



Simple Precision™



KAM® OWD® WATER CUT METER High Range

User Manual
OWD-V2-MAN-0626



IECEX CML 26.0018X
CML 26ATEX1071X
Ex db IIB T6 Gb

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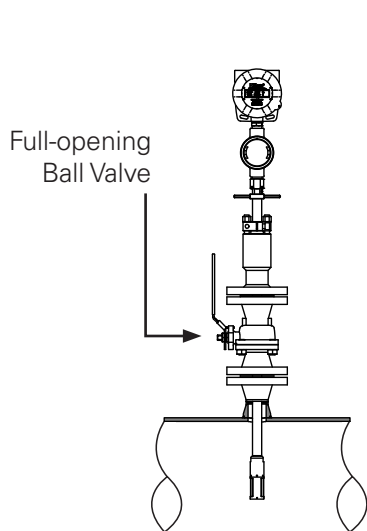
CAUTION:

When installing the OWD® sensor in a pipeline containing petroleum products, petrochemicals, waste waters with the presence of pressure & temperature, and high-pressure steam refer to the Pipeline Operators' "Health, Safety and Environmental Policy Procedures" to ensure safe installation.

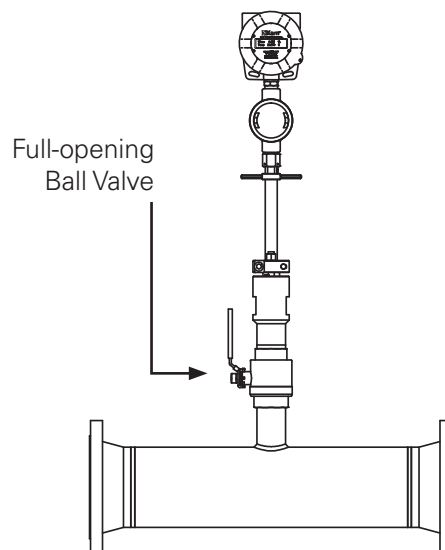
INTRODUCTION

AVAILABLE MODELS and MOUNTING OPTIONS

FIG. 1-1 INSERTABLE/RETRACTABLE MODELS



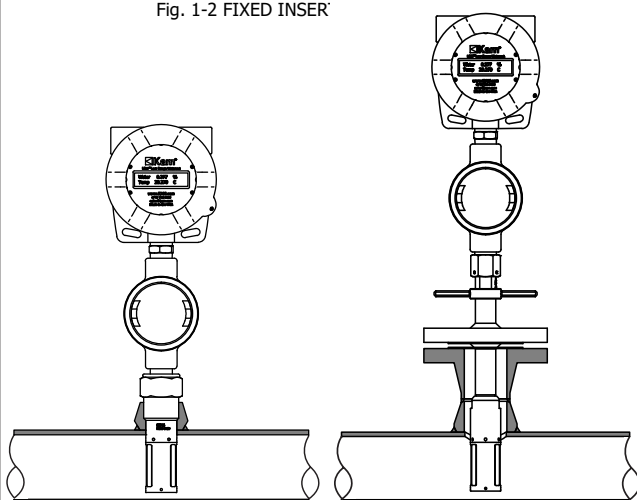
Option 1: Insertable/retractable OWD®
on a main pipe with
2", 3", or 4" flanged seal housing



Option 2: Insertable/retractable OWD®
on a main pipe
with 2" MNPT seal housing

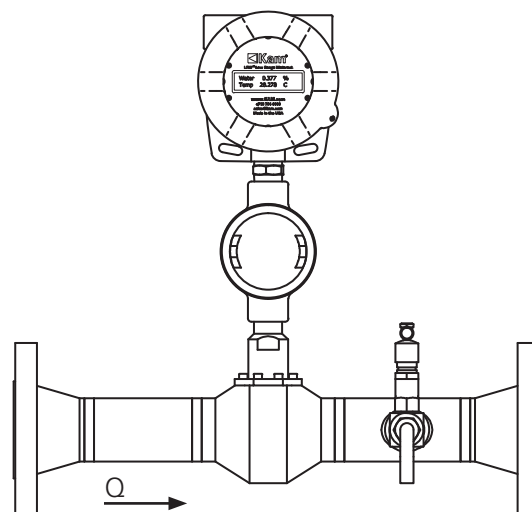
FIG. 1-2 FIXED INSERTION MODELS

Fig. 1-2 FIXED INSERT



Option 3: Fixed-insertion OWD®
with 1.25" NPT or flange

FIG. 1-3 FLOW THROUGH MODELS



Option 4: 2" OWD® flow through
sensor with integrated
KAM® SMS™ Static Mixing Spool

INTRODUCTION CONTINUED

THEORY OF OPERATION

Rugged, easy to use and extremely accurate, the KAM® OWD® Watercut Meter is the ideal instrument for continuously monitoring water concentration in your pipeline. Especially vital in production management, the OWD® sensor lets you maximize oil production versus produced water. The simplicity of design and quality of engineering employed in the OWD® sensor mean there are no moving parts. Patented microwave sensors measure the conductivity, dielectric, and both the real and imaginary part of permittivity of the fluid with an extremely high degree of accuracy. The multiple-antenna design means that different microwave frequencies and antennas measure during the oil-continuous and water-continuous phases, allowing for optimal measurement in each phase and continuous accuracy across the entire 0-100% range. Measurement is fully automatic without the need for operator intervention or supervision. The output signal can be sent to flow computers, SCADA, PLC's or to a central control room for logging or display on chart recorders or monitors.

The KAM® OWD® sensor also uses internal references to auto calibrate for drift caused by temperature changes of the electronics, the aging of the electronics components, and fluid temperature.

To ensure the highest degree of accuracy, the flow at the point of measurement must be homogenous, and OWDs should be installed per the KAM mixing recommendation, which may include a KAM SMS Static Mixing Spool, a KAM SMP Static Mixing Plate, or a KAM ML Measurement loop. KAM units should also be calibrated in the field under process conditions per the steps in this manual.

For larger pipelines, insertable models can be installed through a hot tap and isolation valve, avoiding costly drainage, the need for a bypass loop, or having to cut a section in the pipe. All wetted parts are machined from 316 stainless steel and hastelloy. Space-saving fixed-insertion models can be installed through 1.25" NPT ports or flanged ports. Off-the-shelf shaft lengths are 20", 24", 30" and 36" for insertable models and 7" and 12" for fixed insertion models. Metric and custom lengths are available.

SPECIFICATIONS

Media:	Crude oil, refined products and water. If entrained gas is constant, its effect is factored out. If entrained gas is introduced or removed after OWD calibration, it will shift water cut measurement by approximately 1% for every 1% change in gas levels.
Material:	Wetted parts—316 stainless steel* / hastelloy (Other materials available) Electronics enclosure—Copper-free aluminum or 316 stainless steel
Fluid Temperature:	-40°C to 200°C (32°F to 392°F)
Ambient temperature:	-40°C to 60°C (-40°F to 140° F)
Power requirements:	24 VDC/0.15 amp at 4 watts
Accuracy:	+/- 1 % of full range
Repeatability:	+/- 0.01 %
Resolution:	+/- 0.01 %
Minimum water detection:	100 PPM
Outputs:	4–20 mA Alarm relay RS232/RS485 HART (optional)
Mounting:	½", ¾", 1" or 2" flanged flow through (other sizes available) 2" MNPT seal housing* 2", 3", or 4" flanged seal housing Flanged or 1.25" fixed insertion
Pressure ratings:	ANSI 150, 300, 600, 900* (* fixed insertion models only)
Flow conditions:	Well mixed in accordance with KAM recommendations
Hazardous areas:	IECEX CML 26.0018X CML 26ATEX1071X Ex db IIB T6 Gb
Sensor dimensions:	Ø1.5" x 4.5" (38 mm x 114 mm)
EX enclosure:	Sensor electronics- 5.25" x 5.65" x 4.8" (133 mm x 144 mm x 122 mm)
Shaft length:	Off-the-shelf lengths are 20", 24", 30" and 36" for insertable models (508 mm, 609.6 mm, 762 mm, 914.4 mm) Off-the-shelf lengths are 7" and 12" for fixed insertion models (177.8 mm and 304.8 mm) Additional sizes available
Pipe Size:	½" to 48" (15 mm to 1200 mm)
Weight:	from 20 lbs. (9 kg)

* Seal Housing for 2" MNPT Models are Carbon Steel.

INSTALLATION

INSTALLATION MIXING AND FLOW REQUIREMENTS

The OWD should always be installed per KAM recommendations, including the mixing requirement calculated per customer provided flow conditions. Vertical installations are ALWAYS preferred.

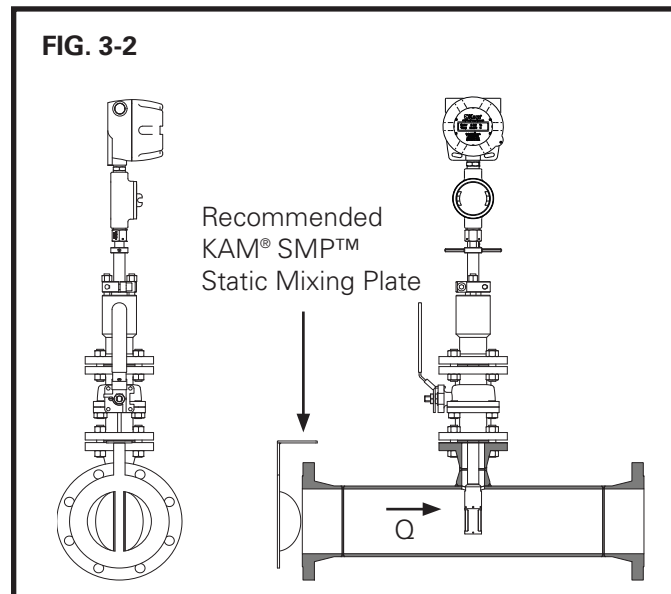
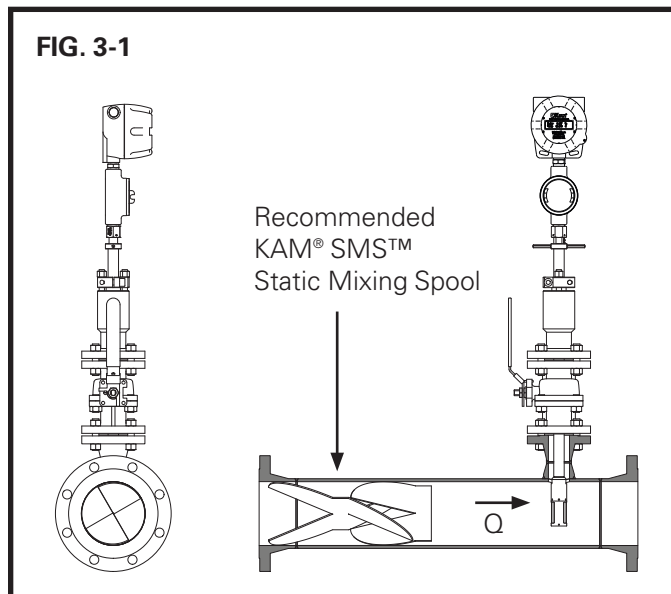
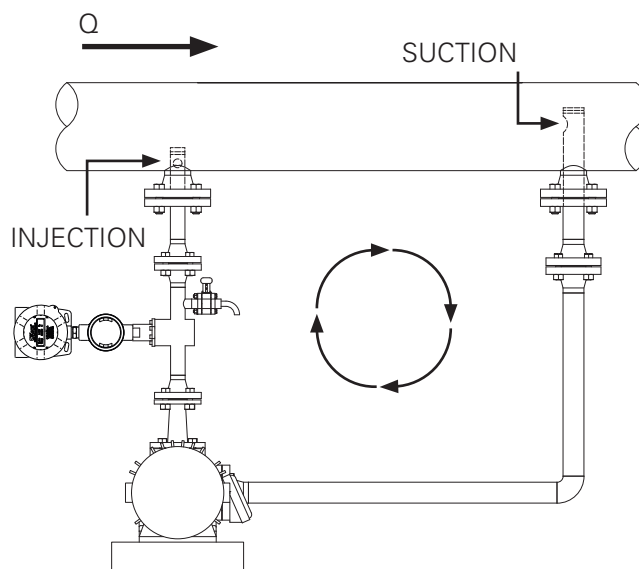


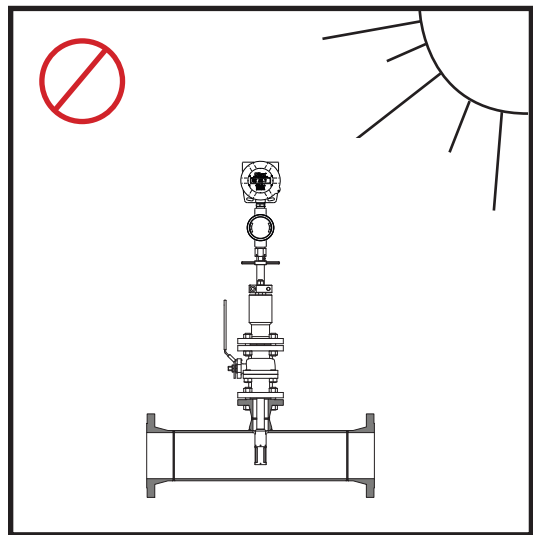
FIG. 3-3 OWD INSTALLED ON A KAM ML MEASUREMENT LOOP



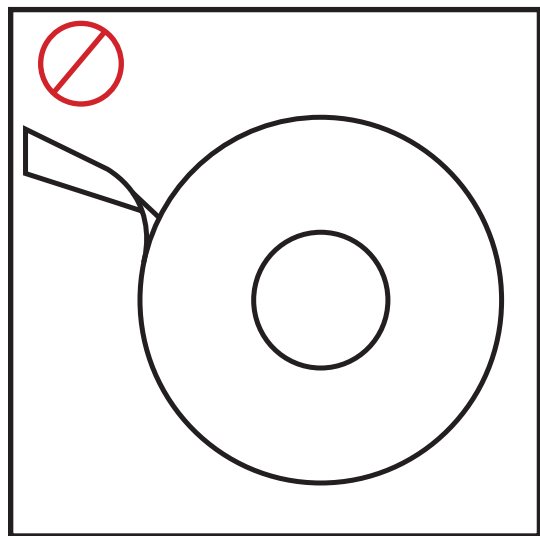
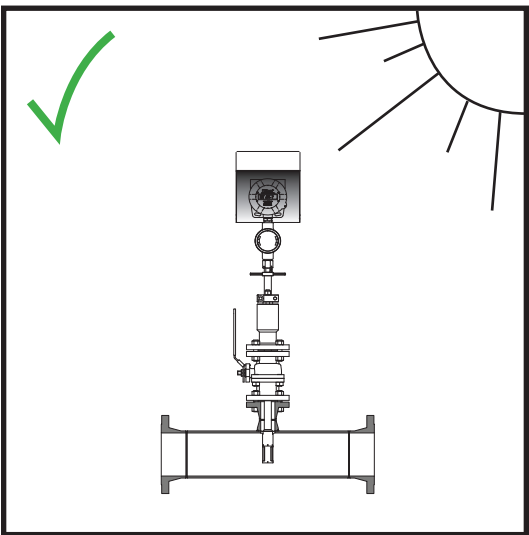
The KAM ML Measurement Loop utilizes a pump to draw a representative flow from the main line into a circulation loop, incorporating a KAM OWD. The loop flow is injected back into the main pipeline upstream of the suction site, creating mixing and homogeneity prior to suction. A homogenous flow of 10–13 fps is maintained at the sensor head for the most accurate measurement at all times.

INSTALLATION CONTINUED

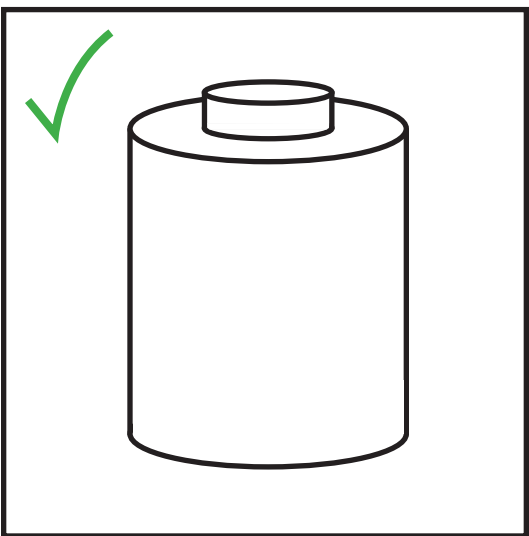
GENERAL INSTALLATION DO'S AND DON'TS



Always install OWD® sensors with the electronics enclosure shaded from direct sunlight.



DO NOT use Teflon tape on threads connecting to the OWD® flow through sensor. DO use liquid thread sealant.



INSTALLATION CONTINUED

PRIORTO INSTALLATION

Remove all the protective packaging materials, and ensure that the OWD® sensor was not damaged during transit.

The following items are provided with the KAM® OWD® sensor:

One (1) RS232 communication cable for connecting your PC to the OWD

One (1) USB-to-serial converter, in case your computer does not have an RS232 serial port

Please ensure you have received these items and store them properly. They will be used for initial startup and operation of the OWD sensor.

REMINDER: Please refer to the Installation Mixing and Flow Requirements on page 5 of this manual to ensure proper sensor placement where at all possible.

In installations below -4°C where the OWD is exposed to an open environment, KAM CONTROLS recommends operators insulate the OWD, and if the pipeline is heated, that the heating trace be extended to include the OWD.

