Manual No: **577014-055** ● Revision: **E**

Grounding and Surge Protection

Recommended Practice

VEEDER-ROOT

Notice

Illustrations

Several of the illustrations used in this book are taken in whole or in part from the Soares Book on Grounding and Bonding, 9th edition, and are used with permission of the International Association of Electrical Inspectors, Richardson, TX 75080-7702. Use of the illustrations does not imply endorsement by IAEI.

Grounding

Surge Protection

Figures

Tables

Grounding

Overview

Proper grounding of electronic equipment is essential for several reasons. First, in a typical grounding scheme, proper grounding prevents hazardous voltages, including surges, from being present on equipment. Secondly, grounding prevents the build-up of static charges on equipment. Either of these conditions could be very hazardous when in the proximity of explosive mixtures found at fuel supply depots and gas/petrol stations.

The following equipment must be connected to earth ground:

- Panel board used for supplying AC power to the TLS Console (mains electrical supply)
- TLS Console used for automatic tank gauging
- Transmitter system used for wireless automatic tank gauging
- Storage tank used for storing liquid products
- Submersible turbine pump used for pumping liquid product from the storage tank

Proper grounding requires that a very low impedance connection be made to the earth which is usually accomplished by means of a conductor buried in the earth (see Figure 1 and Figure 2). When making this connection, all local, regional, national laws and electrical codes must be obeyed.

This manual is divided into two sections, Grounding and Surge Protection. Both subjects are equally important to providing safe use of TLS equipment. In this manual, the term "grounding" is used to describe the earthing or bonding methods used to install intrinsically safe equipment. Details for earthing and bonding of intrinsically safe systems are provided in the applicable Veeder-Root documentation listed in table 1 that are available on

https://www.veeder.com/us/technical-document-library

Table 1. Installation Documents

	ATEX Descriptive System	**IECEx Descriptive System**	**UL/cUL Control Drawing**
Associated Apparatus	**Document No.**	**Document No.**	**Document No.**
TLS-450PLUS/8600	331940-006	331940-106	331940-008
TLS-50 or TLS2 or TLS-IB	331940-003	331940-103	331940-014
TLS4/8601	331940-017	331940-117	331940-018
TLS-XB/8603	331940-020	331940-120	331940-019
Intrinsically Safe Apparatus for Wireless Applications			
Tank Gauge Accessories	331940-005	331940-105	331940-012

Connecting to the 240VAC electrical power supply

Ensure that all local and national electrical regulations and codes are complied with when connecting the TLS console to the mains electrical supply.

> **WARNING**
>
> **The equipment described in this manual must only be installed and commissioned by trained personnel. Installers must have the appropriate technical competence required to:**
>
> - **Carry out operations in all areas required to be accessed during the installation work.**
> - **Be aware of the hazards involved during the installation work and take all necessary precautions to ensure a safe working environment.**
> - **Always evaluate the risk associated with working in hazardous areas in line with IEC/EN60079-10 and any applicable local regulations (note: some Countries require installers operating in or near hazardous locations to obtain a special local permit/approval).**

Safety Precautions

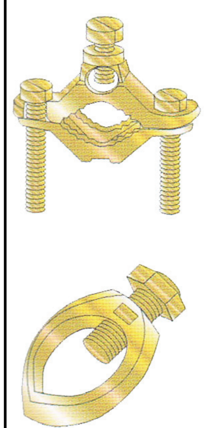
The following safety symbols are used in this manual to alert you to important safety hazards and precautions.

EXPLOSIVE Fuels and their vapors are extremely explosive if ignited.	**WEAR EYE PROTECTION** Epoxy sealant in contact with eyes can cause serious injury. Always wear eye protection when sealing wire splices.
GLOVES Wear gloves to protect hands from irritation or injury.	**RESPIRATORY IRRITANT** Epoxy sealant is irritating to eyes, respiratory system, and skin. Use only in well ventilated areas.
WARNING WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.	**NOTICE** Important information and/or recommended practice.
READ ALL RELATED MANUALS Knowledge of all related procedures before you begin work is important. Read and understand all manuals thoroughly. If you do not understand a procedure, ask someone who does.	

Grounding Electrode

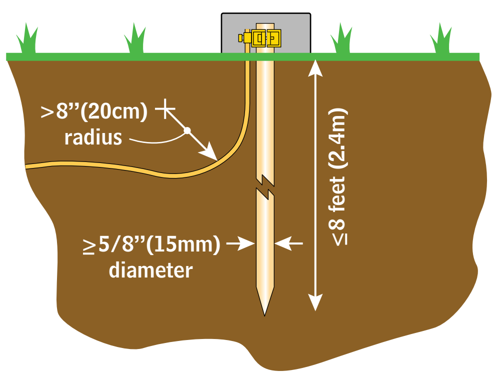
Measures must be taken to ensure that an adequate ground is accomplished. Generally a single ground “rod” is driven into the earth (Figure 1) and the ground wire clamped to it (Figure 2). This rod is usually no less than five-eighths of an inch (greater than fifteen millimeters) in diameter and no less than eight-feet (two and one-half meters) long.

Figure 1. Example - Ground Electrode Installation



- Grounding conductor connected to electrode by exothermic welding, listed lugs, listed pressure connectors, listed clamps or other listed means
- Ground clamps shall be listed for materials of grounding electrode and grounding electrode conductor
- Shall be listed for direct soil burial where used on pipe, rod or other buried electrodes

Figure 2. Example - Grounding Conductor Clamps



Ground clamp to be approved for use without protection or to be protected from ordinary damage unless it is not likely to be damaged, or it is protected in metal, wood, or equal.

Figure 3. Mechanical Protection of Grounding Electrode Conductor

Local regulations can dictate the need for a more complex grounding scheme. This may include the use of multiple ground rods connected together with a very heavy gauge wire (see Figure 4).

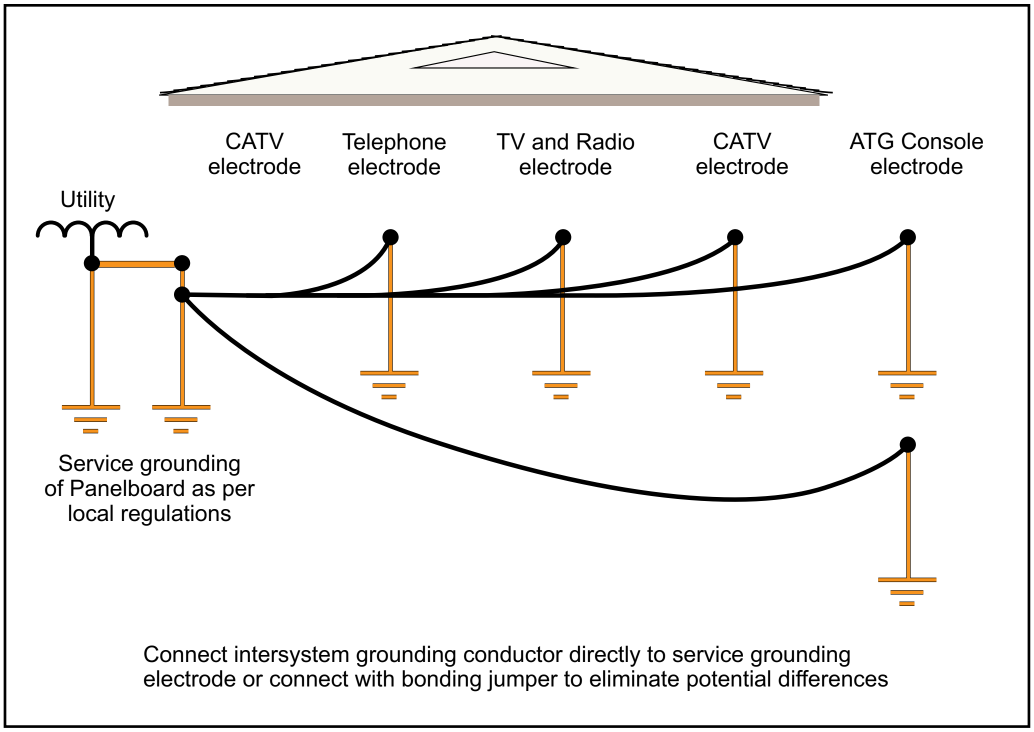


Figure 4. Intersystem Grounding Electrodes

Enhanced Grounding Scheme

When required, a grounding system might consist of deep trenches filled with a ground plane made up of multiple conductors and a special conductive backfill over the conductors (see Figure 5). It is imperative that all local regulations are followed in the construction of an adequate ground system.

