



# MS2100L Transmitter

## Operator's Manual

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## 1. SAFETY INSTRUCTIONS / DISCLAIMER

### 1.1 Designated use

The CorrTran AQUA is a compact, 4-20 mA corrosion transmitter used to detect general corrosion, localized corrosion, and conductance in the water quality industry. The transmitter measures the corrosion rate and pitting factor, giving the readout in mil/year or a 0-1 pitting factor, respectively. It also provides a conductance measurement. The readings are taken in real time and are updated approximately every 34 minutes.

### 1.2 Installation, commissioning, and operation

CorrTran AQUA has been designed to operate safely in accordance with relevant technical and safety standards. If installed incorrectly or used for applications for which it is not intended, application-related dangers may arise. For this reason, the instrument must be installed, connected, operated, and maintained according to the instructions in this manual by appropriately trained personnel. This manual must be read, understood, and the instructions must be followed. Modifications and repairs to the device are permissible only when they are expressly approved in this manual.





### 1.3 Operational safety

**CorrTran AQUA cannot be used in a hazardous (classified) area.**

### 1.4 Notes on safety conventions and symbols

The following conventions are used to highlight safety-relevant or alternate operating procedures in this manual and are shown in the margin where appropriate.

#### *Safety conventions*

Symbol	Meaning
 Warning	A warning symbol highlights actions or procedures that, if not performed correctly, will lead to personal injury, a safety hazard, or destruction of the instrument.
 Attention	An attention symbol highlights actions or procedures that, if not performed correctly, may lead to personal injury or incorrect functioning of the instrument.
 Note	A note symbol highlights actions or procedures that, if not performed correctly, may indirectly affect operation or may lead to an instrument response which is not planned.
	A terminal symbol indicates that a protective grounding (earth) terminal must be connected to earth ground prior to making any other connection to the equipment.

## 1.5 Disclaimer

Metal Samples has no power, nor does it undertake to police or enforce, compliance with the contents of this manual or observance of the safety precautions set forth herein. Metal Samples does not certify, test, or inspect the installations of CorrTran AQUA for safety or other purposes. Metal Samples disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance upon this manual. Metal Samples makes no guaranty or warranty, express or implied, as to the accuracy or completeness of any information published in this manual, and disclaims and makes no warranty that the information in this manual will fulfill any particular purposes or needs. Metal Samples only warranty is set forth in the written Limited Warranty specifically provided by Metal Samples in connection with the purchase of the CorrTran AQUA.

## 2. IDENTIFICATION

### 2.1 Device designation

#### 2.1.1 Nameplates

The logo for CorrTran AQUA is displayed within a rectangular border. The word "Corr" is in a bold, black, sans-serif font. The letter "o" in "Corr" is replaced by a circular graphic with a black and white checkered pattern. The word "Tran" is in a bold, black, italicized sans-serif font, with a black arrow pointing to the right above the letter "n". A small "TM" trademark symbol is located below the "n". The word "AQUA" is in a bold, grey, sans-serif font.

**2.1.2 Model number**

<b>Model Number</b>	<b>Description</b>
CorrTran AQUA - MS2100L	Base unit without local display
CorrTran AQUA with display - MS2150L	Base unit with local display

## 2.2 Contents of delivery



Attention

It is essential to follow the instructions concerning the unpacking, transport, and storage of this instrument given in section 2.3, “Incoming acceptance, transport, storage.”

Unless ordered as components, the contents of delivery consist of:

- Assembled transmitter
- 12' cable (for probe)
- Instruction manual (this document)

## 2.3 Incoming acceptance, transport, storage

### 2.3.1 Incoming acceptance

Check the packing and contents for any signs of damage. Check the shipment to ensure that all parts have been included and to verify that the shipment matches your order.

### 2.3.2 Transport

Protect the transmitter electrodes from damage. Do not attempt to carry the transmitter by its electrodes.

### 2.3.3 Storage

Always pack the instrument for storage or transport to protect it against impact. The original packing material provides the optimum protection for the device. The permissible storage temperature is -40 °F to +176 °F (-40 °C to +80 °C).

## 2.4 Certificates and approvals

The CorrTran AQUA is designed to meet relevant safety requirements. It has been fully tested to ensure that it is in safe operating condition. The instrument complies with the applicable regulations in accordance with known standards.

## 2.5 Registered trademarks

HART®

Registered trademark of HART Communication Foundation, Austin, USA

Viton®

Registered trademark of the company E.I. Du Pont de Nemours & Co., Wilmington, USA

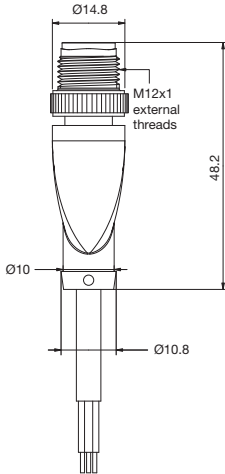
## 2.6 Patents

This instrument is protected by one or more patents registered in the US Patent Office.

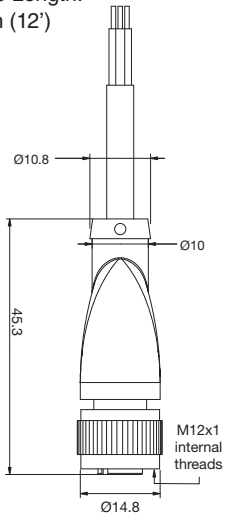


## 3. INSTALLATION AND MOUNTING

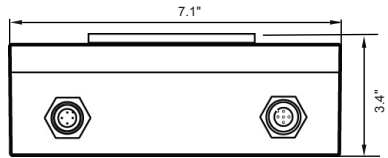
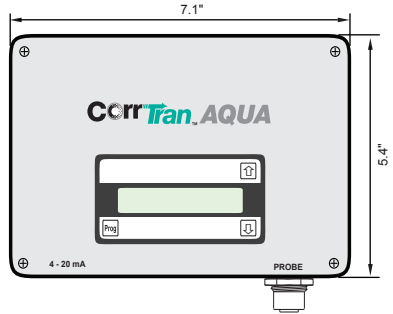
### 3.1 Dimensions



Probe  
Cable Length:  
3.6 m (12')



Probe cable



## 3.2 Mounting safety procedures and hints

The electrodes selected must reflect the same metal properties as the piping or other components susceptible to corrosion.

### 3.2.1 Mounting requirements / scenarios



Attention

The transmitter should not be mounted in a pipe drop since the corrosive liquid may not be in full contact with the electrodes as shown in Figure 1.



Warning

CorrTran AQUA should be mounted in the riser of a pipe near an elbow where the velocity is the highest. In general, CorrTran AQUA should be mounted in pipes or tanks at locations of highest liquid velocity and constant immersion, shown in Figure 2. For velocities greater than 20 fps, the protruding finger electrodes must be protected. As noted above, high fluid velocities can also cause unwanted turbulence in the pipe due to the extension of the probe.

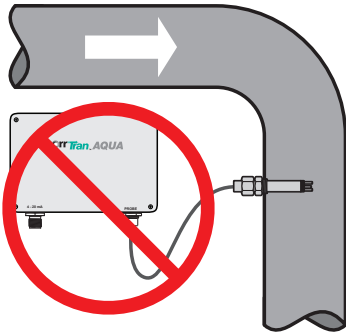


Figure 1. CMC Probe Installation

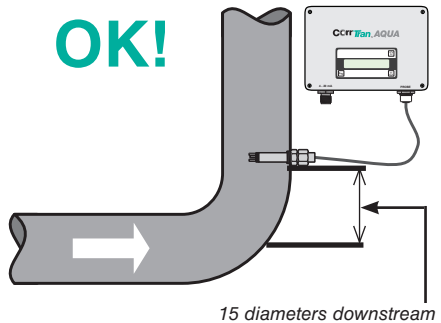


Figure 2. CMC Probe Installation

## CorrTran AQUA Corrosion Monitor

The CorrTran AQUA probe can be located at any point on the pipeline but should always be immersed in the corrosive material as shown in Figure 3.

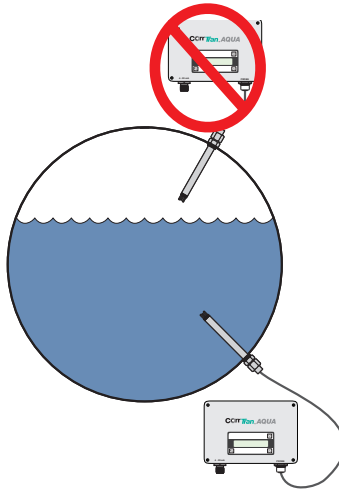


Figure 3. Correct CorrTran AQUA Pipeline Position

A tee in the condensate return line (Figure 4) is a good location to mount the CorrTran AQUA probe

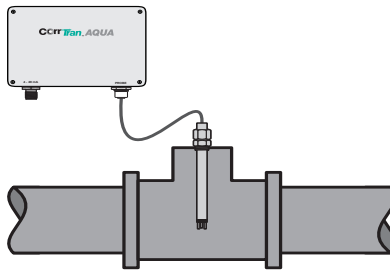


Figure 4. CorrTran AQUA Located in Tee

**Note:** The line must be full at all times and electrodes must be located in the bottom half of the line. Electrodes must be covered at all times.

## CorrTran AQUA Corrosion Monitor

The CorrTran AQUA probe should be located downstream of a control valve for best performance and can also be located in the deadleg portion of a by-pass. Note that the probe located in the by-pass leg should be mounted in front of the valve for best performance. See Figure 5. This guarantees that the electrodes will always be immersed in the corrosive material.

