◀Kam®

Simple Precision™

◀Kam®
LRW Low Range Watercut

| Water | 0.377 | % |
| Temp | 28.278 | C |

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Made in the USA

KAM® LRW™
LOW RANGE WATERCUT

IEC. IECEx C€ ⟨Ex⟩

PTB 08 ATEX 1026
II 2 G Ex db IIB T6 Gb
IECEx PTB 19.0048
Ex db IIB T6 Gb

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KAM CONTROLS, INC. reserves the right to make changes to this document without notice.

1 INTRODUCTION

AVAILABLE MODELS and MOUNTING OPTIONS

FIG. 1-1 FLOW THROUGH MODELS

2" Flow Through LRW with included
static mixer and manual draw-off valve

3" and 4" Flow Through LRW with included
static mixer and manual draw-off valve

FIG. 1-2 FIXED INSERTION MODELS

1.25" NPT Fixed Insertion LRW for pipelines 3" – 8"

Flanged Fixed Insertion LRW for pipelines 3" and up
with 2", 3" or 4" flanged process connection

FIG. 1-3 INSERTABLE/RETRACTABLE MODEL

Insertable/retractable LRW for pipelines 3" and up
2", 3" or 4" flanged seal housing
or 2" MNPT process connection

INTRODUCTION CONTINUED

THEORY OF OPERATION

The KAM LRW™ Low Range Watercut / BS&W meter uses a patented microwave resonance technology, responding to the differing electrical properties of water and oil to determine water content for ranges 0-3%, 0-5% and 0-10%. The technology is highly repeatable and offers industry-leading accuracy (±0.03% up to 3% water). Additionally, proprietary AnyDensity™ technology allows the instrument to compensate for any change in density across the entire API gravity range. Compensation is based on a density input from a mass flow meter or densitometer and all compensation is automatic. This is paramount in situations where a single truck or rail unloading site could see swings in API gravity from the 20s to the 70s.

The unit can be calibrated and verified in line.

The LRW's high-quality components are made and assembled entirely in the USA, providing reliable and consistent performance for long-term use.

TABLE 1-1 MEASUREMENT CAPABILITIES: CALIBRATED RANGE AND ACCURACIES

| Range (water in oil)	0-3%	3-5%	5-10%
Accuracy	±0.03%	±0.05%	±0.1%

2 SPECIFICATIONS

Media:	Crude oil, water and refined products
Material:	Wetted parts–316 SS, Hastelloy, & PEEK (Other materials available)
	Electronics enclosure–Copper-free aluminum
Fluid temperature:	32ºF to 176ºF (0ºC to +80ºC)
Ambient temperature:	-4º F to 131º F (-20º C to +55º C)
Power requirements:	24 VDC
Power consumption:	12 watts
Available ranges:	0-3%, 0-5%, 0-10% water in oil
Accuracy:	+/- 0.03% up to 3% water; +/- 0.05% from 3-5% water; +/- 0.1% from 5-10% water
Repeatability:	+/- 0.01%
Resolution:	+/- 0.01%
Minimum water detection:	100 ppm
Outputs:	4–20 mA
	Alarm relay
	RS232/RS485
Input:	4-20 mA for density
Density Correction:	AnyDensity™ compensates for changes in fluid density across entire API gravity range (requires density input)
Ingress protection:	NEMA IV; IP66
Pressure ratings:	ANSI 150, 300, 600, 900
Flow conditions:	Well mixed in accordance with KAM recommendations
Hazardous area:	PTB 08 ATEX 1026
	II 2 G Ex db IIB T6 Gb
	IECEx PTB 19.0048
	Ex db IIB T6 Gb

