RST INSTRUMENTS LTD.

RST Strain Gauge Piezometer Instruction Manual

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RST Strain Gauge Piezometer

Product: RST Strain Gauge Pressure Trasducer
Instruction Manual

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1 OVERVIEW

The RST Strain Gauge Piezometer series of transducers/transmitters are specifically designed to meet the rigorous environments encountered in level measurement applications. These transmitters provide repeatable, precision depth measurements of pore water pressure under the most adverse conditions.

These devices feature high performance internal signal conditioning and are available in both 4-20mA and 0-5VDC output versions (other outputs are available upon request). This provides easy integration into numerous types of data acquisition systems. A key benefit of these transducers is that they can be read at a high frequency which is ideally suited to applications where dynamic monitoring of water level is required.

2 GENERAL DESCRIPTION

RST submersible pressure transducers use isolated diaphragm sensors that are specifically designed for use with hostile fluids and gases. These sensors utilize a silicon pressure cell that has been fitted into a stainless steel or titanium package with an integral, compliant stainless steel or titanium barrier diaphragm. This sensor assembly is housed in a rugged 316 stainless steel or titanium case which provides for a variety of pressure inputs from 0-2 through 0-15000 psi. Our devices feature internal signal conditioning. Standard outputs are 4 to 20 mA , mV and VDC. Other outputs are available upon request.

All units containing active electronic components that have surge and reverse polarity protection. For ease of use in the field, our transducers are permanently etched with our logo and name, wiring information, part number (P/N), serial number (S/N), date of manufacture (DOM), range, excitation and output. Pressure transducers are offered in diameters of 1.0 and .75 inches.

3 CARE AND HANDLING

Our submersible transducers are designed for rugged use. However, they need protection from over pressure and sharp impact. When lowering them into a liquid, penetrate the surface slowly and only to the depth necessary. Avoid dropping the unit from above the surface. Clean all transducers by rinsing them in a mild detergent. Direct probing of the diaphragm or attempts to remove protective screens will damage the sensor, voiding the warranty.

4 CALIBRATION

All pressure transducers are shipped with calibration information unique to each transducer. Make sure you keep each calibration report. However, should you misplace your calibration sheet, you can contact the factory to have a duplicate faxed or e-mailed to you.

5 PRODUCT ACCESSORIES AND OPTIONS

5.1 NOSE CAPS

There are several different user-installable nose caps for the Series 700, 710, 720, 730, 735 submersible pressure transducers. A closed-face ported cap (Delrin) with threaded hole is best used where weights are required and for those installations where users may encounter sharp, protruding objects. An open-face cap which allows maximum contact with the liquid media is ideal for wastewater and "greasy" applications where clogging of the sensor is a concern. The 1/4" male NPT pressure cap is not only useful for calibration purposes but also allows the device to be used as a submersible or above ground pressure transducer. The piezometer cap allows the unit to be buried in saturated soil without damage to the sensor diaphragm.

5.2 ABSOLUTE/SEALED GAUGE TRANSDUCER

The sealed gauge option for submersible transducers eliminates the need for a vent filter. The standard output of a sealed gauge transducer is 4 mA at 14.70 psi. Before ordering a sealed gauge transducer, the customer should determine the altitude (above sea level) of the installation and inform RST of this value. During manufacture, the output of the transducer will be adjusted to compensate for the altitude difference.

5.3 VARIETY OF ELECTRICAL OUTPUTS

Most applications call for a 0-5 VDC, 4-20 mA or a 0-100 mV output. But where necessary, our transducers offer a broad choice of possibilities including, among others, 0-10 VDC, 0-2.5 VDC, or ratiometric mV/V.

5.4 REVERSE SIGNAL

For some applications, it is important to know how far the water is from the top of the tank or the surface of the ground. If specified by the customer, a custom sensor can be ordered, set so that zero pressure reads full scale electrical output and maximum pressure reads zero output.