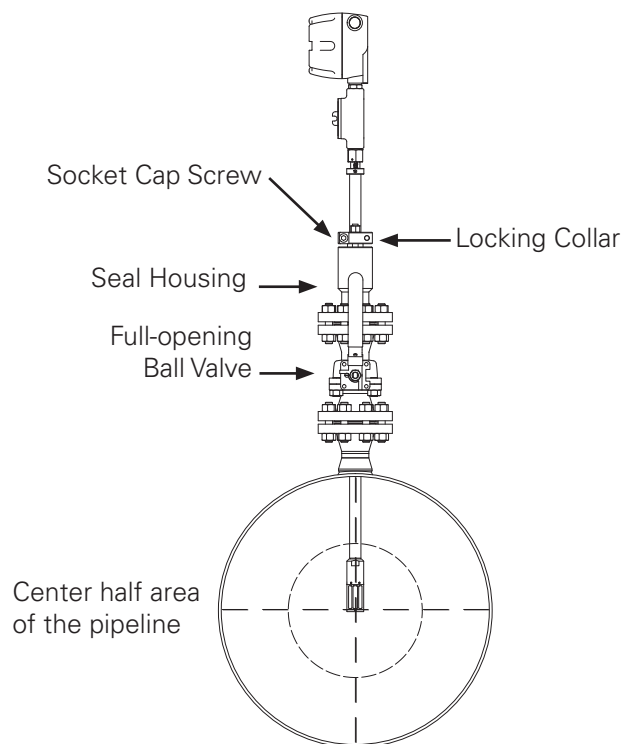
If the pipeline is not going to flow for extended amount of time and the pipe is not heated then OWD should be taken out to avoid damage to the sensor probe by freezing water.

MAIN LINE INSTALLATION INSERTABLE MODELS

The KAM® OWD® sensor should be installed according to FIG. 3-4. A full-opening ball valve is used to isolate the OWD® sensor from the pipeline during installation or removal. The seal housing of the OWD® sensor allows the probe to be inserted and removed from the pipe under pressure and flow conditions. The OWD® sensor should be inserted so that the windows of the probe are located approximately in the center half area of the pipeline.

NOTE: If line pressure exceeds 100 psi, use a KAM®IT Insertion Tool when installing/removing the KAM® OWD® sensor. Failure to do so could result in damage to the instrument and/or serious bodily injury.

FIG. 3-4 KAM® OWD® INSTALLED ON A MAIN PIPE



INSTALLATION CONTINUED

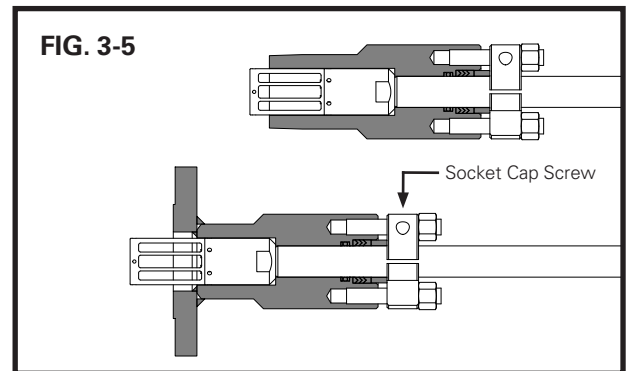
CALCULATING THE REQUIRED INSERTION LENGTH

Prior to mounting the OWD™ sensor on the Full-opening Ball Valve, you must determine the insertion length required.

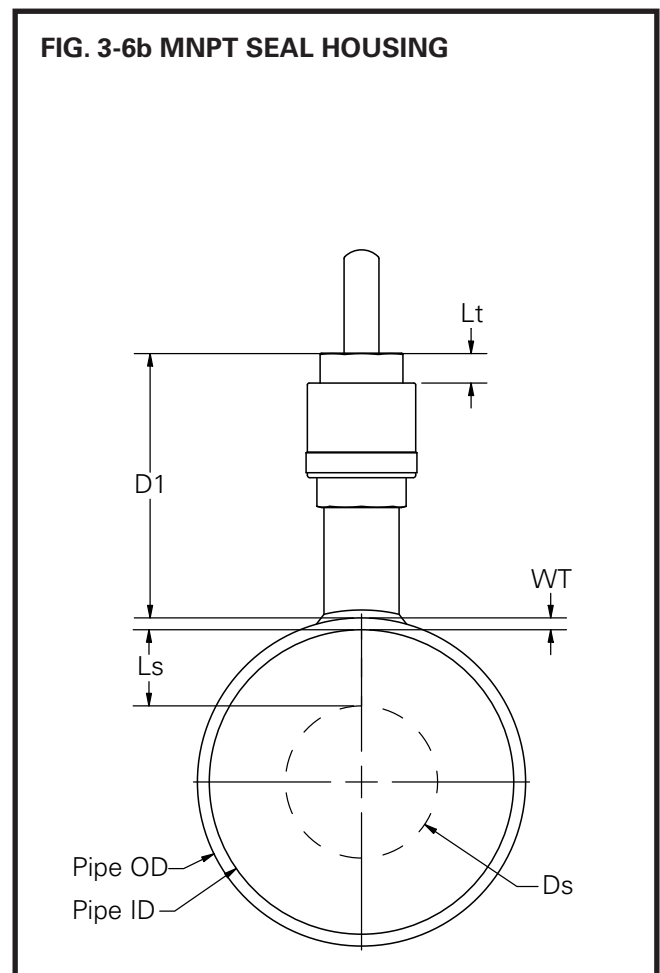
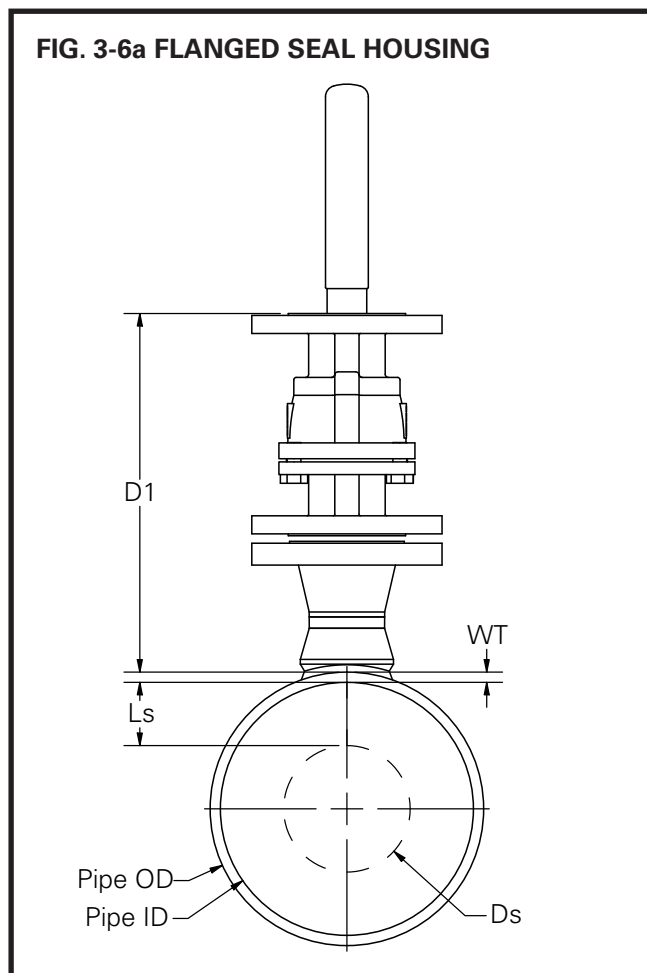
1. Lay the OWD™ sensor on the ground or a table.
2. Loosen the Socket Cap Screws, using a 3/8" Allen wrench on the locking collar. This will allow the OWD™ shaft to slide through the seal housing.
3. Push the OWD™ back through the seal housing until the OWD probe is retracted inside the seal housing. FIG. 3-5.

NOTE: The antennas on the OWD sensor probe won't necessarily end up all the way inside the seal housing.

4. Retighten the Socket Cap Screws on the locking collar. This will prevent the OWD™ shaft from sliding and the probe from getting damaged during mounting.



5. Measure the distance (D1) from the outside diameter of main pipe to the end of the connection where the OWD® sensor is going to be installed. FIG. 3-6a and FIG. 3-6b.



INSTALLATION CONTINUED

6. Calculate the insertion distance:

For flanged Seal Housing models

MID	–	Minimum Insertion Distance
D1	–	Distance from the top of the valve to the pipe
Lg	–	Gasket Width (Typical 0.134")
WT	–	Pipe Wall Thickness
Ls	–	Pipe ID x 0.25 (Sampling Area Length)
Ds	–	Pipe ID x 0.5 (Sampling Diameter Area)

TABLE 3-1 OWD FACTOR

Class Rating	2" Size	3" Size
150#	1.00"	1.20"
300#	1.12"	1.37"
600#	1.50"	1.75"
900#	2.00"	2.00"

Minimum Insertion Distance (MID)= D1 + Lg + WT + Ls + OWD Factor

Example: D1=14"
Lg=0.134"
WT=0.25"
ID=8.125"
OWD Factor 2" 150#=1"

MID=14 + 0.134 + 0.25 + (8.125 x 0.25) + 1
MID=14 + 0.134 + 0.25 + 2.03 + 1 = 17.41"

Take note of the calculated MID and proceed to step 7.

NOTE: The recommended sampling area per API guidelines is approximately the center half of the pipe. Use the "Ds" parameter described above to determine this area if needed.

For 2" MNPT Seal Housing models

D1	–	Distance from the top of the valve to the pipe
WT	–	Pipe Wall Thickness
Ls	–	Pipe ID x 0.25 (Measurement Area Length)
Lt	–	Thread Engagement (0.75")
Ds	–	Pipe ID x 0.5 (Measurement Diameter Area)

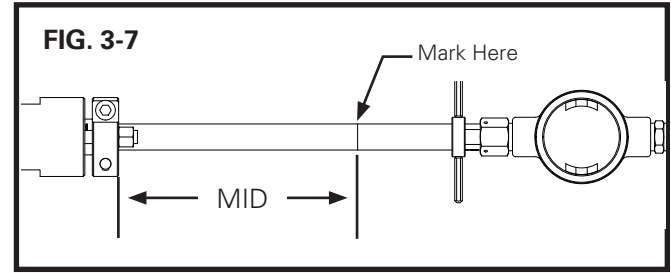
Minimum Insertion Distance (MID)= D1 + WT + Ls + OWD Factor - Lt

Example: D1=14"
WT=0.25"
ID =8.125"
OWD Factor= 1.65
Lt=0.75"

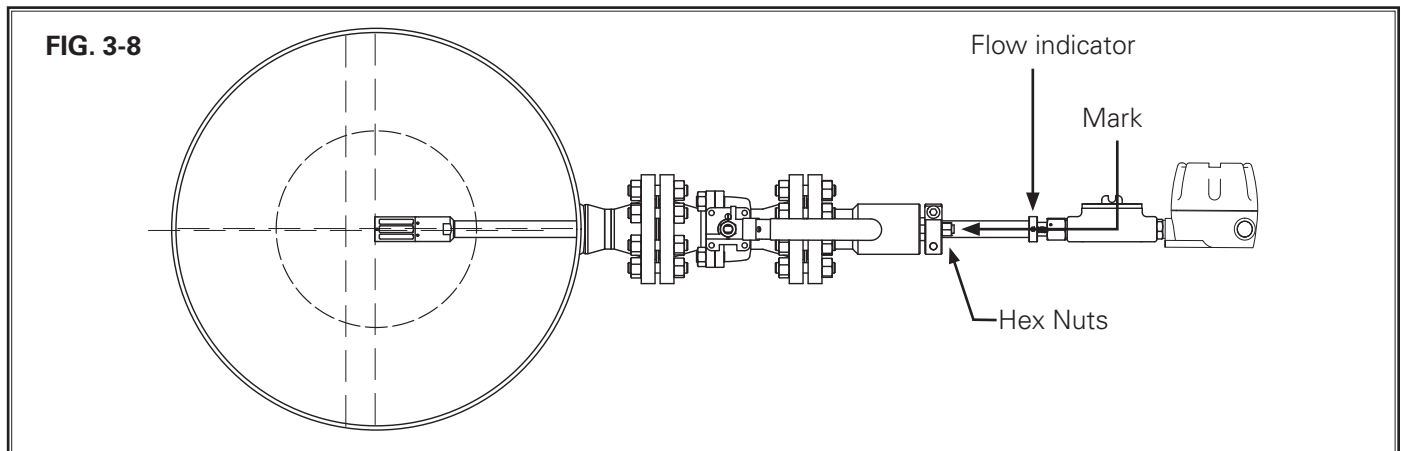
MID=14 + 0.25 + (8.125 x 0.25) + 1.65 - 0.75
MID=14 + 0.25 + 2.03 + 1.65-0.75 = 17.18"

INSTALLATION CONTINUED

7. Measure the calculated MID from the top of the Locking Collar and place a mark with a permanent marker or tape on the Shaft (Do not use anything sharp to mark the shaft as this will create grooves that will damage the O-rings in the seal housing.) FIG. 3-7.



8. You can now attach the OWD to the valve on the pipeline. For threaded models, KAM CONTROLS recommends liquid thread sealant and not Teflon tape for the threaded OWD™ sensor.)
9. Open Full-opening Valve.
10. Loosen Socket Cap Screws on the Locking Collar.
11. Push OWD® sensor in until the mark is at the top edge of the Locking Collar. Ensure that OWD® flow indicator is aligned with pipeline flow direction. FIG. 3-8.



INSTALLATION CONTINUED

12. Re-tighten the Socket Cap Screws.
13. Tighten the hex nuts holding down the Locking Collar one half turn. (FIG. 3-8) These should never be over-tightened. Their major function is to apply light pressure on the chevron packing to ensure a seal between the seal housing body and the insertion shaft.

REMOVING THE INSERTABLE/RETRACTABLE OWD® SENSOR

1. To remove the OWD® sensor, first shut off power to the instrument.
2. Loosen the Socket Cap Screw on the Locking Collar.
3. Add grease to the shaft. Push shaft in approximately 4" (if possible).
4. Slide the OWD® sensor outward until the probe rests inside the seal housing.
5. Close the Full-opening Ball Valve tightly. Drain oil from valve if possible.
6. The OWD® sensor may now be unbolted from the system.

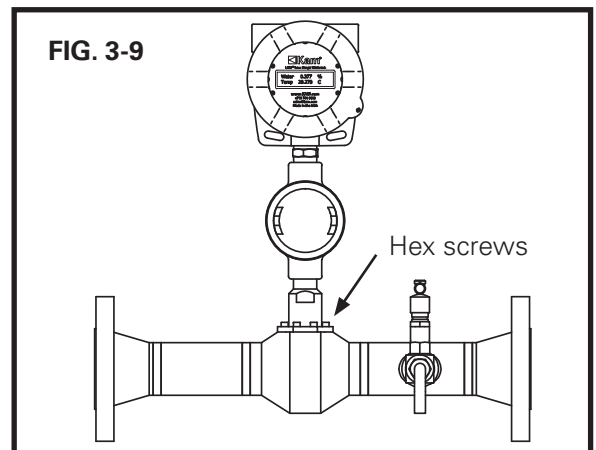
NOTE: If line pressure exceeds 100 psi, use a KAM® IT Insertion Tool when installing/removing the KAM® OWD® sensor.

Removal should be conducted in accordance with all regional and Class requirements.

REMOVING THE OWD® SENSOR FROM 2" FLOWTHROUGH SPOOLS

1. To remove the OWD® sensor, first shut off power to the instrument.
2. Discontinue flow in loop from the main line and drain fluid from loop.
3. The probe can be removed from the housing by removing the Hex screws on the collar. FIG. 3-9.
4. The probe can then be lifted from the cell for testing/inspection/calibration purposes.

Removal should be conducted in accordance with all regional and Class requirements.



REMOVING FIXED INSERTION OWD® SENSOR

1. To remove the OWD sensor, first shut off power to the instrument.
2. Discontinue flow in line and drain.

Removal should be conducted in accordance with all regional and Class requirements.

INSTALLATION CONTINUED

WIRING

Any components attached or installed (e.g. terminal compartments, bushings, explosion-proof cable entries, connectors) shall be of a technical standard that complies with the specifications on the cover sheet as a minimum and for which a separate examination certificate has been issued. The operating conditions set forth in the relevant component certificates must by all means be complied with.

The temperature of the process fluid must not exceed +200 °C.

All wiring and maintenance on the KAM OWD must be done in accordance with regional electrical and classification requirements. It is the user's responsibility to understand these requirements.

It is also recommended that the OWD be wired with flexible wiring/conduit with additional slack/length in the wire to accommodate insertion, removal, and testing.

Operator's should take all possible precautions to avoid any moisture from entering the electronics enclosure. The enclosure should not be left open in inclement weather or for long periods of time, especially during operation as condensation will accumulate. Lid should be tightly screwed shut, all conduits should be sealed and secured in accordance with regional and classification requirements, and unused 3/4" NPT openings should be sealed in accordance with regional and classification requirements. Do not power wash the unit.

The installed 3/4" NPT plug is not part of the instrument installation and should be replaced by the appropriate Ex certified 3/4" NPT plug for the final installation.

The Oil Water Detector KAM OWD shall be connected by means of suitable cable entries or conduit systems, which meet the requirements of IEC 60079-1, sections 13.1 and 13.2, and for which a separate examination certificate has been issued.

Cable entries (conduit threads) and sealing plugs of simple designs must not be used.

Should the Oil Water Detector KAM OWD be connected by means of a conduit entry which has been approved for this purpose, the appertaining sealing device shall be installed within 4 inches (100 mm) of the instrument enclosure.

Openings not used shall be sealed in compliance with IEC 60079-1, section 11.8. or using suitable plugs that meet the requirements for the local area classification.

The connecting wire of the Oil Water Detector KAM OWD shall be installed to provide for permanent wiring and adequate protection against mechanical damage.

If the temperature at entry fittings should exceed 70 °C, the connecting cables used have to be of the temperature resistant type.

The Oil Water Detector KAM OWD has to be included into the local equipotential bonding.

The connecting wire of the Oil Water Detector KAM OWD has to be installed in an enclosure which complies with the requirements of an accepted type of protection acc. to IEC 60079-0, section 1, if the connection takes place in an area with potentially explosive atmosphere.