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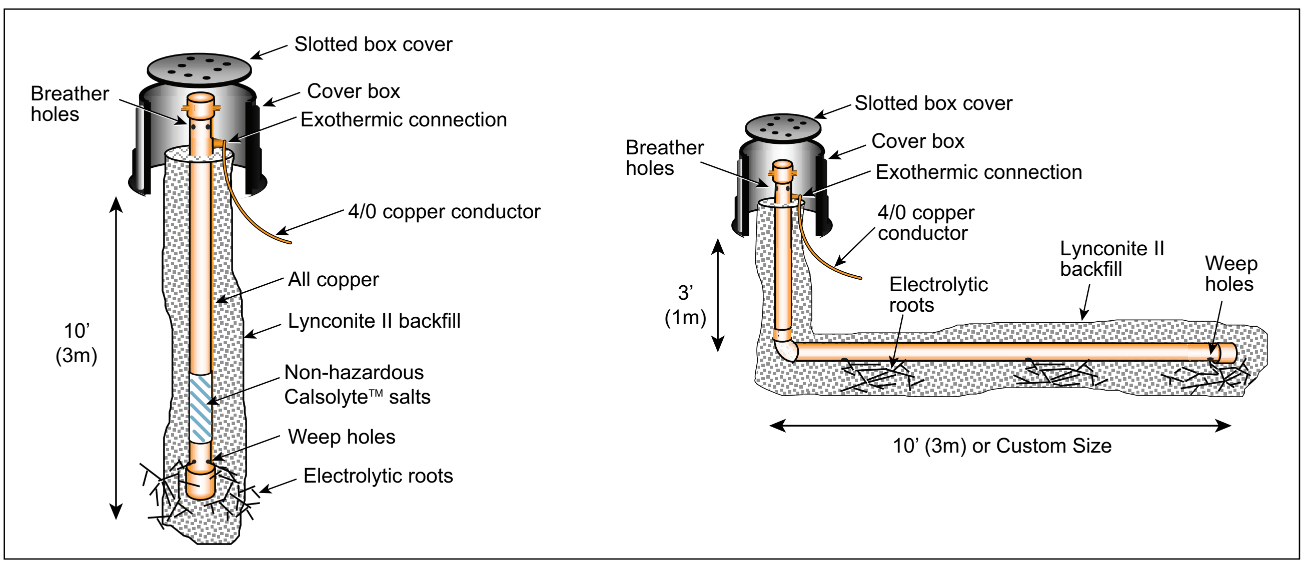

Figure 5. Anatomy of an Enhanced Grounding Electrode

Grounding Description

A solid connection between the metallic parts of equipment and the earth (the ground), will limit the voltage imposed upon that equipment caused by line surges, frayed or damaged wiring, equipment malfunction and lightning. The solid earth connection may be referred to as a bonding conductor. Any improper connection (circuit fault) between a properly grounded piece of equipment and the site supply voltage will cause a circuit breaker or fuse to disconnect the power to the faulted circuit. Even though a fault can activate the circuit breaker or fuse, there could also be a problem with the actual earth ground, such as a high impedance path in the ground circuit. It is imperative that a solid, low impedance path in the earthing ground circuit is verified by testing.

Internal to the building, all of the metal systems will be connected to the grounding point located in the main electrical panel. Grounding includes all electrical equipment as well as any metal plumbing, structural steel, etc. In some power systems, there is a "neutral" wire which is connected to ground at the electrical panel, but is a current carrying wire. Such a neutral wire must not be used as the grounding wire (see Figure 6).

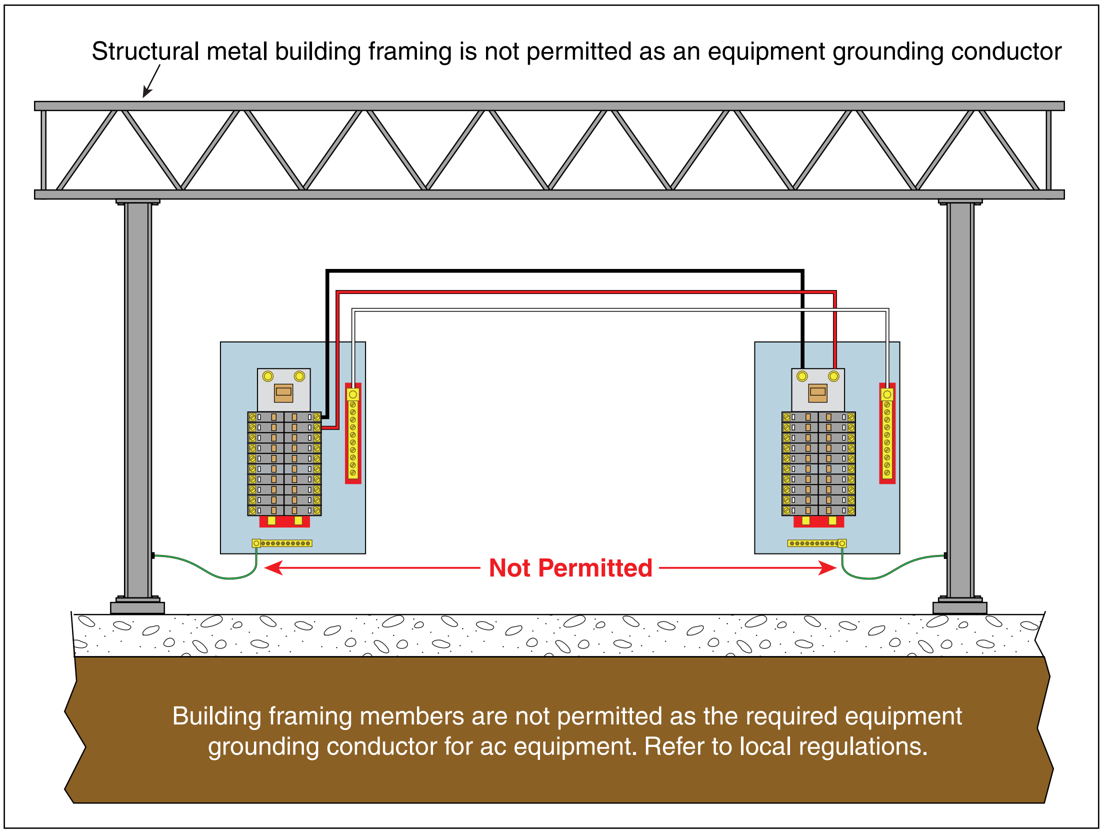

Figure 6. Structural Metal Building Framing is not Permitted as an Equipment Grounding Conductor

A separate grounding wire is required, and in most localities it will be a green or green with yellow stripe wire. The grounding wire is not intended to carry current except in the case of grounding faults. This is the wire that is commonly referred to as the "ground" wire. This is the connection that must be verified to ensure that the equipment is properly grounded. The wire used for the ground connection should generally be no less than four square millimeters in cross section, or a ten-gauge wire.

The ground connection must be established between each piece of equipment by running a separate ground wire from the equipment, back to the main distribution panel. This connection must not go to anything else – such as a water pipe, structural steel or any other piece of equipment. It is imperative that all local, regional and national regulations are followed in this regard.

Ground Measurements

Testing the ground connections will require an ohmmeter that is capable of reading down to 0.01 ohms. Testing a point-to-point connection, requires a length of wire that is long enough to reach from the ohmmeter inside at the console to the panelboard's outside grounding rod. The wire should be 12-gauge or larger ($3mm^2$ or larger, e.g., 12-gauge, 10-gauge). Using the ohmmeter, make a baseline measurement of the length of wire by measuring the resistance of the wire and recording the value (see Step 1 Figure 7).

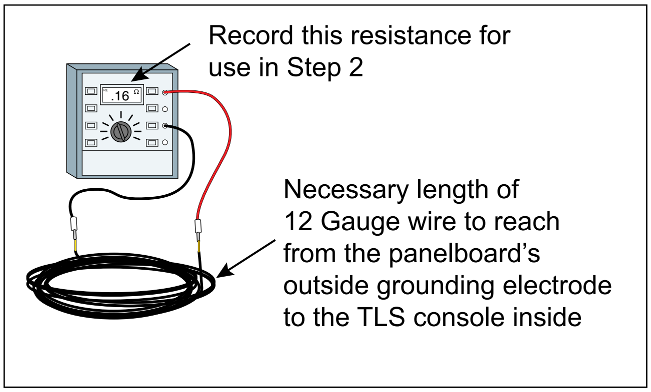

Figure 7. Two Point Resistance Measurement Method - Step 1

Then, using the wire measured in Step 1, attach one end to the panelboard's outside grounding rod and bring the other end into the building to the TLS console. Touch one of the meter's test leads to the end of the wire and the meter's other test lead to the TLS console's ground clamp and measure the resistance of the ground circuit. Subtract the length of wire's resistance measured in Step 1 from the ground circuit's resistance measured in Step 2 (see Figure 8). The resulting resistance must be less than one-ohm.