5.5 TEMPERATURE OUTPUT

A 4-20 mA output for temperature is also available for most transducers having a 4-20 mA pressure output. The temperature sensor requires an excitation of 9-30 VDC and is calibrated for a temperature range of 0 to 500^{o}C or -20 to 60ºC with an accuracy of ±2ºC.

6 INSTALLATION & MAINTENANCE TIPS

General Installation Procedures

Following is important installation and preventive maintenance information.

1. **Transducer Anchors:** Most users either suspend the instrument in stilling wells or attach them to rigid conduit. This is done to prevent damage to the transducer from shock caused by water turbulence. It is not advisable to tie your transducer to a pump or to piping, as any problem with the transducer could require that the pump be pulled from the installation which could prove to be very expensive. (Please refer to the Cable Anchoring Schemes drawing in Appendix A).

   Some applications use an optional bracket to clamp the transducer to a fixed object (i.e., wall, ladder, step) or require the unit to be suspended without any protective still well or attachment device. In all installations, care should be taken to ensure no damage occurs to the cable as cable damage represents one of the most frequent causes of transducer failure.

2. **Transducer Submersion:** Lower your transducer into the liquid very slowly, making sure the cable does not drag over sharp edges. When lowering them into a liquid, penetrate the surface slowly and only to the depth necessary. Avoid dropping the unit from above the surface. Cable damage represents one of the most frequent causes of transducer failure.

3. **Cable Protection:** An inexpensive way to protect the cable from damage is to order the submersible pressure transducer with a ½" conduit attachment. Connect an inexpensive flexible 5/8" garden hose to the ½" conduit fitting with an equally inexpensive female PVC ½" NPT x 3/4" NHT swivel fitting, available at your local hardware store.

4. **Bending of Cable:** RST's polyurethane jacketed cables are quite flexible. Care needs to be taken to ensure that when bending the cable to suit your installation you do not crimp the vent tube inside the cable (if applicable). Consequently, do not bend the cable more than a radius of 1 inch.

5. **4-20 mA Wiring:** When connecting a 2-wire 4-20 mA transducer to a typical power supply and milliammeter, verify that the meter has an input impedance of at least 10 Ohms. If you are unsure of the input impedance, then a 10 Ohm resistor may be placed in series with the

meter and transducer. Connect the + (red) lead of the transducer to the + terminal of the power supply. If the 10 Ohm resistor is required, connect it to the - (black) lead of the transducer. Use a short length of 22-24 AWG wire to connect the + terminal of the meter to the resistor (if it is required) or the - (black) wire of the transducer. Connect the – terminal of the meter to the - terminal of the power supply with a length of 22-24 AWG wire. Connect the drain wire from the transducer to a good earth ground (See Appendix, page A-2 for wiring diagram). Please refer to "Maximum Cable Lengths and Minimum Supply Voltage" in Appendix C, page C-2 to verify minimum loop supply voltage requirements.

6. **VDC Wiring:** To connect a 3 wire VDC output transducer to a typical power supply and the voltmeter, connect the - terminal of the power supply to the - input terminal of the meter with a length of 22-24 AWG wire. Connect the - excitation (black) lead of the transducer to the - input terminal of the meter. Connect the + input terminal of the meter to the signal lead (white) of the transducer. Connect the + terminal of the power supply to the + lead (red) of the transducer. Connect the drain wire to a good earth ground. (See Appendix A, page A-2).

7. **Sealed-Gauge Transducer Configured For Altitude Above Sea Level:** Since sealed-gauge transducers are normally calibrated at sea level, there would be considerable error induced when used at the higher elevation if the transducer was constructed without taking into consideration the difference in atmospheric pressure at sea level and the higher elevation. In order to eliminate error due to the difference between atmospheric pressure at sea level and that where the transducer will be installed, the customer is asked to identify the elevation of the place where the transducer will be used. Using the supplied elevation information, the nominal atmospheric pressure at the installation location is calculated and the zero output set for that pressure.