The Oil Water Detector KAM OWD must be connected to a suitable ground electrode per the local installation codes as applicable. The resistance of the ground path must be less than 1 ohm.

INSTALLATION CONTINUED

WIRING CONTINUED

The following relate to the installation and/or safe use of the equipment/component:

If the equipment is used in a manner not specified by Kam Controls, the protection provided by the equipment may be impaired.

WARNING: Do not open the instrument when energized

- I. The equipment enclosure include flameproof joints that have dimensions that differ from the requirements of EN 60079-1:2014 / IEC 60079-1:2014 Ed. 7 Table 2/Table 3. As such, the flameproof joints are not intended to be repaired by anyone other than the manufacturer.
- II. The models have the following ambient temperature ranges:

Models	Enclosure	Ambient Temperature Range	Maximum Process Temperature
OWD	EX500	-40°C to +60°C	+200°C

INSTALLATION CONTINUED

WIRING CONTINUED

INPUTS

24VDC - GND
24VDC + 24-30 VDC

OUTPUTS

4-20 mA - Current output, source powered.
Set to requisite percent water at factory.

4-20 mA +

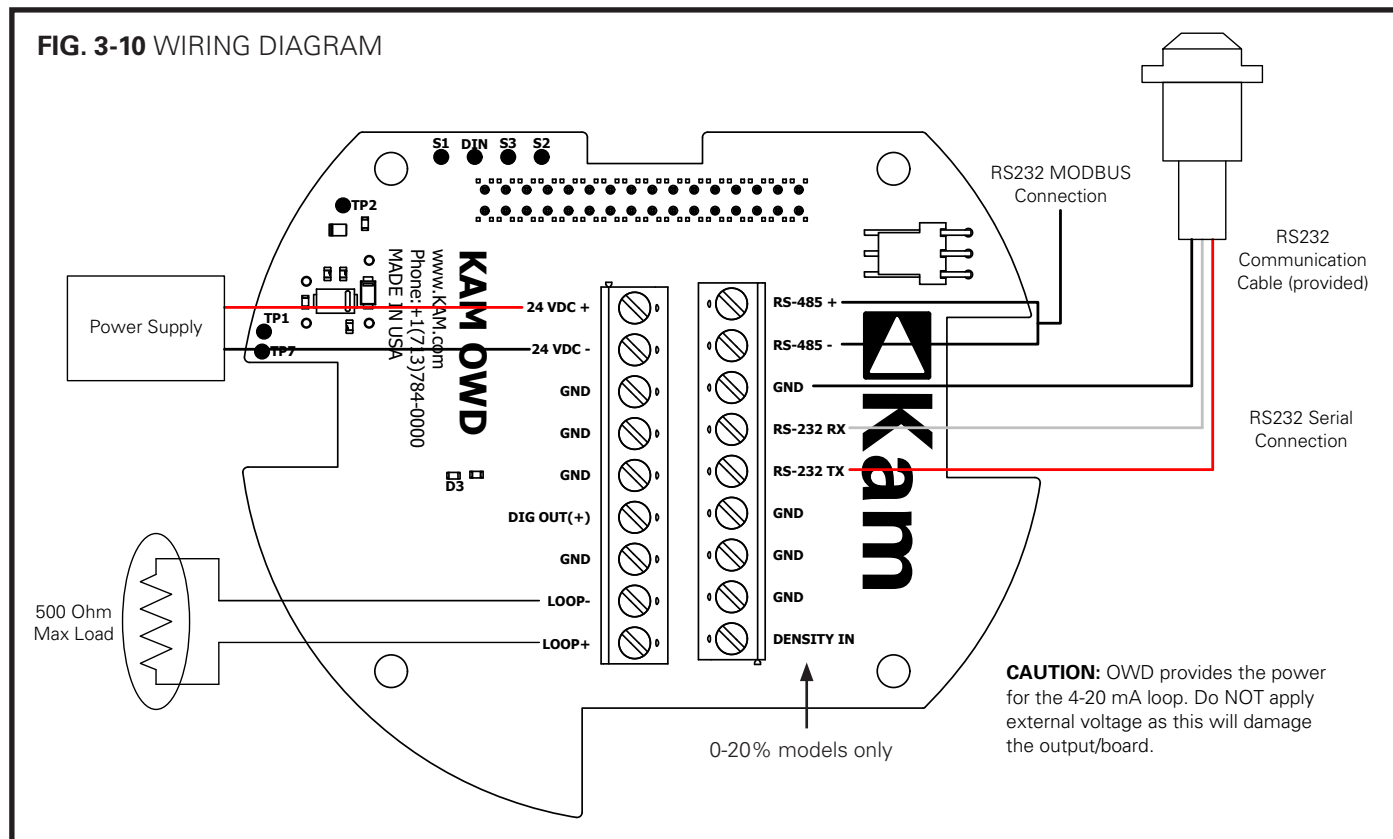
DIG OUT (+) Alarm or relay (digital contact closure)

RS485 Modbus interface

INPUT/OUTPUT

RS232 Console port – communication interface
for calibration

WIRING CONTINUED

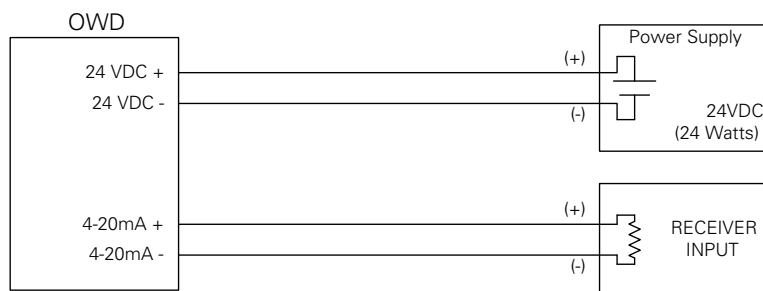


INSTALLATION CONTINUED

WIRING CONTINUED

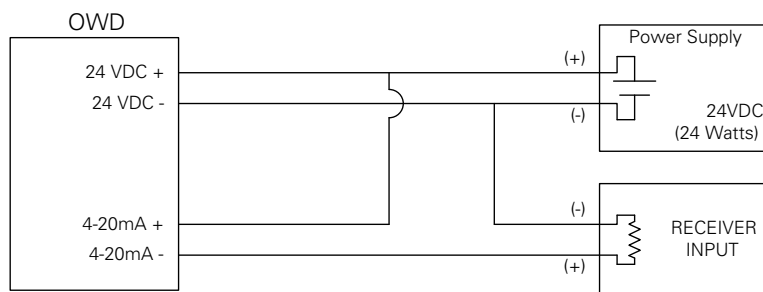
TYPICAL POWER AND LOOP WIRING CONFIGURATION

FIG. 3-11



TYPICAL WIRING

Recommended configuration see FIG. 3-12/3-13



WRONG WIRING

The OWD provides power for the 4-20 mA loop. Adding external power can damage the output and/or board.

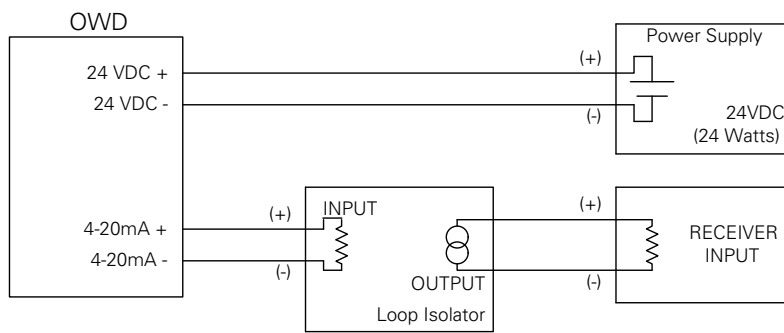


INSTALLATION CONTINUED

WIRING CONTINUED

POWER SUPPLY AND OUTPUT WIRING WITH LOOP POWERED ISOLATOR (RECOMMENDED)

FIG. 3-12



Recommended 4-20 mA Loop Isolators:

XCONPC528P DIN Rail Mount Loop Powered Isolator, 4-20mA, Galvanic, UL Listed or similar (V min 10 Volts)

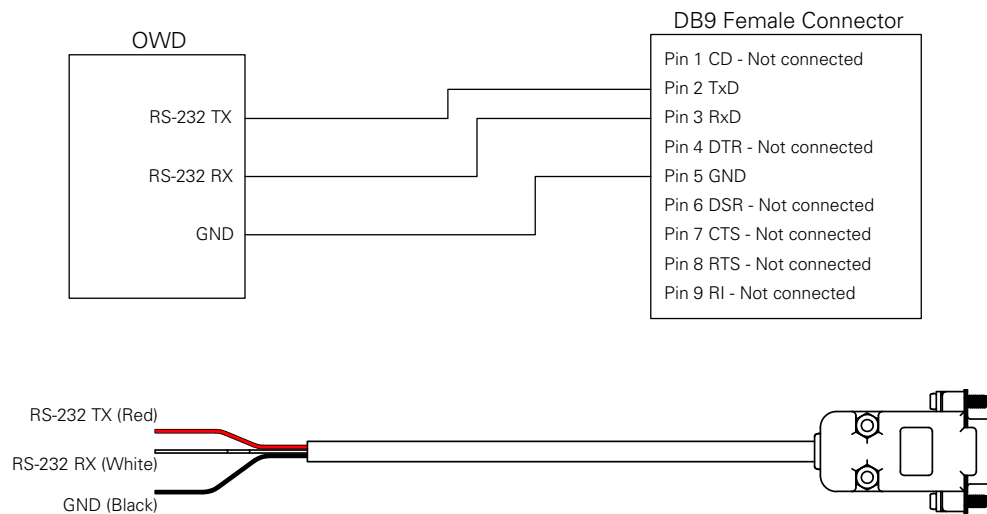
Loop Isolator Minimum Requirements:
Voltage: 6- 30 VDC
Input Range: 0-20 mA

INSTALLATION CONTINUED

WIRING CONTINUED

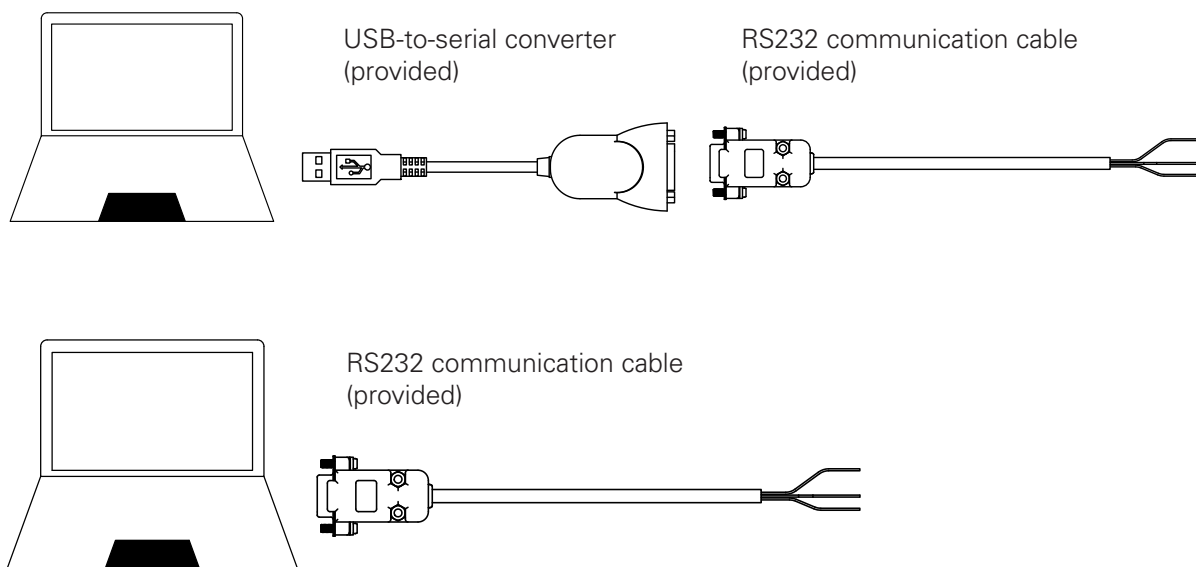
RS232 WIRING DIAGRAM

FIG. 3-13



NOTE: To avoid repeatedly opening electronics enclosure during diagnostics, it is recommended operators permanently wire an RS232 connection to the instrument with corresponding 9-pin connection at junction box for PC connection.

FIG. 3-14

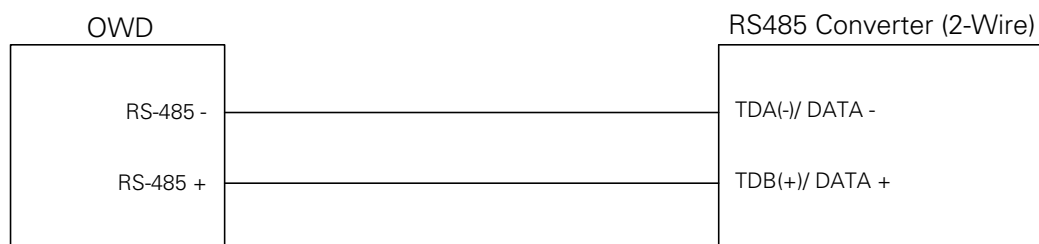


INSTALLATION CONTINUED

WIRING CONTINUED

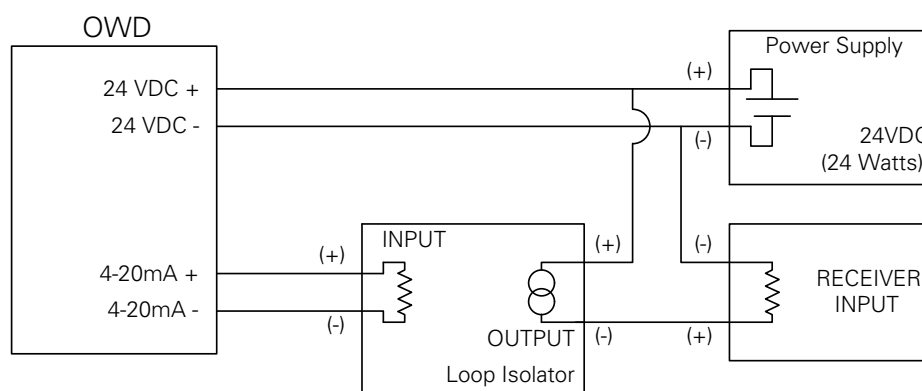
RS485 WIRING DIAGRAM

FIG. 3-15



POWER SUPPLY AND OUTPUT WIRING WITH EXTERNAL POWER ISOLATOR

FIG. 3-16

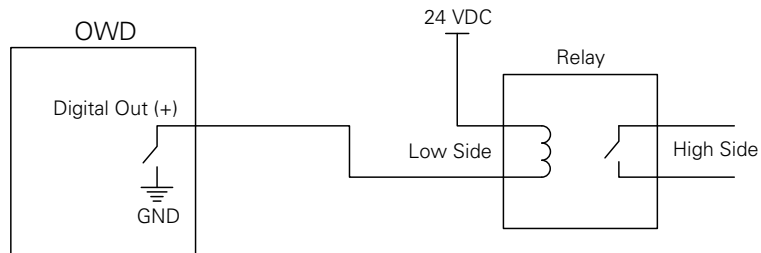


INSTALLATION CONTINUED

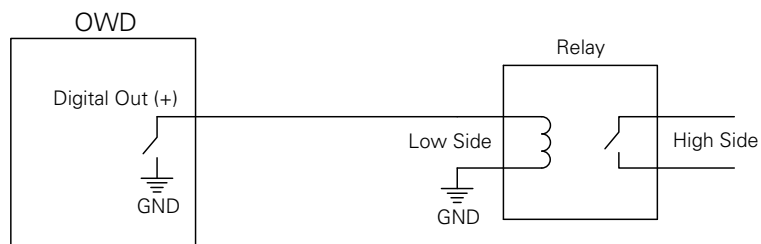
WIRING CONTINUED

DIGITAL RELAY CONFIGURATION

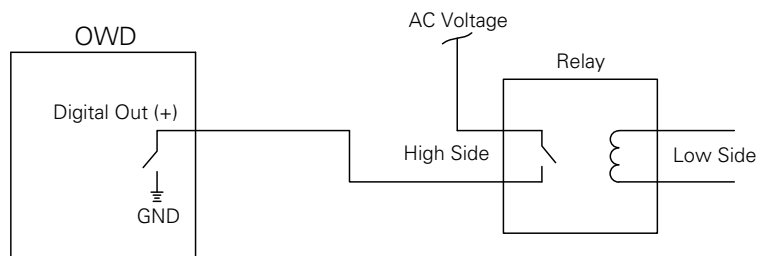
FIG. 3-17



**TYPICAL
WIRING**



**WRONG
WIRING**



**WRONG
WIRING**



KAM OWD OPERATION REALTERM

OWD CONNECT SOFTWARE

PLEASE NOTE: OWD CONNECT SOFTWARE IS AVAILABLE AS A FREE DOWNLOAD WITH NO LICENSING FEES AND IS THE PREFERRED METHOD FOR USER INTERFACE WITH THE KAM OWD.

