

DC Decoupling/AC Grounding Of Electrical Equipment In Cathodically Protected Systems



Application Note 2A

Introduction

DC decoupling and simultaneous AC grounding of electrical equipment in cathodically protected (CP) systems can be accomplished while remaining in compliance with electric codes and without any effect on CP voltage levels. This can be accomplished by grounding the equipment through a solid-state decoupling device that has been third party listed to the applicable code requirements. In addition, an entire facility can be DC decoupled from the power company grounding system using similar methods.

In the U.S., the applicable code is the National Electrical Code (NFPA 70). The sections of the code that apply are Section 250.2 which defines the requirement for "an effective [AC] grounding path," and Section 250.6(E), which allows the use of a listed decoupling device for "blocking the flow of objectionable DC current from cathodic protection systems." Section 250.6(E) is a new section in the code starting with the 1999 edition. For Canada, the products must be certified as meeting the "effective grounding path requirements" per Canadian codes, CSA Standard C22.2 No. 0.4-M1996 using Canadian Electric Code Part 1, Section 10-500 as a guide. Other countries have similar codes.

If the installation location is also defined as a hazardous location as defined in NFPA 70, Sections 500-505, then products must also be third-party listed for the applicable hazardous location. (A reference that clarifies hazardous locations, as defined by NFPA 70, is an American Gas Association article entitled "Classification of Gas Utility Areas for Electrical Installations, XF0277.") Other countries have similar codes to define hazardous locations.

Typical Application

A typical application is that of grounding an electric motor operated valve in a cathodically protected pipeline. Previously, to comply with code, it was necessary to install an insulated flange on each side of the motor operator so the motor could be grounded to electrical system ground without affecting CP voltage levels. A bonding jumper was then placed around the motor operator to provide CP continuity for the pipeline. Now, a motor operator can be grounded through an appropriately listed decoupling device, insulated joints are not required, and CP voltage levels are not affected. This application is shown in Figure 1.

Instead of isolating one or several pieces of electrical equipment, the entire facility can be decoupled from the power company grounds, as shown in Figure 2. This schematic shows user-implemented decoupling that can be employed for pipeline or tank facilities, underground metal vaults with electrical equipment, or any facility that requires improvement in cathodic protection due to the effects of AC power grounding connections.

Although these two schematics show a single-phase service, the same guidelines apply to commonly used three-phase services.

Products

The products predominantly used in this application are the DEI models PCR and SSD which can be used in ordinary, Division 2, or Zone 2 hazardous locations, and are UL and C-UL listed and CE marked. In Division 1 locations, use the model PCRH, which is UL and C-UL listed. All products are UL and C-UL listed as an "effective grounding path" in compliance with the

US and Canadian electrical codes mentioned above.

Product Ratings

After selecting a product it is necessary to select the appropriate ratings for that product. The key rating is the AC fault current capability for the product. The product fault current rating must encompass the available fault current for its time duration. The fault current of interest is the fault current that would flow in the grounding conductor of the equipment to be grounded through a decoupling device as illustrated in Figures 1 and 2 in the event of a fault.

The fault current rating required can be determined by one of the following methods.

1. The most conservative method is to determine the maximum fault current that is available at the transformer terminals. This method is suggested if the electrical equipment is very close to the transformer. All of the information required to calculate the fault current is on the transformer nameplate or available from the power utility.

First, determine the "Secondary Full Load Current" (I_{FL}) for the transformer using one of the following formulas:

$$I_{FL} = \text{Single-phase kVA} / \text{kV Secondary}$$

(For a single-phase service)

or

$$I_{FL} = \text{Three-phase kVA} / \sqrt{3} \text{ kV Secondary}$$

(For a three-phase service)

(Note: "kV Secondary" is the phase-to-phase voltage expressed in kV)

Second, determine the available AC Fault Current ($I_{AC \text{ FAULT}}$) at the transformer terminals as follows:

$$I_{AC \text{ FAULT}} = [I_{FL} / \% \text{ Transformer Impedance}] \times 100$$