3 INSTALLATION

INSTALLATION FLOW AND LOCATION REQUIREMENTS

KAM HIGHLY RECOMMENDS VERTICAL INSTALLATIONS WHEREVER POSSIBLE FOR OPTIMAL MIXING. For LACT units, truck unloading risers, etc., KAM recommends installation of the LRW in the vertical flow up, immediately after the pump (**OPTION 1**) or in the vertical flow down after a static mixer (**OPTION 2**). For other options, please consult with the KAM factory.
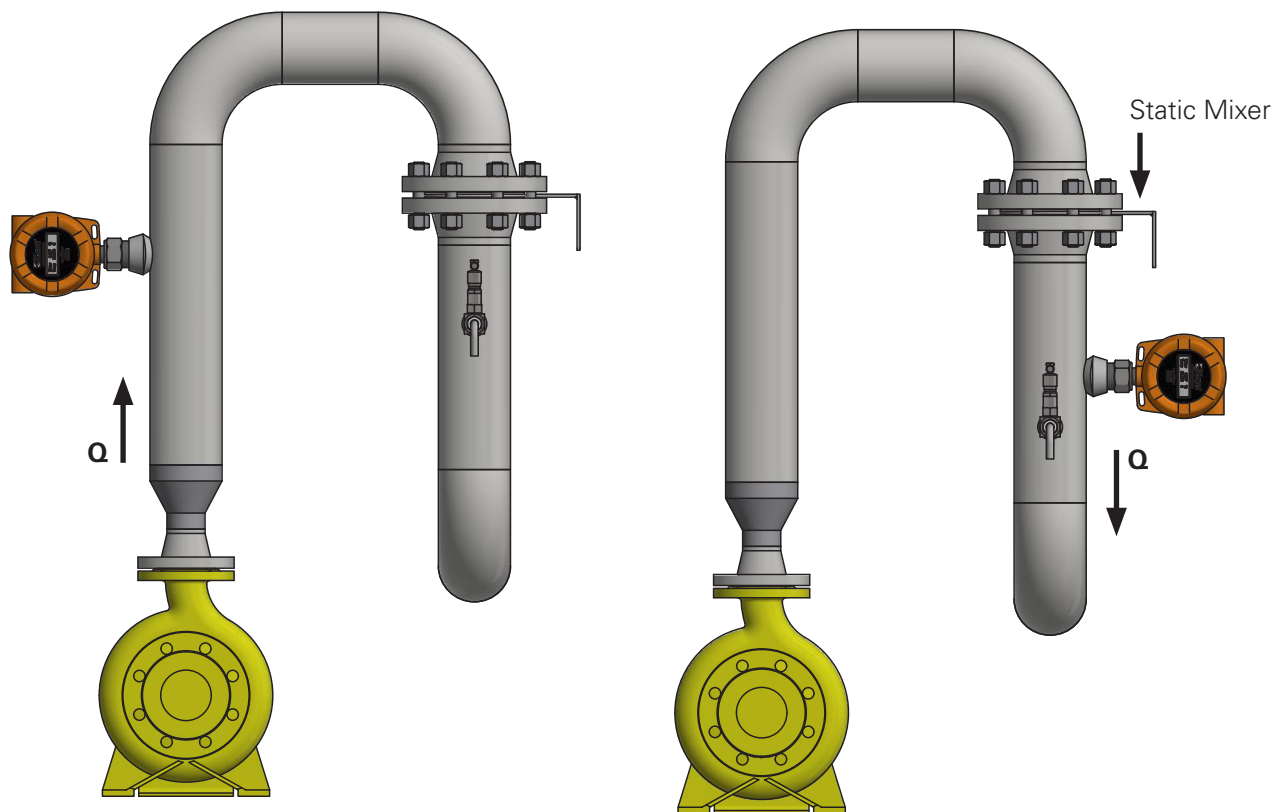
PLEASE NOTE: The LRW should always be installed per KAM recommendations, including the mixing requirement calculated per customer provided flow conditions. Vertical installations are ALWAYS preferred.

CAUTION: When installing the LRW® 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.

INSTALLATION CONTINUED

PRIOR TO INSTALLATION

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

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

One (1) RS232 communication cable, for connecting your PC to the LRW
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 LRW sensor.

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

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

If pipeline flow is going to be stopped for an extended amount of time and the pipeline is not heated, then the LRW should be removed from the line to avoid damage to the sensor from freezing water.

LRW FLOW THROUGH ASSEMBLY

Flow through (spool) units will be shipped partially assembled. LRW unit can be wired prior to insertion into the spool for convenience, but this is not required.