Download the software using the link below:

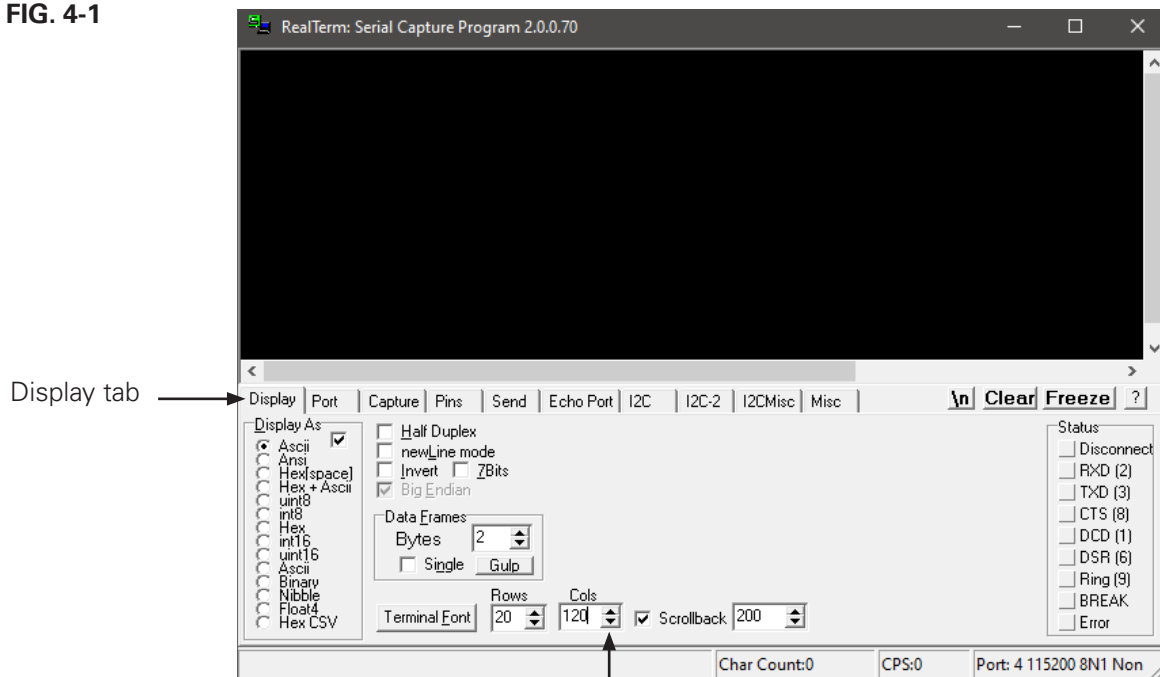
<https://documentation.kam.com/index.php/s/ro4K4kn9NkPKwqj/authenticate/showShare>

REALTERM SOFTWARE CONFIGURATION

RealTerm software is used for calibration, debugging and configuration of the OWD. To download RealTerm, go to <https://www.kam.com/documentation/> and download the file "Realterm Software" from the "Software" section. Once downloaded, unzip the file, double-click on the executable file (.exe) and follow on-screen instructions to install.

1. Open RealTerm software. A window will open as shown in FIG. 4-1.
2. The window will automatically default to the "Display" tab. Click on the up arrow underneath of the "Cols" window until the number reaches 120. Do not attempt to type the number in as this will result in an error message. If you receive the error message, you must close RealTerm and reopen.

FIG. 4-1



KAM OWD OPERATION REALTERM CONTINUED

- Click on the "Port" tab (FIG. 4-2) and change the Port settings as follows:

Baud: 9600

Parity: None

Data Bits: 8

Stop Bits: 1

Hardware Flow Control: 1

Port: Select port number assigned to your serial port or USB port connected to the converter. You can find this information in the Device Manager of your PC under "Ports." FIG. 4-3.

- Click on the "Change" button to save these settings.

FIG. 4-2

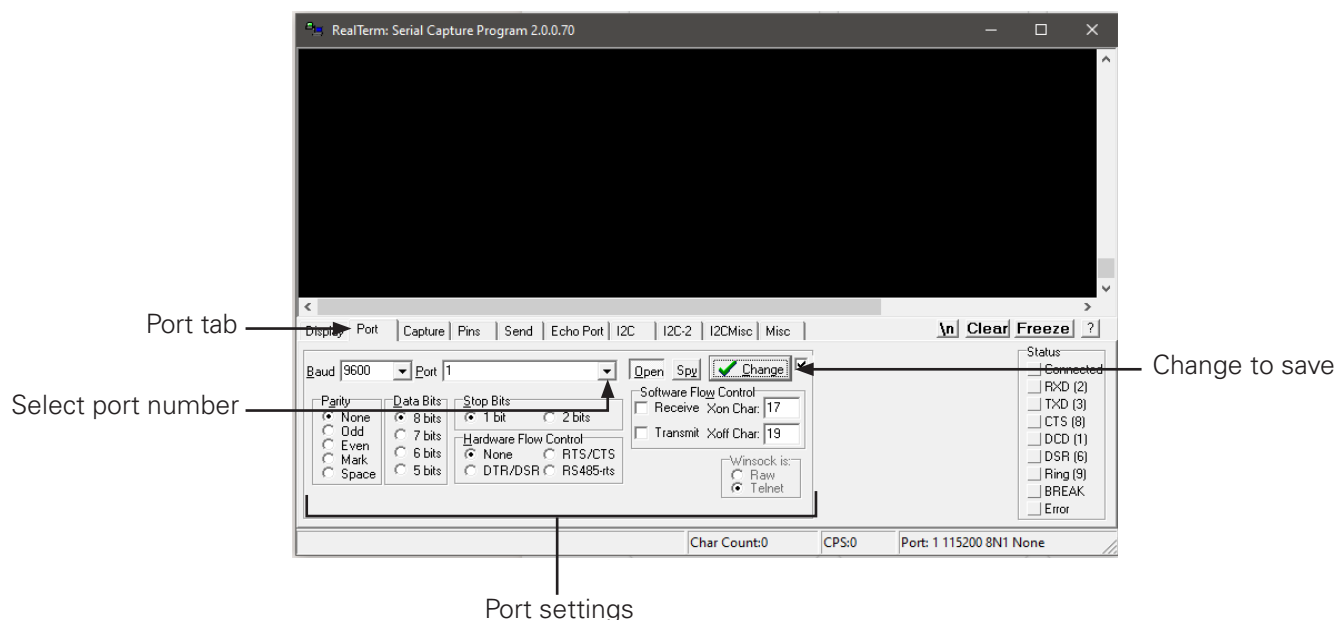
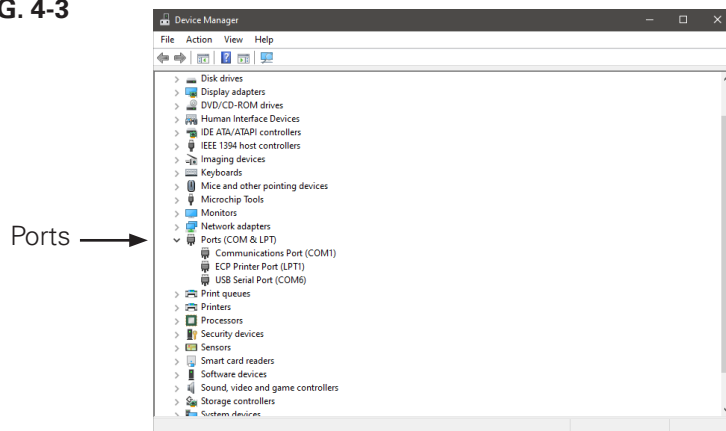


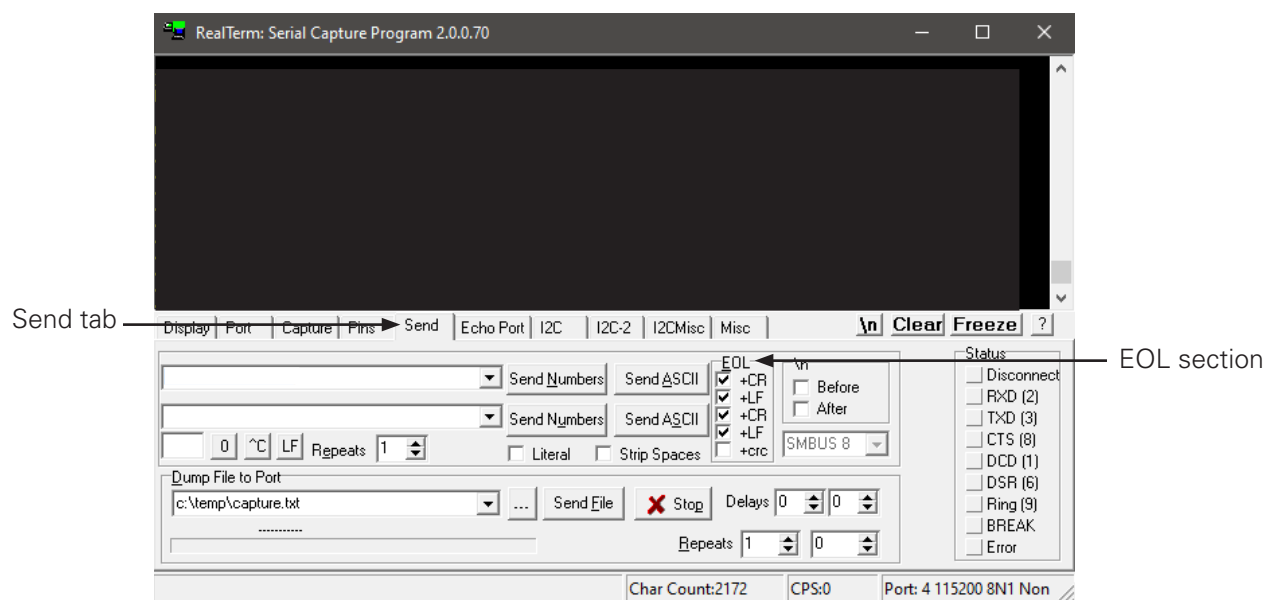
FIG. 4-3



KAM OWD OPERATION REALTERM CONTINUED

5. Click on the "Send" tab. FIG. 4-4.
6. Check the first 4 boxes in the "EOL" section. FIG. 4-4.
7. The RealTerm software configuration is complete.

FIG. 4-4



KAM OWD OPERATION REALTERM CONTINUED

OUTPUT DATA

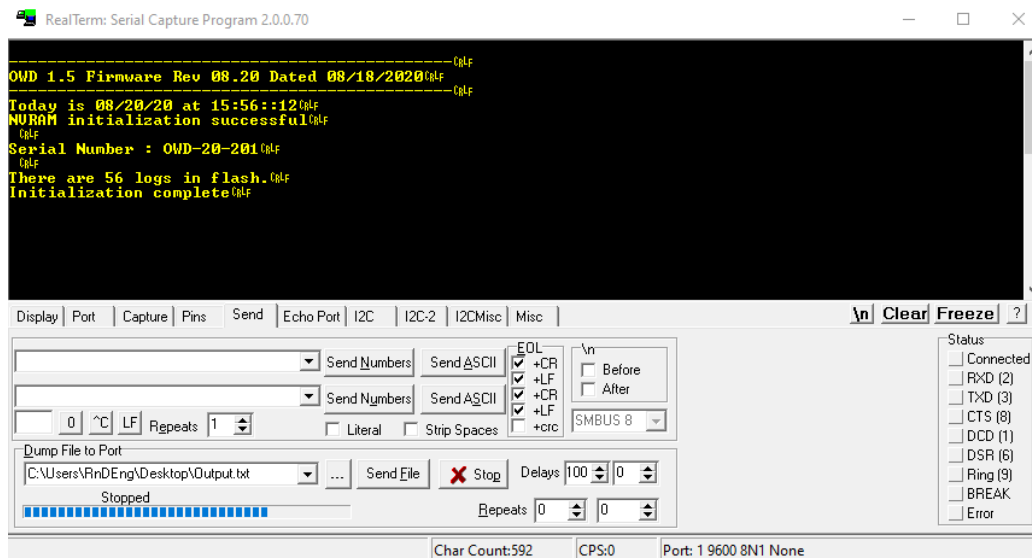
An RS232 cable for connecting your PC to the OWD has been supplied with the OWD along with a USB-to-serial converter in case your computer does not have an RS232 serial port. Go to <https://www.kam.com/documentation/> and download the file "RS232 Driver" from the "Software" section. Once downloaded, unzip the file, double-click on the executable file (.exe) and follow on-screen instructions to install.

Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Ensure your PC is connected to the OWD sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 15. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

Follow the steps below to view output data.

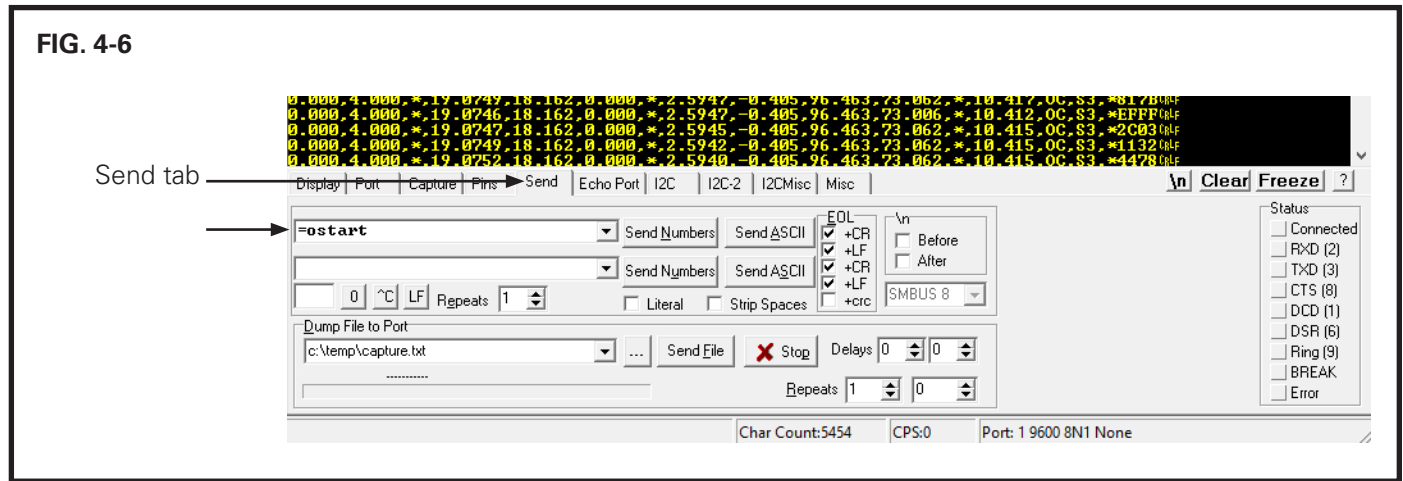
1. Launch RealTerm and turn on power to the OWD. The initial message will only appear once the unit is powered up and after all the connections and configurations are made. If the OWD was already on, the message won't display. FIG. 4-5.

FIG. 4-5



KAM OWD OPERATION REALTERM CONTINUED

2. Go to the "Send" tab, type "=ostart" on either command box for continuous data output every second, and click on the "Send ASCII" button on the same line as the text box where the command is entered to send the command.
FIG. 4-6.

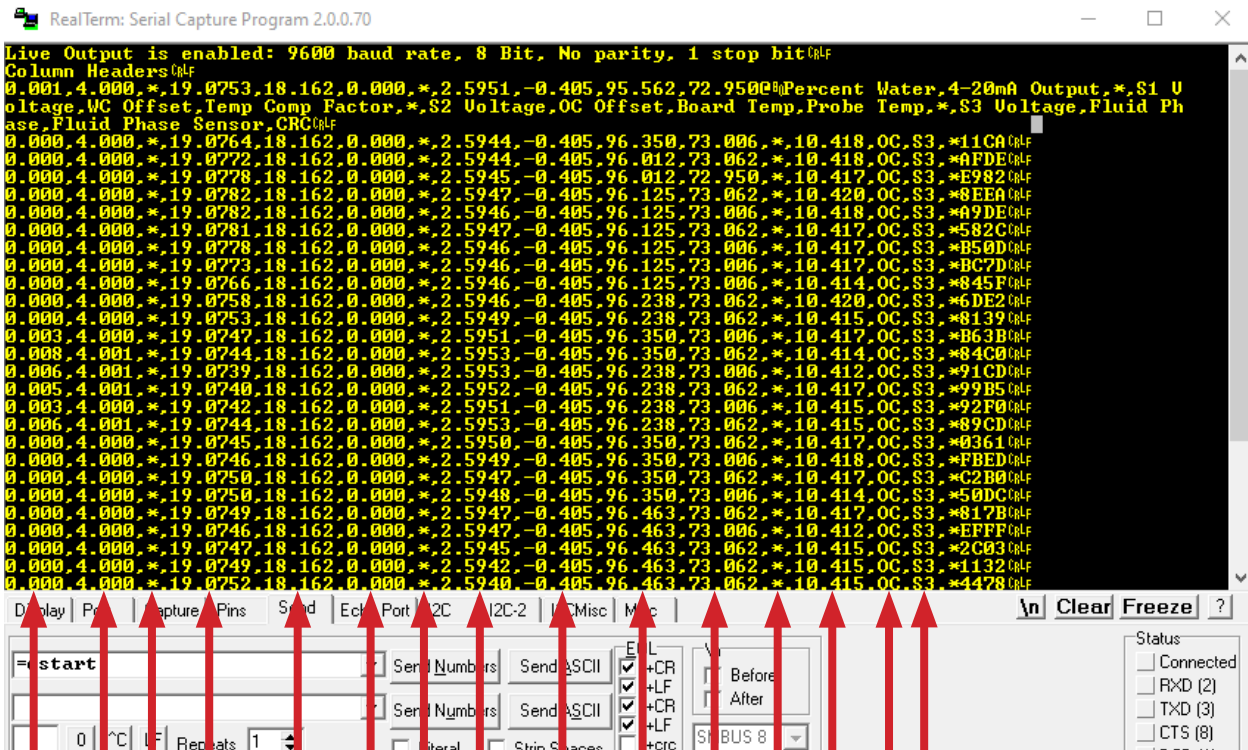


3. The output will start automatically in CSV (comma separated values) format. See FIG. 4-7 on page 26 for output data definitions.

If the output readings do not display in the RealTerm menu, proceed to the "RS232 Communication" troubleshooting section on page 45 of this manual.