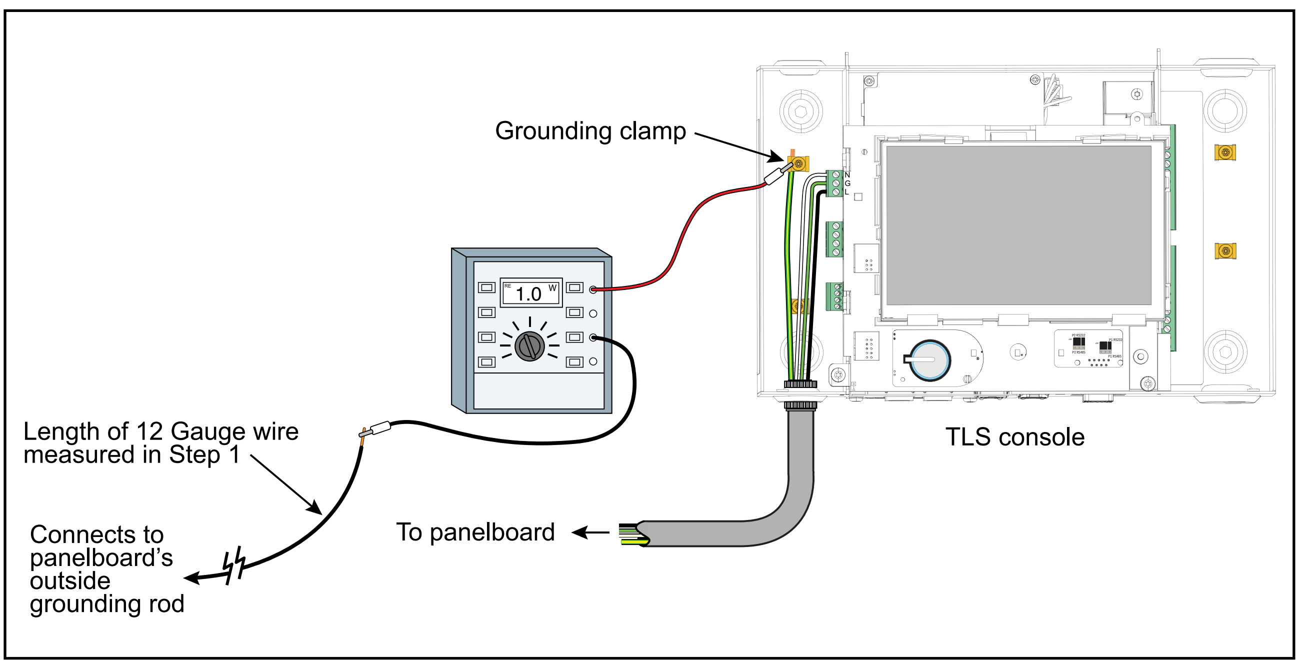

Figure 8. Console to Ground Two Point Resistance Measurement Method - Step 2

Step 3 requires ensuring that the site's grounding system itself be checked for a proper connection between the main panelboard and the actual earth ground. This is tested as described in Steps 1 and 2 above by using the ohmmeter and the same length of wire. Measure the resistance between the ground point in the electrical panel and the ground connection at the outside earth grounding system (see Figure 9). Again, the resulting resistance for the grounding connection must be less than one-ohm and ideally, should be less than two-tenths of one ohm (0.20 ohms).

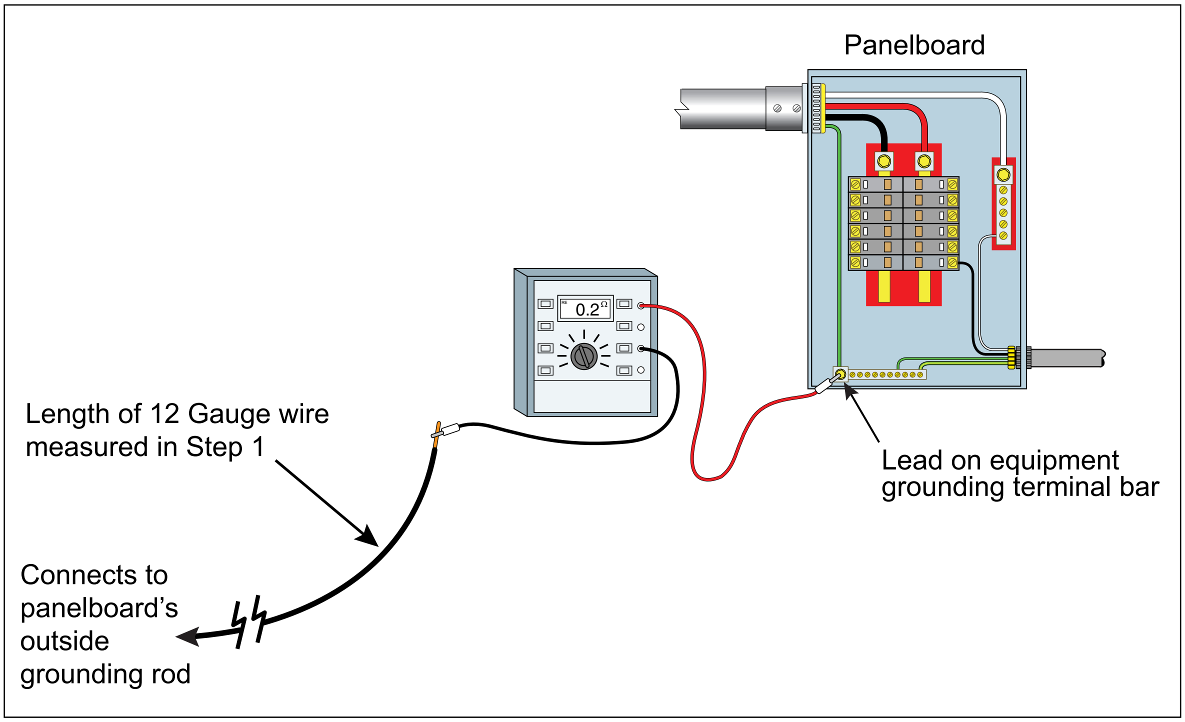

Figure 9. Panelboard to Ground Two Point Resistance Measurement Method - Step 3

As a guide, the following reference book will prove invaluable:

Soares Book on Grounding and Bonding

ISBN-13: 9781890659363

ISBN: 1890659363

Edition: 9

Pub Date: 2004

Publisher: International Association of Electrical Inspectors

Ground Circuit Installation Guidelines

Effective lightning and surge protection for the TLS Console is accomplished by installing a proper earth ground circuit. The barrier ground wire should not have any sharp 90 degree bends as doing so adds unwanted inductance to the earth ground circuit. Note that inductance is a form of impedance and adding impedance to the earth ground circuit will result in a measurable voltage potential between different grounding rods during a lightning strike. Impedance can block the lightning discharge path, causing a destructive current to flow through the TLS Console. The barrier ground wire run should use a minimum bend radius of 200mm (8") between the saddle clamp of TLS Console and the grounding busbar located at the panel. Earth ground bonding occurs at the power distribution panel where the earth ground is tied to the busbar.

Do not coil or loop the barrier ground wire as this also adds inductance to the grounding circuit. Keep the barrier ground wire as short as possible and route it on the straightest possible path to the bonding point for earth ground.

A TLS Console is properly grounded when the grounding circuit resistance is 1 ohm or less. Grounding circuits above 1 ohm should be modified until the resulting earth ground circuit resistance is 1 ohm. Modifications to the ground rod may include increasing the length, burial depth and location. The ground rod must be long enough to reach compressed soil with increased moisture content, so be prepared to excavate as needed. Typically, a deeper burial depth will result in lower ground resistance.

Follow the AC wiring instructions carefully when installing the TLS console. TLS consoles contain intrinsically safe (barrier) circuits that depend on a reliable earth ground. Use a three-wire connection from the distribution panel for Line, Neutral and AC Ground. In addition to the three power wires, a separate ground wire MUST be run between the ground clamp of the TLS console to the grounding bar located inside the power distribution panel.

When ground conditions result in a poor earth ground circuit, use of additional or alternate ground rod schemes and ground enhancement material (GEM) are recommended. Further details are available on the following web sites:

- Link to GEM Product Information and Installation Manual / Instruction Sheet: https://www.nvent.com/en-us/erico/products/gem-ground-enhancement-material-0
- Link to Ground Rod and other grounding and bonding equipment: https://www.nvent.com/en-us/erico/products/grounding-and-bonding

Surge Protection

Wireless installations require that single-channel I.S. Circuit Protectors or Surge Protectors be installed between each probe/transducer and their transmitter to provide the transmitter system with an electrical connection to earth ground.

Without proper grounding, TLS equipment cannot be protected from electrical surges. In addition to proper grounding, the decision to add surge protection hardware should be followed if any of the conditions listed in the Surge Risk Considerations table below applies to the site's location.

Table 2. Surge Risk Considerations

The site may experience a lightning strike[1]
The installation of the tanks and/or probe is less than 330 ft (100m) away from an electric railway, underground railway, or tram line
The installation of the tanks and/or probe is less than 330 ft (100m) away from other high voltage sources such as power turbines
The site does have high voltage power cables supported by pylons passing overhead
The installation does use above-ground tanks
The site is used for high blend ethanol fuels
The site does use cathodic protection for the tanks

[1]Additional geographic data for the site's location may be required. One of these data, the Lightning flash density, is defined by the average number of instances of lightning strikes in a defined area per year and is available on an Isokeraunic or Flash Density Map for each country. For U.S. locations, an example flash density map is available at: https://hazards.fema.gov/nri/lightning

Where required, a lightning ground flash density number can be estimated for the site's location from the lightning density map.

Use the applicable system descriptive documentation listed in Table 1 to determine how and where to install surge protection hardware.