7 GENERAL MAINTENANCE TIPS

7.1 DESICCANT MAINTENANCE

If you use a desiccant vent filter, you should establish a regular maintenance schedule. You should change your vent filter when it is 75% spent (pink color). Replacement filters are available at a nominal cost from the factory. Do not remove the old vent filter until a new one is available. The most common failure mode of our transducers is moisture and corrosion damage due to lack of use or maintenance of the vent filter. Remember to remove the filter's protective cap when in use.

7.2 CLOGGED NOSE PIECE OR DIRTY DIAPHRAGM

Either of these conditions could result in erroneous readings from your transducer. NEVER attempt to clean your transducer's nose piece or diaphragm with a sharp or hard object. This could dent the sensor diaphragm and cause permanent damage to the transducer. Your transducer may be cleaned in accordance with the procedures listed in section 7.4, below.

7.3 DRYING YOUR TRANSDUCER CABLE

If you happen to get water in the vent tube and in the submersible pressure transducer, coil the cable and transducer in a pan and place the pan in an oven at 50ºC for a minimum 2 hours. You MUST remove the desiccant/aneroid bellows filter prior to heating the cable. This on-site remedy may do the trick. Be careful that the oven temperature does not exceed 50ºC. Otherwise, you may damage the transducer and cable.

7.4 CLEANING YOUR TRANSDUCER

Materials required:

- Plastic bowls 8-12 inches in diameter and 4-6 inches deep
- Supply of clean, lint-free cleaning rags

- 32 ounce bottle of “The Works-Tub and Shower Cleaner” (a mild detergent) manufactured by Lime-O-Sol Company in Ashley, IN 46705 and available locally through WalMart, KMart, Target, and Ace Hardware stores at $2 to $4 per bottle.

Preparation: Prior to cleaning your pressure transducer, ensure that all procedures have been followed in the proper cleaning of the cable and transducer to remove any hazardous materials. The vent filter (or bellows) must be properly attached. The cable should be coiled to ensure ease of handling and it must be protected against the possibility of accidental abrasion and/or penetration of the cable jacket by sharp objects. A lead length of 1 to 1 ½ feet of cable from the transducer should be allowed to facilitate handling during cleaning. The protective covering (or similar protective device) that is shipped with each transducer should be attached to the transducer at all times. It should only be removed prior to installation or cleaning. Your work surface needs to be clean and free of clutter and large enough to accommodate all materials required in addition to the transducer and cable. Fill one of the bowls with fresh water, one with a mild detergent mixed with water and the last with 16 ounces of “The Works”.

Cleaning:

Step 1: Holding the cable 6 inches from the transducer, immerse the unit in the bowl containing the mild detergent and stir for 20-30 seconds. Remove and rinse in the bowl containing the fresh water, using the same stirring motion used in the mild detergent. Rinse and wipe dry.

Step 2: Holding the body of the transducer with one hand so that you are looking at the retaining screen protecting the sensor, carefully remove the sensor nose piece by simply unscrewing it from the sensor body.

Do not touch the sensor diaphragm with your finger or any other object. Also, do not try to dry the inside portion of the transducer, as you risk damaging the pressure sensor.

Step 3: Place the transducer in a vertical position with the pressure sensing end facing downward in the bowl containing “The Works” solution for approximately 15-20 seconds. Rinse in the bowl containing clean water and wipe dry the external casing only. Place the protective screen in the same solution for 15-20 seconds, rinse and wipe dry.

Step 4: Holding the transducer in a vertical position so that you can see the face of the pressure sensor, screw the protective nose piece back into place.