KAM OWD OPERATION REALTERM CONTINUED

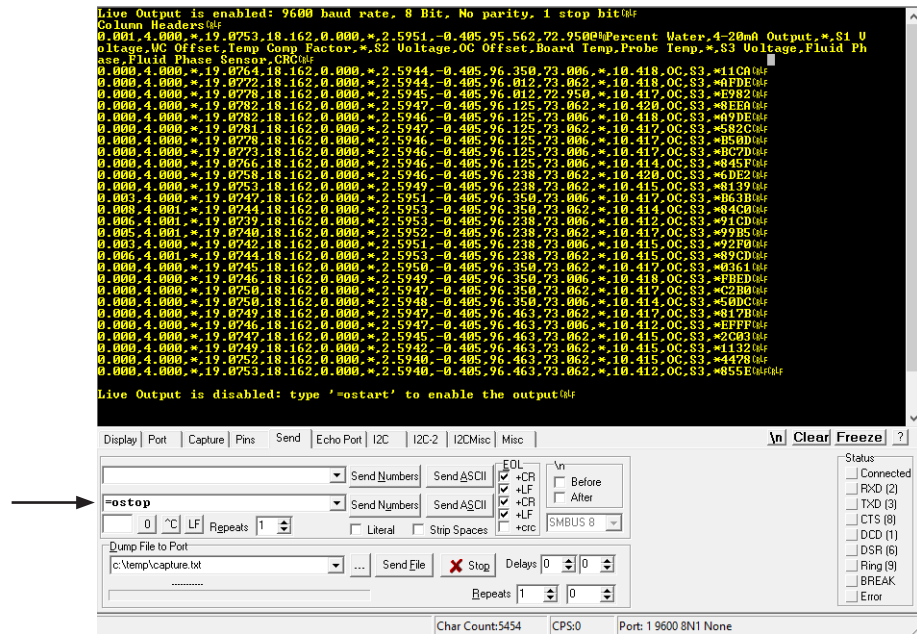
FIG. 4-7 OUTPUT DATA



KAM OWD OPERATION REALTERM CONTINUED

4. Type "=ostop" and click on "Send ASCII" to stop the continuous output. **Always do this before disconnecting.**

FIG. 4-8



KAM OWD OPERATION REALTERM CONTINUED

OFF-LINE CALIBRATION

NOTE: This procedure should be used in applications where manual samples are not easily collected from the main line.

Although the OWD has been calibrated in the factory, it should be calibrated in process conditions prior to use. This can be done using 100% brine (produced water) and 100% dry oil in buckets as outlined below. Once installed, it will need to be adjusted per the steps in the following "In-Line Calibration and Verification" Section.

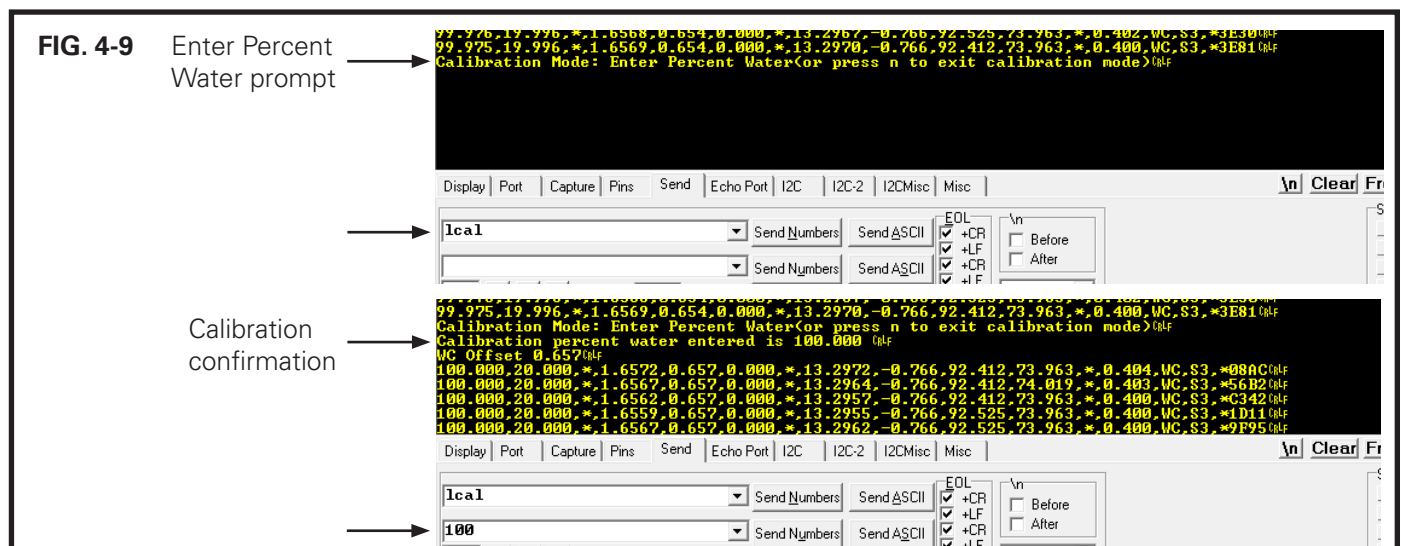
For the brine/dry oil method, in addition to fluid samples, operators will need appropriate tools for the extraction of the OWD, an RS232 cable (supplied) or an USB-to-serial converter (supplied), and a PC equipped with RealTerm software. Follow instructions on the "RealTerm Software Configuration" section to install and configure RealTerm.

1. If the OWD has been installed, remove from the line according to the instructions on page 12 of this manual. Clean the OWD sensor according to the guidelines on page 43 of this manual.
2. Restore power to the OWD. Connect your PC to the OWD sensor via supplied RS232 serial port or USB-to-serial converter as per the wiring diagram on page 14 of this manual. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.
3. Launch RealTerm. Let the OWD warm up for 20 minutes. This will stabilize the electronics temperature.
4. Insert the sensor in a bucket with brine (produced water). Probe should remain in brine until a stabilized temperature is observed. Readings should show 100% water or something close to 100% (Column 1) and the water-continuous state (Column 14) in the RealTerm menu.

NOTE: As all water in crude oil has salt, the OWD sensor has already been calibrated for salt water. You will not get an accurate reading if you use fresh water for testing. Salt water content should match stated content on approved drawings/data sheet. It should also show 20 mA if the mA range is calibrated for 0-100%, which you can measure at the output terminal. Regardless of readings, the sensor must be recalibrated.

WARNING: If the sensor is submerged in brine and Column 14 does not display WC (Water Continuous), do not perform the calibration and contact KAM Technical Support for further assistance.

5. On RealTerm, type "lcal" (lower case L) on the first command box under the "Send" tab and click on "Send ASCII." An "Enter Percent Water" prompt will appear, you have 20 seconds to enter the water percentage. Type "100" on the second command box and click on "Send ASCII." The calibration confirmation message will display. FIG. 4-9. If the 20-second window expires, repeat the process.

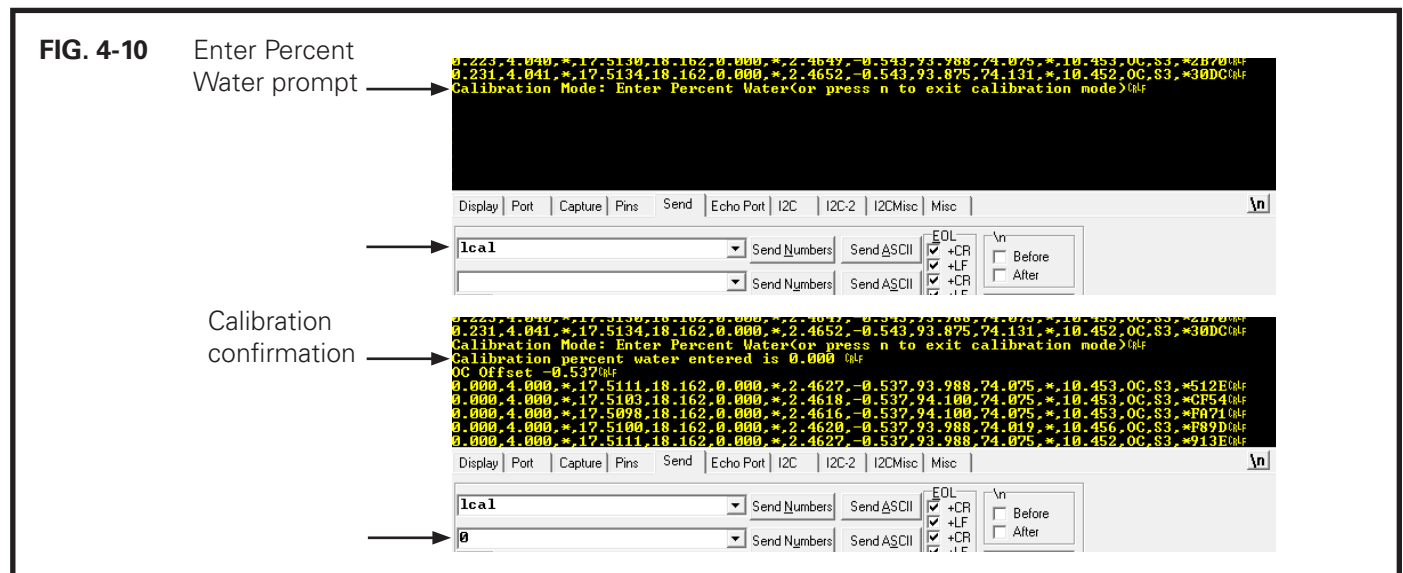


KAM OWD OPERATION REALTERM CONTINUED

6. Remove the instrument from brine, and thoroughly clean and dry the probe.
7. Insert the OWD sensor into a bucket or a jar filled with a sample of dry oil. To accurately test the OWD, you must use oil that does not have any water in it or which has a known, low percentage of water (preferably <1%). Sample water percentage can be determined by Karl Fischer, centrifuge or distillation per API Chapter 10. The water percentage reading should show 0% or reflect the known water percentage (Column 1) and the oil-continuous state (Column 14) on RealTerm.

WARNING: If the sensor is submerged in dry oil and Column 14 does not display OC (Oil Continuous) do not perform the calibration and contact KAM Technical Support for further assistance.

8. Type "lcal" (lower case L) on the first command box under the "Send" tab and click on "Send ASCII." An "Enter Percent Water" prompt will appear, you have 20 seconds to enter the water percentage. Type "0" or the known percentage of water on the second command box and click on "Send ASCII." The calibration confirmation message will display. FIG. 4-10. If the 20-second window expires, repeat the process.



9. The OWD has now been calibrated to process conditions and can be installed.

KAM OWD OPERATION REALTERM CONTINUED

IN-LINE CALIBRATION AND VERIFICATION

PLEASE NOTE: The following calibration steps are to be conducted during initial installation with existing process conditions; during routine verification procedures; or when OWD readings indicate a slight drift off acceptable accuracies in continuous operation. You will need an RS232 cable (supplied) or an USB-to-serial converter (supplied), a PC equipped with RealTerm software, and a means for manually collecting and measuring samples.

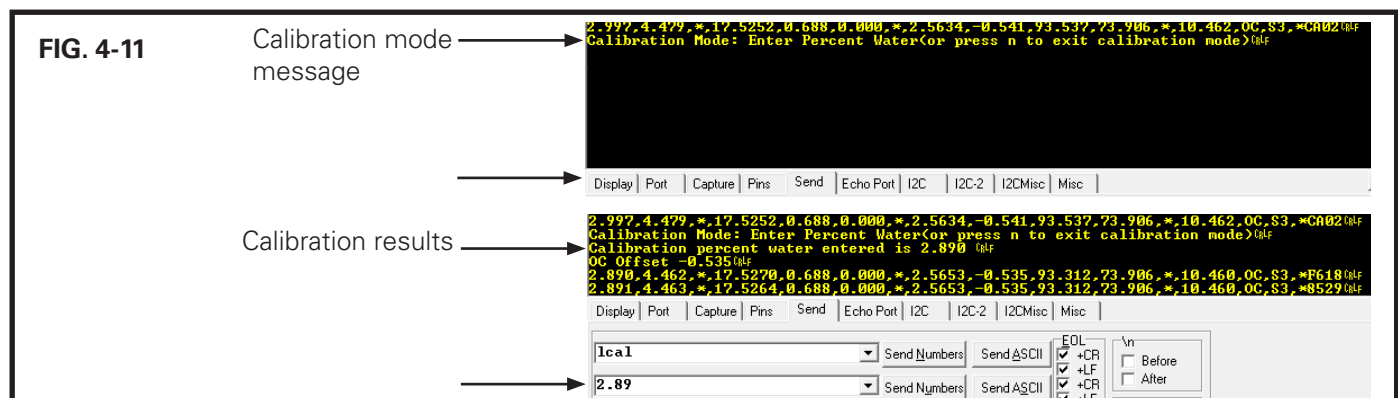
Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Ensure your PC is connected to the OWD sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 14. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

1. Launch RealTerm. Manually draw (3) samples of fluid according to API MPMS Chapter 8.1, waiting at least 15 minutes in between each sample draw.

NOTE: It is preferable to take the manual samples when you have steady OWD readings not varying by more than 1%.

2. Each time a sample is drawn, note value or take a screenshot of the current percent water OWD reading (Column 1) in the RealTerm window.
3. Determine water percentage in each sample using centrifuge or the best available method to measure the amount of water required.
4. Average the water content from the three manual samples per API Chapter 10.
5. Average the water content from the three OWD readings or screenshots (Column 1 in RealTerm).
6. Take note of the current reading of the OWD in RealTerm or capture it in your computer.
7. Calculate the difference between the manual sample average and the OWD average and add or subtract that value to the current reading of the OWD in RealTerm. This value is the calculated percent of water to be entered in RealTerm to calibrate the OWD. See Calibration Example on page 31.
8. Type "lcal" (lower case L) on the first command box under the "Send" tab and click on "Send ASCII." The "Calibration Mode" message will appear, you have 20 seconds to enter the value. Type the calculated percent of water (i.e. 2.89 for 2.89%) on the second command box and click on "Send ASCII." The calibration results will display. FIG. 4-11. If the 20-second window expires, repeat the process.

NOTE: For 0-100% water applications, calibration is required on both oil-continuous and water-continuous phase. If the OWD will operate on the water-continuous phase (approximately 75% to 100%) range only, water-continuous phase calibration alone is required. If the OWD will operate on the oil-continuous phase (approximately 0 to 40%) range only, oil-continuous phase calibration alone is required.



KAM OWD OPERATION REALTERM CONTINUED

CALIBRATION EXAMPLE

Manual samples water content:

1. 2.51%

2. 2.75%

3. 2.62%

Average = 2.63%

OWD screenshots water content:

1. 2.60%

2. 2.91%

3. 2.70%

Average = 2.74%

Difference of averages:

$2.74\% - 2.63\% = 0.11\%$

According to the averages, the OWD is reading 0.11% high.

Current reading: 3.0%

To adjust the OWD, the reading needs to be lowered by 0.11%.

$3.0\% - 0.11\% = 2.89\%$.

This is the new value to be entered into the OWD.

KAM OWD OPERATION REALTERM CONTINUED

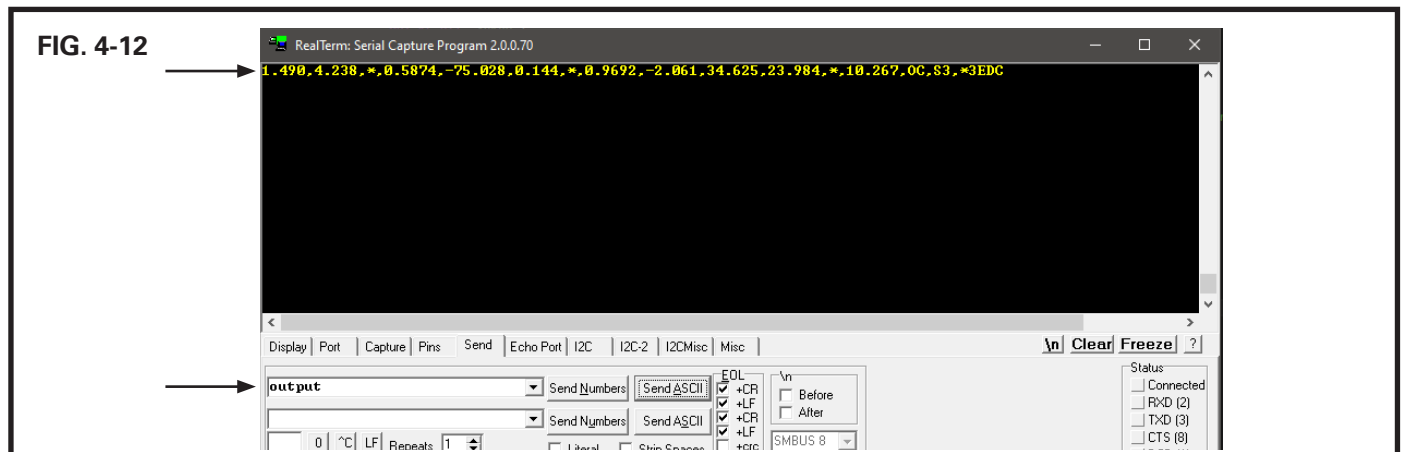
CALIBRATION WITH LABORATORY ANALYSIS

In cases where on-site reference measurement (Karl Fischer or centrifuge) is not available, the OWD can be verified after obtaining results of manual sample analysis at a laboratory. The oil-continuous mode and water-continuous mode need to be calibrated separately.

Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Ensure your PC is connected to the OWD sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 14. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

OIL CONTINUOUS CALIBRATION

1. Launch RealTerm. Got to the "Send" tab, type "output" on either command box and click on "Send ASCII" to get one line of OWD reading. FIG. 4-12.