Surge Protection Kits

When required, a surge arrestor must conform to Clause 12 of IEC/EN 60079-25 and must be installed in accordance with the requirements for surge protection devices defined in Clause 16.3 of standard IEC/EN 60079-14 as follows:

1. Surge protection is required between each conductor of the cable including the screen and the structure where the conductor is not already bonded to the structure.
2. The surge protection device shall be capable of diverting a minimum peak discharge current of 10 kA (8/20 us impulse according to IEC 60060-1 for 10 operations).
3. The connection between the protection device and the local structure shall have a minimum cross-sectional area equivalent to 4mm^2 copper.
4. The cable between the intrinsically safe apparatus in Zone 0 and the surge protection device shall be installed in such a way that it is protected from lightning.
5. Any surge protection device introduced into an intrinsically safe circuit shall be suitably explosion protected for its intended location.

6. The use of surge protection devices which interconnect the circuit and the structure via nonlinear devices such as gas discharge tubes and semiconductors is not considered to adversely affect the intrinsic safety of a circuit, provided that in normal operation the current through the device is less than 10 uA.

Recommended Solutions To Electrical Transients

Surge protection devices are not installed for Mag Probes that are bonded to a storage tank using conductive hardware such as a gland nut. Mag Probes located in a riser pipe/tube may be installed using one of the following three types of hard-wired Surge Protection Devices. These devices are Ex ia (intrinsically safe circuits) rated for either indoor or outdoor use but are not rated for use with AC power circuits.

TYPE 1 – SURGE PROTECTOR WITH ENCAPSULATION (10KA)

Construction: Reference Figure 10 for an encapsulated housing with flying lead connection wires for Intrinsically Safe (I.S.) devices. Earth conductor must be connected to a grounded structure. Lightning protection component is a Gas Discharge Tube (GDT).

Ratings:

Peak Current:	10,000 Amps with a (8/20 µS) waveform
Working Voltage:	12.6 Volts or less
Break Over Voltage:	75 Volts

Applications: Intrinsically Safe Mag Flex Probes and Mag Probes used in a TLS System. For use in locations that require a protection level of 10KA or less.

Part No.	Part Name
848100-001	Single Channel Surge Protector, ATEX/IECEx
848100-002	Dual Channel Surge Protector, ATEX/IECEx

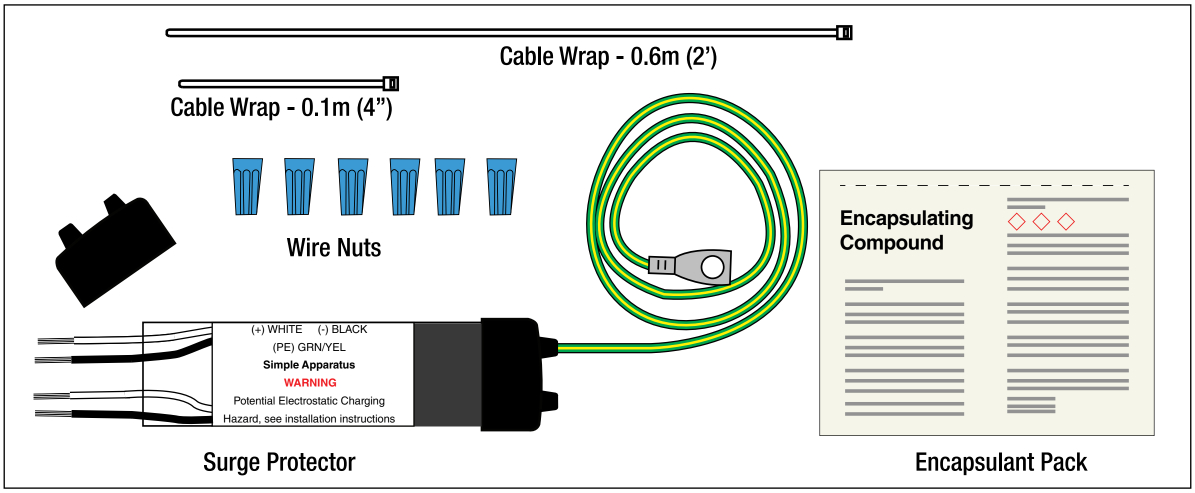

Figure 10. Surge Protector Kit Contents

TYPE 2 – I.S. CIRCUIT PROTECTOR WITH ENCAPSULATION

Construction: Reference Figure 10 for an encapsulated housing with flying lead connection wires for I.S. devices. Earth conductor is connected to a grounded structure. Lightning and transient voltage protection component type is a high-speed semiconductor.

Ratings:

Peak Current:	800 Amps with a (8/20 µS) waveform
Working Voltage:	12.6 Volts or less
Break Over Voltage:	50 Volts

Applications: Intrinsically Safe Devices used in a TLS System, all probe and sensor types. An I.S. circuit protector provides 800 Amps of protection at a lower operating voltage with very fast response times.

Part No.	Part Name
848190-001	Single Channel I.S. Circuit Protector, UL/cUL
848190-002	Dual Channel I.S. Circuit Protector, UL/cUL
848100-011	Single Channel I.S. Circuit Protector, ATEX/IECEx
848100-012	Dual Channel I.S. Circuit Protector, ATEX/IECEx

TYPE 3 – SURGE PROTECTOR WITH SEALED METALLIC ENCLOSURE

Construction: Reference Figure 11, removable housing cover with field wiring connection points for I.S. devices. Each cable entry uses a gland fitting with a cable bushing. Customer supplied earth conductor must be connected to a grounded structure. Lightning protection component is a Gas Discharge Tube (GDT).

Ratings:

Peak Current:	12,000 Amps with a (8/20 µS) waveform
Working Voltage:	60 Volts or less
Break Over Voltage:	350 Volts

Applications: Intrinsically Safe Mag Flex Probes and Mag Probes used in a TLS System. For use in locations that require a protection level of 12KA or less. The sealed enclosure does not require a separate sealing compound.

Part No.	Part Name
848100-004	Dual Channel Surge Protector, Model BA 350-2

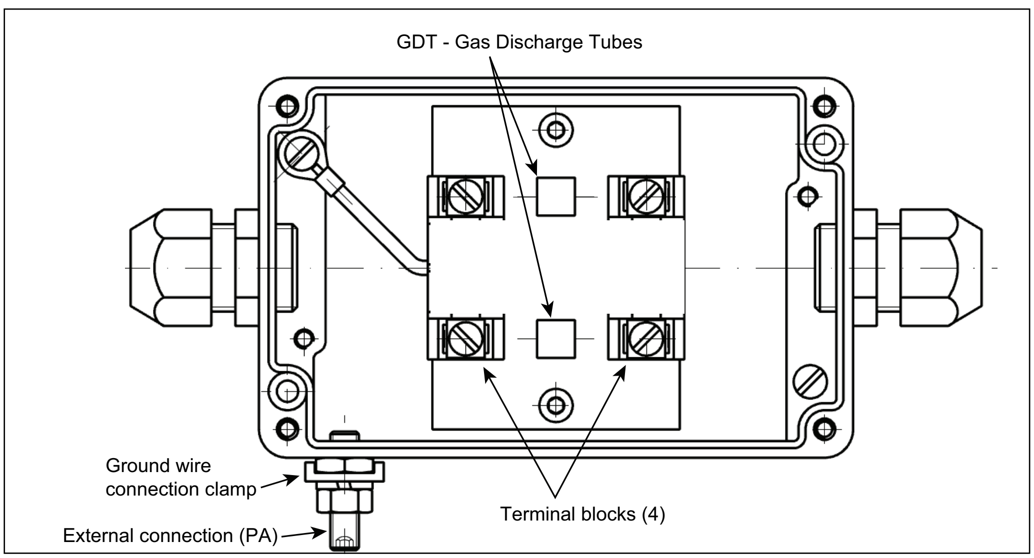

Figure 11. Surge Protector Kit for Wired Installations - Dual Channel Surge Protector BA-350 or Equivalent

Field Wiring

TLS CONSOLE TO PROBE/TRANSDUCER

Pull appropriate cable from the TLS console to each probe/transducer location.

Explosion could occur if other, non–intrinsically safe wires share TLS intrinsically safe wire conduits or wiring troughs. Conduits and wiring troughs from probes and sensors to the console must not contain any other wires.

At least 6 feet (2m) of free cable must be left for connection at both the TLS console and the probe/transducer location.

Failure to correctly mark probe/transducer field wiring at the TLS console may lead to re-work, delays in system installation and additional charges.

MAXIMUM CABLE LENGTHS

A maximum of 1000 feet (305m) of cable length per probe/transducer must be observed.

I.S. CIRCUIT/SURGE PROTECTOR INSTALLATIONS

Wireless installations require a single-channel I.S. Circuit or Surge Protector between the probe/transducer and the transmitter.

Some wired probe/transducer installs, that are subject to high levels of electrical interference, may require the installation of the dual-channel I.S. Circuit or Surge Protector between the probe/transducer and the TLS console. In these instances, the I.S. Circuit or Surge Protector replaces a weatherproof junction box and epoxy-sealed connections.

1. Cut the soft vinyl epoxy enclosure end cap entrance holes of the appropriate protector to accommodate each cable diameter. Keep the hole sizes to a minimum. Insert about 5 inches (127mm) of each cable through the openings [Figure 12]. Remove 3 inches (76mm) of the outer jacket from each cable. Trim the insulation from the conductors.

Wireless Transmitter System kits provide a 5' (1.5m) cable. One end of the cable already has 3" (76mm) of the outer jacket removed from the end to insert through the enclosure end cap openings. The other end of the cable already has 1.5" (38mm) of the outer jacket removed from the end for connection to the transmitter.

