

CONDUCTOR SIZE AND INSULATION

Presenter: Dick Peterson

CODE:

650.5 (a) Size. Not less than Number 28 for electronic signal circuits and not less than Number 26 for electromagnetic valve supply and the like. A main common return conductor in the electromagnetic supply shall be not less than 14 AWG.

650.5 (b) Insulation. Conductors shall have thermoplastic or thermosetting insulation.

QUESTION:

1.- What is meant by AWG?

ANSWER: AWG stands for American Wire Gauge, which is a standardized way of designating the size (cross section area) of wire. The smaller the gauge the larger the conductor and therefore the greater the current carrying capacity. It is useful to remember the rule of thumb that a wire of any given gauge has twice the cross section area of another wire three numbers larger. For example, a 12 gauge wire has twice the cross section area of a 15 gauge wire. Wire sizes from 4 gauge to 28 gauge and smaller are generally available only in even number sizes. A 1/0 gauge wire is larger than a 1 gauge wire and sizes 2/0, 3/0 and 4/0 are larger still.

QUESTION:

2.- What is an "electronic signal circuit" ?

ANSWER: A "signal" according to Webster's New World Dictionary, is anything which occasions, i.e. causes, a certain action or response. In a solid state switching system a very small "signal" current can cause a switching transistor to switch a larger current from the rectifier to a pipe valve or action magnet. In such solid state systems, most of the wires in the main cable are used for "signal circuits".

QUESTION:

- 3.- What is meant by the terms "the electromagnetic valve supply and the like", and the "electromagnetic supply"?

ANSWER: The "electromagnetic valve supply and the like" refers to the source of power for the electromagnetic valves and the like. Since not all of the electro magnets in an organ are used to operate valves, the term electromagnetic supply is really more appropriate. In any case, both terms refer to the organ rectifier.

QUESTION:

- 4.- What is "a main common return conductor"?

ANSWER: The terms "return" and "feed" refer to the two wires that must connect to any magnet to make it work. Usually the "return" leads of a number of magnets are connected together to form a common return. The main common return logically refers to the common return conductor from the rectifier to any junction point in an organ chamber, or console to which the other common returns are connected.

QUESTION:

- 5.- The code specifies minimum conductor size, but how do we figure out when the conductors need to be larger than minimum?

ANSWER: Another useful rule of thumb is that a 14 guage wire can safely carry a continuous current of up to about 15 amperes, without getting noticeably hot. According to the rule of thumb in the answer to question 1 above, a 12 guage wire will safely carry a current of about 25 amperes, and so on.

There is however, another point to consider, and that is the loss of voltage (electrical pressure) that occurs when a current flows through a wire. The voltage loss that occurs depends on the wire size, and to the length of the wire. If too much voltage is dropped across the length of the wire, the magnets or other devices may not operate properly. More detailed information on this is being supplied by another presenter.

QUESTION:

6.- What is the effect on conductor size requirements of the length of a conductor?

ANSWER: It is obvious from the preceding question and answer that if a very long conductor is used, it must be of a heavier guage if excessive voltage drop is to be avoided.

QUESTION:

7.- Can the same kind of conductors be used for any device in the organ provided it is of adequate size for the current requirements of the device? (Chest magnets, pull-down magnets, slider motors, relays for electric tremolo motors, electric swell motors, zimmelsterns, relays for higher voltage sub-systems such as chimes, etc.).

ANSWER: Yes. It should be noted however that things such as blowers, that connect to 120 Volt or 240 Volt circuits, are not covered by this article of the National Electrical Code, and generally must be hooked up by licensed electricians who must abide by the other appropriate articles.

QUESTION:

8.- What about slider motors which involve motors rather than solenoids? Do these fall under the same rules of this code?

ANSWER: As long as they operate on less than 30 Volts.

QUESTION:

9.- Does the code say anything about the guage of key contacts or relay contacts?

ANSWER: No, but for long contact life the contacts should be of adequate size. This is never a problem with solid state systems that almost always involve small contact currents.

QUESTION:

10.- What is the meaning of "Thermoplastic"?

ANSWER: Thermoplastic: Capable of softening when heated, and hardening again when cooled.

QUESTION:

11.- What is the meaning of "Thermosetting"?

ANSWER: Thermosetting: Capable of becoming permanently rigid when heated and cured.

QUESTION:

12.- What types of wire insulation are not acceptable under the new code?

ANSWER: The newly revised N.E.C. article 650 on "organs" (this article was last revised in the early 1930s) no longer permits the use of rubber, asbestos, silk or cotton covered wires.

CABLES AND THEIR COVERING

Presenter: Dick Peterson

CODE:

650.5 (c) **Conductors to Be Cabled.** Except the common-return conductors and conductors inside the organ proper, the organ sections and the organ console, conductors shall be cabled. The common return conductors shall be permitted under an additional covering enclosing both cable and return conductor, or shall be permitted to be in contact with the cable.