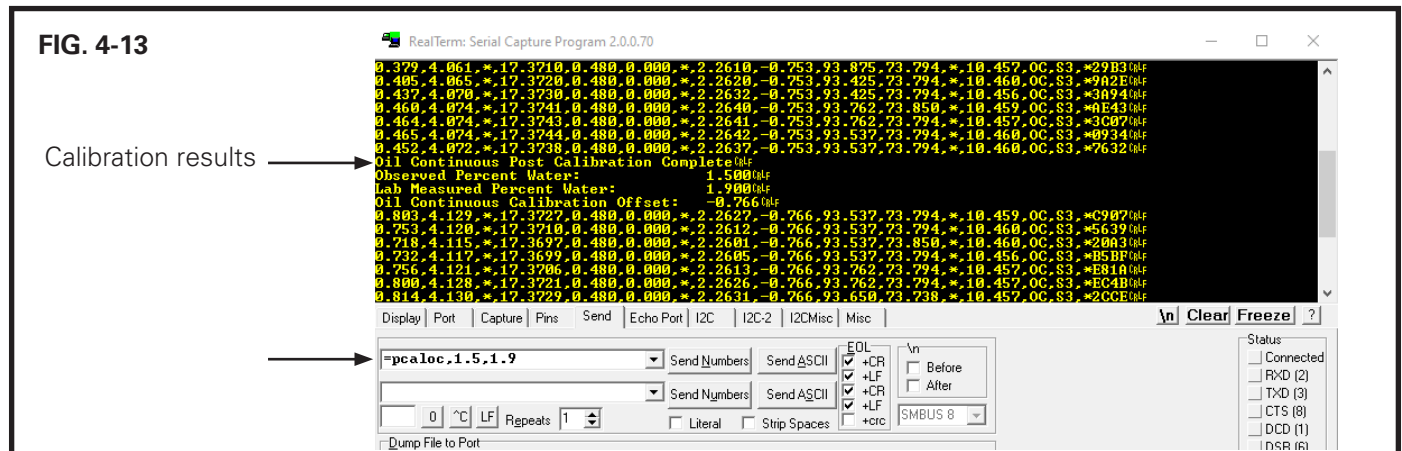
2. Check column 14 to ensure that the OWD is in OC mode (Oil Continuous).
3. Manually draw (3) samples of fluid according to API MPMS Chapter 8.1, waiting at least 15 minutes between sample draws.
4. Each time a sample is drawn, note or take a screenshot of the current OWD reading in the RealTerm window.
5. Send the samples to the lab for water content determination.
6. Once results have been received from the lab, average the water content from the three samples. This value is the "Lab observed % water".
7. Average the water content from the three OWD screenshots. This value is the "OWD observed % water."

NOTE: The "OWD observed % water" should be more than 0.

KAM OWD OPERATION REALTERM CONTINUED

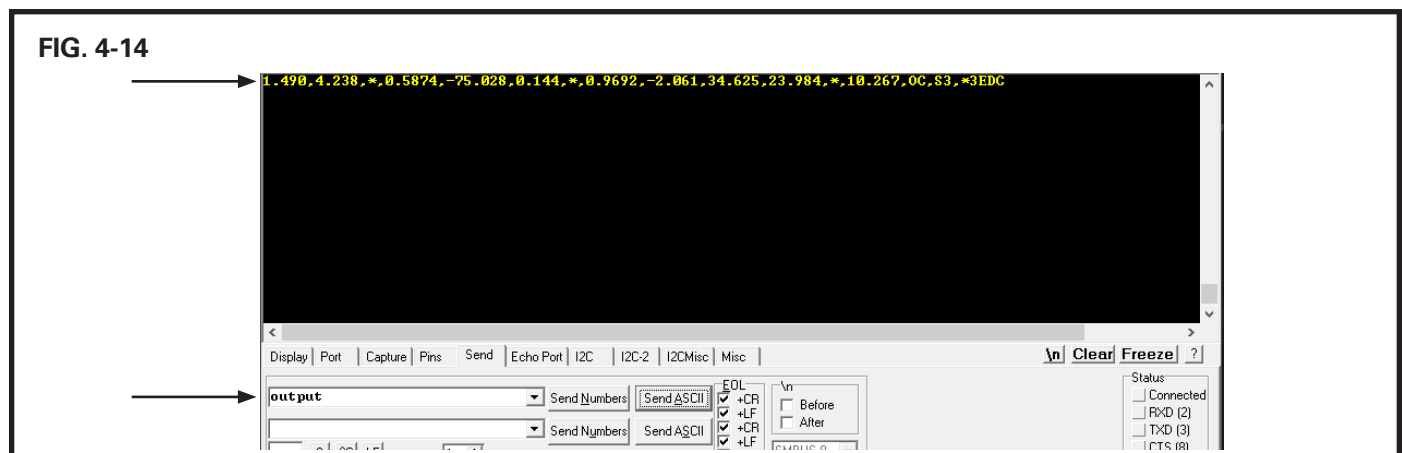
- Type "=pcaloc,<OWD observed % water>, <Lab observed % water>" in either command box under the "Send" tab and click on "Send ASCII." For instance, if the OWD observed percent water was 1.5% and the Lab observed percent water was 1.9%, you would input "=pcaloc,1.5,1.9". FIG. 4-13.

Calibration results will be displayed. FIG. 4-13. If not, calibrate once more or contact KAM Technical Support for further assistance.



WATER CONTINUOUS CALIBRATION

- Launch RealTerm. Go to the "Send" tab, type "output" on either command box and on click on "Send ASCII" to get one line of OWD reading. FIG. 4-14.



- Check column 14 to ensure that the OWD is in WC mode (Water Continuous).
- Manually draw (3) samples of fluid according to API MPMS Chapter 8.1, waiting at least 15 minutes between sample draws.
- Each time a sample is drawn, note or take a screenshot of the current OWD reading in the RealTerm window.
- Send the samples to the lab for water content determination.
- Once results have been received from the lab, average the water content from the three samples. This value is the "Lab observed % water."

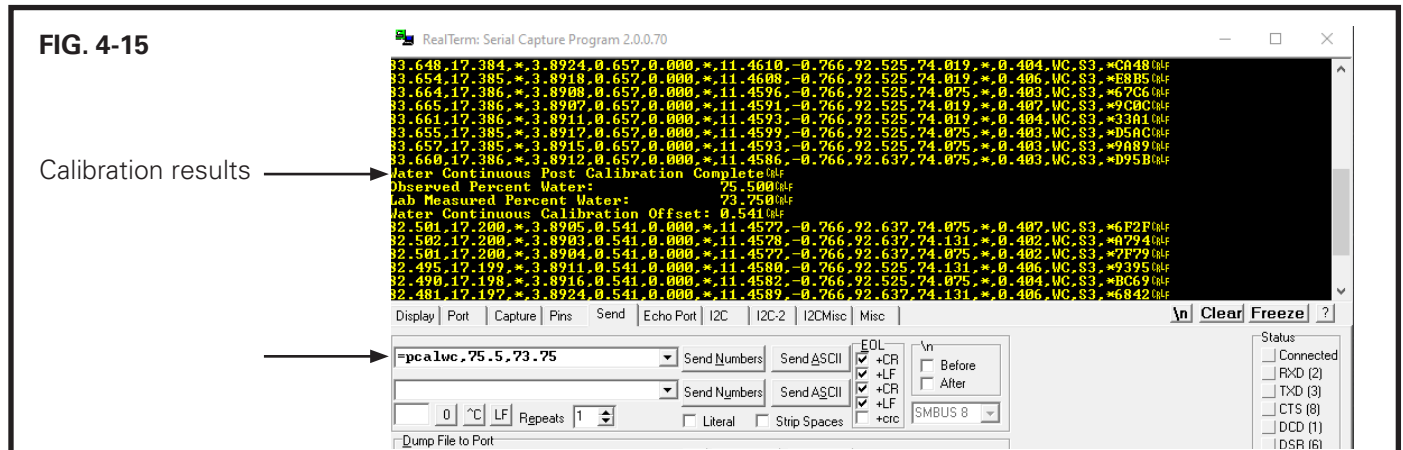
KAM OWD OPERATION REALTERM CONTINUED

7. Average the water content from the three OWD screenshots. This value is the "OWD observed % water."

NOTE: The "OWD observed % water" should be more than 0.

8. Type "=pcalwc,<OWD observed % water>, <Lab observed % water>" in either command box under the "Send" tab and click on "Send ASCII." For instance, if the OWD observed % water was 75.5% and the Lab observed % water was 73.75%, you would input "=pcalwc,75.5,73.75". FIG. 4-15.

Calibration results will be displayed. FIG. 4-15. If not, calibrate once more or contact KAM Technical Support for further assistance.



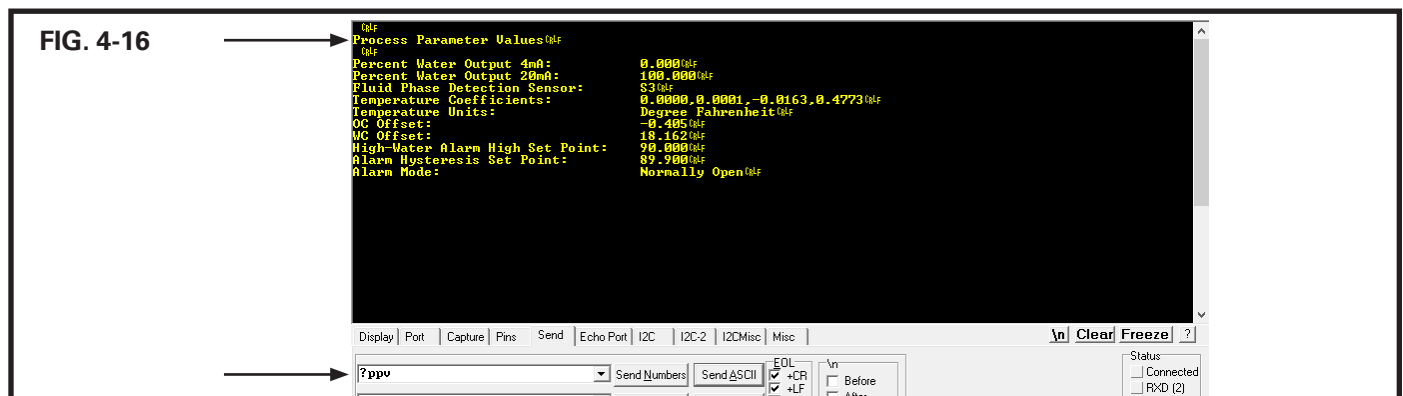
PROCESS PARAMETER VALUES

The overall configuration of the instrument is shown within the process parameter values, which include the 4-20 mA loop (water percent range), phase sensor, temperature coefficients, temperature units, OC-WC offsets, and alarm settings.

Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Ensure your PC is connected to the OWD sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 14. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

To view the parameters:

1. Launch RealTerm. Type "?ppv" in the command box under the "Send" tab and click on "Send ASCII." The configured values for process parameters will be displayed. FIG. 4-16.



KAM OWD OPERATION REALTERM CONTINUED

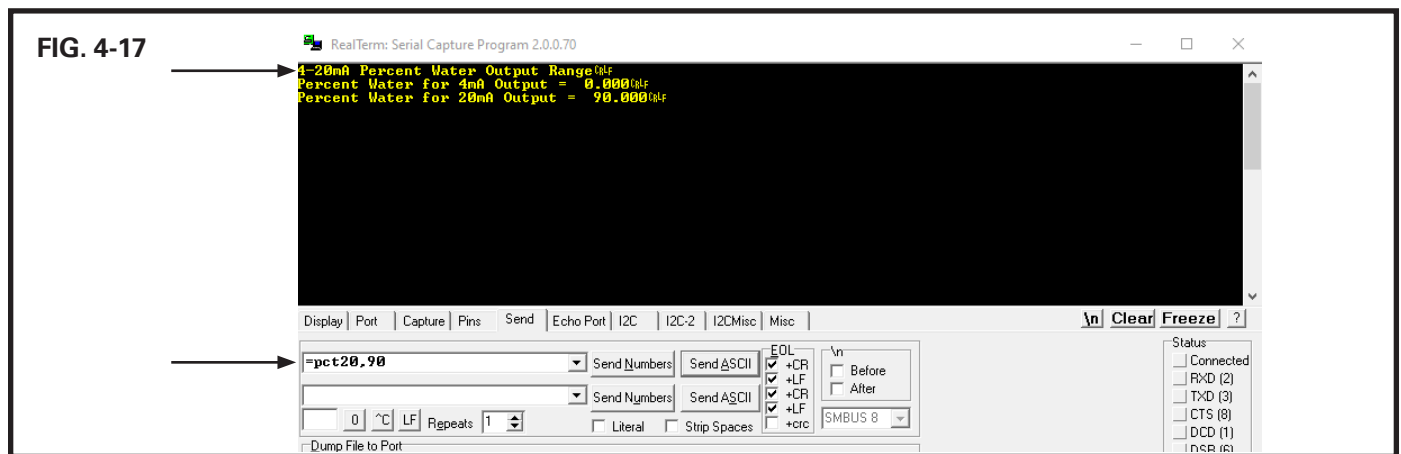
SETTING THE PERCENT WATER FOR THE 20 mA OUTPUT

Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Ensure your PC is connected to the OWD sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 14. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

The default percent water for the 20 mA output is 100%. To set a lower percent water for the 20 mA loop output:

1. Launch RealTerm. Go to the "Send" tab, type "pct20,<percent value>" on either command box and click on "Send ASCII." For example, if the water percent equivalent to the 20 mA of the output loop is 90, you would enter "pct20,90". The change will be confirmed in the main window. FIG. 4-17.

NOTE: Setting this value does not change the accuracy of the instrument +/- 1.0%

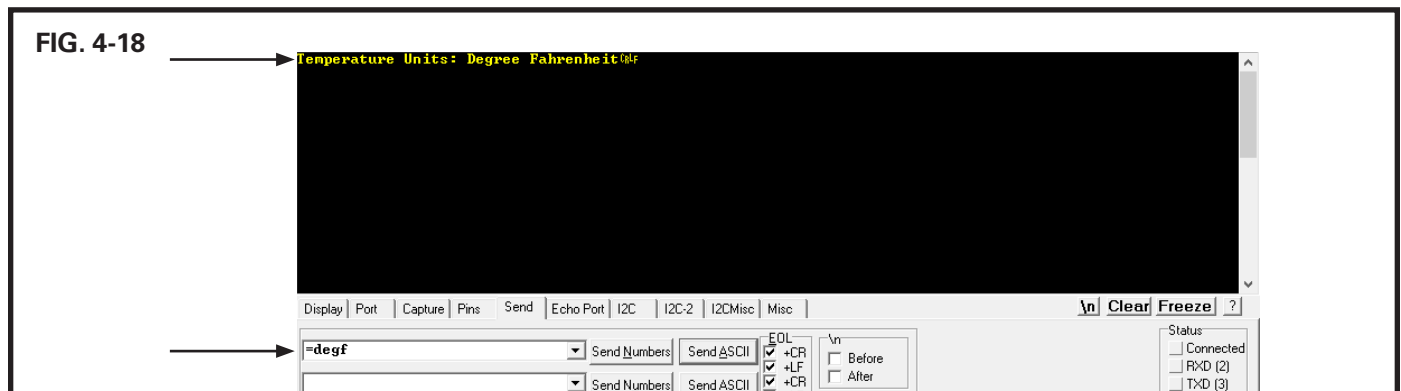


CHANGING THE TEMPERATURE UNITS

Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Ensure your PC is connected to the OWD sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 14. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

To change the temperature unit (The default unit for temperature is degrees Celsius):

1. Launch RealTerm. Type "=degf" for Fahrenheit or "=degc" for Celsius on either command box under the "Send" tab and click on "Send ASCII." The change will be confirmed in the main window. FIG. 4-18.



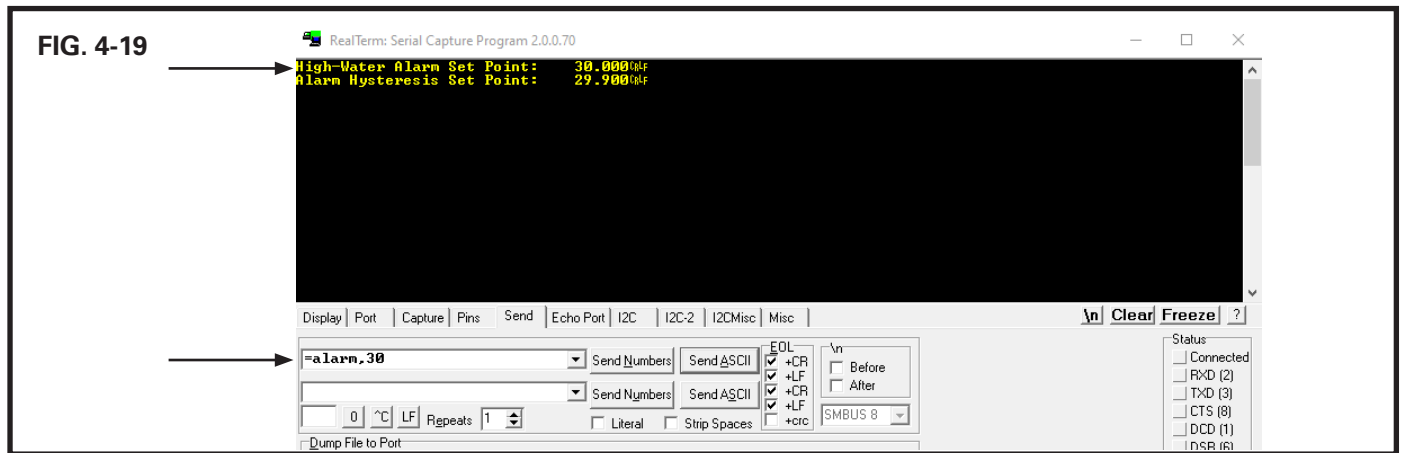
KAM OWD OPERATION REALTERM CONTINUED

SETTING THE ALARM SETPOINTS

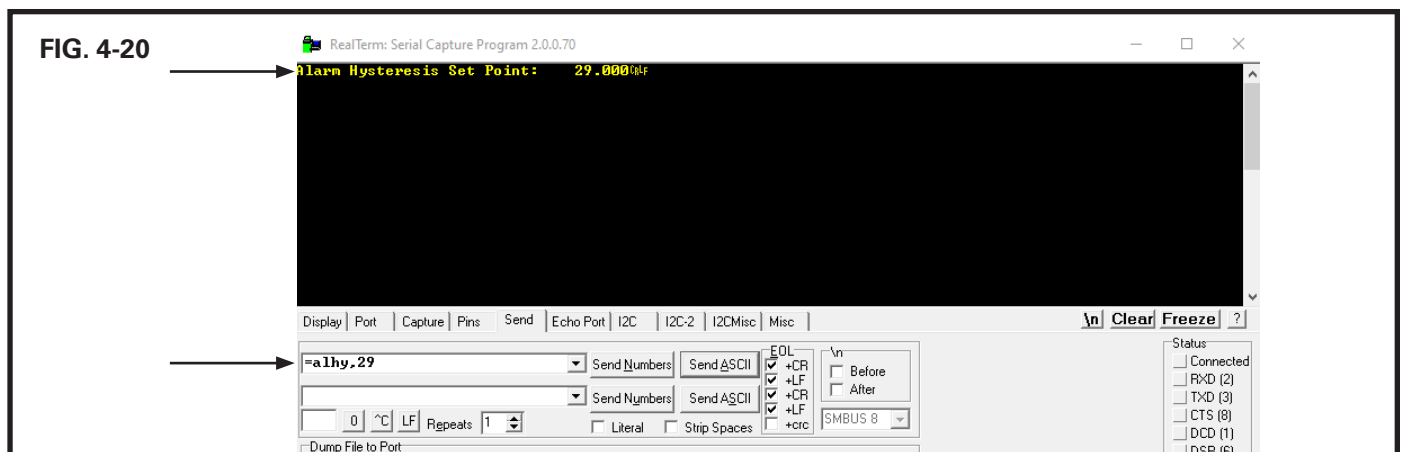
Ensure RealTerm is installed and configured as per instructions on pages 20-22 of this manual. Connect your PC to the OWD sensor via supplied RS232 serial cable or USB-to-serial converter as per wiring diagram on page 15. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

To set the alarm [Digital Out (+)]:

1. Launch RealTerm, go to the "Send" tab, type "=alarm,<percent value>" on either command box and click on "Send ASCII." For example, if the percent water where the alarm will activate is 30, you would enter "=alarm,30". The configured values will be displayed. FIG. 4-19.



