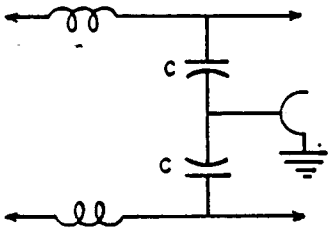

FIG. 5

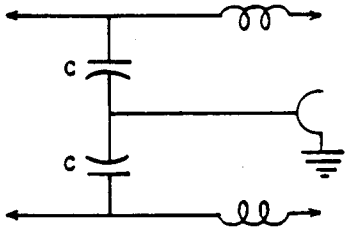

FIG. 6

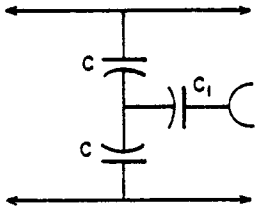

FIG. 7

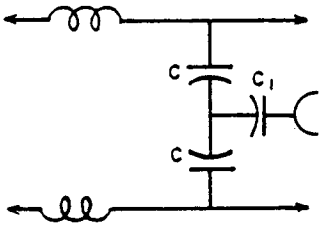

FIG. 8

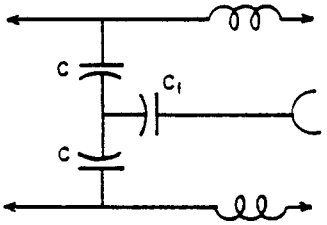

FIG. 9

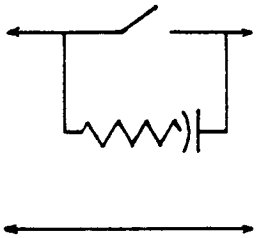

FIG. 10

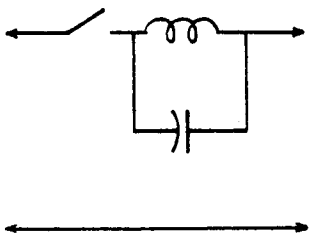

FIG. 11

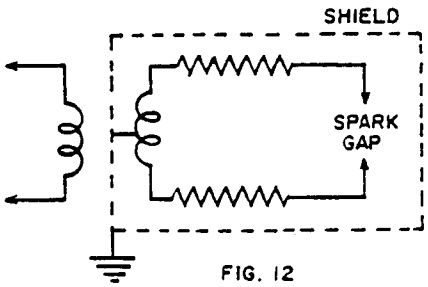

FIG. 12