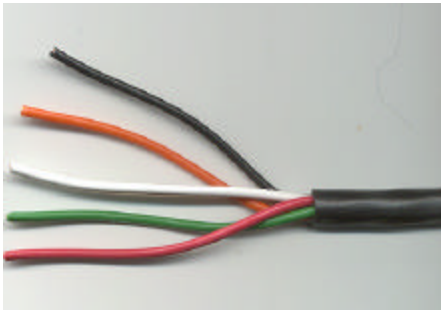


## NEC Wire Color Requirements for Traffic Signal and Street Lighting Applications

### What Are the Specific Conductor Color Requirements Used for Traffic Signal and Roadway Lighting Applications in the NEC?

In Traffic Signal applications, a comment is often made that the wiring to the signal head is a code violation because the green conductor is used for the green display. What does the NEC have to say about this apparent violation? Another question that is frequently asked is “where are the requirements for phase colors such as Black-Red-White for 120/240 V single phase and Brown-Orange-Yellow-Gray for 277/480 V three phase?”



**Is the green conductor in IMSA 19-1 Traffic Signal Cable allowed to be used as non-grounding conductor?**

**Authors Note:** Proper terminology in the NEC is conductor, the commonly used term wire is not used in the NEC. Also, using No. or # to designate conductor size was changed in the 2002 to the correct industry term AWG. Please refer to the NEC for the complete text of the sections summarized here.

The NEC only requires a few specific colors for conductors. The most obvious is the color for the grounded (neutral) conductor, found in *Article 200 - Use and Identification of Grounded Conductors*. This color requirement is so important that an entire article is devoted to it. Note that the correct term is Grounded Conductor, not neutral. A grounded conductor is not always a neutral, for example in a 120/240V 3 phase high leg delta, the grounded conductor is not a neutral because it is not a solidly grounded system. There are other color requirements in the NEC but they are for cables, portable cord, etc., and are not covered in this article.

**The following are the NEC requirements for conductor color coding:**

#### **Orange-High Leg Delta**

##### ***ARTICLE 110 Requirements for Electrical Installations*** ***Section 110.15 High-Leg Marking***

High leg delta systems that have the midpoint of one phase grounded are required to have that phase conductor marked with orange tape, orange finish or similar. This marking is only required where a connection is made and the grounded conductor is present.

**Comment:** Also known as a Red Leg Delta, or Wild Leg, this is a 120/340 V 3 phase 4 wire system with one phase having 208 V to ground. In the 1999 NEC this requirement was in Article 384 - Switchboards and Panelboards, and only applied to equipment within the scope of that article. Now it is Article 110 - Requirements for Electrical Installations and it applies to any installation where a high leg delta system is used. Sometimes this system is and continues to be identified with red for the high leg, but this is a violation of the NEC. Common usage is for the high leg to be placed on the “B” phase.

### **White or Gray – Grounded Conductor**

#### ***ARTICLE 200 Use and Identification of Grounded Conductors***

#### ***Section 200.6 Means of Identifying Grounded Conductors***

##### ***(A) Sizes 6 AWG or Smaller***

Grounded conductors smaller than 4 AWG are to have an outer finish that is white or gray, or three white stripes along its length.

**Comment:** The term “natural” was deleted from the 2002 NEC, because no one could clearly identify what natural gray insulation was.

##### ***(B) Sizes Larger Than 6 AWG***

For 4 AWG and larger, the conductor can be white, gray, or have three white stripes. A conductor can be reidentified by the use of a white marking where terminated.

**Comment:** Often 6 AWG and 8 AWG conductors are reidentified in the field with white phase tape. This is a NEC violation, although it is often overlooked. Because 4 AWG and larger can only be reidentified with “white markings”, it would be violation to reidentify with gray. This was an oversight in the 2002 NEC revision and will likely be corrected for the 2005 edition.

Identification of a 277 V grounded conductor can be done using a gray conductor if desired. However, if two or more grounded conductors from different systems, such as 120/240 and 277/480, are present see the requirement in (D) below.

##### ***(D) Grounded Conductors of Different Systems***

If different system grounded conductors are present in the “same enclosure, cable, box, auxiliary gutter or other type enclosure”, then one grounded conductor can white or gray, and the other will be white with a stripe that is “not green”. This requirement has been in the NEC since 1987 and is often overlooked.

**Comment:** The NEC did allow the practice of using gray to identify a 277 V grounded conductor until the 2002 NEC. Prior to 2002 the requirement was a grounded conductor be “white or natural gray”. Gray colored insulated wire and gray phase tape were available but not natural gray. Where a 120/240 V grounded conductor and a 277 V, or other system grounded conductor, are present, then one can be white or gray, and the other is white with a stripe, other than green.

#### ***Section 400.22 Grounded-Conductor Identification.***

(C) For jacketed cords furnished with appliances, one conductor has its insulation colored light blue, with the other conductors having their insulation of a readily distinguishable color other than white or gray.

**Comment:** Although not a Traffic Signal (TS) or Roadway Lighting (RW) application, this section covers the identification of conductors using the European standard for 3 wire cords using light blue, brown, green/yellow stripe for the grounded conductor, ungrounded conductor and equipment grounding conductor.

For ungrounded systems operating at 50 VAC or less, the white or gray conductor is not required to be identified as the grounded conductor, per NEC section [250.20 (A)]. This allows a common 1 pair jacketed cable with white/black conductors to be used for pedestrian push buttons or detector loop lead in cables, without having to reidentify the white conductor.