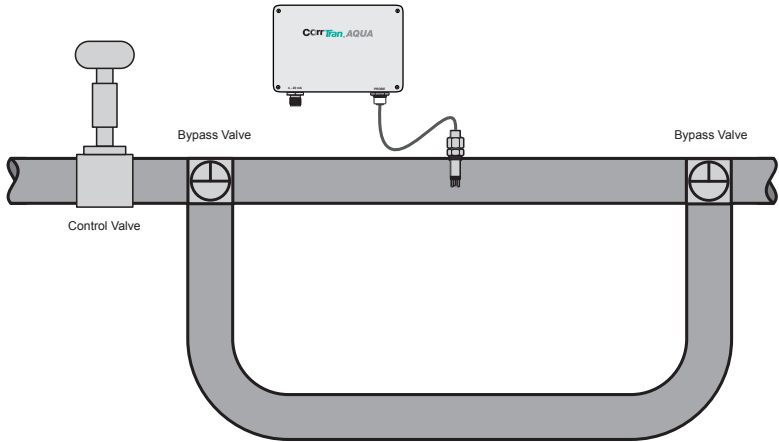


Figure 5. CorrTran AQUA Located in Bypass Loop  
Top View



Note

Installing separate CorrTran AQUA probes with different electrode materials on the suction side of the pump will ensure monitoring of the pump impeller and the pipe as shown in Figure 6. There should be a minimum separation distance of 50 cm (19.7") between probes.

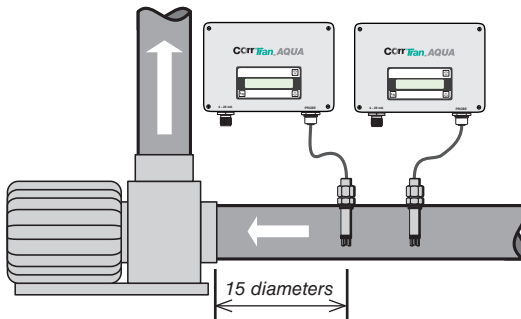


Figure 6. CorrTran AQUA Probes Mounted With Different Electrodes

In addition to pipes, a condensate flash tank, shown in Figure 7, is also a good application.

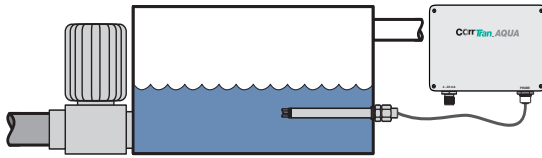


Figure 7. CorrTran AQUA Installed in a Condensate Flash Tank

The CorrTran AQUA probe should NOT be located in the blow down of a Y-strainer as shown in Figure 8. Nor should it be located in the discharge side of the basket strainer as shown in Figure 9.

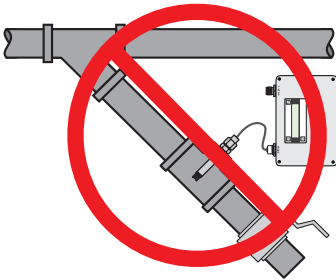


Figure 8. Probe Mounted in Y-Strainer

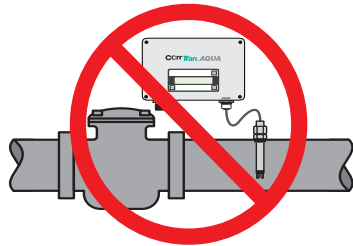


Figure 9. Probe Mounted in Basket Strainer

CorrTran AQUA may be implemented in a rack in place of traditional metal-loss coupon monitoring and can be installed in an existing coupon rack. In this case, the CorrTran AQUA probes should be inserted in place of the coupon holder ports as shown in Figure 10.

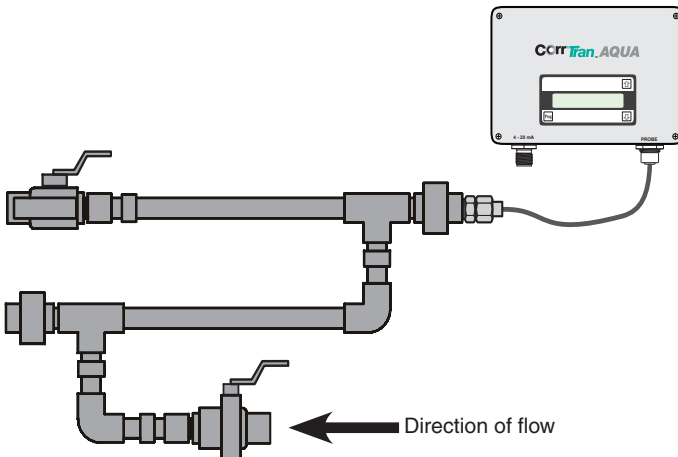


Figure 10. CorrTran AQUA Mounted in a Coupon Rack

## 3.3 Installation instructions

### 3.3.1 General



Warning

A trained specialist must perform the necessary installation and commissioning of CorrTran AQUA. Recognized rules of the technology and setup requirements must be maintained both during and after installation. Safety requirements must be observed during all installation steps.

If the pipe or vessel into which the CorrTran AQUA is to be inserted is under pressure and/or contains any hazardous substance, such as steam, caustic solutions, acids, toxins or other substances specified by OSHA as physical or health hazards, the pipe or vessel must first be depressurized, any hazardous substance purged therefrom, and appropriate lockout/tagout procedures observed in accordance with Section 1910.147 of the OSHA Regulations, before CorrTran AQUA can be installed. **Failure to follow these procedures may result in serious injury or death.**

CorrTran AQUA consists of three basic components:

- Transmitter: A transmitter housing contains the electronics and provides the 4-20 mA with HART output signal.
- Probe: The remote mount probe is supplied with a 12' cable.
- Electrodes: Either finger electrodes or electrodes flush to the probe end are used. For accurate measurements, use electrodes of the same alloy as the metal being investigated.

### 3.3.2 Electrode installation

The electrodes are sold separately and must be installed hand-tight. Ensure that the



Viton (standard) or Kalrez (on request) gaskets are in place prior to installing the electrodes.

Note

Typically, carbon steel electrodes are inspected every 90 to 180 days and yellow metal electrodes (copper and copper alloy) are inspected every 180 to 360 days. It's not just the general corrosion rate, it's also fouling or bridging that occurs that may result in false readings. When installed in corrosion coupon racks, the probes should be inspected whenever a corrosion coupon is removed and replaced. If the electrodes are fouled, they should either be carefully cleaned or replaced.

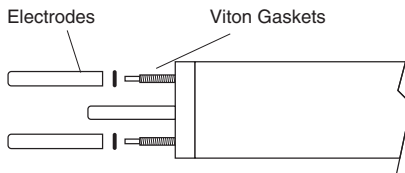


Figure 12. Electrodes and Viton Gaskets

Metal Samples recommends that the person installing the electrodes wear a plastic glove of the type used in medical offices or the type used by food preparers. It is important not to touch the electrodes with your bare hands.

### 3.3.3 Probe connection

Connect the transmitter to the probe using the supplied probe cable.

Tighten the connectors finger-tight to ensure a good, weatherproof connection.

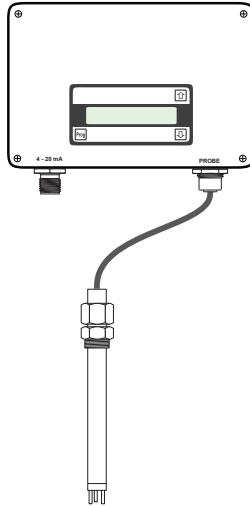


Figure 13. Probe Connection

## 4. STARTUP AND WIRING

### 4.1 Startup

The measurement cycle of CorrTran AQUA is 34 minutes. When power is first applied to the unit, the output will read 4 mA for 34 minutes. After the first rearing, the output should go to higher than 4 mA, depending on the corrosion rate.

#### 4.1.1 Quick wiring guide

Field installable V1-G connector (117051), Figure 14.

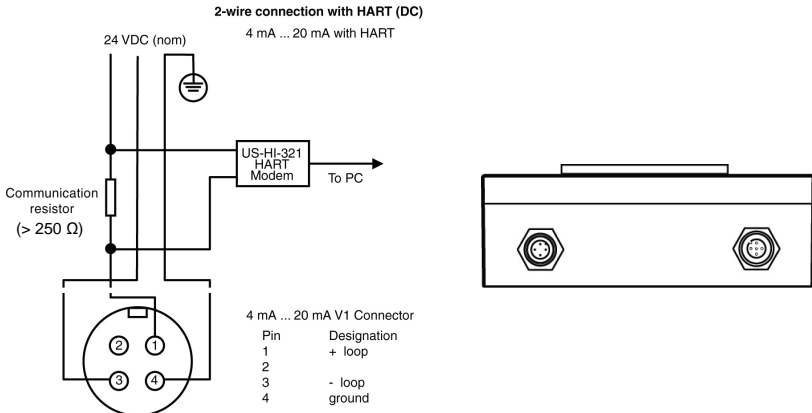


Figure 14. Transmitter Wiring

### 4.2 HART introduction

Metal Samples' CorrTran AQUA probe supports the HART communication protocol. HART is an acronym for Highway Addressable Remote Transducer. The HART protocol makes use of the Bell 202 FSK standard to superimpose digital signals at a low level on top of the 4-20 mA signal. This enables two-way communication and makes it possible for additional information beyond just the normal process variable to be communicated to and from a smart field instrument.