8 APPENDIX A – WIRING DIAGRAMS

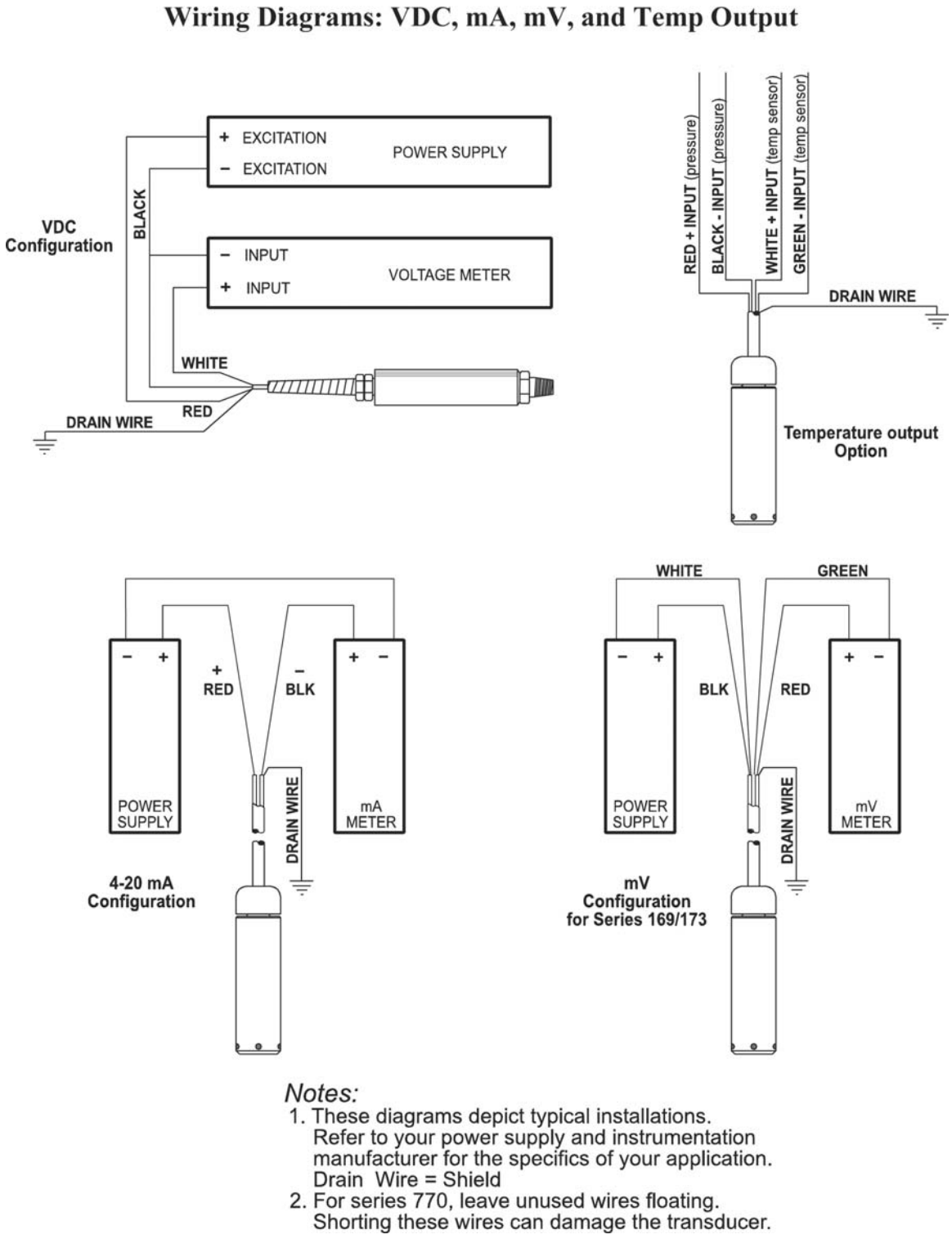

Figure 1 – Typical Wiring Diagrams

9 APPENDIX B - FREQUENTLY ASKED QUESTIONS

1. I need proof pressure much greater than 1.5 X. How can you help me?

We can provide 5 X over pressure protection on most ranges if you can accept a thermal error of 0.1% full scale output per degree Celsius.