### **Green, Green with Yellow Stripe-Equipment Grounding Conductor**

#### ***ARTICLE 250 Grounding***

#### ***Section 250.119 Identification of Equipment Grounding Conductors.***

For conductors 6 AWG and smaller, the equipment grounding conductor is identified by green outer finish or green with yellow stripe(s).

#### ***(A) Conductors Larger Than 6 AWG.***

Insulated conductors 4 AWG and larger can be permanently reidentified when installed by:

- (1) Stripping the insulation from the length of the exposed conductor*
- (2) Coloring the exposed insulation or covering green*
- (3) Marking the exposed insulation or covering with green tape or green adhesive labels*

**Comment:** The “equipment grounding conductor” is commonly and incorrectly referred to as “ground wire” or “green wire”. This conductor bonds together the metal enclosures and raceways to the grounded conductor or grounding electrode conductor at the service. Metallic raceways can be and are often the equipment grounding conductor, see NEC [Section 250.118]. The identification requirements are similar to that of the grounded conductor, and remarking a 6 AWG and smaller conductor with green phase tape is a violation, although it is commonly done.

### **Light Blue-Intrinsically Safe Conductors**

#### ***ARTICLE 504 Intrinsically Safe Systems***

#### ***Section 504.80 Identification.***

#### ***(B) Color Coding.***

Intrinsically safe conductors where they are colored light blue

**Comment:** Not a TS or RW application, but it is a conductor color code requirement.

### **Orange, Yellow, Brown-Isolated Power Systems**

#### ***ARTICLE 517 Health Care Facilities***

#### ***Section 517.160 Isolated Power Systems.***

### **(5) Conductor Identification.**

Health care systems use Orange, Brown and Yellow (if three phase) to identify isolated circuit conductors.

**Comment:** Not a TS or RW application, but it is a conductor color code requirement.

### **What about a System Color Code?**

The question often comes up about using black/red/white for 120/240 V single phase and brown/orange/yellow/gray (BOY) for 277/480V three phase and similar. There used to be a color code requirement in the NEC, but it was removed in the mid-70's. Many proposals have been made to require a color code requirement, and the code making panels response is "We don't want you to look at wire color and assume because its red it is 120 to ground. We want you to test it and be sure". There is nothing stopping an agency from adopting a color code standard if it can be enforced. Often what gets installed is what is on the truck. If a color code standard is used for multiwire branch circuits, then the ungrounded conductor identification must be posted at each branch circuit panel board, see *Section 210.4 Multiwire Branch Circuits, (D) Identification of Ungrounded Conductors*. Using gray for a 277 V grounded conductor is acceptable only if it is not present with another system grounded conductor. See discussion under Article 200.

### **No Color - Grounding Electrode Conductor**

There is no color requirement for the grounding electrode conductor (the wire from the service to the ground rods). It is often phase taped green, however green is the required identification for the equipment grounding conductor, which serves a different purpose altogether. It could be a violation if white or orange is used, as those colors are used for other purposes. Black or bare copper is commonly used.

### **Is it a Violation to use the Green Conductor in Traffic Signal Cable for the Green Display?**

In the UL General Information for Electrical Equipment Directory (White Book) there is a product category for Traffic Signal Cable, XNTL - Traffic Signal Cable Classified in Accordance with IMSA Specifications:

*This category covers cable investigated in accordance with International Municipal Signal Association Inc. specifications. The cable is intended for installation as aerial cable or in underground conduit as part of a traffic signal system. This cable employs a color-code scheme that permits a conductor with green insulation to be used for other than grounding purposes. This cable has not been evaluated for flammability. This cable is not suitable for use as a substitute for cable or wiring systems covered in NFPA 70, "National Electrical Code."*

#### **ADDITIONAL INFORMATION**

*For additional information, see Electrical Equipment for Use in Ordinary Locations (AALZ).*

#### **LOOK FOR CLASSIFICATION MARK**

*The Classification Mark of Underwriters Laboratories Inc. on the attached tag, the reel or the smallest unit container in which the product is packaged is the only*

*method provided by UL to identify products manufactured under its Classification and Follow-Up Service. The Classification Mark for these products consists of the statement "Classified by Underwriters Laboratories Inc. in accordance with IMSA Specifications XX-X" together with a control number and the product name "Traffic Signal Cable." In addition, the Classification Mark may include the UL symbol (as illustrated in the Introduction of this Directory).<sup>1</sup>*



## The UL White Book

**Comment:** Note the requirement *This cable employs a color-code scheme that permits a conductor with green insulation to be used for other than grounding purposes.* This allows the use of the green conductor for the green display, but the allowance would technically only apply to “listed” traffic signal cable. A search of the UL on line database for category XNLT lists two manufacturers, but each manufacturer states they do not make a listed Traffic Signal cable. It would be up to the Authority Having Jurisdiction (AHJ) to determine if a nonlisted Traffic Signal cable is allowed. One of the basis for approval of a product is the labeling or listing, per Section 90.4. As UL recognizes the unique use of the green conductor there could be a precedent for approval of a non listed traffic signal cable. Note that listed Traffic Signal cable is only allowed to be used as *part of a traffic signal system, and not for use as a substitute for cable or wiring systems covered in NFPA 70, "National Electrical Code."*

The UL General Information for Electrical Equipment Directory, 2002 edition, is available from UL, Northbrook Illinois at (847)-272-8800 or [www.ul.com](http://www.ul.com)

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