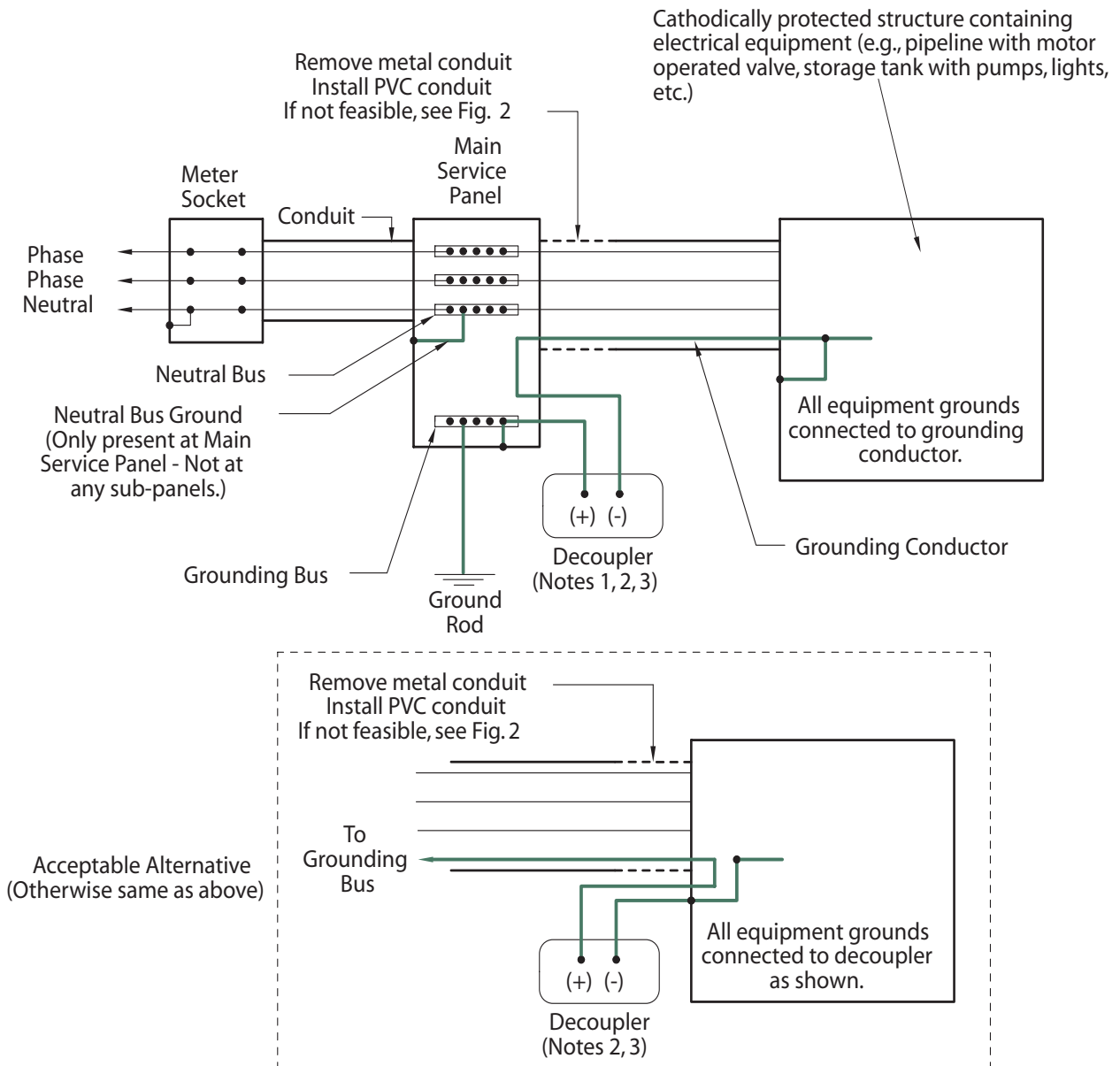
In applications where there is a considerable length of conductor to the load, the available fault current will be reduced significantly from the worst case value at the transformer. It is reasonable to assume that most faults will be cleared within 3 to 10 cycles.

2. An alternate method is to select a fault current rating based on the circuit breaker clearing curve, if known. Select a product rating in which the fault

current capability for a given time exceeds the current/time clearing curve for the breaker.

3. A third method is to select a product fault current rating that equals or exceeds that fault current carrying capability of the wiring to the electrical load. First, determine the grounding conductor size and material type. Second, look up the fault current ampacity. For copper conductors this information is shown in Figures 2 and 3 in NACE Standard RP0177-2000. Third, select a product rating that meets or exceeds the conductor ampacity. The DEI catalog provides the fault current capability for all products at 1, 3, 10, and 30 cycles. Most fault conditions are cleared within several cycles.