### 4.3 Wiring with HART

If you are using CorrTran MV with a non-HART compatible I/O of data collection device, the KFD2-HLC-Ex1.D, HART Loop Converter, can integrate the three CorrTran AQUA variables into separate, independent 4-20 mA outputs.



Please observe the following guidelines:

- Always use a grounded power supply (on the AC side).
- Ensure that the I/O card is isolated from ground.



Figure 15. Connecting to analog auxiliary port on controller

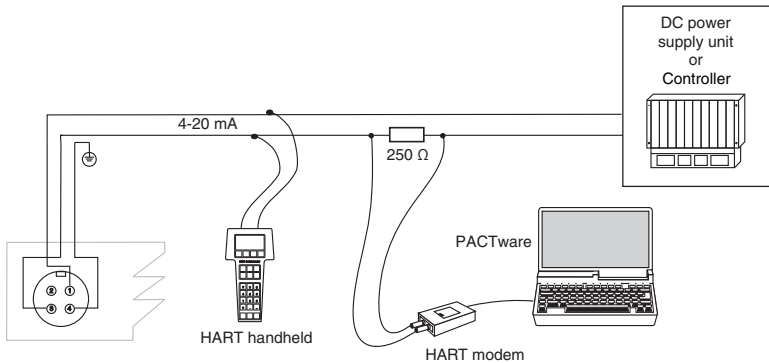


Figure 16. Connecting with a HART modem or handheld

## 4.4 Post-installation check

After wiring the transmitter and connecting the probes, perform the following checks:

- Is the probe secure and tightened to specified torque? (See section 3.4.3.)
- Have the electrodes been cleaned? (See section 3.4.2.)
- Is the terminal assignment correct? (See section 4.1.)
- Is the housing cover screwed tight?

## 5. THE HART MODEM

### 5.1 HART modem general description

As an optional accessory, a MicroLink 101-0027 USB HART® protocol modem can be ordered with the CorrTran AQUA. The modem provides the hardware interface between Highway Addressable Remote Transducer devices (HART) and a Windows® PC with a USB interface. MicroLink is used for commissioning, diagnostics, monitoring, and testing HART field devices.

Virtual serial port drivers allow the USB MicroLink to appear as an RS-232 com port to Windows and your HART software. A rugged design makes MicroLink an ideal choice for field engineers and technicians who service HART devices in an industrial environment. MicroLink is compatible with all registered HART devices and all leading HART configuration and monitoring software.

### 5.2 Driver pre-installation

The USB drivers should be installed before the MicroLink HART modem is connected to the PC's USB port. After the drivers are installed, Windows will automatically detect the modem when it is connected to the USB port and complete the setup.

#### **Important!**

**Install USB driver before connecting to the USB port.**

To pre-install the drivers, run **Msetup.exe** from the included CD. The CD will auto-run this file if the Windows autorun feature is enabled for your CD drive.

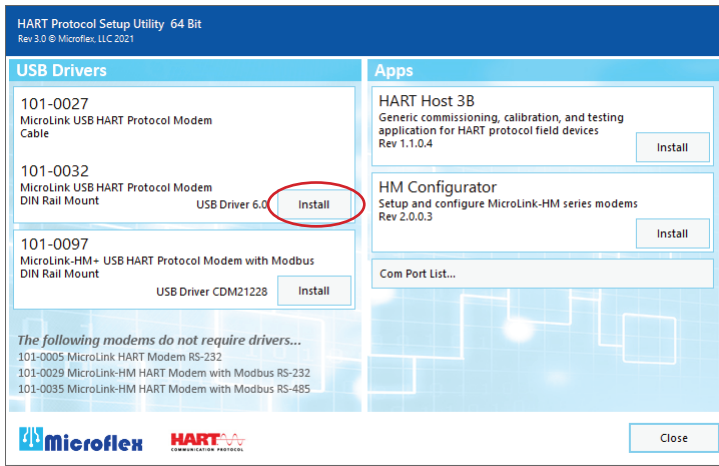


Figure 17. Msetup.exe HART Protocol Setup Utility

Click the **Install** button in the 101-0027 window to pre-install the USB drivers. The driver installer will guide you through the setup process. Installers can also be run manually from the CD, without running Msetup, by running `\x86\dpinst.exe` file for 32 bit operating systems or `\x64\dpinst.exe` for 64 bit operating systems.

#### **Don't have a CD drive?**

Download the HART Protocol CD image from [www.microflx.com/pages/support](http://www.microflx.com/pages/support). Running the file will self-extract the compressed files and start the Msetup.exe HART Protocol Setup Utility.

## 5.3 Driver inf file - manually installed

To manually install the driver inf file:

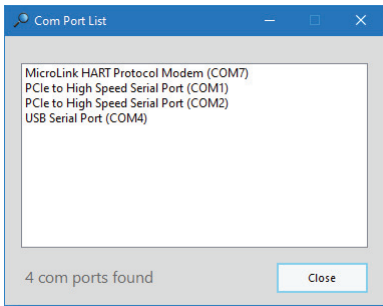
1. Connect the Converter to the USB port.
2. Open the Windows Device Manager.
3. The New Device Wizard will have added the converter under **Ports (COM & LPT)** and will appear as **MicroLink HART Protocol Modem (COMx)**. Right click the device and select **Update Driver Software...**
4. Choose to Browse for the driver software and browse to the CD or the location of the **MxHART.inf** file.
5. Follow the wizard prompts to complete the driver setup.

## 5.4 Uninstalling the USB drivers

If needed, use Windows Device Manager to uninstall the driver from your system. With the modem connected to the USB port, locate the MicroLink modem in the Device Manager hardware tree under **Ports (COM & LPT)**. Right click on **MicroLink HART Protocol Modem** and select **Uninstall** from the pop-up menu. When the process has finished, unplug the modem from the USB port.

## 5.5 Finding the assigned COM port number

When Windows installed the serial port driver the next available COM port number was assigned to the converter. The software you use with the converter must be set to use the same COM port number. To find the number assigned to your converter run Msetup.exe from the CD and click the **Com Port List...** button to show a list of found devices and assigned COM port numbers.



To use the list...

Unplug the modem from the USB port and it will be removed from the Com Port List.

Plug the modem into the USB port and it will be added to the Com Port List.

Set your HART software to use the same COM number assigned to your modem.

Figure 18. Com Port List view. MicroLink modem is assigned to COM 7

## 5.6 Using Windows device manager

The assigned COM port number can be found using Windows Device Manager. Open Device Manager and select **View > Devices by Type**.

You may need to expand the Device Manager tree under **Ports (COM and LPT)** to see the converter.

In the example shown below, the modem is assigned to COM 7.

The assigned serial COM port number can be changed to any available COM port using Windows Device Manager.

Expand **Ports (COM & LPT)** in the list to see which port the converter is assigned to.

Right click **MicroLink HART Protocol Modem (COM7)** and select **Properties** from the pop-up menu.

On the **Port Settings** tab, click **Advanced**.

Drop down the **COM Port Number** list and select the desired port number.

Click OK to use the new port number and close the window.

Unplug the MicroLink modem from the USB port and then reconnect it to allow Windows® to update the USB device parameters.

Click OK again to close the Properties window.

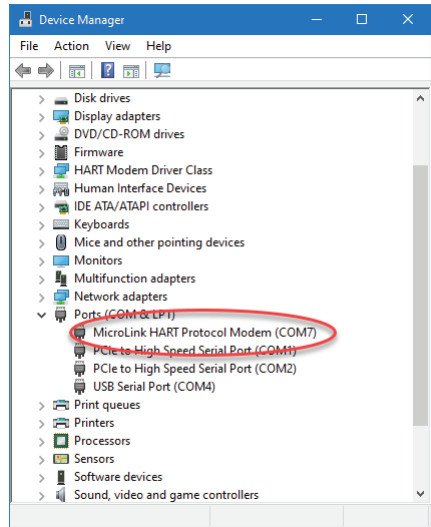


Figure 19. Windows Device Manager

## 5.7 Software setup

Make sure your HART software is set to use the same serial COM port number that the MicroLink modem is assigned to.

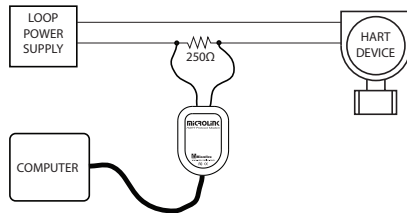
There are no hardware settings required by the MicroLink modem and modem power is provided by the USB port. All other settings, such as BAUD rate and parity, are taken care of by your HART software.

## 5.8 Connecting to the HART device

Connect the two mini-clips to the HART device or HART loop. MicroLink provides electrical isolation between the HART loop and the PC. It is safe to ignore grounding and polarity issues when making the HART connections.

The HART protocol requires a loop resistance of 230 to 600 ohms, typically 250 ohms. Refer to your equipment installation instructions for details on connecting a HART protocol modem or configuration device to the loop.

MicroLink HART modem connected across the HART loop resistor.



MicroLink HART modem connected across the HART device.