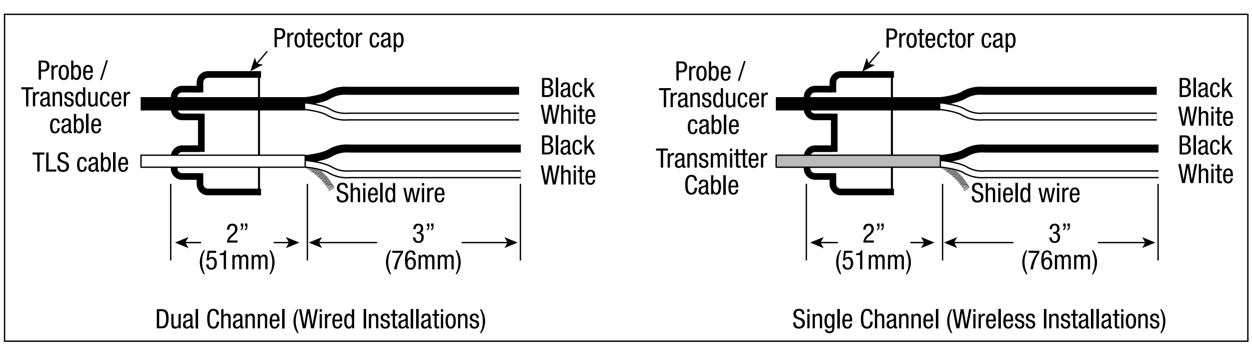

Figure 12. Splice Length Dimensions

2. Connect incoming cable wires to the protector wires using wire nuts as shown in Figure 13. Cut off the TLS cable's bare shield wire at the cable jacket.

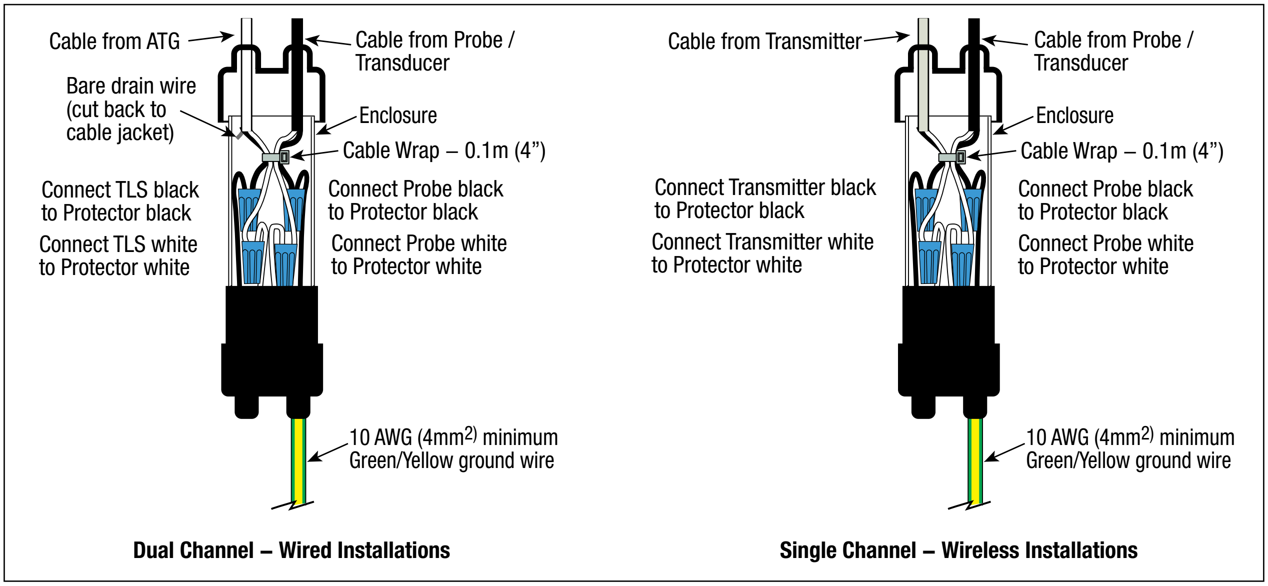

Figure 13. I.S. Circuit Splice Connections

3. Use the 0.1m [4"] cable wrap to hold the cables together (see Figure 13).

Older kits may contain a split bolt and nut instead of this cable wrap to hold the cables together.

4. Center the splices in the clear plastic sleeve. Assemble the protector enclosure, making sure the sleeve is fully inserted into each of the vinyl end caps. Rotate the sleeve cover until both openings line up. Place the splice on a level surface.

WARNING

Sealing compound contains isocyanate. Vapor and liquid may cause sensitization. May be irritating to the eyes.

Avoid skin and eye contact. Avoid repeated and prolonged breathing of vapor. Use only in well ventilated areas or wear respiratory protection. Wear chemically resistant gloves.

Inhalation – provide fresh air. In case of eye contact flush eyes with plenty of water for 10 minutes and get medical attention. If ingested do not induce vomiting. Get medical attention. Wash with soap and water in case of skin contact.

Store the sealing compound at 16°C (60°F) or warmer until ready to mix. Failure to do so can result in an improper seal once the mixed compound has hardened.

Read the information on the sealing compound package prior to mixing and follow all warnings and instructions provided.

5. Remove bag of "Sealing compound" from foil package. Grasp the ends, one in each hand, then pull sharply to remove plastic clip [Figure 14].

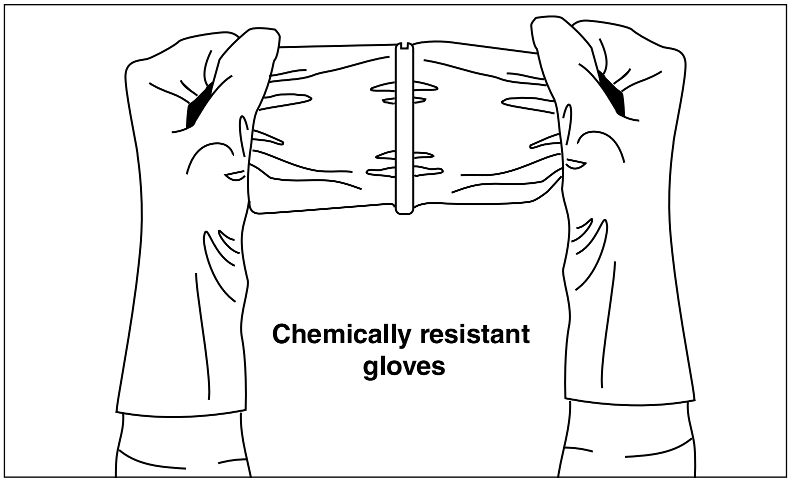

Figure 14. Removing Sealing Compound Clip

6. Thoroughly mix compound together. Invert bag several times while squeezing compound from one end to the other for a minimum of one minute.
7. Once the mixture feels warm, immediately cut one corner and slowly fill the protector's plastic sleeve. Stop just short of filling the entire sleeve. **Do not overfill**. [Figure 15]

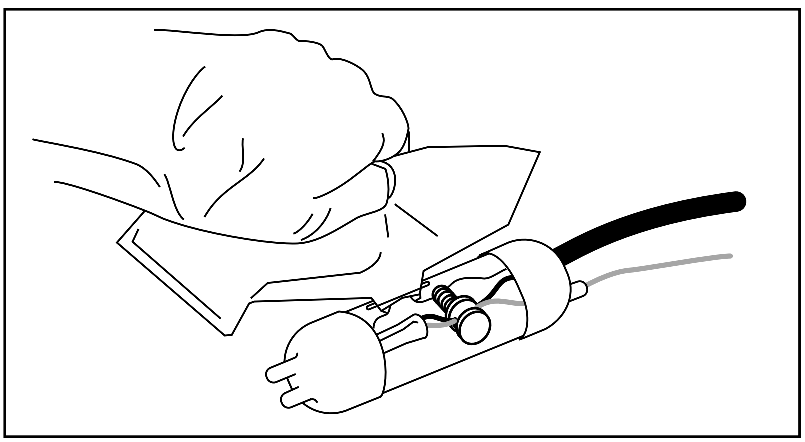

Figure 15. Pouring Sealing Compound into Sleeve

8. With a twisting motion, rotate the outer clear plastic barrel to close the pouring slot.
9. Wait at least five minutes, then use the large cable tie to mount the protector to the riser pipe or probe canister as applicable and connect green/yellow ground wire from protector to an appropriate ground (see Figure 16 through Figure 18).

I.S. Circuit/Surge Protector Installation Examples

Example surge protection installations of a wired mag probe in a fiberglass tank and in a steel tank are shown in Figure 16 and Figure 17 respectively. An example surge protection installation of a wireless mag probe in an above ground steel tank is shown in Figure 18.

Example surge protection installations of a wired DPLLD transducer in a fiberglass tank and in a steel tank are shown in Figure 19 and Figure 20 respectively.