650.5 (d) **Cable Covering.** Each cable shall be provided with an outer covering, either overall or on each of any subassemblies of grouped conductors. Tape shall be permitted in place of a covering. Where not installed in metal raceway, the covering shall be flame retardant or the cable or each cable subassembly shall be covered with a closely wound fireproof tape.

QUESTION:

1.- **What is the "common return conductor"?**

ANSWER: A common return conductor is logically any "return" conductor that is "common" to two or more magnets or other power consuming devices. The code doesn't specifically use the term "feed", but it is logical to assume that the conductor sizes specified for common return also apply to common feed wires. It is also true that, particularly in solid state systems, a wire that may be thought of as a "return" to one part of an organ (a wind chest for example) might be the "feed" for another part of the organ (the combination action for example). The terms are therefore somewhat ambiguous.

QUESTION:

2.- **How does this section affect the main supply lines (feed and return) from the rectifier to the organ?**

ANSWER: The code specifically permits the main supply lines to be included in the main cable (if of proper wire size and insulation type).

QUESTION:

3.- Does the phrase "common return conductor" refer to all returns throughout the electrical system?

ANSWER: Any conductor that carries return current from more than one magnet is a common return conductor. The wire from a single magnet to the point where it connects to the common return conductor is not a common return conductor

QUESTION:

4.- What is meant by the terms "organ sections" and "organ proper"?

ANSWER: The term "organ sections" refers to the various organ components, or divisions, that are physically separate. For example, a Swell organ in a chamber, a Choir organ in another chamber, and an unenclosed Great organ are all sections of the "organ proper" which includes the entirety of the sound producing portions.

QUESTION:

5.- What is the definition of "cabled"?

ANSWER: A "cable" according to Websters New World dictionary is "a bundle of insulated electrical wires through which electrical currents can be passed". A cable can be made by binding or forming the wires into a unitary assembly by means of twisting, lacing, tying, taping, or covering with an insulating jacket.

QUESTION:

6.- What is the definition of "coverings"? What kind of coverings are acceptable?

ANSWER: The covering on a cable may be in the form of an extruded or molded jacket, a plastic sleeve or tube or the cable can be wrapped with a suitable tape.

QUESTION:

- 7.- What kind of "additional covering" is appropriate for combining the common return conductors with other cables.

ANSWER: One suitable covering is an expandable plastic sleeving that works on the principal of a "Chinese Finger Lock". It can be expanded and slipped over the cable and then pulled tight so that it holds the wires firmly in place. This material is available in a grade that meets the flame retardant requirements of the code. One such product is manufactured by the Western Filament Company of Glendale, California and is called expandable sleeving type F.R..

QUESTION:

- 8.- What types of tape are permitted?

ANSWER: Various types of electrical tape are available that are U.L. approved for this application. Most of the common vinyl electrical tapes made by such companies as 3M and Plymouth Bishop Insulating Products of Canton, Ohio are suitable. Flame retardant tapes such as Scotch Super 33+, and Scotch Super 8 meet U.L. specification 510.

QUESTION:

- 9.- If you are running an individual wire to a tremolo, what kind of covering is required?

ANSWER: An individual plastic insulated wire can be run to the tremolo provided that it is neatly dressed and is suitably protected from physical damage.

QUESTION:

- 10.- What does "flame retardant" mean? Are there any specific standards?

ANSWER: Flame retardant means that the insulation will not support combustion.

QUESTION:

- 11.- What does "closely wound" mean?

ANSWER: A closely wound tape wrap means that the tape is wrapped with a spiral overlay.

QUESTION:

12.- What is the difference between "fireproof" and "fire retardant"?

ANSWER: Fireproof means that the material does not have open combustion . Fire retardant applies to materials that will burn in the presence of high heat, such as flames, but will stop burning when the heat is removed.

QUESTION:

13.- What are examples of types of cable covering which are in use and available but which are not permitted under the new code?

ANSWER: Friction tape, many kinds of cloth and rubber tape, and woven braids of combustible fabrics are all examples of coverings that are not permitted.

IMPORTANT

It should be clearly understood that the material presented above represents the presenters opinion as to a reasonable interpretation of what Article 650 of the National Electrical Code requires. Neither the presenters, the A.I.O. nor the A.P.O.B.A., assume any responsibility for the accuracy or completeness of this information.

We are not qualified or authorized to "officially" interpret the code which may be subject to various interpretations. The organ builder should also be aware that articles other than Article 650 concern other aspects of organ building and installation, as for example the 120 and 240 Volt wiring system. In addition, Article 518 imposes additional requirements for Places of Assembly accomodating over 100 persons. Still other articles may also apply in at least some circumstances.