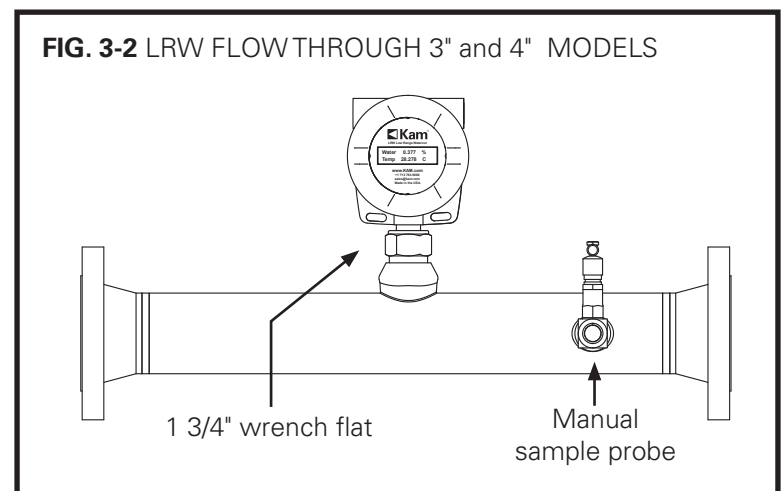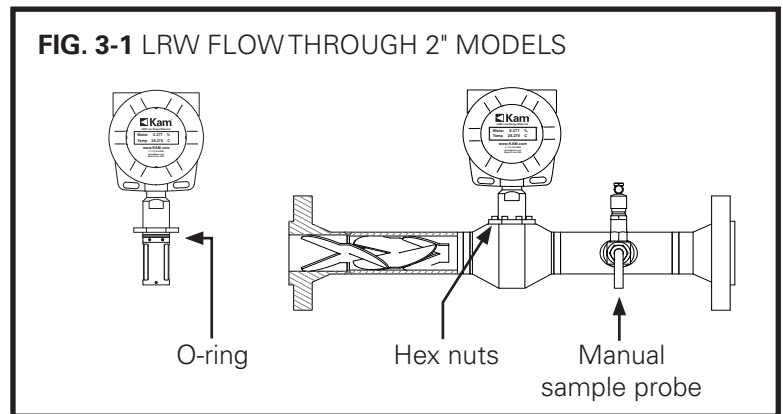For 2" units (FIG. 3-1):

1. Grease around the O-ring below the small flange.

2. Insert LRW body into the spool and ensure unit is fully seated.

    NOTE: LCD screen face should be aligned with direction of pipe flow.

3. Using a 5/8" Allen wrench, install (8) hex screws around the circumference of the flange until tight. Screw manual sample probe into valve until tight.

For 3" and 4" flow through units (FIG. 3-2):

1. Screw LRW body into spool using 1 3/4" wrench flat. KAM Controls recommends using liquid pipe sealant rather than Teflon tape.

2. Screw manual sample probe into valve until tight.

FIG. 3-1 LRW FLOW THROUGH 2" MODELS

O-ring   Hex nuts   Manual sample probe

FIG. 3-2 LRW FLOW THROUGH 3" and 4" MODELS

1 3/4" wrench flat   Manual sample probe

INSTALLATION CONTINUED

MAIN LINE INSTALLATION INSERTABLE MODELS

The KAM® LRW sensor should be installed according to FIG. 3-3. A full-opening ball valve is used to isolate the LRW® sensor from the pipeline during installation or removal. The seal housing of the LRW® sensor allows the probe to be inserted and removed from the pipe under pressure and flow conditions. It is the user's responsibility to ensure that the LRW® sensor be placed at the most representative point within the flow profile (see flow recommendations on page 5 of this manual). The LRW® sensor should be inserted so that the window of the probe is located in the center half of the diameter of the pipeline.