Figure 21 illustrates a connection diagram for a mag probe in a riser pipe with and without optional surge/circuit protection. Figure 22 shows both wired and wireless installation examples of a Mag-Flex tall tank probe with a BA-350 surge protector and Figure 23 shows both wired and wireless installation examples of a Mag-Flex tall tank probe using either an I.S. circuit protector or a surge protector. Figure 24 shows an example of a Vapor Pressure Sensor installed in a dispenser using either an I.S. circuit protector or a surge protector.

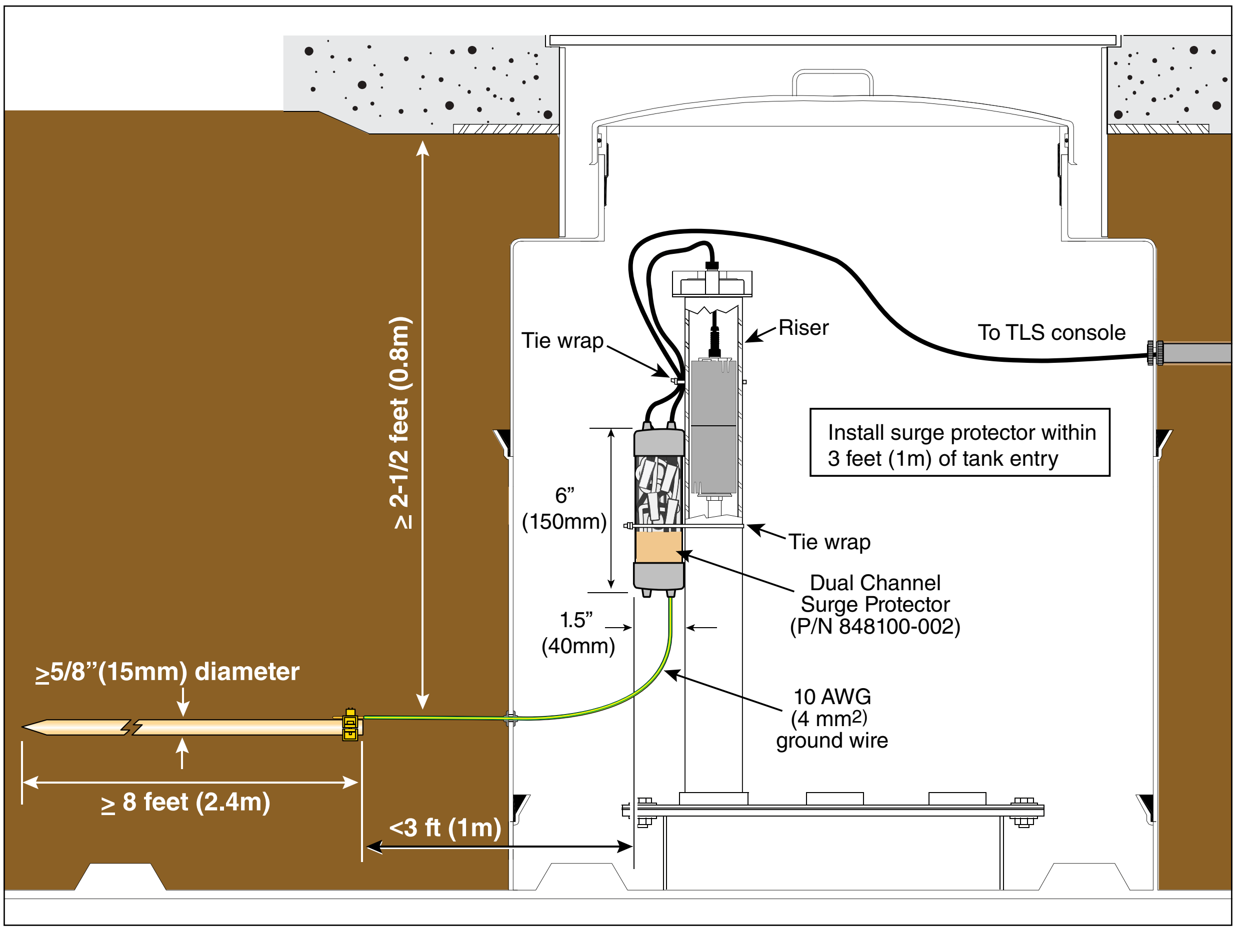

Figure 16. Example Wired Mag Probe with Dual Channel Surge Protection Installed - Fiberglass Tank

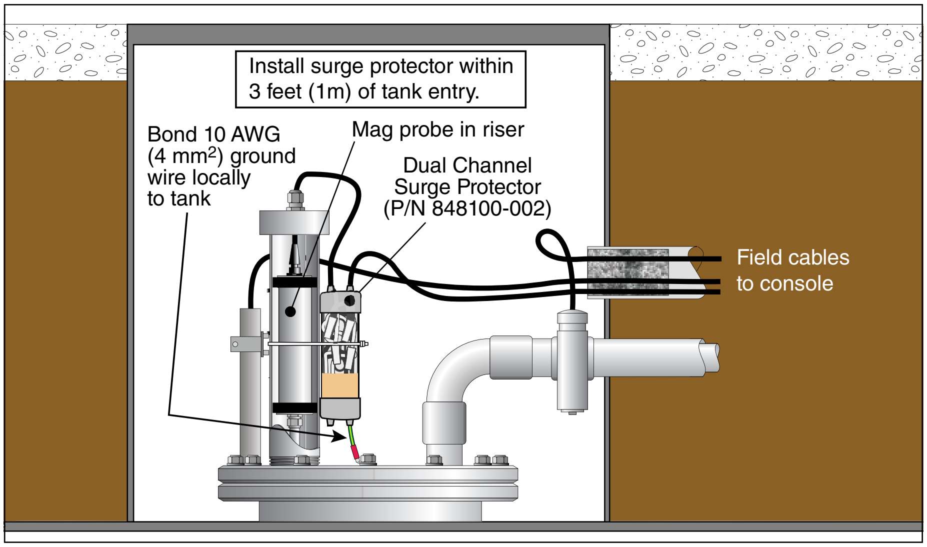

Figure 17. Example Wired Mag Probe with Dual Channel Surge Protection Installed - Steel Tank

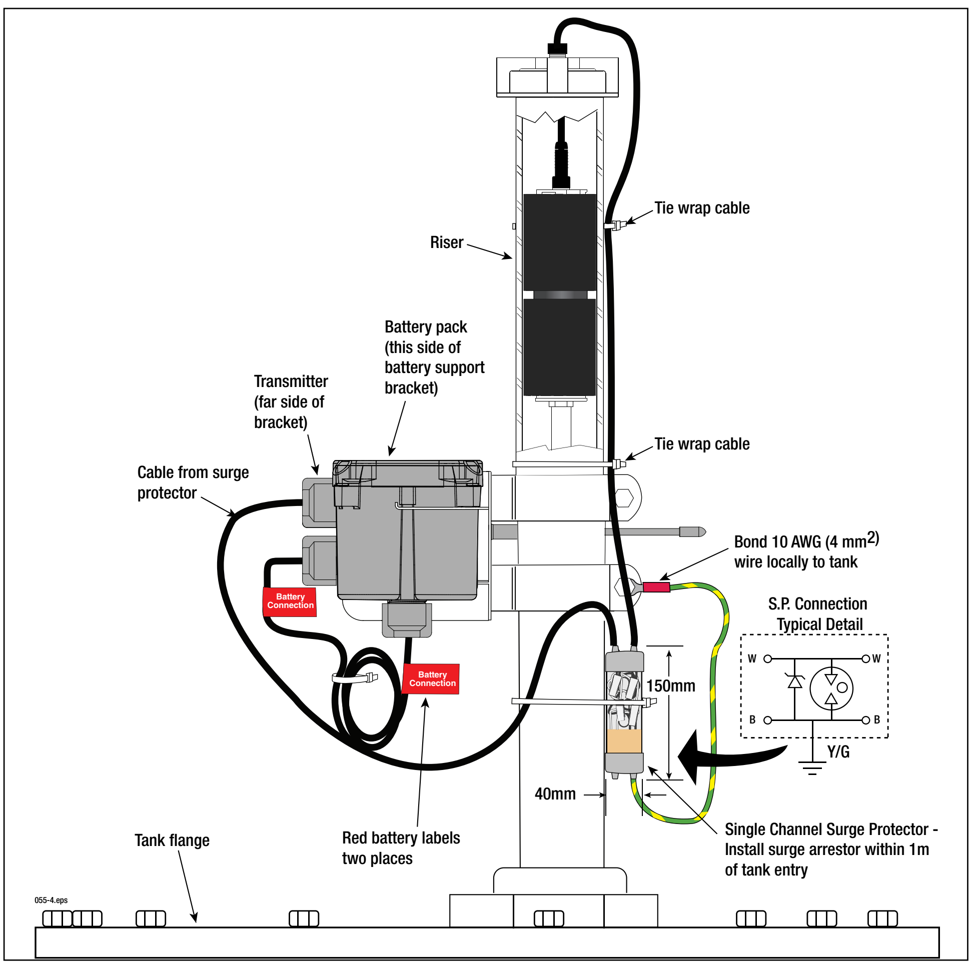

Figure 18. Example Wireless Mag Probe with Single Channel Surge Protection Installed - Steel Tank