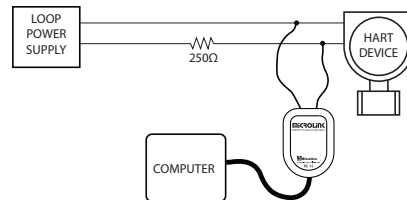
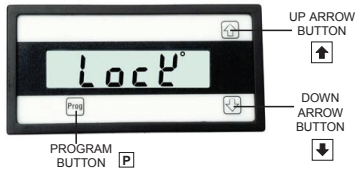


Figure 20. Two common methods for connecting the HART modem to a loop powered device.

## 6. CONFIGURING THE DISPLAY (if equipped)

### Controls and Indicators



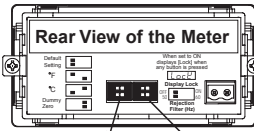
**PROGRAM BUTTON:** This button is used to move from one program step to the next. When pressed simultaneously with the UP ARROW button, the Programming Mode is entered.

**UP ARROW BUTTON:** Increases the value of the displayed parameter.

**DOWN ARROW BUTTON:** Decreases the value of the displayed parameter.

**NOTE:** When the display lock switch is on and any button is pressed, the display will show only [Lock] momentarily as shown above and then return to the normal operational display.

### Dip Switch Settings



Effect on Display	Digit/Descriptor	Display Lock/ Frequency
300000	1 <input type="checkbox"/> ON 2 <input type="checkbox"/> ON	When set to ON displays [Lock] when any button is pressed
300000F	1 <input type="checkbox"/> °F ON 2 <input type="checkbox"/> ON	Display Lock
300000C	1 <input type="checkbox"/> °C ON 2 <input type="checkbox"/> ON	When set to ON displays [Lock] when any button is pressed
3000000	1 <input type="checkbox"/> ON 2 <input type="checkbox"/> ON	Display Lock
30000000	1 <input type="checkbox"/> ON 2 <input type="checkbox"/> ON	When set to ON displays [Lock] when any button is pressed

Rejection Filter (Hz): OFF 1  ON 60 2  ON 60

Dummy Zero: 1  ON 2  ON

### Two Point Digital Scaling and Calibration - Quick Reference Guide

#### Two Point Calibration and Scaling

Example: 4 to 20 mA input to read 0 to 20,000

**Step 1** Operational Display: Set DIP switch to lock OFF. Press at same time. Enter the Calibration Mode.

**Step 2** Select [cAL on].

**Step 3** Enter the LOW Input [Lo in] Mode. Maximum positive reading is 30,000 & maximum negative reading is -19,999. Maximum display span is 50,000 counts.

**Step 4** Adjust display to desired reading for LOW input. Any value between -19,999 and 30,000 may be selected. Reverse scaling is accepted.

**Step 5** Apply the 4 mA LOW input calibration signal to the meter. Press 1. Set the LOW input value and enter the HIGH Input [hi in] Mode. If the input signal is disconnected after Step 5, the [Lo in] values are saved, and the meter automatically returns to the [hi in] mode when signal power is re-applied.

**Step 6** Adjust display to the desired reading for HIGH input. Max difference between [hi in] & [Lo in] display values selected cannot exceed 32,000 counts.

**Step 7** Apply the 20 mA HIGH input calibration signal to the meter. Press 1. Set the HIGH input value and return to Operational Display. If display shows [cALen] the calibration has been canceled and the previously calibrated scale factors are retained in memory. (See page 2, para 5).

Set DIP Switch to Lock On.

#### Decimal Point Setting

**Step 1** Operational Display: Set DIP switch to lock OFF. Press at same time. Enter the Calibration Mode.

**Step 2** Pass Calibration Mode and enter Decimal Point Setting Mode.

**Step 3** Adjust the decimal point to the desired position.

**Step 4** Set the decimal point position and return to Operational Display. Press 1.

Operational Display: Set DIP switch to lock ON.

## 7. CorrTranMV EVALUATION TOOL

### 7.1 CorrTranMV Evaluation Tool introduction

CorrTran MV Evaluation Tool is supplied with every CorrTran AQUA. (***The CorrTran MV Evaluation Tool is functionally equivalent to the CorrTran AQUA.***) It provides an easy-to-use setup feature for CorrTran AQUA plus the ability to store AQUA data in ASCII files that can be imported into your favorite analysis package.

The unit may also be programmed using Metal Samples' PACTware programming environment. Please contact the factory for more information on PACTware.

### 7.2 Establishing communication with the CorrTranMV Evaluation Tool

- To establish communication between your CorrTran AQUA using the CorrTran MV Evaluation Tool, you must first ensure that your CorrTran AQUA and HART modem are connected as shown in section 4.3, the device drivers for your HART modem have been successfully installed, and you have the CorrTran MV Evaluation Tool software installed on your computer.
- Open CorrTran MV Evaluation Tool. Figure 21 shows the main (default) screen you will see when opening the program.

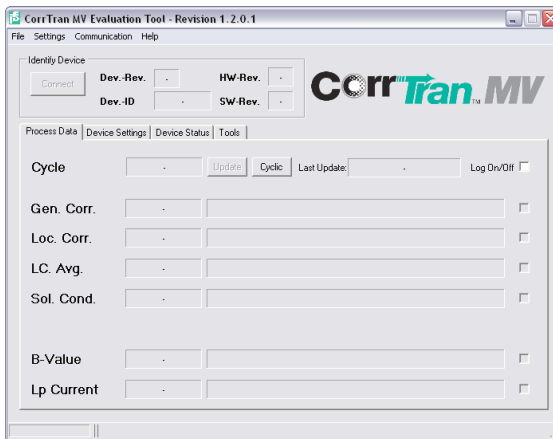


Figure 21. CorrTranMV Evaluation Tool Main (default) Screen

#### 7.2.1 Assigning the HART modem to the correct com port

When first launched, the CorrTran MV Evaluation Tool defaults to Com1 and will very likely need to be changed unless you are using a RS232 HART modem.

USB connections will show up as com ports in the CorrTran MV Evaluation Tool environment. If you are not sure what com port your modem is using, go to your computer's device manager by opening the following windows:

- 'Control panel' > 'System' > 'Hardware' > 'Device Manager'
- Expand the 'Ports (COM & LPT)' to find out which com port is being used by the USB modem, as seen in Figure 22.

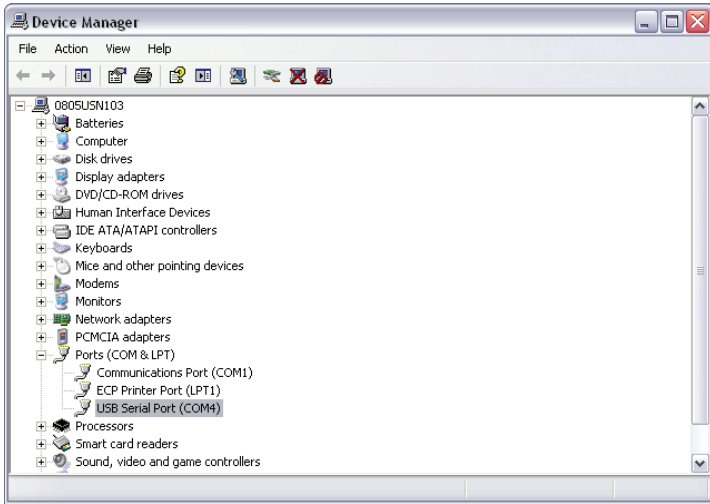


Figure 22. Device Manager Ports (COM & LPT)

Now that you know the appropriate Com Port for your HART modem:

- Select 'Communication' > 'Com Port' from the tool bar and select the Com Port that has been assigned to your HART Modem.

## 7.2.2 Connection to the CorrTran AQUA

- Select 'Communication' > 'Open' from the tool. The 'Connect' button will become available as seen in Figure 23.
- Press the 'Connect' button to establish communication between the CorrTran AQUA and CorrTran MV Evaluation Tool. If everything has been done properly all the fields will be populated as seen in Figure 24.

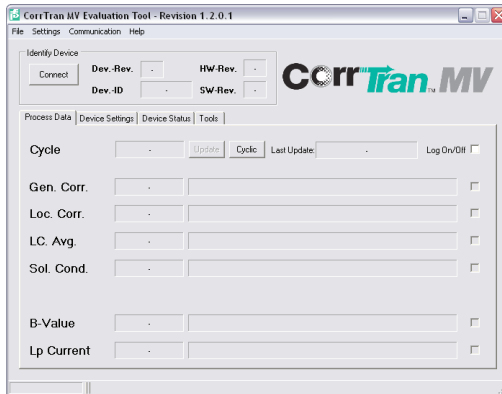


Figure 23. After Communication Opened



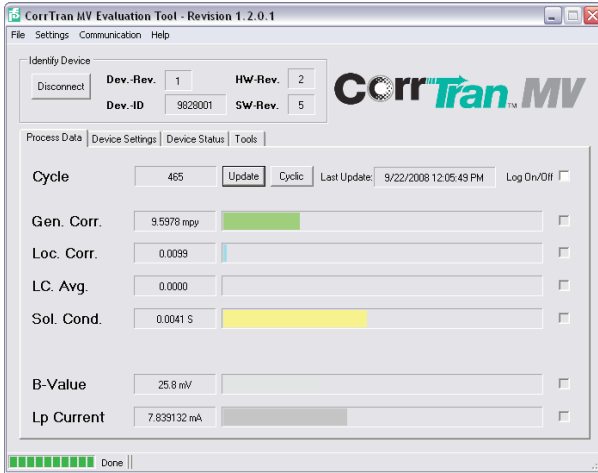


Figure 24. After Successfully Connected

At the top of the screen the following read only information is displayed:

- Device revision
- Device ID
- Hardware revision
- Software revision

### 7.3 CorrTran MV Evaluation Tool capabilities

Once a connection has been established, information from the CorrTran AQUA transmitter can be gathered.