2. What installation ideas do you have to help me get rid of electrical noise interfering with the signal?

An ounce of prevention goes a long way. Either try to eliminate the source of noise or move the transducer as far away from it as possible. We strongly encourage you to secure our cable shield to a good earth ground and that you use a 4-20 mA signal output. Armed with these precautions and the fact that many of our transducers are CE approved for electromagnetic interference, you should have few problems.

3. My cable on the submersible always seems to get cut and damaged. What am I doing wrong?

This is the most common problem that our users encounter. Make sure that all of your colleagues and staff understand the importance of handling the cable with care. The cable should not be bent around rough or sharp edges. Always use a cable reel during transport. Where possible, suspend the unit in a perforated 2" PVC pipe and thread the cable through protective conduit to the nearest junction box. This is a problem that Pressure Systems' directly addresses with the water block feature in our cable.

4. I have an application where the transducer is frequently damaged by voltage spikes. What can be done to prevent this?

At a minimum, make sure the cable shield is connected to an earth ground as near as possible to the transducer. We can provide a surge protection kit for both our below and above ground transducers and transmitters. These kits will handle typical spikes that might come in through the power lines as well as surges that travel through the ground due to nearby lightning strikes.

5. How much impact shock can your submersible transducers withstand?

The lower pressure ranges can be damaged if dropped from several feet onto an unforgiving surface like concrete, so we recommend that the protective shipping foam remain in place until the unit is installed.

6. What is the response time of your transducer?

From initial power up, the transducer output will stabilize within a fraction of a second. The frequency response is rather low, probably less than 1 kHz, but it really depends on the application, the media, plumbing, etc. Call our factory for application assistance if frequency response is critical in your application.

7. What is the best way to mark my cable?

Use white vinyl marking tape available from your local hardware or electronic stores. These same stores may also sell cable marking kits.

8. Any ideas for preventing marine growth on your submersible transducers?

You might want to try waterproof grease. Remove the threaded nose cap to facilitate applying the grease. Take care when applying the grease not to trap air bubbles against the sensing diaphragm and not to damage the diaphragm.

9. How many pressure measurements can you make before the diaphragm on the pressure sensor fails?

In normal operation - millions of cycles. We find that transducer failure is rarely due to diaphragm fatigue.

10. What is the mean time between failure for your submersible pressure transducer?

Most failures are due to misuse by the end user. However, properly installed units last tens of thousands of hours.

11. What is the longest length of cable you have attached to a submersible transducer?

Two thousand feet.

12. Why do you use 316 SS housings and sensors for your standard transducers?

It offers a good combination of corrosion resistance and reasonable cost. As an option, we do offer Titanium for very corrosive environments.

13. What wire gauge should I limit myself to when connecting to your 22 AWG wire?

Use 22 AWG or greater.

14. Does it make any difference if I mount the transducer in a vertical or horizontal position?

No. Our units have a minimum amount of position sensitivity. You should mount it in the same position, however, throughout the measurement cycle.

15. What happens when you freeze your transducer in a column of water?

We have frozen our submersibles in a container of water in a home freezer, with no resulting damage. However, depending on the pressure range of the unit, over pressure of the unit is possible. In harsh environments where debris is common and ice shifts, you might expect damage to both the transducer and cable.

10 APPENDIX C - FIELD CHECKOUT AND TROUBLESHOOTING TECHNIQUES

10.1 QUICK CHECK PROCEDURE

The following is a quick, simple field checkout procedure for RST level and pressure transducers. It will be referred to throughout the troubleshooting section.