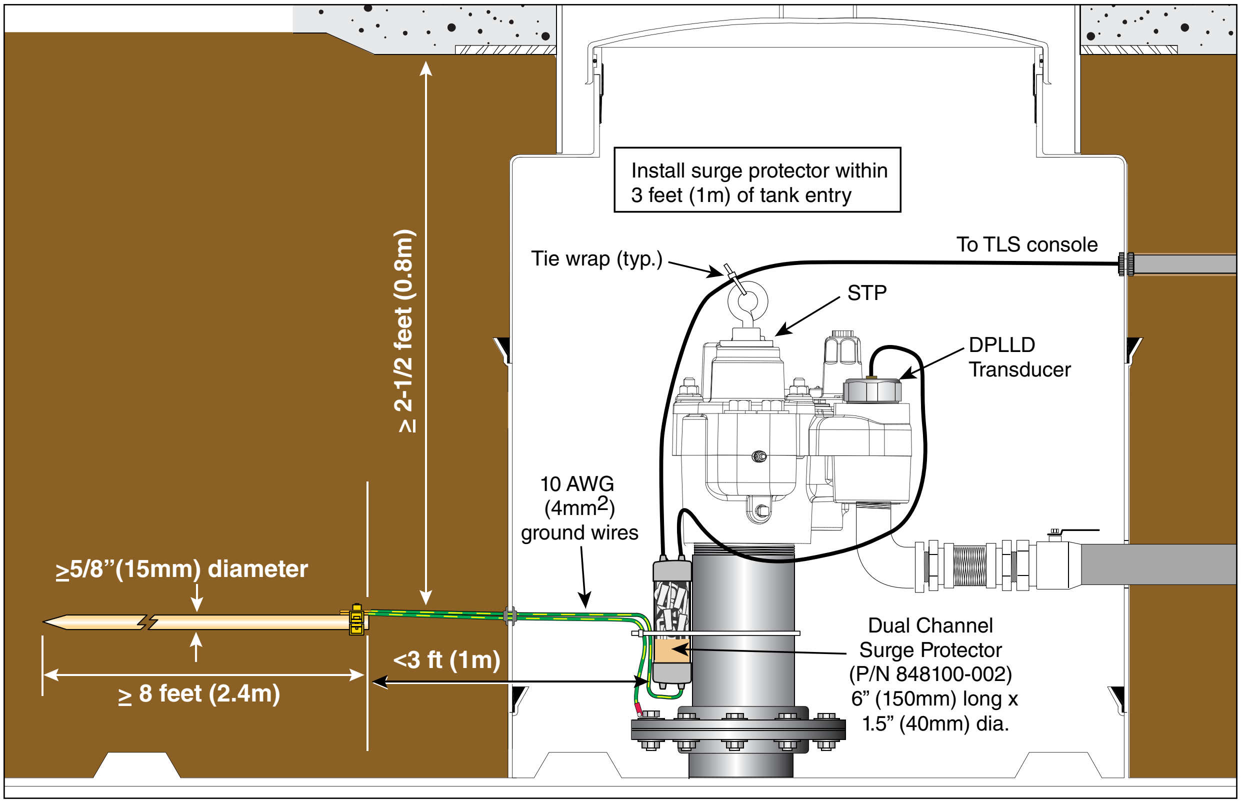

Figure 19. Example Wired DPLLD Transducer with Dual Channel Surge Protection Installed - Fiberglass Tank

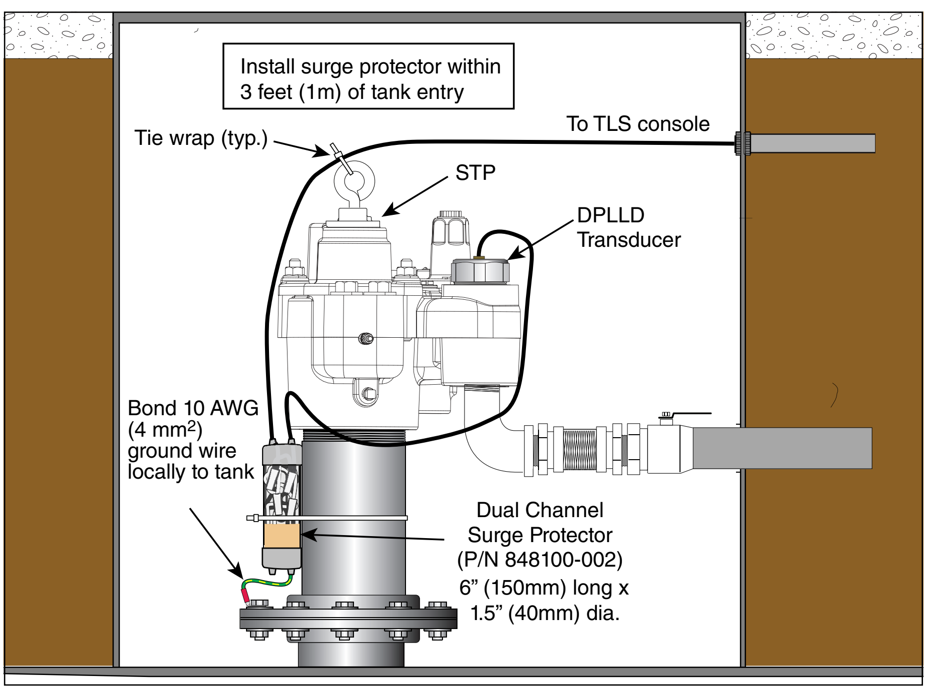

Figure 20. Example Wired DPLLD Transducer with Dual Channel Surge Protection Installed - Steel Tank

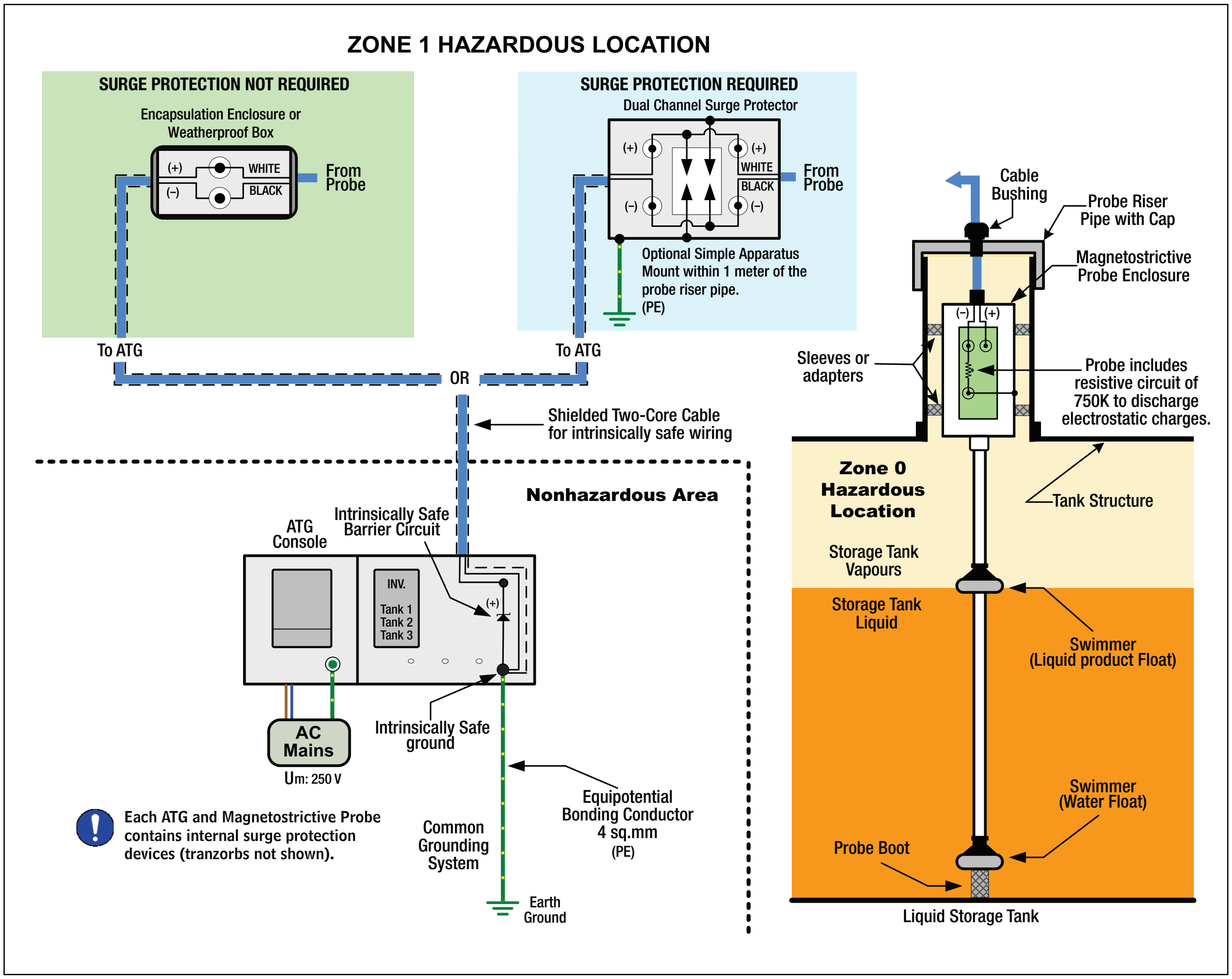

Figure 21. Connection Diagram for a Mag Probe in a Riser Pipe with and without Optional Surge/Circuit Protection