2. The hysteresis point is adjusted automatically to 0.1 % lower than the high set point.
3. To adjust the hysteresis point manually, type the command "=alhy,<hysteresis percent>" and click on "Send ASCII." The hysteresis percent must have a difference higher than 0.1 % from the high set point. For example, if the water percent lower limit where the alarm will clear the high-water status and be able to reactivate is 29, you would type "=alhy,29". The new hysteresis alarm value will be displayed. FIG. 4-20.



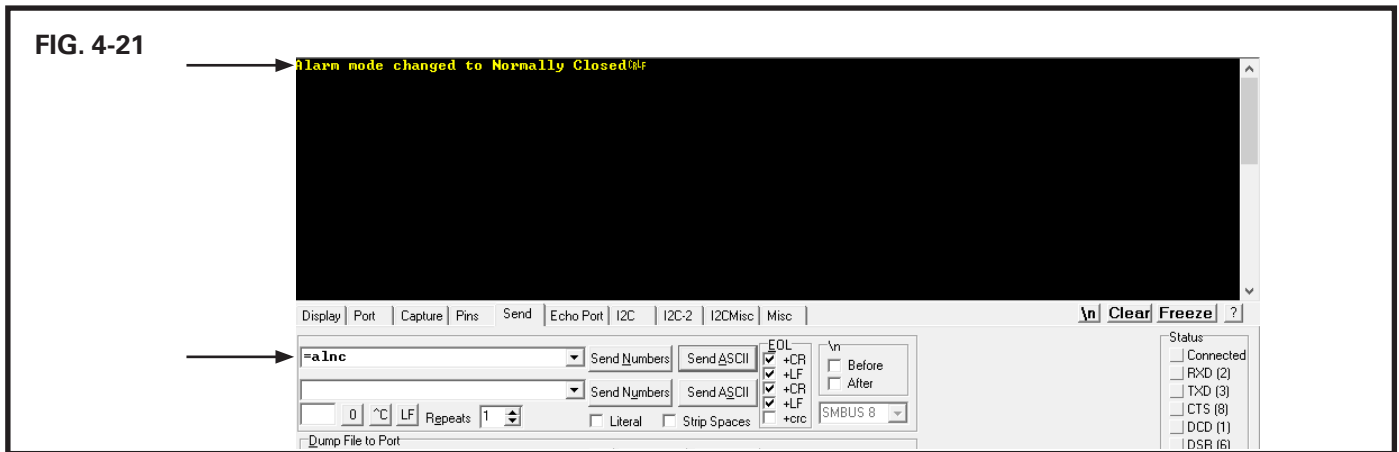
KAM OWD OPERATION REALTERM CONTINUED

SETTING THE ALARM MODE

Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Ensure your PC is connected to the OWD sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 14. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

The alarm mode is set to "Normally Open" by default, follow the steps below to change the mode to "Normally Closed."

1. To set the alarm mode, launch RealTerm and type "=alnc" on either command box under the "Send" tab. Click on "Send ASCII." The change will be confirmed in the main window. FIG. 4-21.

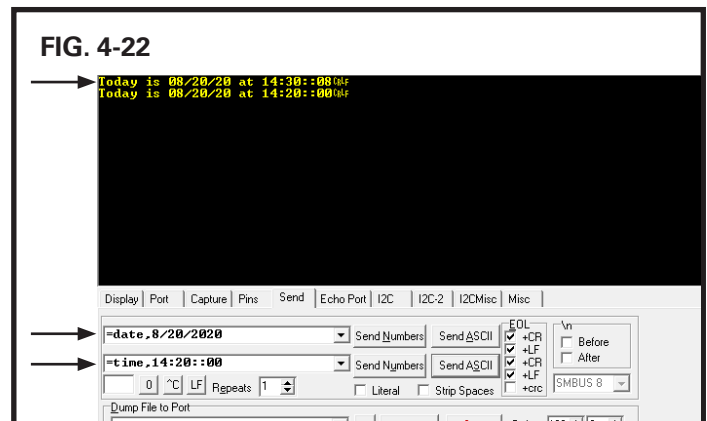


2. To change the alarm mode back to "Normally Open", type the command "=alno" and click on "Send ASCII."

SETTING THE DATE AND TIME

Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Ensure your PC is connected to the OWD sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 14. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

1. To set the date, launch RealTerm and type the command "=date,<MM>/<DD>/<YYYY>" on either command box under the "Send" tab. Click on "Send ASCII." For example, if the desired date is August 20th, 2020, you would enter "=date,08/20/2020". The change will be confirmed in the main window FIG. 4-22.
2. To set the time, type the command "=time,<HR>:<MM>:<SS>". For example, if the desired time is 14:20:00 hrs, you would enter "=time,14:20:00". The change will be confirmed in the main window. FIG. 4-22.



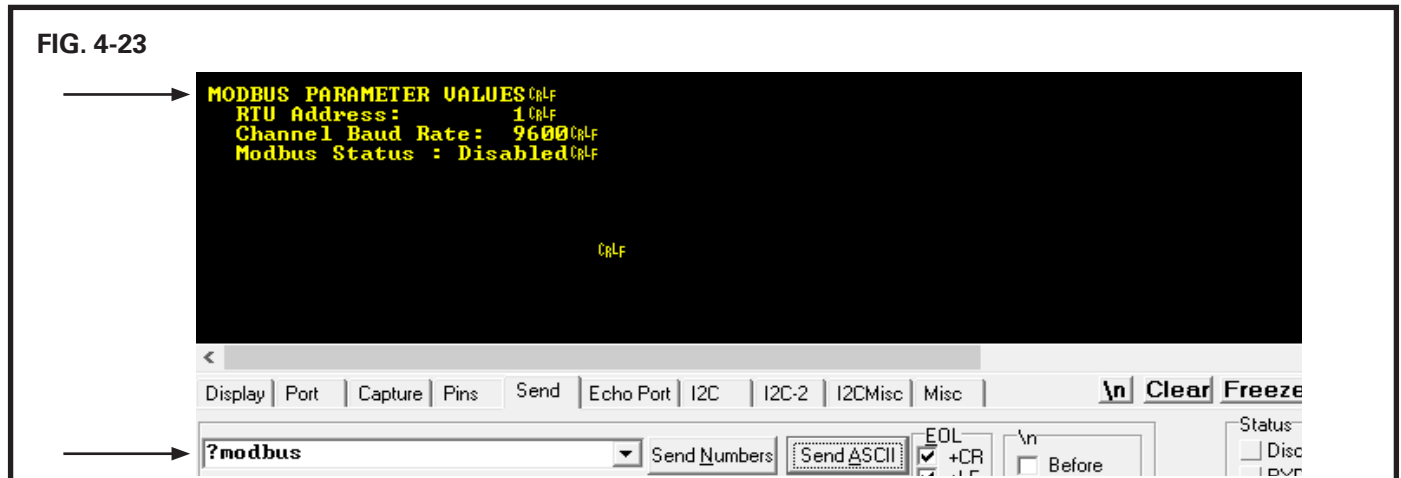
KAM OWD OPERATION REALTERM CONTINUED

ENABLE/DISABLE MODBUS

Unless requested, Modbus is usually disabled prior to shipment from KAM. Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Ensure your PC is connected to the OWD sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 14. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

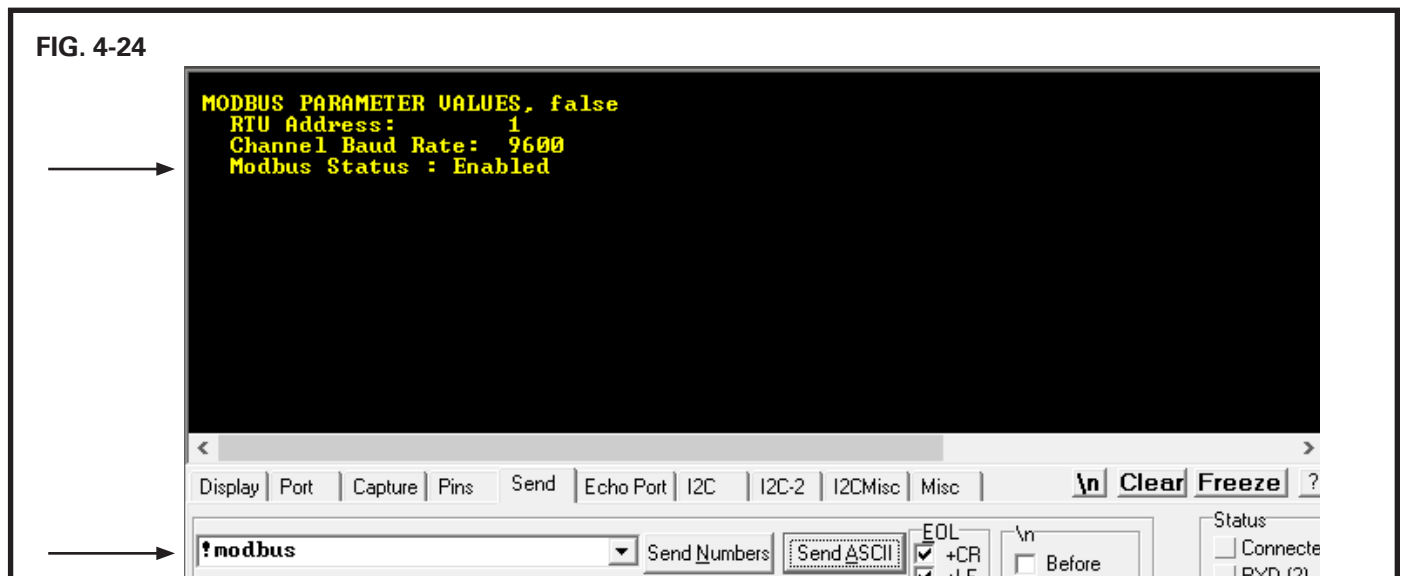
1. Launch RealTerm. Go to the "Send" tab, type "?modbus" on either command box and click on "Send ASCII" to check Modbus status. The Modbus parameters will display on the RealTerm window. FIG. 4-23.

FIG. 4-23



2. Type the command "!modbus" and click on "Send ASCII" to enable Modbus. Modbus status will change to "Enabled" confirming the change. FIG. 4-24.

FIG. 4-24



3. Power cycle (turn off and on) the OWD to start the Modbus communication.
4. To disable Modbus, use the same command "!modbus" and click on "Send ASCII." Modbus status will change to "Disabled" confirming the change.

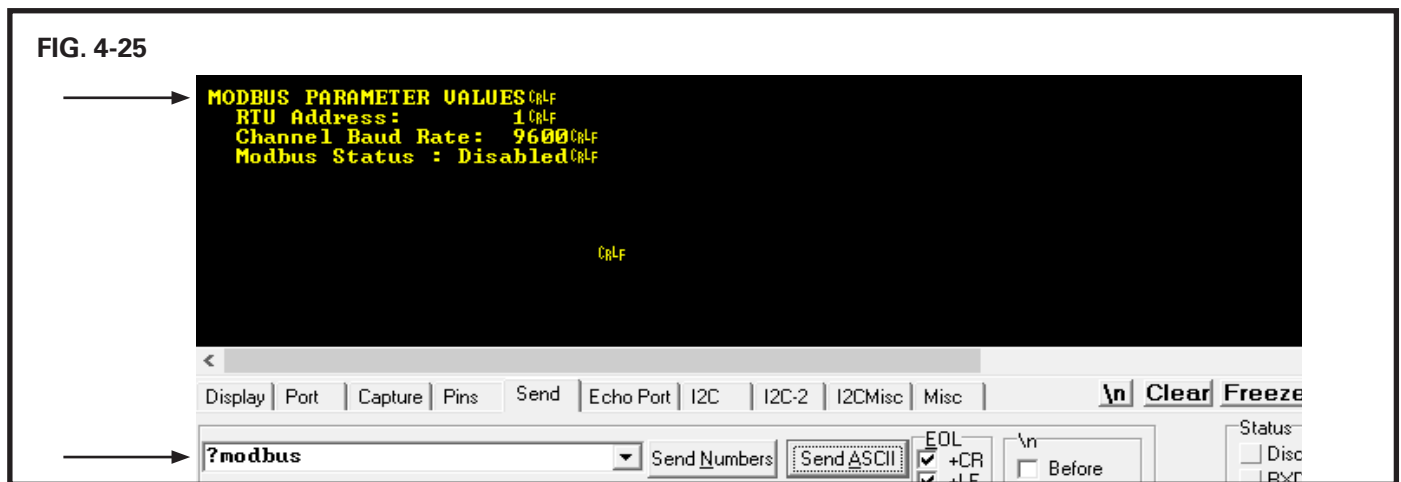
KAM OWD OPERATION REALTERM CONTINUED

CHANGE THE MODBUS ADDRESS

The default Modbus address is 1. This address can be changed to any number from 1 to 247. Follow the steps below to change the Modbus address.

Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Ensure your PC is connected to the OWD sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 14. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the Explosion Proof electronics enclosure and remove the cover.

1. On RealTerm, go to the "Send" tab and type the command "`=modbus,2,9600`" on either command box. Click on "Send ASCII." FIG. 4-25. The #2 represents the new address.



2. To complete the change, turn the OWD power off, wait two to three seconds, and turn it back on.

KAM OWD OPERATION REALTERM CONTINUED

COMMAND LIST

Once RealTerm has been installed and configured as per the instructions on the "RealTerm Software Configuration" section, any of the commands listed in the table below can be used to view or change the various instrument's parameters.

TABLE 4-1

COMMAND	PURPOSE
^ostart	Start continuous output
output	Single line output
^ostop	Stop continuous output
lcal (lower case L)	Live calibration
^pcaloc,<value>,<value2>	Oil Continuous calibration for laboratory sample analysis
^pcalwc,<value>,<value2>	Water Continuous calibration for laboratory sample analysis
?ppv	View the process parameters values
=degc	Set the temperature units displayed to Celsius (°C)
=degf	Set the temperature units displayed to Fahrenheit (°F)
^pct20, <value>	Set the percent water for the 20 mA output
^alarm, <value>	Set high water percent alarm value
^alhy,<value>	Set alarm hysteresis (lower limit for the alarm activation band)
=alnc	Set alarm mode to normally closed
=alno	Set alarm mode to normally open
=date,<MM>/<DD>/<YYYY>	Set the current date
=time,<HR>:<MM>::<SS>	Set the current time
^modbus	View/Change Modbus parameters
?sn	View the serial number of the instrument
?version	Display the software version of the instrument
help	Display a list of commands

The command the symbol "^" can be replaced with the following options:

- "*" to see the command usage details
- "?" to see the current value of the parameter
- "=" to change the value of the parameter

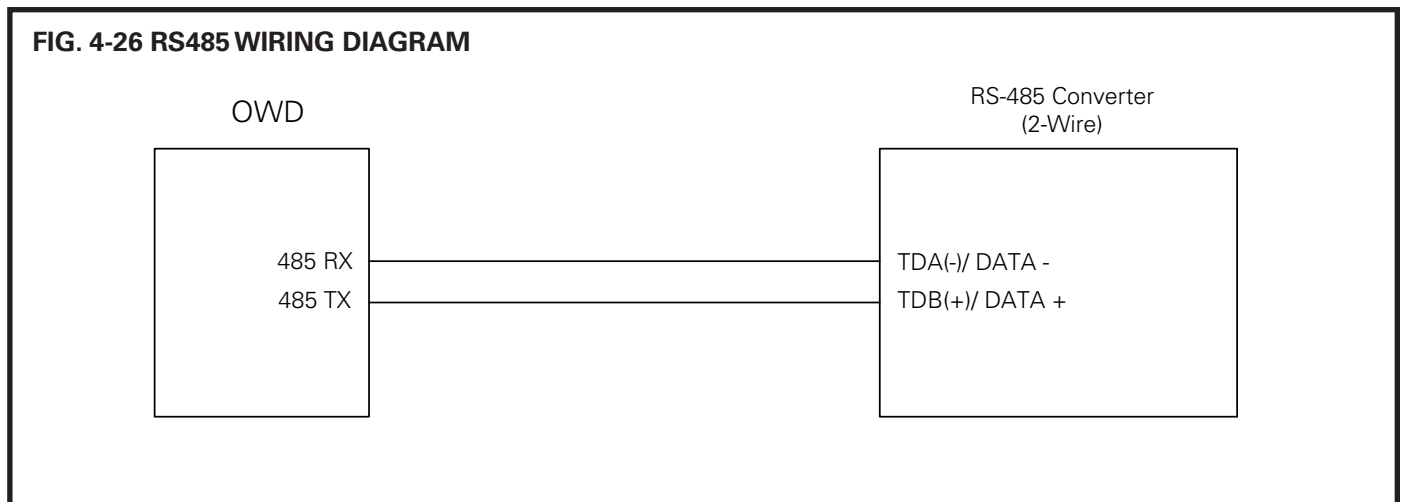
Type the command with the replaced symbol in the command box and click on "Send ASCII" to send the command.