#### 7.3.1 Process data tabs

The process data tab, seen in Figures 23 and 24, allows you to view the most recent outputs from the CorrTran AQUA.

- Cycle: Number of corrosion measurement cycles completed on CorrTran AQUA transmitter since the device was last reset. See Section 7.3.4 for information on resetting the number of cycles.
- Update – Pressing this button populates all categories on the process data tab with the current CorrTran AQUA output values.
- Cyclic – Pressing this button enables the CorrTran MV Evaluation Tool to update the values on the process data tab every measurement cycle. When this button is engaged the time remaining in the current cycle is displayed at the bottom of the screen.
- Log On/Off – When checked it enables the data logging capabilities of the CorrTran MV Evaluation Tool. You will need to place a checkmark by each data point you wish to log. Figure 27 provides data logging of every possible data point in a cyclical manner. For more information on the logging capabilities of the CorrTran MV Evaluation Tool see section 7.3.4.



Note

A data set can be manually added to the log file by clicking the update button, or logging can be made automatic for every measurement cycle by having cyclic selected.

- Gen. Corr.: Current general corrosion reading and its measurement units.
- Loc. Corr.: Current localized corrosion reading.
- LC. Avg: The average localized corrosion value. This value is averaged until the Cycles/Avg is reset or the CorrTran AQUA is reset to factory default. See Section 7.3.4 for information on Cycles/Avg reset and resetting to factory default.
- Sol. Cond.: Current solution conductance measure in Siemens (S)
- B-Value: Current measured Stern-Geary value (Bharm)
- Lp Current: Current loop current

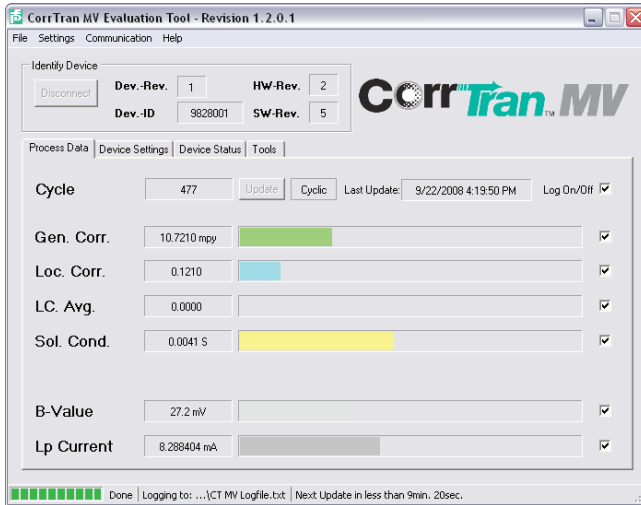


Figure 25. Log On For All Data Points, Cyclic Mode

### 7.3.2 Online parameters: process variables

The device Setting tab, seen in Figure 26, allows you to configure the following parameters:

- PV Preferences: Allows you to configure the Primary Variable (PV) as either general or localized corrosion.



Note

If general corrosion is selected as the Primary Variable then localized corrosion becomes the secondary. If localized corrosion is selected as the Primary Variable then general corrosion becomes the Secondary Variable. The Tertiary Variable (TV) is always conductance and cannot be changed.

- PV Units, LRV, URV: allows you to configure the PV units and range, when general corrosion is assigned as the PV. The default values on the CorrTran AQUA are in units of mpy with a range of 0...40 mpy. The full range of CorrTran AQUA is 0...1000 mpy (0...25 mmpy).



When localized corrosion is assigned as the PV, no units or range are selectable because localized corrosion is unitless and is on a scale from 0 to 1, with 0 being no localized corrosion and 1 being very high.)

Note

- **Alarm Mode:** Controls the settings for an alarm that activates when the PV corrosion rate goes beyond the URV. The default is Auto, and the options are as follows:
  - Auto – Output goes to 22.5 mA and resets automatically
  - Manual – Output goes to 22.5 mA and resets manually
  - Off – Alarm is turned off
- **B value:** Refers to the B value or Stern-Geary voltage, which is defaulted to 25.6 mV. B User is only relevant in LPR only mode. This value does not normally need to be changed.
- **A Elect Area:** Allows you to change the electrode area, which is required for the corrosion calculation. The surface area is defaulted to 4.75 cm<sup>2</sup> for the finger type electrodes. Flush mount electrodes are defaulted to 0.316 cm<sup>2</sup>.
- **K Probe Const:** refers to the K probe constant, or corrosion constant K. This value is dependent on the pipe's metal properties and is required for the calculation process.

The default is  $11597.63 \frac{mm * cm^2}{year * cm^2}$

$$K = \frac{3270.22 * (\text{atomic mass of metal in grams})}{(\# \text{ of electrons in the corrosion reaction}) * (\text{density in g/cm}^2)}$$

**See Electrode Material Guide Table in the Appendix for factory calculated K values of common electrode materials.**

- **Measurement Mode:** Certain corrosion measurements can be turned off to give a faster response if not required for the calculation. The two variables that can be switched off are general corrosion (GC) and localized corrosion (LC). Conductance is required for both corrosion types and cannot be turned off. If all three are used, the default is GC + LC + Cond. The three possible configurations and cycle times are:
  - GC + LC + Con – General, Localized, Conductivity: 21 min. cycle
  - GC + Con – General, Conductivity: 4 min. cycle
  - LC + Con – Localized, Conductivity: 17 min. cycle

- **Device Mode:** This determines the way the general corrosion calculation is performed by the CorrTran AQUA.
  - Normal (HDA/LPR) – A process-specific Stern-Geary voltage (B<sub>harm</sub>) is calculated with every measurement cycle through HDA. This value is then implemented in the LPR corrosion rate calculation. This is the default setting and should be left intact to maintain the best accuracy.
  - LPR only – A user defined Stern-Geary voltage ('B User') is specified and used for all LPR corrosion rate calculations. This is how CorrTran AQUA is configured.
- **Device Settings Tab Buttons:** These buttons are found at the bottom of the Device Status Tab page.
  - Reset Alarm - This button is used to reset the alarm when operating the CorrTran AQUA in Manual Alarm Mode.
  - Read Values - Pressing this button populates all categories on the device settings tab with the current values programmed on the CorrTran AQUA transmitter.
  - Write Values - Pressing this button programs the CorrTran AQUA transmitter to all settings currently displayed on the Device Settings Tab.

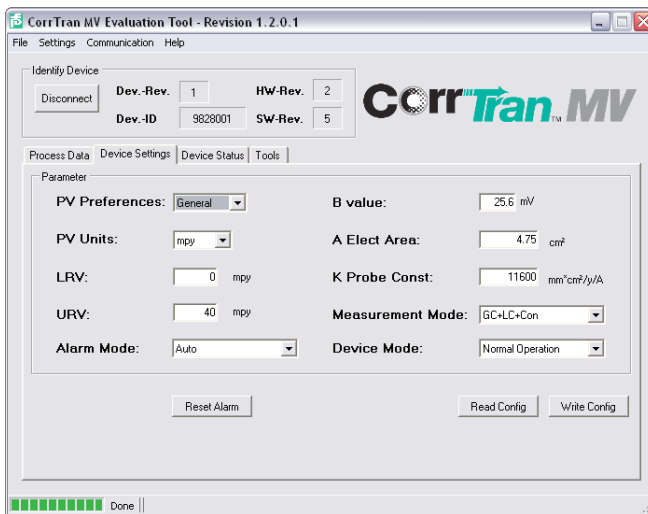


Figure 26. Device Setting Tab

## 7.3.3 Device status tab

The Device Status tab, seen in Figure 27, allows you to view any system errors or faults the CorrTran AQUA may be experiencing. Errors or faults appear as check marks next to their descriptor.

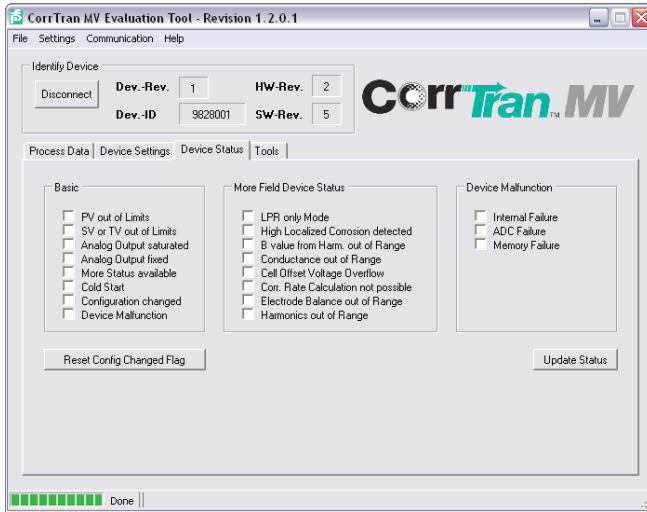


Figure 27. Device Status Tab Device

The cause of each error or fault is described in Section 12, **Troubleshooting**, Table 2.