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

FIG. 3-3 KAM® LRW INSTALLED ON A MAIN PIPE

Locking Collar

Socket cap screw

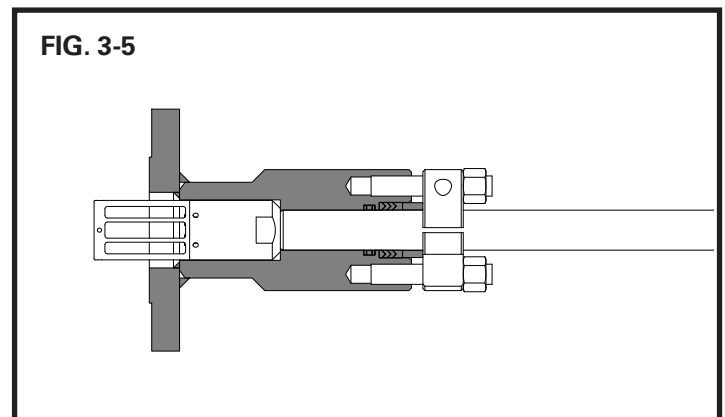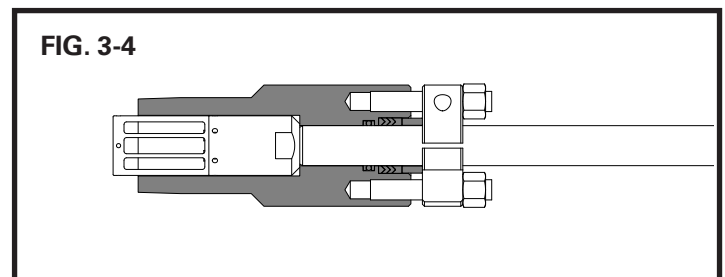Seal Housing

Full-opening Ball Valve
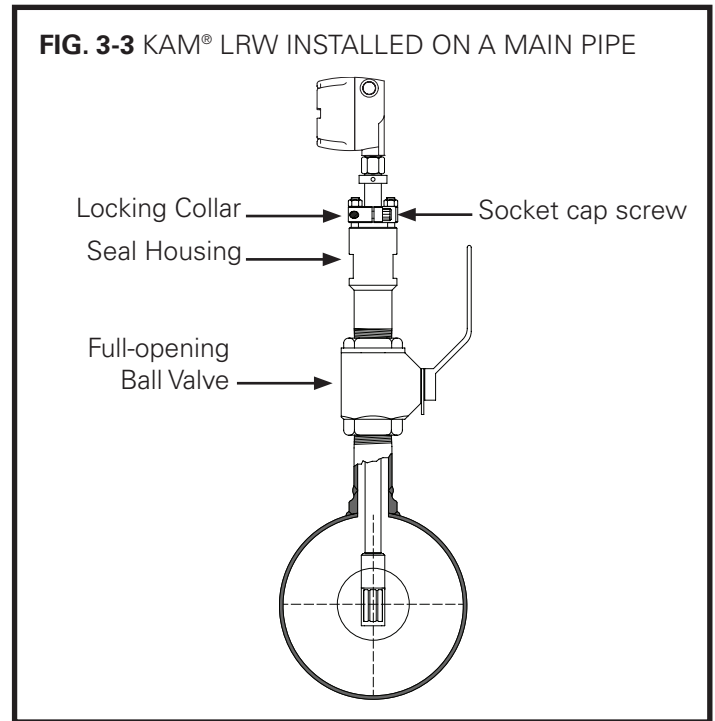
CALCULATING THE REQUIRED INSERTION LENGTH

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

1. Lay the LRW™ 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 LRW™ shaft to slide through the seal housing.

3. Pull the LRW™ back through the seal housing until the LRW probe is retracted inside the seal housing. FIG. 3-4 and FIG.3-5.

   NOTE: The antennas on the LRW 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 LRW™ shaft from sliding and the probe from getting damaged during mounting.