Should a problem be encountered with a transducer or transmitter, it is sometimes helpful to test the transducer independently from the rest of the system, thereby establishing where to concentrate the troubleshooting effort. Shown below and on the next page are simple hookup diagrams for the two most common types of electrical output, a 0-5 VDC transducer and a 4-20 mA transmitter. In either case, the "power supply" can be a common 12 volt lantern battery, or even a 9 volt transistor radio battery, although the lifetime of a 9 volt battery will be limited. The meter should be a digital type capable of reading at least 2 digits to the right of the decimal point. Use 20-24 gauge hookup wire or clip leads for jumpers. If your unit has other than a 0-5 VDC or 4-20 mA output, please contact RST Instruments Ltd. for further assistance.

Once your transducer is correctly configured per one of the diagrams below, orient the transducer in a vertical position with the pressure port down and then read the zero output on your meter. For a 0-5 VDC output, the zero should be between 0 and 0.060 volts, and for a 4-20 mA output, between 3.88 and 4.12 mA. If the output is outside of these limits, you may, at your option, choose to troubleshoot the transducer per the suggested measurements shown below. Otherwise, contact RST Instruments for a Return Material Authorization number (RMA).

If the zero output is within these limits, the problem will more than likely be found elsewhere in your system.

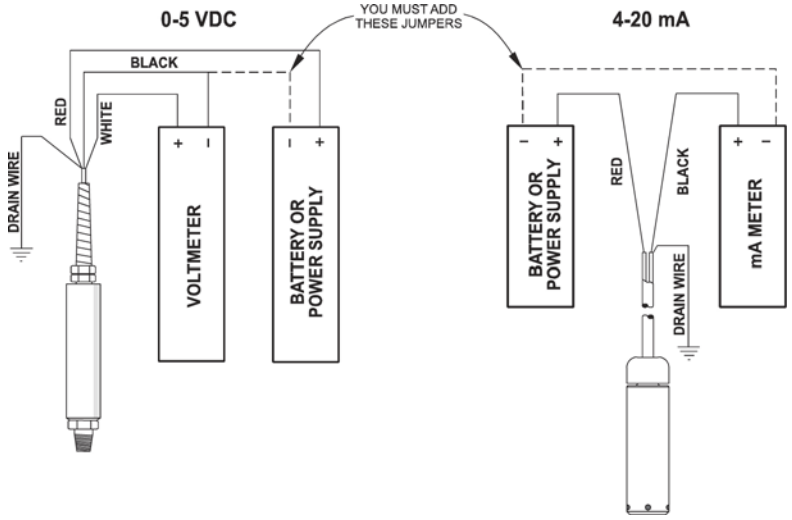

Figure 2 – Transducer Wiring

When an error is observed at a customer's installation, it is important to determine whether the fault lies in the transducer or the instrument reading the transducer signal. To do this a second instrument should be used to confirm the observations. The second instrument may be a handheld DMM (Digital Multi-Meter) or a dedicated milliammeter capable of reading 4-20 mA of current to a resolution of at least 0.1 mA. The diagram above illustrates the attachment of the meter in series with the black (negative signal) wire of the transducer using a 9-30 VDC power supply for transducer excitation.

Some suggested power supplies are:

- 1 - 12 VDC automotive battery.
- 2 - 6 VDC lantern batteries connected in series (for a total of 12 VDC).
- 2 - 9 VDC transistor batteries connected in series (for a total of 18 VDC).

Batteries are suggested to power the transducer during testing to eliminate the possibility that line noise is passing through an improperly filtered, grounded, or damaged power supply. All measurements should be recorded and sent to RST Instruments along with the transducer to assist in the evaluation process.

10.2 FURTHER MEASUREMENTS:

0-5 VDC	Should read:		4-20 mA	Should read:
+Excitation (white) to Shield (drain)	> 2.5 Mohms		+ Excitation (red) to Shield (drain)	> 2.5 Mohms
- Excitation (black) to Shield (drain)	> 2.5 Mohms		- Excitation (black) to Shield (drain)	> 2.5 Mohms
+ Output (red) to Shield (drain)	> 2.5 Mohms		Shield (drain) to Housing	< 2 ohms
Shield (blue) to Housing	< 2 ohms			