- Device Settings tab buttons: These buttons are found at the bottom of the Device Status tab page
- Reset config changed flag: Clears a check next to configuration changed
- Update Status: Updates the device status tab with the most recent system errors or faults

## 7.3.4 Tools tab

The Tools tab, seen in Figure 28, allows you to log corrosion data, extract previously collected corrosion data, and access the resetting features of CorrTran AQUA.

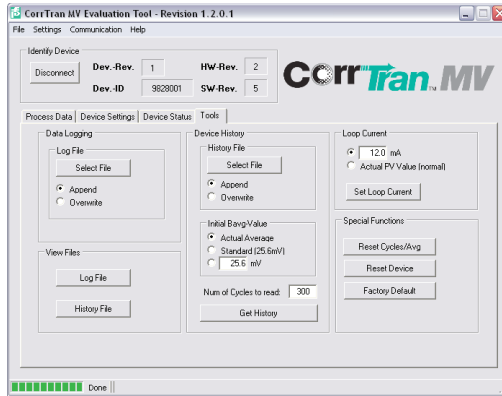


Figure 28. Tools Tab

- **Data Logging:** The Select File button allows you to set the location for and the name of the Log File where data is stored when the Log function is enabled on the Process Data tab, see section 6.3.1. Data is saved in one of two ways:
  - Append – Data is added to previously logged data
  - Overwrite – Data replaces previously logged data
- **History File:** The Select File button allows you to set the location for and the name of the History File where data is stored when Get History button is pressed. Data is retrieved and saved in one of two ways:
  - Append – Data is added to previously retrieved data
  - Overwrite – Data replaces previously retrieved data
- **View Files:** Clicking the Log File button or the History File button will open their respective files.
- **Initial Bavg-Value:** The default setting is Actual Average and results are typically best if left as is.
- **Num of Cycles to read:** The CorrTran AQUA stores data from its last 300 cycles in its internal memory. By pressing the Get History button the CorrTran AQUA Evaluation Tool extracts the data for a user defined number of cycles (1 to 300) and appends or overwrites it to the History File.
- **Loop Current:** When using HART communication for data collection, the 4-20 mA signal is no longer important. You can choose to set the loop current to a constant fixed value. If you get an error for Electrode Balance out of Range on the Device Status tab, setting the loop current to a high mA fixed value should clear this. If you want the loop current to change between 4-20 mA as the primary variable changes select Actual PV Value (normal) which is the default setting.
- **Special Features:**
  - Reset Cycles/Avg – Resets the number of cycles to 0, clears the internal memory of its historic data, and resets the LC. Avg. calculation.
  - Reset Device – Cycles power to the CorrTran AQUA.
  - Factory Default – Has the same functions of the Reset Cycles/Avg button, and resets all settings to the factory default.

## 8. TRANSFERRING PROCESS DATA TO EXCEL

The CorrTran MV Evaluation Tool allows you to view CorrTran AQUA process data in two ways. You can use the logging function to set up a running log file that will record the corrosion values you select. The second method involves retrieving data from the internal memory, which stores data from the last 300 cycles creating a history file. Both the Log File and History File are saved as .txt documents. To transfer this data into Excel, click on the view log file or history file button on the tools tab and the appropriate .txt file will open as seen in Figure 29 (for this example, the log file is used).

Date/Time	Cycle	GeneralCorr	LocCorr	LocCorr Av
9/24/2008 11:05:45 AM	1	10.63698	0.02521894	0.02521894
9/24/2008 11:13:45 AM	2	10.49234	0.2525982	0.1389086
9/24/2008 11:34:45 AM	3	10.77792	0.08254321	0.1201201
9/24/2008 12:16:35 PM	4	10.91024	0.03579314	0.09903836
9/24/2008 12:37:35 PM	5	10.96619	0.08025841	0.09528238
9/24/2008 12:58:25 PM	6	10.99193	0.1966061	0.1121697
9/24/2008 1:19:25 PM	7	11.10464	0.02410228	0.0995886
9/24/2008 1:40:26 PM	8	11.10243	0.04323979	0.092545
9/24/2008 2:01:25 PM	9	11.07702	0.2563344	0.1107438
9/24/2008 2:22:15 PM	10	11.07661	0.099608	0.1096302
9/24/2008 2:43:16 PM	11	11.26411	0.09709231	0.1084904
9/24/2008 3:04:16 PM	12	11.51494	0.2544869	0.1206568
9/24/2008 3:25:05 PM	13	11.44291	0.1232397	0.1208555
9/24/2008 3:46:06 PM	14	11.33615	0.0486482	0.1156978

Figure 29. CorrTran MV Log File

- Select 'Edit' > 'Select All' from the tool bar to select all the data in the log file.
- Select 'Edit' > 'Copy' from the tool bar to copy all the data in the log file.
- Open a new Excel work book and select cell A1.
- Select 'Edit' > 'Paste' from the Excel tool bar to transfer all the log data to Excel. At this point the data is all in column A as a text format and will appear as seen in Figure 30.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	9/24/2008	11:05:45 AM	start logging...										
2	DateTime	Cycle	GeneralCorr	LocCorr	LocCorr Avg	Conductance	AvgEValue	LpCurrent	DeviceStatus				
3	9/24/2008	11:13:45 AM	1	10.63698	0.02521894	0.02521894	0.003735744	25.6	8.254791	00-00-00			
4	9/24/2008	11:34:45 AM	2	10.49234	0.2525982	0.1389086	0.003735722	25.66763	8.196936	00-00-00			
5	9/24/2008	11:55:35 AM	3	10.77792	0.08254321	0.1201201	0.00373275	25.73036	8.311167	00-00-00			
6	9/24/2008	12:16:35 PM	4	10.91024	0.0579314	0.08903636	0.003739658	25.75989	8.364296	00-00-00			
7	9/24/2008	12:37:35 PM	5	10.96619	0.08025841	0.09528238	0.003744351	25.83793	8.386477	00-00-00			
8	9/24/2008	12:58:25 PM	6	10.99193	0.1966061	0.1121697	0.003750252	25.84793	8.39677	00-00-00			
9	9/24/2008	1:19:25 PM	7	11.10464	0.02410228	0.0898886	0.003755617	25.90673	8.441857	00-00-00			
10	9/24/2008	1:40:26 PM	8	11.10243	0.04523979	0.092545	0.00375673	25.95372	8.44097	00-00-00			
11	9/24/2008	1:01:25 PM	9	11.07702	0.2563344	0.1107438	0.003765698	26.02363	8.430807	00-00-00			
12	9/24/2008	1:22:15 PM	10	11.07661	0.099608	0.1096302	0.003766396	26.06039	8.430642	00-00-00			
13	9/24/2008	1:43:16 PM	11	11.26411	0.09100231	0.1084804	0.003770707	26.13949	8.505644	00-00-00			
14	9/24/2008	1:04:16 PM	12	11.51494	0.2544869	0.1206558	0.003773011	26.15454	8.605976	00-00-00			
15	9/24/2008	1:25:05 PM	13	11.44291	0.1232397	0.1208555	0.003772382	26.1783	8.577166	00-00-00			
16	9/24/2008	1:46:06 PM	14	11.33615	0.0486482	0.1156978	0.003770024	26.19922	8.534458	00-00-00			

Figure 30. CorrTran MV Log File

- Select all of column A as seen in Figure 30, Select 'Data' > 'Text to Columns...' from the tool bar and the screen in Figure 31 will appear.

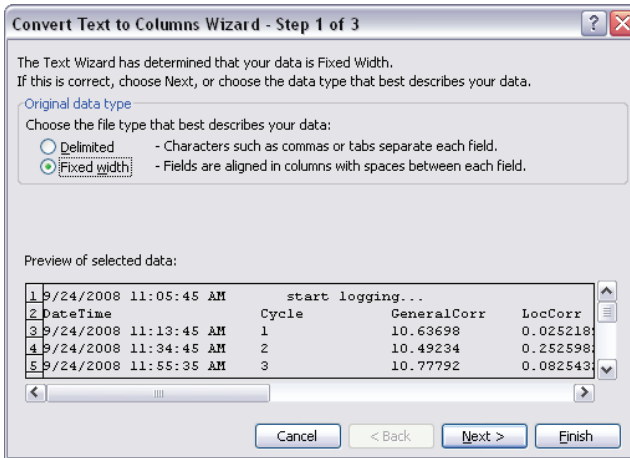


Figure 31. Text to Columns

- Select Fixed width as seen in Figure 31 and then press Finish. The text data has now been transposed to the proper columns with the proper headings as seen in Figure 32. Adjust the column sizes to accommodate the data as needed.