FIG. 3-4

FIG. 3-5

INSTALLATION CONTINUED

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

FIG. 3-6a

FIG. 3-6b
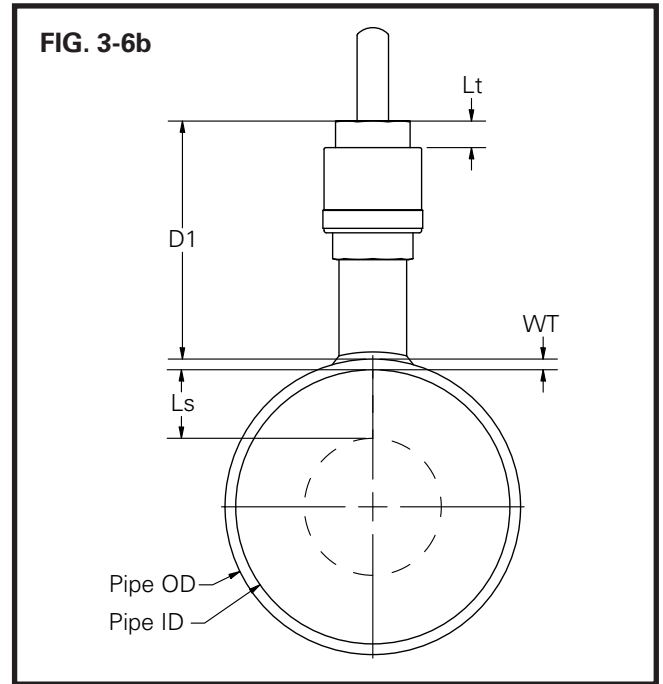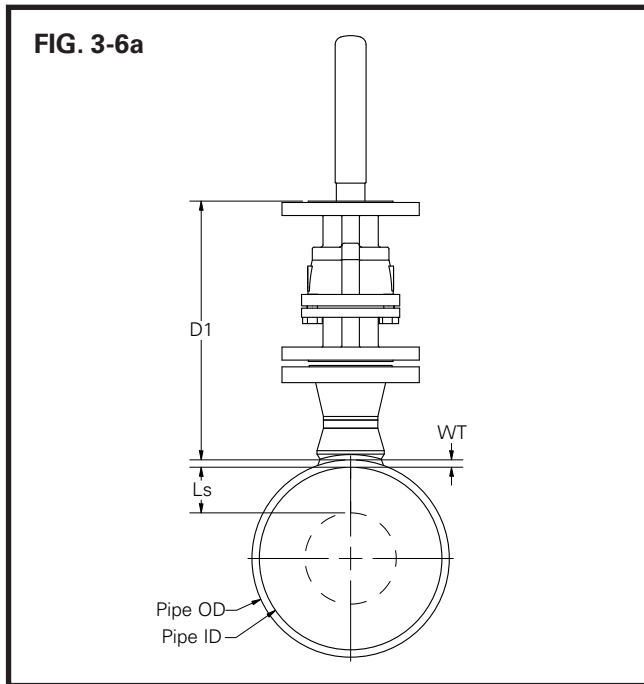
6. Calculate the insertion distance:

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 (Measurement Area Length)
Ds	–	Pipe ID x 0.5 (Measurement Diameter Area)

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

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

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

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

TABLE 3-1 LRW FACTOR - Flanged SH

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"

INSTALLATION CONTINUED

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)
LRW Factor	–	1.65"
Lt	–	Thread Engagement (0.75")

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

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

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

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.


FIG. 3-7
Mark Here
MID
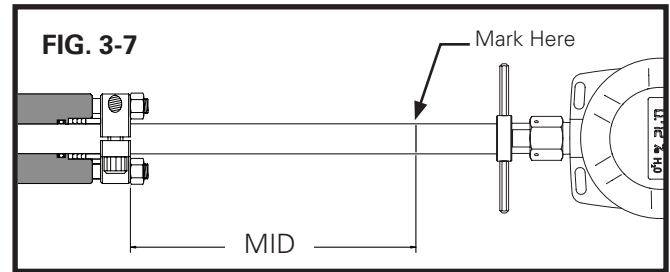
8. You can now attach the LRW to the valve on the pipeline. For threaded models, KAM CONTROLS recommends liquid thread sealant and not Teflon tape for the threaded LRW™ sensor.)

9. Open Full-opening Valve.

10. Loosen Socket Cap Screws on the Locking Collar.

11. Push LRW® sensor in until the mark is at the top edge of the Locking Collar. Ensure that LRW® flow indicator is aligned with pipeline flow direction. FIG. 3-8.