10.3 MAXIMUM CABLE LENGTHS AND MINIMUM SUPPLY VOLTAGE

The maximum length of cable to be used with our submersible transducers is largely dependent upon the type of electrical output of the transducer. For a 0-5 VDC output, a maximum cable length of 100 feet is recommended. A voltage output is more susceptible to electrical interference than a 4-20 mA signal. A 4-20 mA signal can be transmitted much longer distances, depending upon such factors as temperature, wire size, length of the wire, power supply, and voltage requirements of any devices to be powered. At 25ºC the 22 AWG conducting copper wire used in our polyurethane jacketed cable has a resistance of 16.45 ohms per 1000 feet.

Using Ohms Law (E=IR) where E=voltage, I=current and R =resistance, one finds that a 20 mA signal requires .329 volts to drive it along 1000 feet of 22 AWG copper wire (E=16.45 x .020). This drop is seen on both the supply and return wire for a total loop voltage drop of 0.658 volts.

To find out how much voltage is required to drive our submersible pressure transducer's 4-20 mA signal 10,000 feet, just add the minimum power requirement of the 700 (9 VDC) to the resistance offered by 10,000 feet of polyurethane jacketed cable (10,000÷1000 x .658=6.58). The resulting power requirement is 15.58 VDC (9 + 6.58).

Connect the cable shield (drain wire) to a good earth ground. This will protect the transducer from relatively minor transient voltages. The only exception to this rule is if high rates of electrolytic corrosion have been previously experienced with grounded submersible devices. In this case it may be better to leave the shield disconnected.

Please Note

When using products with the lightning protection option on 4-20 mA products, users should take into account the additional series resistance of this option when selecting the loop power supply. This option will increase total loop resistance by 88 Ohms.

10.4 TROUBLESHOOTING TECHNIQUES

1. **Symptom:** Transducer fails to give output of any kind.

   Procedure: Isolate the problem to either the transducer or the power supply/readout. See the Quick Check Procedures (above) for this check. If it can be determined that the transducer is no longer operable, remove it from service for further analysis. If the transducer output falls within the limits described above, the fault lies somewhere else in your system.

2. **Symptom:** Transducer has failed and has been removed for analysis.

   Procedure: Inspect the cable for physical damage. Cuts in the cable jacket can result in liquid incursion into the transducer housing, which can cause permanent damage. To determine if the transducer has been damaged, dry the transducer and cable (see section 7.3) and test for proper operation. If operational, the cable should be repaired or replaced. The cable can be repaired using a splice kit supplied by RST Instruments or can be replaced at the factory.

   Inspect the transducer housing. It should be intact and free of corrosion. If the outer surface of the transducer is pitted, this could be an indication of galvanic corrosion caused by stray ground currents. If this is the case, the transducer will probably require replacement. If the external case exhibits none of these characteristics, carefully unscrew the nosepiece and look into the pressure sensing end of the transducer. The concentric rings of the sensing diaphragm should be visible. If they are not, it could be that residue has accumulated on the diaphragm, preventing it from responding properly to pressure changes. The transducer can be cleaned by gently swishing the transducer back and forth in a bucket of warm, soapy water until the residue softens and washes off (section 7.4). Under no circumstances should any object or tool be used to remove residue from the sensing diaphragm or else permanent damage will be done. If cleaning the diaphragm does not solve the problem, the transducer should be returned to the factory for repair or replacement.

3. **Symptom:** Transducer develops a negative offset and gets worse over time (actual level exceeds specified level).

   Procedure: This may be a sign that moisture has entered the reference (vent) tube in the cable and is inside the transducer housing. This is usually the result of not maintaining the desiccant vent filter or of operating the transducer without a desiccant filter or aneroid bellows. If caught early enough, the transducer can be saved by coiling the cable and transducer in a pan and baking it in an oven at 50^{o}C (122^{o}F) for a minimum of 2 hours. Be careful that the oven temperature does not exceed 50^{o}C (122^{o}F) or both the transducer and the cable can be damaged. Alternatively, suspend both the cable and transducer in a vertical position (with vent tube down) overnight to allow water to drain from the transducer and vent tube.