Detailed instructions on how to use commands and examples are available in the previous sections.

KAM OWD OPERATION MODBUS

OPERATION USING MODBUS

1. If you have not already done so, follow instructions on the "Enabling/Disabling Modbus" on page 38 of this manual to enable Modbus.
2. Ensure power to the OWD is turned off.
3. Set any jumpers on the RS485 converter to use two wire mode.
4. Set your RS485 converter for two-wire mode as per the instructions on the RS485 converter manufacturer's manual.
5. To access the boards, use a 7/16" wrench to remove the (6) hex screws on the electronics enclosure and remove the cover.
6. Connect the "RS-485 +" terminal on the OWD's Terminal Board to the Data(+) line on the RS485 converter. FIG. 4-26.
7. Connect the "RS-485 -" terminal on the OWD's Terminal Board to the Data(-) line on the RS485 converter. FIG. 4-26.



8. Turn on power to the OWD.
9. Make sure the activity indicator (when available) on the converter blinks as data is transferred or read by the Modbus master reader software.
10. Set the appropriate COM port in the Modbus software. This setting varies with the system and whether the connection to the converter is connected to the serial communications port or to the USB port. Follow converter manufacturer's recommendations for settings.
11. Use the following configuration settings in the Modbus software:
 - Mode: RTU
 - Baud Rate: 9600
 - Data Bits: 8
 - Stop Bits: 1
 - Parity: None
 - Function Code: 3
 - Slave ID: 1 (By default, the Slave ID or Modbus Address is set to 1. To change Modbus address see "Changing Modbus Address" section on page 39 if necessary).
 - Offset: 40001

KAM OWD OPERATION MODBUS CONTINUED

12. Registers 40100 to 40111 are 16 bit registers. Registers 40100, 40107 and 40108 are multiplied by 100 therefore to get the correct value divided by 100 after receiving. Registers 40101 to 40106 and 40110 are multiplied by 1000 therefore to get the correct value divided by 1000 after receiving.

TABLE 4-2

Register	Data	Type of Register	Type of Data	Expected Value Range	Multiplier
40100	Water Percentage	Read	16 Bit Int	0 - 100	100
40101	Current Output (mA)	Read	16 Bit Int	4 - 20	1000
40102	S1 Voltage	Read	16 Bit Int	0 - 24	1000
40103	S2 Voltage	Read	16 Bit Int	0 - 24	1000
40104	S3 (OC/WC) Volatge	Read	16 Bit Int	0 - 24	1000
40105	OC Offset	Read	16 Bit Int	0 - 24	1000
40106	WC Offset	Read	16 Bit Int	0 - 24	1000
40107	Board Temperature	Read	16 Bit Int	(-) 40 to (+) 120	100
40108	RTD Temperature	Read	16 Bit Int	(-) 40 to (+) 120	100
40109	OC-WC Enabled/Disabled State	Read	16 Bit Int	0 or 1	1
40110	Temperature Compensation	Read	16 Bit Int	0 - 24	1000
40111	Phase State(OC/WC)	Read	16 Bit Int	0 or 1	1

13. Registers 40200 to 40222 are 32 float registers. (See table 4-3 for detail information)

TABLE 4-3

Register	Data	Type of Register	Type of Data	Expected Value Range
40200	Water Percentage	Read	32 Bit Float	0 - 100
40202	Current Output (mA)	Read	32 Bit Float	4 - 20
40204	S1 Voltage	Read	32 Bit Float	0 - 24
40206	S2 Voltage	Read	32 Bit Float	0 - 24
40208	S3 (OC/WC) Volatge	Read	32 Bit Float	0 - 24
40210	OC Offset	Read	32 Bit Float	0 - 24
40212	WC Offset	Read	32 Bit Float	0 - 24
40214	Board Temperature	Read	32 Bit Float	(-) 40 to (+) 120
40216	RTD Temperature	Read	32 Bit Float	(-) 40 to (+) 120
40218	OC-WC Enabled/Disabled State	Read	32 Bit Float	0 or 1
40220	Temperature Compensation	Read	32 Bit Float	0 - 24
40222	Phase State(OC/WC)	Read	32 Bit Float	0 or 1

MAINTENANCE

CLEANING AND INSPECTION

If probe is removed from the line for inspection, NEVER use sharp or metallic objects such as a knife or screw driver to clean the antenna. Do NOT power wash the unit.

Instead, to remove any oil residues for visual inspection, use a clean cloth with oil solvent or part washer. Preferred solvents include, any petroleum solvent such as mineral spirits, xylene, toluene, gasoline, or diesel. Do not use WD40 or other chemicals.

If you have a question regarding cleaning solvents, please contact KAM CONTROLS directly at +1 713 784 0000, or email: sales@kam.com

During inspection, ensure that there are no foreign objects stuck in the probe or attached to the antennas.

TROUBLESHOOTING

If experiencing any of the issues listed below, please proceed to follow instructions on each of the following sections in their specific order, starting with the "Power Verification" section.

- Instrument is not powering on
- No 4-20 mA output
- PLC is not reading the 4-20 mA output
- No RS232 communication
- No RS485 communication
- Output is not changing
- Instrument does not calibrate

To perform any of the troubleshooting procedures, you will need to access the boards. To do so, use a 7/16" wrench to remove the (6) hex screws on the electronics enclosure and remove the cover.

A device to measure both voltage and amperage is needed during the troubleshooting process. Please have a multimeter available before proceeding.

NOTE: Regardless of the problem being experienced, the troubleshooting steps need to be followed in order, starting from the "Power Verification" section.

POWER VERIFICATION

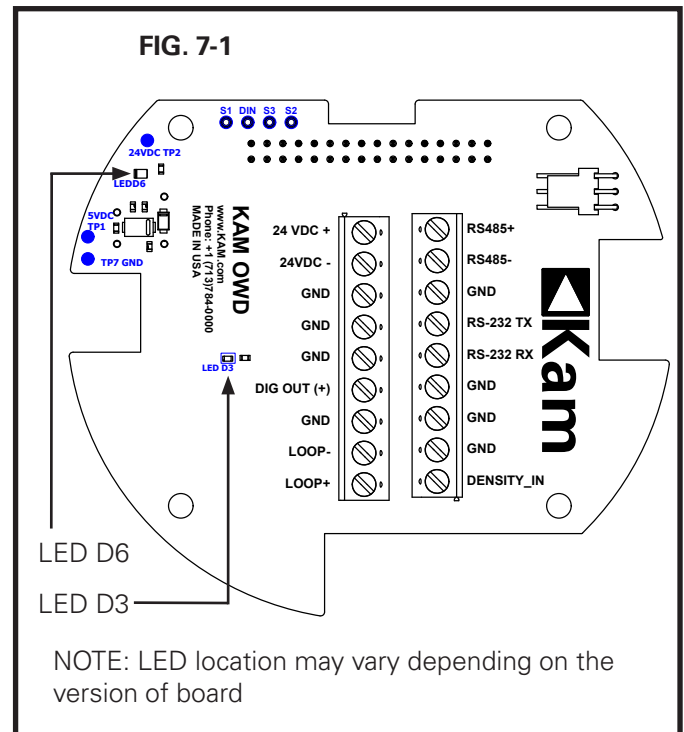
There are 2 LEDs on the OWD's Terminal Board. These LEDs indicate the presence of power. When any of the LEDs are lit, it indicates that there is voltage going to the boards, but not necessarily the proper voltage. When any of the LEDs are not lit, it may indicate they are damaged. In any case, the first step is to check all power supplies. Please follow the procedure below.

1. Use a multimeter in voltmeter mode to measure the voltage across the power loop terminals 24 VDC + and 24 VDC -. The voltage should be within the instrument's requirements (24 V) and close to the power supply ratings (+/- 0.5 V). For example, a 24 V power supply could measure 23.5 V on the OWD terminals. If the voltage is not within those requirements, verify that the power supply has a wattage capability of 24 watts, and check for any blown fuses, faulty wiring, or a faulty power supply.

If LED D6 does not light up, but you have the adequate voltage at the power terminals, it indicates a bad LED. The faulty LED will not affect the operation of the instrument, it is only an indicator that a voltage is present.

2. Once the voltage across power loop terminals has been verified, make sure the OWD is wired with the correct polarity as per the wiring diagram on page 15 of this manual. If the polarity is wrong, turn off the power and rewire the OWD with the correct polarity. Turn the power back on when done.

NOTE: The OWD has built-in protection to avoid incorrectly polarized voltages from damaging the instrument.



TROUBLESHOOTING CONTINUED

3. Using a multimeter in voltmeter mode, verify the voltage of the primary power supply by measuring across TP1 and TP7 (GND). The voltage should be between +4.8 VDC and 5.1 VDC.

If the voltage is lower than 4.8 VDC, it indicates that the primary power supply of the Terminal Board is not working properly or there is a short circuit on the board. In this case, the Terminal Board needs to be fixed or replaced. Please contact KAM Technical Support for further assistance.

NOTE: LED D3 on the Terminal Board remains lit when there is voltage between TP1 and TP2. If not, it indicates a faulty LED. The faulty LED will not affect the operation of the instrument, but a Terminal Board repair is recommended.

4-20 mA OUTPUT LOOP

Once the power supplies have been verified as per instructions in the previous section ("Power Verification"), proceed to verify the output loop by following the procedure below.

1. Use a small screwdriver to disconnect the wires connected to the 4-20 mA terminals from the Terminal Board.
2. Using a multimeter in voltmeter mode, measure the voltage across the two wires that were connected to the "4-20 mA+" and "4-20 mA-" terminals by placing one of the voltmeter's test lead in one wire and the other test lead on the other wire. Polarity is not important. The voltage should be 0 V. If there is any voltage, the loop is powered up externally. Proceed to disable the power source from the connected device.
3. Use a small screwdriver and fully close the terminals on the "4-20 mA+" and "4-20 mA-" terminals by turning the screwdriver clockwise. Using a multimeter in voltmeter mode, measure the voltage across the "4-20 mA+" and "4-20 mA-" terminals. The voltage should be between 10.0 to 12.0 volts. If the voltage is within the specified range, continue to step 4. If not, contact KAM Technical Support for further assistance.
4. Using a multimeter in ammeter mode, measure the amperage across the "4-20 mA+" and "4-20 mA-" terminals. The electric current should be between 3.9 to 20.1 mA. If the voltage from step 3 is within the set limits but the electric current is not, check the multimeter fuse and repeat this step. If there is no change, contact KAM Technical Support for further assistance.

If the measurements are within the corresponding ranges, reconnect the 4-20 mA output loop wires to the OWD as per the wiring diagram on page 14. If the PLC cannot read the output, there could be a wiring issue with the loop. Please inspect the wires from the OWD to the PLC. If the issue persists, continue to the next section, and contact KAM Technical Support for further assistance.

NOTE: The 4-20 mA terminals are isolated from the chassis/earth ground.

RS232 COMMUNICATION

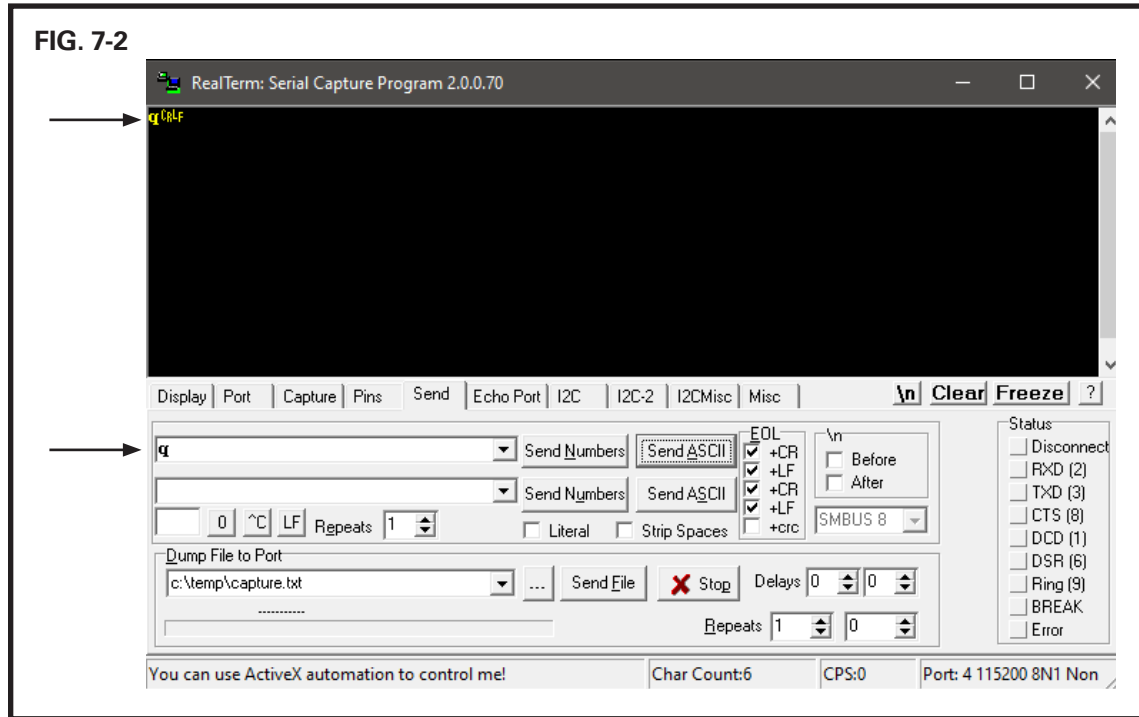
If you have not already done so, follow the previous procedures of the Troubleshooting section to verify power supplies.

Before proceeding, install and configure RealTerm as per instructions on pages 20-22 of this manual. Also, please ensure the driver for the supplied USB-to-serial converter is installed on your PC.

1. If the RS232 cable is connected to the OWD, ensure all 3 wires from the OWD terminal are disconnected. Proceed to connect the supplied RS232 serial cable and USB-to-serial converter to your computer and launch RealTerm.

TROUBLESHOOTING CONTINUED

2. The RS232 serial cable has three wires (red, white, and black). Connect the tips of the white wire (RS232 RX) and the red wire (RS232 TX) together. While the tips of these wires are connected, type any letter (i.e. "q") in either command box of the "Send" tab on RealTerm and click on "Send ASCII." If the configuration is done properly, the letter should appear in the window display. FIG. 7-2.



If there is no change, use another RS232 serial cable and/or USB-to-serial converter and try sending the command once more. If the same letter you typed does not appear, try reinstalling the USB-to-serial converter drivers or try a different converter and repeat step 2.

If there is still no change, there might be a communication issue with the RS232 serial cable, the USB-to-serial converter, or the computer. Please contact KAM Technical Support for further assistance.

3. Once the letter appears on the window display, connect the RS232 serial cable to the OWD as per the wiring diagram on page 14 of this manual.
4. Turn the OWD off and back on.
5. Type the command "help" in either command box and click on "Send ASCII." A list of commands should appear in the window. If the list does not appear, proceed to the next step. If the list appears, you are now ready to perform the desired procedures, such as calibration or configuration changes by following the instructions on the corresponding sections of this manual.
6. Using a multimeter in voltmeter mode, measure the voltage between the terminals "RS232 RXD" and "GND." Ensure the terminal screws on the board are fully closed. The voltage should be between -5 and -10 volts. If the voltage is not between the stated range, the RS232 port from the OWD may be damaged. Contact KAM Technical Support for further assistance.

If the voltage is within the specified range, but you are still not able to establish communication with the OWD, please contact KAM Technical Support for further assistance.

TROUBLESHOOTING CONTINUED

RS485 COMMUNICATION

The following procedure is to be conducted in cases where the Power Connections, RS232 Communication and Electronics Debugging sections' steps have been performed, but there is no RS485 communication with the PLC/computer.

1. Ensure the Modbus settings are configured according to the instructions on page 41 of this manual and verify that the RS485 converter (not provided) is installed on your PC as per the device's user manual.
2. Connect the RS485 converter to the OWD per the wiring diagram on page 19 of this manual.
3. Use a multimeter in voltmeter mode to measure the voltage between the "485 TX" and "485 RX" on the Terminal Board. The differential voltage is usually around 2 volts. Continue to the next step.

NOTE: The RS485+ and RS485- lines in two-wire mode are differential, so their voltage needs to be measured with respect to each other to conform to the RS485 standards. The bias is provided by the master device.

4. Ensure the OWD and PLC/Computer are connected properly as per the RS485 converter's user manual.
5. Check the activity LEDs on the RS485 converter connected to the RS485 terminals of the OWD. The LEDs should be blinking while data is being sent/received.
6. If the differential voltage is not present and/or there is no activity on the LED of the RS485 converter, contact KAM Technical Support for further assistance.