FIG. 3-8
Mark
Flow indicator
Hex Nuts
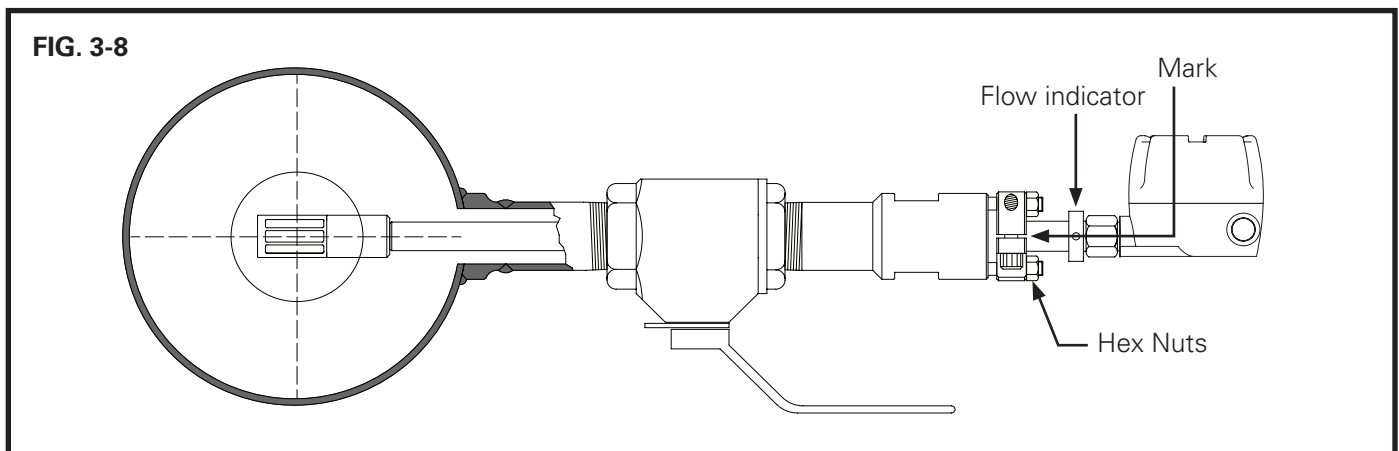
INSTALLATION CONTINUED

12. Re-tighten the Socket Cap Screws so that the gaps between the two halves of the locking collar are the same distance. FIG. 3-9.

13. Tighten the hex nuts holding down the Locking Collar one half turn (FIG. 3-9). 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.

FIG. 3-9 TOP VIEW LOCKING COLLAR
Gap
Socket Cap Screw
Hex Nut
Socket Cap Screw
Locking Collar
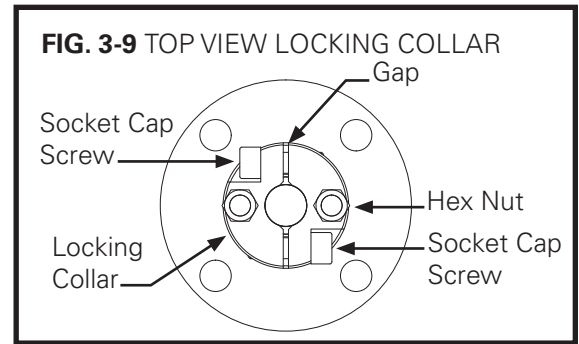
REMOVING AN INSERTABLE LRW SENSOR

1. To remove the LRW sensor, first shut off power to the instrument.

2. Loosen the Socket Cap Screws on the Lock Down Collar, using a 3/8" Allen wrench.

3. Loosen Hex Nuts 1/2 turn.

4. Slide the LRW sensor upward until the probe rests inside the seal housing. There is a mechanical stop when the unit is fully retracted.

5. Retighten the Socket Cap Screws.

6. Next, close the Full-opening Ball Valve tightly. Drain oil from valve if possible.

**7.** The LRW 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® LRW sensor.

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

REMOVING THE LRW® SENSOR FROM FLOW THROUGH SPOOL

1. To remove the LRW® sensor, first shut off power to the instrument.

2. Discontinue flow in loop from the main line and drain fluid from loop.

3. Using a 5/32" Allen wrench, remove the (10) 32 x 5/8" Hex screws with on collar (2" models) or unscrewed from spool body (3" and 4" models) using the 1 3/4" wrench flat. FIG. 3-10.