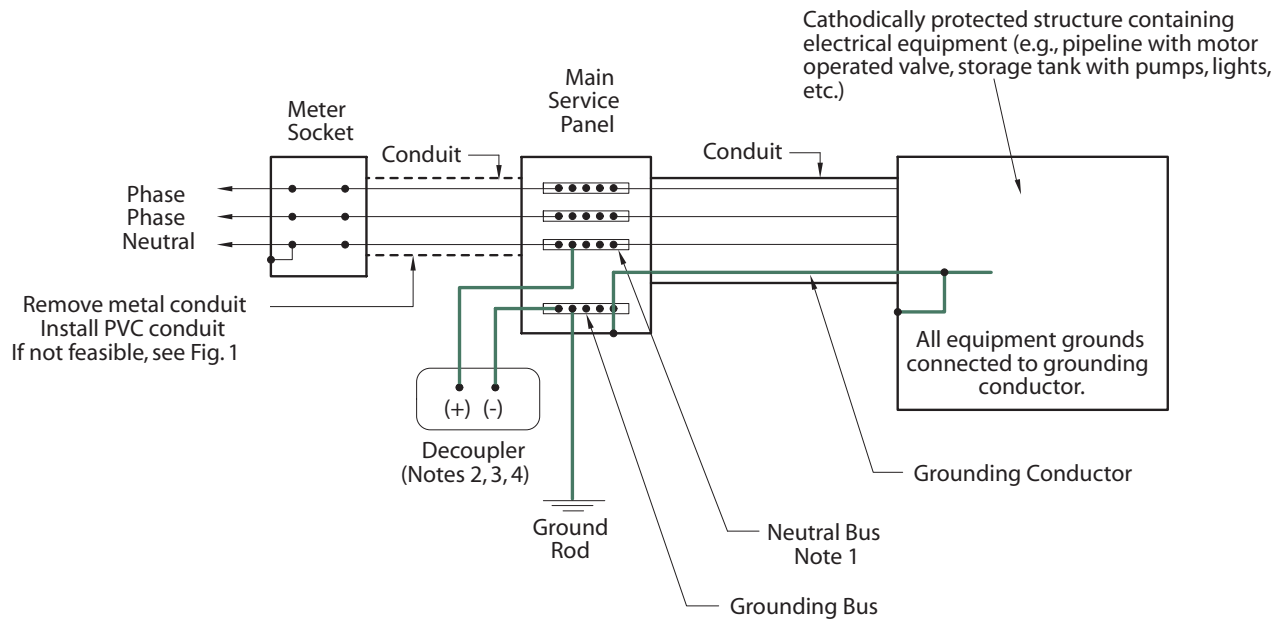
FIGURE 1 Typical installation to provide DC decoupling and AC grounding for cathodically protected structures containing electrical equipment



Notes:

1. Decoupler = PCR or SSD models by DEI. UL listed per NFPA 70, Article 250.2, 250.4(A)(5), 250.6(E) and 500-505. All decoupler models Canadian Standards Association (CSA) certified per section 10-500. All decouplers listed for use in Ordinary and Class I, Division 2 hazardous locations.
2. Observe polarity marks when installing the decoupler if polarity marks are provided.
3. Do not install the decoupler in series with the secondary neutral. This is not allowed per electric codes.
4. After installation, temporarily remove the (+) lead at the decoupler and test to assure that there is no electrical continuity between the (-) terminal and the neutral bus in the main service panel. Then reattach the (+) decoupler lead. (Note, if continuity exists in the above test and the facility has telephone service, contact the local phone company as they often have a parallel connection between the power utility grounding system and a users grounding system that can be interrupted.
5. If there is any question as to proper installation procedures for a given application, call DEI for assistance.

FIGURE 2 User-implemented decoupling of an entire facility from the power company grounding system



Notes:

1. The screw in the neutral bus must be removed so that the neutral bus is only connected to the ground bus and the service panel enclosure through the decoupler. This installation procedure only applies for decoupling at the main service panel.
2. Decoupler = PCR or SSD models by DEI. UL listed per NFPA 70, Article 250.2, 250.4(A)(5), 250.6(E) and 500-505. All decoupler models Canadian Standards Association (CSA) certified per section 10-500. All decouplers listed for use in Ordinary and Class I, Division 2 hazardous locations.
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6. If there is any question as to proper installation procedures for a given application, call DEI for assistance.