Date/Time	Cycle	GeneralCorr	LocCorr	LocCorr Avg	Conductance	AvgBValue	LpCurrent	DeviceStatus
9/24/2008 11:05:45 AM	1	10.63698	0.02521894	0.02521894	0.003735744	25.6	8.254791	00-00-00
9/24/2008 11:34:45 AM	2	10.49234	0.2525982	0.1389088	0.003735722	25.86763	8.196936	00-00-00
9/24/2008 11:55:35 AM	3	10.77792	0.06254321	0.1201201	0.00373275	25.73036	8.311167	00-00-00
9/24/2008 12:16:35 PM	4	10.91024	0.03579314	0.09803838	0.003738659	25.75989	8.354096	00-00-00
9/24/2008 12:37:35 PM	5	10.96619	0.08025841	0.09528238	0.003744351	25.83793	8.396477	00-00-00
9/24/2008 12:58:25 PM	6	10.99193	0.1966061	0.1121697	0.003750252	25.84793	8.39677	00-00-00
9/24/2008 1:19:25 PM	7	11.10464	0.02410228	0.0996886	0.003755617	25.90573	8.441857	00-00-00
9/24/2008 1:40:26 PM	8	11.10243	0.04323979	0.092545	0.003756673	25.95372	8.44097	00-00-00
9/24/2008 2:01:25 PM	9	11.07702	0.2563344	0.1107438	0.003765698	26.02353	8.430807	00-00-00
9/24/2008 2:22:15 PM	10	11.07651	0.039600	0.1098302	0.003766398	26.06039	8.430642	00-00-00
9/24/2008 2:43:16 PM	11	11.26411	0.09709231	0.1084904	0.003770707	26.13949	8.505644	00-00-00
9/24/2008 3:04:16 PM	12	11.51494	0.2544869	0.1206568	0.003773011	26.15454	8.605976	00-00-00
9/24/2008 3:25:05 PM	13	11.44291	0.1232397	0.1208555	0.003772382	26.1783	8.577166	00-00-00
9/24/2008 3:46:06 PM	14	11.33615	0.0486482	0.1156979	0.003770024	26.19922	8.534458	00-00-00

Figure 32. Properly Sorted Data

- You can now trend and analyze the log data as needed. Figure 33 is an example of how you can plot general corrosion, localized corrosion, and conductance over time.

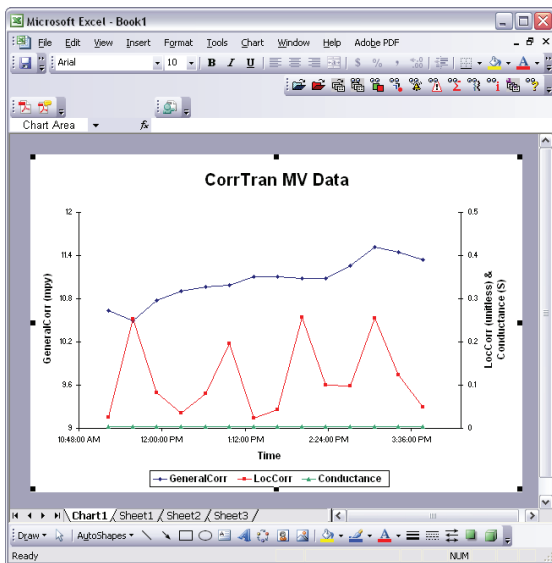


Figure 33. Example Log Data Graph

## 9. CHANGING CORRTRAN AQUA OPERATING MODE TO REDUCE THE EXCITATION FREQUENCY (Factory Default Setting for CorrTran AQUA)

The functionality here is that under certain conditions the CorrTran can read values that are, typically, much higher than expected. This may be due to a high-capacitance effect on the electrodes caused by filming inhibitors.

To see if this effect is present, it is necessary to reduce the sine wave frequency in order to eliminate the capacitance effect. Operating the unit in Enhanced Mode 1 or 2 facilitates the lower frequency sine wave. If the effect is not present, there will be little change between standard and enhanced modes. If there is a big reduction in the corrosion rate, then the capacitance effect is real and Enhanced Mode 1 or 2 should be set permanently for that application. Determining which Enhanced Mode to operate in is determined empirically.

*Figure 34 is for the CorrTran EC. It is identical on the CorrTran MV or CorrTran AQUA. Note: CorrTran AQUA is shipped from the factory defaulted to this setting.*

1. Connect the CorrTran Evaluation Tool. Establish Communication.
2. On the Tools Tab, under LPR/HDA Performance select Enhanced Mode 1. Press the Set button to send the setup to the unit. If the corrosion rate does not change after 1-2 hours of operation, there is no capacitance effect. Return the unit to Standard Mode.
3. If there is a reduction in corrosion rate, try Enhanced Mode 2. If a reduction in corrosion rate is still produced, use Enhanced Mode 2 otherwise return setting to Enhanced Mode 1.

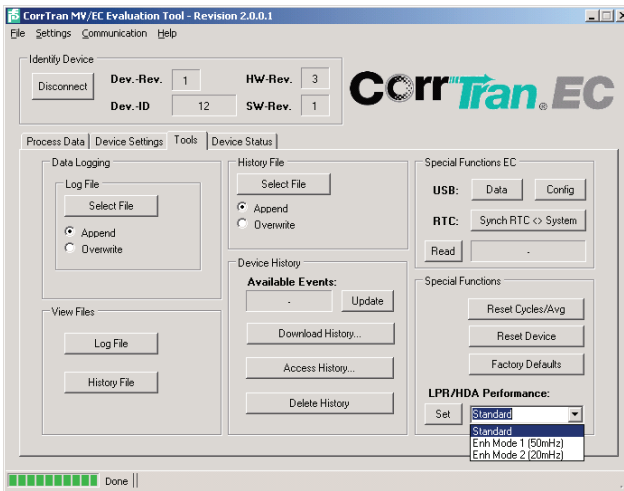


Figure 34. Enhanced Mode

Disconnect the Evaluation Tool and reconnect your DCA. Note: The evaluation time for a complete cycle changes from 21 minutes in Standard Mode to approximately 37 minutes when running Enhanced Mode 2. It is between the two for Enhanced Mode 1. This is the reason to back down to Enhanced Mode 1 if Enhanced Mode 2 does not produce an additional reduction in corrosion rate.

## 10. REPLACEMENT PARTS AND ACCESSORIES

### 10.1 CorrTran AQUA parts

Please submit the serial tag number on the nameplate when ordering replacement parts for CorrTran AQUA.



Warning

If the pipe or vessel into which the CorrTran AQUA is to be inserted is under pressure and/or contains any hazardous substance, such as steam, caustic solutions, acids, toxins or other substances specified by OSHA as physical or health hazards, the pipe or vessel must first be depressurized and any hazardous substance purged there from, and appropriate lockout/tagout procedures observed in accordance with Section 1910.147 of the OSHA Regulations, before CorrTran AQUA can be removed or the electrodes replaced. **Failure to follow these procedures may result in serious injury or death.**

### 10.2 Accessories

ET915548	HART modem, HART to USB interface For direct connection to your PC
ET1804	HART Loop Converter Converts HART signal to 3 separate 4 ... 20 mA outputs

## 11. SYSTEM SPECS

### ***Application***

The CorrTran AQUA performs continuous (electro-chemical) corrosion measurement of liquids and gasses.

### ***Function and System Design***

Measuring Principle: The CorrTran AQUA utilizes state-of-the-art algorithms and data analysis techniques to accurately measure general corrosion rate and pitting. To improve the performance of the industry accepted Linear Polarization Resistance (LPR) technique the Harmonic Distortion Analysis (HDA) is used to calculate and update a process specific Stern-Geary variable ( $B_{\text{harm}}$ ) every measurement cycle. To further enhance the performance, an application-specific Stern-Geary variable (B-value) is calculated and updated every measuring cycle. There is no need to manually update the B-value because of process changes. During the measurement cycle, CorrTran AQUA also performs an automated Electrochemical Noise (ECN) measurement which provides a localized corrosion (pitting) measurement. At the completion of each measurement cycle, the respective corrosion rate and pitting value in the form of a 4-20 mA/HART signal is produced and made available to plant personnel.

### ***Equipment Architecture***

See Section 4.3 Wiring with HART.

## Technical data

### Input

Measured Variable	<ul style="list-style-type: none"> <li>• General corrosion: Electro-chemical corrosion that proceeds more or less uniformly over the surface of the material exposed to the corrosive environment.</li> <li>• Localized corrosion (pitting): Electro-chemical corrosion that occurs at discrete sites on the material exposed to the corrosive environment.</li> <li>• Conductance: The reciprocal of the solution resistance. It is a measure of how easily electricity flows along a certain path through an electrical element.</li> </ul>
-------------------	---

### Measuring Range

- General corrosion: 0 ... 1000 mpy (0 ... 25 mmpy), 0 ... 40 mpy (0 ... 1 mmpy) default value
- Localized corrosion (pitting): Unitless number from 0 ... 1, with 0 being no localized corrosion and 1 being very high.
- Conductance: Not adjustable. Measured in Siemens.

### Output

Output Signal	4-20 mA with HART protocol, 2-wire
Signal on Alarm	Error information can be accessed via the following interfaces: <ul style="list-style-type: none"> <li>• Current output, 22.5 mA</li> <li>• Digital interface</li> </ul>

### Auxiliary Energy

Load HART	Minimum load for HART communication: 250 $\Omega$
Cable Entry	Industry standard V1 (M12 connector)
Supply Voltage	11-30 VDC without display 15-30 VDC with optional display
Rated Operating Voltage	11 VDC min at max loop current
Connectable Load	Max. load at 24 VDC: 575 $\Omega$ with alarm / 650 $\Omega$ without alarm
B-Value (Start-up)	25.6 mV

### Performance Characteristics

Reference Operating Conditions	<ul style="list-style-type: none"> <li>• Temperature: -40 °C to +70 °C (-40 °F to +158 °F)</li> <li>• Solution conductance: Min 4 <math>\mu</math>S</li> <li>• General corrosion rate: 0 ... 1000 mpy (0 ... 25 mmpy)</li> </ul>
Accuracy	<ul style="list-style-type: none"> <li>• Voltage measurement and electrode excitation: &lt;0.02%</li> <li>• Current measurement: &lt;0.1%</li> </ul>

## Technical data (continued)

### Operating Conditions

#### Operating Conditions

Installation Instructions    See Section 3.4 Installation Instructions

#### Environment

Ambient Temperature Range    Ambient temperature for the transmitter:  
 • With display: -10 °C to +50 °C (-14 °F to +58 °F)  
 • Without display: -40 °C to +70 °C (-40 °F to +158 °F)

Storage Temperature

Degree of Protection

### Mechanical Construction

#### Design, Dimensions

See Section 3.1 Dimensions

#### Weight

Approx. 500 g (16.1 oz), transmitter housing

#### Material

• Housing: ABS

### Human Interface

#### Operation Concept

See Section 4.3 Wiring with HART.  
 See Section 5 Configuration and Commissioning

### Certificates and Approvals

#### Patents

U.S. patents: 7,239,156; 7,245,132; 7,265,559; 7,282,928

## 12. TROUBLESHOOTING

If you encounter problems configuring or using your CorrTran AQUA, consult the following troubleshooting table. If you continue to have problems, please contact your Metal Samples representative for further assistance.

