

Connecting TrupH™ Electrodes to a Transmitter

TrupH measurement systems require proper handling when connecting the electrode to the transmitter. The quality of the cable and the cleanliness of the connectors can impact the precision and accuracy of the pH measurement loop. This application note specifies requirements for the cable and connector, as well as connection methodology to ensure a proper connection.

Connection Cable

pH electrodes have a high internal resistance (up to 5×10^9 ohms[Ω]), so that any electrical connection between a pH electrode and a pH meter/transmitter is prone to electro-magnetic interference. As a result, the use of a good quality cable such as a coaxial (or triaxial) cable is recommended. In general, this cable should have:

- 1 A high insulation resistance:** a cable resistance that is higher than the input impedance of both the electrode and meter/transmitter (normally $\sim 10^{12}$ Ω) is recommended. A low-noise, insulated coaxial cable is preferred, especially one that has an insulation resistance of 10^{14} Ω to 10^{17} Ω per meter of cable length.
- 2 A low capacitance:** minimizing the cable capacitance is recommended, in order to preserve the time constant of the signal transmission and hence the measurement system time response. For example, a 200 pF/m cable capacitance on a 50 m long cable would add about 50 seconds of a delay to the response time of the pH measurement loop. Therefore, the capacitance of a pH connection cable should not exceed ~ 150 pF/m. Coaxial cables having

a capacitance ranging from 64 pF/m to 102 pF/m are readily available, and are recommended for pH measurement loops.

- 3 An appropriate temperature rating:** For normal bioprocess applications, the standard coaxial cable temperature rating of -30°C to $+80^\circ\text{C}$ is sufficient. However, special high temperature cables are available for processes that require a temperature rating of up to 130°C .

TrupH electrodes are combination electrodes. Depending on the type of connector used, either a single or double screened coaxial cable (triaxial cable) is required. For TrupH sensors having a K8 or S8 connector, a single-screen coaxial cable is sufficient, whereas for a VP connector a more complex cable is needed. Suitable coaxial and triaxial cable designs are shown in figure 1. Normally, the pH measurement electrode is connected to the internal conductor; the reference electrode is connected to the inner screen (screen 1) for a coaxial cable. If triaxial cable is used, then the outer screen (screen 2) is grounded.

Cable Preparation and Cable Routing

The pH connection cable (see figure 1) is insulated using both a copper wire mesh (screen) and a black semiconductor layer. This layer suppresses voltages which are created when the coaxial cable is handled. This black layer must be carefully removed when preparing the cable ends for connection to the electrode plug and/or to the meter/transmitter. If the black layer is not removed, it will cause a short circuit between the internal conductor and the copper screen.

When stripping the coaxial cable, tools and hands should always be dry and completely

clean. After stripping is complete, the cable ends should be cleaned with alcohol or acetone using a clean tissue, cloth, or brush. Touching the stripped cable ends with wet or dirty fingers will reduce the insulation resistance to 10^7 ohms or less, which will result in an effective "short circuit" within the high resistance measuring chain of the electrode and the meter/transmitter, thereby precluding an accurate pH measurement.

When routing the pH connection cable, care must be taken not to route the pH connection

TrupH

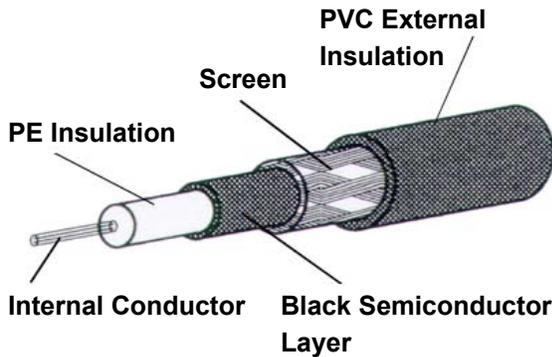
Figure 1 Coaxial (left) and triaxial (right) cables that should be used to connect TrupH electrodes to a meter/transmitter.

cable close to power cables. Any power cables located in the vicinity of a pH connection cable will lead to electro-magnetic induction interference. Such interference will preclude an accurate pH measurement. Furthermore, the outer screen (screen 2) of the triaxial cable should always be grounded on one side only. For permanent connections, pH cables cannot be buried directly in the ground, but must be installed in a metal or plastic conduit.

Every pH connection cable should be as short as possible. In no circumstances should the length of the cable exceed 150 feet (50 meters).

An electrode plug connection eases the electrode removal or replacement during maintenance. A plug is more flexible and economical than a permanent cable, even though it may not provide as good a seal against environmental factors. Finesse offers three types of plugs on its cables that correspond to the electrode connectors: K8, S8, and Variopin (VP). In any case, care must be taken to always connect the electrode socket firmly to the cable plug. Otherwise, moisture can penetrate the socket/plug coupling and result in poor measurement accuracy.

Coaxial Cable



Triaxial Cable