4. **Symptom:** Transducer suddenly fails during or just after a nearby lightning event.

   Procedure: This failure is usually caused by over-voltage due to ground transients resulting from a direct or indirect lightning event. These transients can travel distances of a mile or more. The transducer may be returned to the factory for repair and optional retrofit of our lightning protection system.

5. **Symptom:** Transducer response to pressure/level input changes becomes sluggish.

   Procedure: This is usually a sign that the pressure sensing end of the transducer has become fouled with residue. The transducer must be removed from service and the pressure sensing diaphragm cleaned as described in section 7.4, (warm, soapy water). If fouling persists, the transducer may be replaced with a wide mouth transducer, which is specifically designed for trouble-free operation is a high residue environment.

6. **Symptom:** Output reading is within limits but "freezes" at one point.

   Procedure: In certain environments "crust" may form over the sensing diaphragm, preventing the sensor from identifying change in level. Removing the transducer from service and cleaning it (as described in section 7.4) will generally solve the problem. To combat marine growth, you might try wrapping the transducer with copper wire similar to that found in wire scouring pads for cleaning dishes. Marine growth occurs on the copper and eventually erodes the copper and drops off or the copper is manually removed during routine maintenance. Alternatively, there are various companies that will impregnate/coat the 316 stainless steel with anti-fouling chemicals of coatings. Level sensors temporarily removed from the well or sump should not be stored dry, but should be stored in a bucket of fresh water in order to prevent "crust" formation.

7. **Symptom:** No electrical output from your transducer.

   Procedure: Check all electrical connections to ensure they are correct and secure. Double check your power supply or use a battery (as described previously) to ensure the transducer is getting power. If all checks OK, the problem could be a circuit board or the sensor in your transducer. The unit must be returned to the factory for evaluation. The most probable cause of this type of failure is damage to the submersible cable jacket allowing water to leak down the cable and into the transducer housing or lightning damage.

8. **Symptom:** Transducer was installed and an offset was detected right away.

   Procedure: Ensure the cap to the vent filter was removed.

9. **Symptom:** Formation of marine growth on a submersible transducer.

   Procedure: Certain transducer construction materials, for example, 316 stainless steel, attract marine life (snails) and algae. Clean the transducer diaphragm by soaking it in a bucket of warm water with a non-aggressive cleaning solution. You can also coat the transducer with marine grease. This may be the most effective and inexpensive way to protect your transducer.

10. **Symptom:** Submersible transducer exhibits corrosion or pitting on body or diaphragm.

    Procedure: Dissimilar metals (for example, your transducer housing and your pump housing) in an electrolytic environment (fluid in your well) can lead to galvanic corrosion of the metal that is nearer the anodic end of the galvanic series. Likewise, a voltage potential between the ground wire of the transducer and the ground of other equipment in the well can lead to galvanic corrosion. Installation of a sacrificial anode will help protect your transducer from galvanic corrosion. Sacrificial anodes are made of a zinc alloy that, being nearer the anodic end of the galvanic series than the 316 stainless steel or titanium housing of the transducer, will corrode before the transducer.

11. **Symptom:** The transducer is buried in dirt and silt and the readings seem to be erroneous.

    Procedure: Use of a piezometer nosepiece in this application would help. This nosepiece can be easily installed in the field and features a very fine screen to keep dirt from fouling the diaphragm, but allows the diaphragm to sense moisture levels.

12. **Symptom:** Transducer has an offset error.

    Procedure: Our submersible transducers perform best when the sensing end is pointing in a downward manner. Keep in mind that you can experience offset error due to the position sensitivity or orientation change of the sensor. Offset errors are more prominent in low pressure applications with the sensing end of the transducer lying flat or pointing upward.