Symptom	Cause/Procedures	Solution
No 4-20 mA output	Check voltage and compare it with the specifications on the nameplate.	Connect the correct voltage
Measuring correct voltage but unit does not respond	Check polarity on the terminals.	See section 4.1: Quick Wiring Guide
HART communication does not function	The communication resistor is not installed properly.	See chapter 4.3: Wiring with HART

Table 1. CorrTran AQUA Basic Troubleshooting Guide

Device Status Codes	Description	Troubleshooting
PV out of limits	The primary variable has exceeded either the LRV or URV.	This can only happen if General Corrosion is assigned to the PV and the ranges are not set properly. Extend the range values to include current data point. See section 6.3 for more information.
SV or TV out of limits	The secondary or tertiary variable has exceeded either the LRV or URV	This can only happen if General Corrosion is assigned to the SV and the ranges are not set properly. Extend the range values to include current data point. See section 6.3 for more information. The TV cannot be out of limits because it has no limits.
Analog output saturated	The analog output has reached either its minimum or maximum	This can only happen if the alarm mode is off and the PV exceeds its LRV or URV.
Analog output fixed	The analog output signal has been set to a fixed mA value.	This is a result of setting the Loop Current to a fixed value on the tools tab. See section 6.3 for more information.
More status available	This flag indicates that one or more of the flags in the More Field Device Status section are set	Information only.
Cold start	This flag is set after power has been recycled for one communication transaction.	Information only.
Configuration changed	A change has been made to the CorrTran AQUA configuration.	This can be reset by pressing the Reset Config Changed Flag on the device status tab. See section 6.3 for more information.
Device malfunction	This flag indicates that one or more of the flags in the Device Malfunction section are set.	Information only.

Table 2. Device Status Codes Troubleshooting Guide (continued on next page)

Device Status Codes	Description	Troubleshooting
High localized corrosion detected	The localized corrosion rate is above 0.3.	Information only.
Conductance out of range	The measured solution conductance is lower than 4 $\mu\text{S}$ . This equals a conductivity of approximately 1 $\mu\text{S}/\text{cm}$ for finger electrodes.	The CorrTran AQUA needs at least 4 $\mu\text{S}$ of solution conductance or solution conductivity of 1 $\mu\text{S}/\text{cm}$ for full accuracy. This can also be an indication that there is too much build up on the surface of the electrodes and they may need to be cleaned or they may not be fully immersed in the process fluid.
Cell offset voltage overflow	The CorrTran AQUA has detected a voltage difference between the three electrodes which is too high to compensate.	Typically this is an indication that there is too much build up on the surface of the electrodes and they need to be cleaned or that they have exceeded their useful life and should be replaced.
Corrosion rate calculation not possible	The CorrTran AQUA was not able to get any useful data.	Check the electrodes for debris, check for other flags, and make sure that the electrodes are fully immersed.
Electrode balance out of range	Due to an extremely high unbalanced potential (voltage difference) of the electrodes, the CorrTran AQUA is drawing more power from the loop than available.	One way to deal with this problem is to set the loop current to a fixed value (max is 20 mA). This should only occur under very rare circumstances, where the corrosion rate is very small (loop current is approx. 4 mA) but at the same time there is a huge potential difference between the electrodes. This can indicate contamination of one or more electrodes, corrosion masking effects of buildup, or that one electrode is bent or missing from the probe.
Internal failure	Hardware failure detected	Replace transmitter
ADC failure	ADC failure detected	Replace transmitter
Memory failure	Memory failure detected	Replace transmitter

*Device Status Codes Troubleshooting Guide (continued from previous page)*



## 13. MEASURING PRINCIPLE

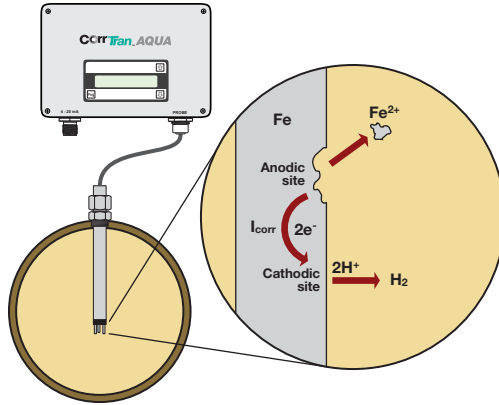


Figure 35. CorrTran AQUA Corrosion Cell

### General corrosion

Linear Polarization Resistance (LPR) is based on the fact that in a corroding electrode the relationship between  $i_{corr}$  and the polarization resistance is given by the following equation:

$$i_{corr} = \frac{B}{R_p}, \text{ where } R_p = \frac{\Delta E}{\Delta I} \text{ with } \Delta E \text{ being the applied voltage and } \Delta I \text{ the resulting current.}$$

Harmonic Distortion Analysis (HDA) allows CorrTran AQUA to determine  $i_{corr}$  without using the Tafel slopes (ba, bc). This is typically done by applying a low frequency sinusoidal voltage and determining the distance of the resulting current.

CorrTran AQUA accurately measures the general corrosion rate by implementing Harmonic Distortion Analysis (HDA) to improve the performance of Linear Polarization Resistance (LPR). A process-specific Stern-Geary voltage (Bharm) is calculated with every measurement cycle through HDA. This value is then implemented in the LPR corrosion rate calculation resulting in a highly accurate self adjusting, process specific corrosion rate calculation. CorrTran AQUA can measure the general corrosion rate from 0 ... 1000 mpy (0 ... 25 mmpy).

### Localized Corrosion (Pitting)

Electrochemical Noise (ECN) is the method of monitoring spontaneous fluctuations generated at the interface of the corroding metal and process solution. As localized corrosion occurs, these fluctuations increase.

The CorrTran AQUA monitors for these fluctuations on the electrode surfaces for 17 minutes. It then performs a statistical analysis resulting in a unitless pitting factor value between 0 and 1. A pitting factor of nearly 0 represents no localized corrosion activity and a pitting factor of 1 represents high localized corrosion activity. Independent studies have revealed that a sustained pitting factor of greater than 0.3 is cause for concern and you should investigate the source of the elevated Localized Corrosion rate. For more information on the interpretation of localized corrosion please review our white paper: "Detecting and Interpreting Localized Corrosion Using CorrTran AQUA."

### Conductance

Solution resistance is a measure of how easily electricity flows along a certain path through an electrical element. The reciprocal of the solution resistance is solution conductance.

The CorrTran AQUA measures solution resistance in order to more accurately calculate the general corrosion rates. As an added feature CorrTran AQUA provides you with the solution conductance in units of Siemens as the tertiary variable that is not scalable. CorrTran AQUA requires a minimum solution conductance of 4  $\mu$ S in order to provide reliable corrosion data.

The solution conductance value that CorrTran AQUA provides can be used to approximate solution conductivity by this relationship:

$$\text{Conductivity} \left( \frac{S}{cm} \right) \approx \frac{\text{Conductance (S)}}{19}$$



Solution conductivity is a function of distance. As the electrodes corrode, their sizes and geometry change causing this correlation to deteriorate. The CorrTran AQUA should not be considered as a replacement for standard conductivity meters.

Note

## 14. APPENDIX

### Electrode material guide

Electrode material	Key number	K value	UNS number
<b>Aluminum</b>			
1100	0N	10940.96	A91100
2024	0O	11400.51	A92024
6061	0T	—	A96061
7075	1O	—	A97075
<b>Carbon &amp; steel alloys</b>			
1010	0S	—	G10100
1018	0A	11597.63	G10180
1020	1T	11401.49	G10200
C4130	1R	11283.76	G41300
<b>Stainless steel</b>			
1.4301 / 304	0C	11334.57	S30400
1.4307 / 304L	0D	11342.80	S30403
1.4401 / 316	0E	11513.39	S31600
1.4404 / 316L	0F	11519.53	S31603
1.4571 / 316Ti	1M	11382.15	S31635
1.4438 / 317L	1G	11400.62	S31703
1.4939 / 904L	1K	11287.19	N08904
<b>Copper alloys</b>			
CDA110ETP (99.9 Cu)	0J	11686.71	C11000
CDA220 (bronze)	0P	8644.02	R50400
CDA443 (ARS AD. brass)	0M	12324.74	C44300
CDA687 (Aluminium brass)	0L	12411.53	C68700
CDA706 (Cu/Ni 90/10)	0K	11513.44	C70610
CDA715 (Cu/Ni 70/30)	0I	11337.86	C71500

Other materials are available on request.