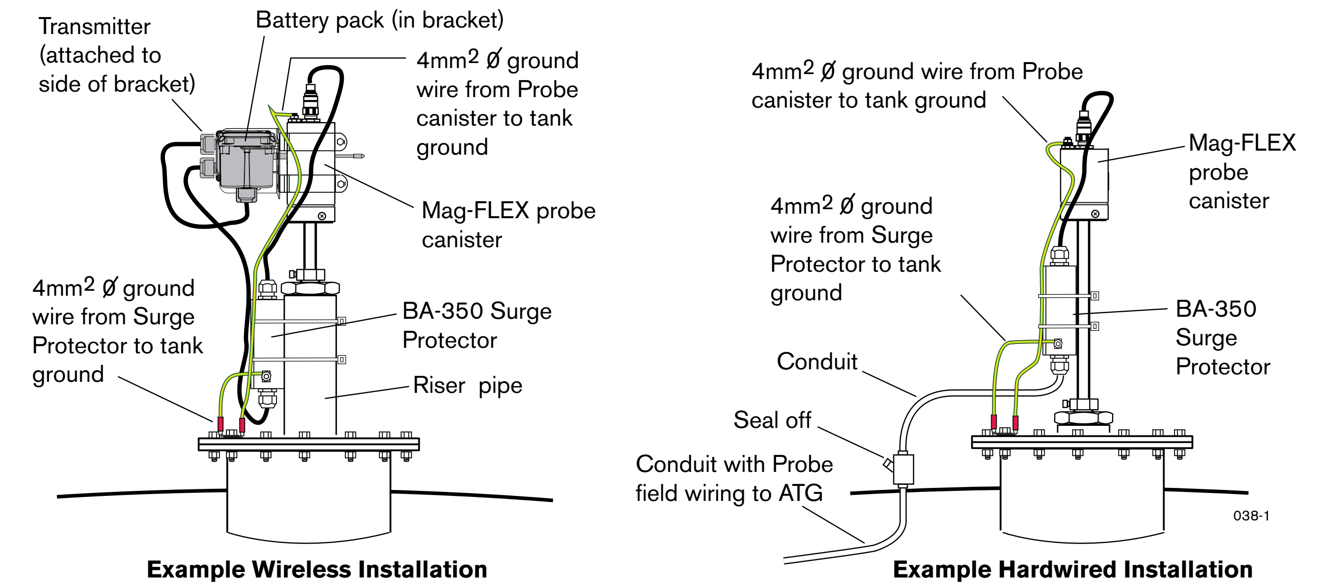

Figure 22. Mag-Flex Probe With BA-350 Surge Protector - Installation Examples

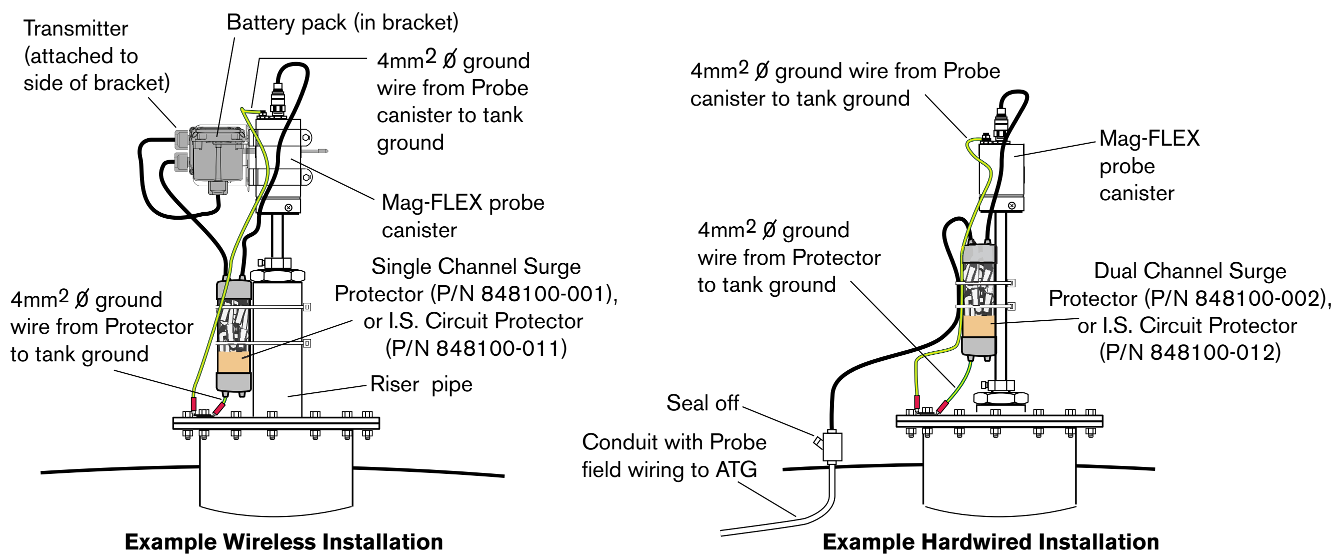

Figure 23. Mag-Flex Probe with Intrinsically-Safe Circuit Protector or Surge Protector - Installation Examples

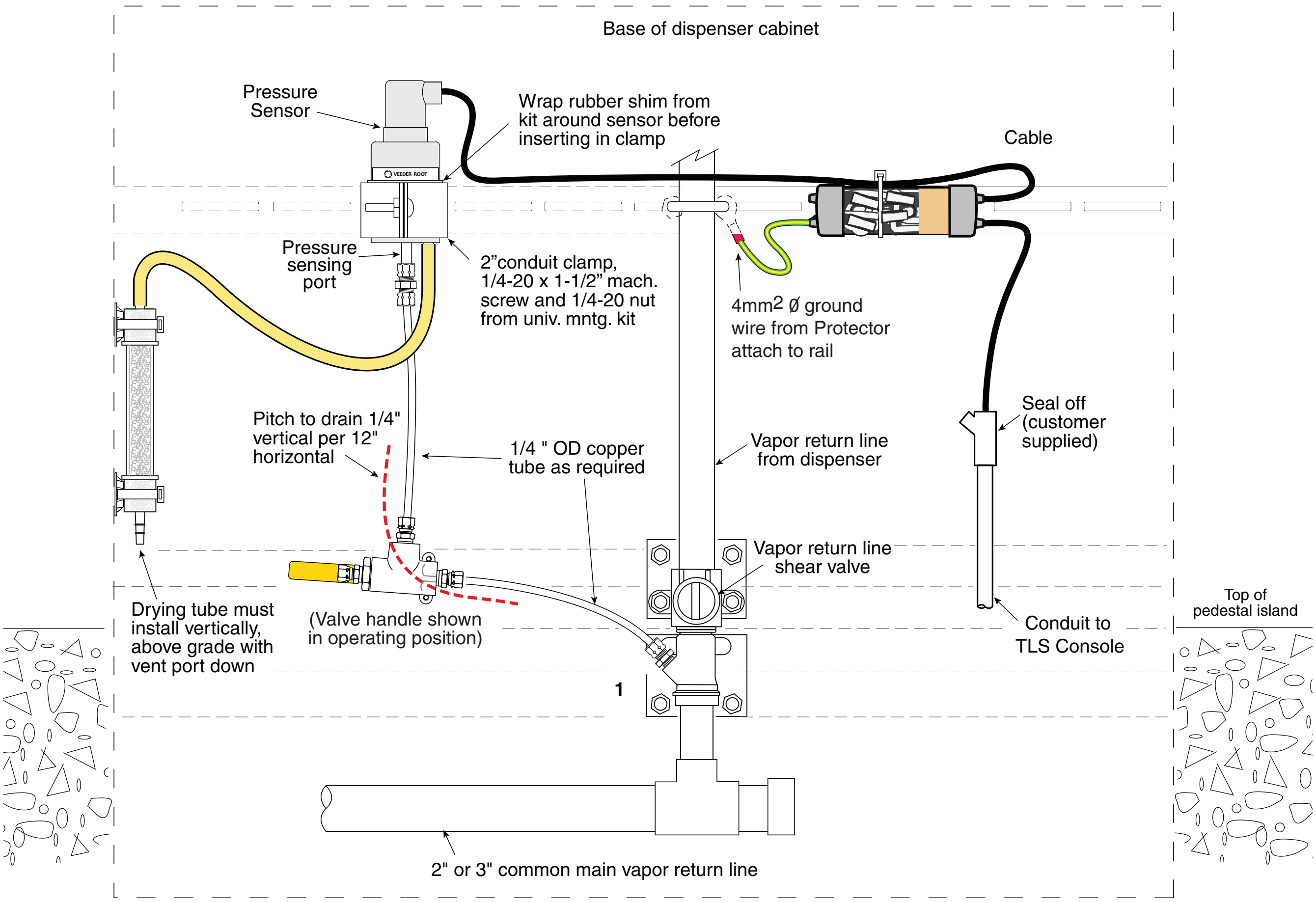

Figure 24. Vapor Pressure Sensor with Intrinsically-Safe Circuit Protector or Surge Protector - Installation Example

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