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.

FIG. 3-10
2" LRW Flow Through model
Hex screws

3" and 4" LRW Flow Through models

1 3/4" wrench flat
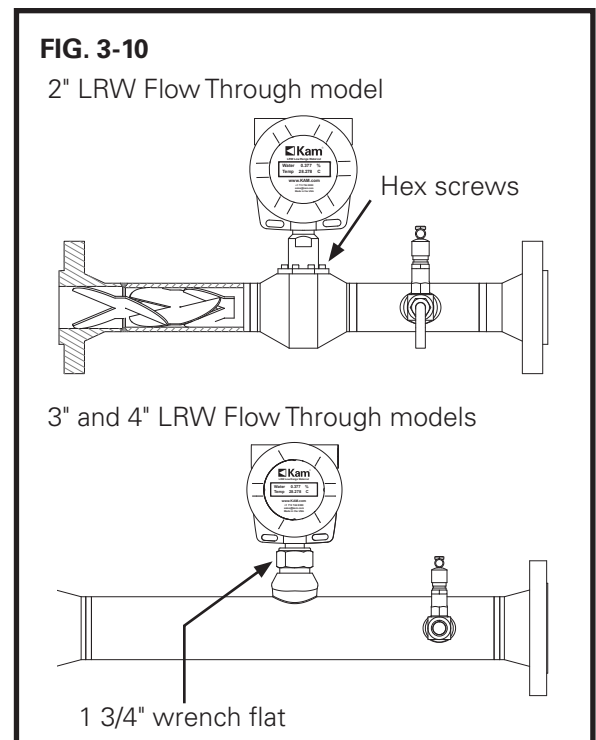
INSTALLATION CONTINUED

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 +80 °C.

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

It is also recommended that the LRW 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/ATD/LRW 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/ATD/LRW be connected by means of a conduit entry which has been approved for this purpose, the appertaining sealing device shall be provided immediately at the terminal box.
- Openings not used shall be sealed in compliance with IEC 60079-1, section 11.8.
- The connecting wire of the Oil Water Detector KAM OWD/ATD/LRW 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/ATD/LRW has to be included into the local equipotential bonding.
- The connecting wire of the Oil Water Detector KAM OWD/ATD/LRW 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.

INPUTS

POWER–	GND
POWER+	24-30 VDC
DENSITY IN	Current loop output from mass flow or densitometer.
GND	

INPUT/OUTPUT

232-RXD	Console port – communication interface
232-TXD	for calibration, connection to PLC

OUTPUTS

|	
4-20–	Current output, **source powered**. Set to requisite
4-20+	percent water at factory.
DOUT	Alarm or relay (digital contact closure)
485-	Modbus interface
485+	

LED INDICATORS

LED1	24 VDC Power
LED2	5 VDC Internal supply

INSTALLATION CONTINUED

WIRING DIAGRAMS

CAUTION: Do not connect power to 4-20 mA output. This will damage the board and void product warranty.
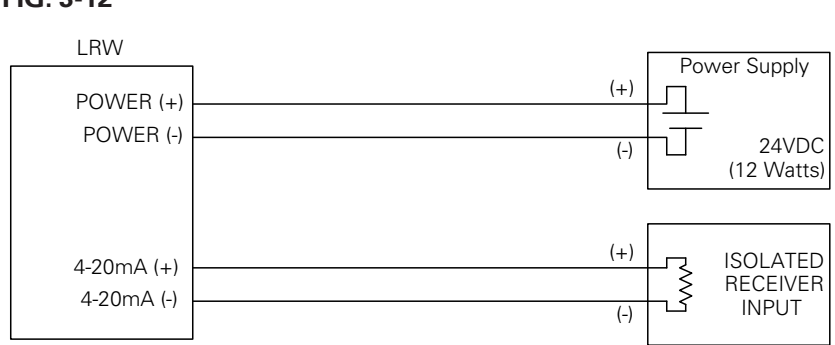
FIG. 3-11 WIRING DIAGRAM
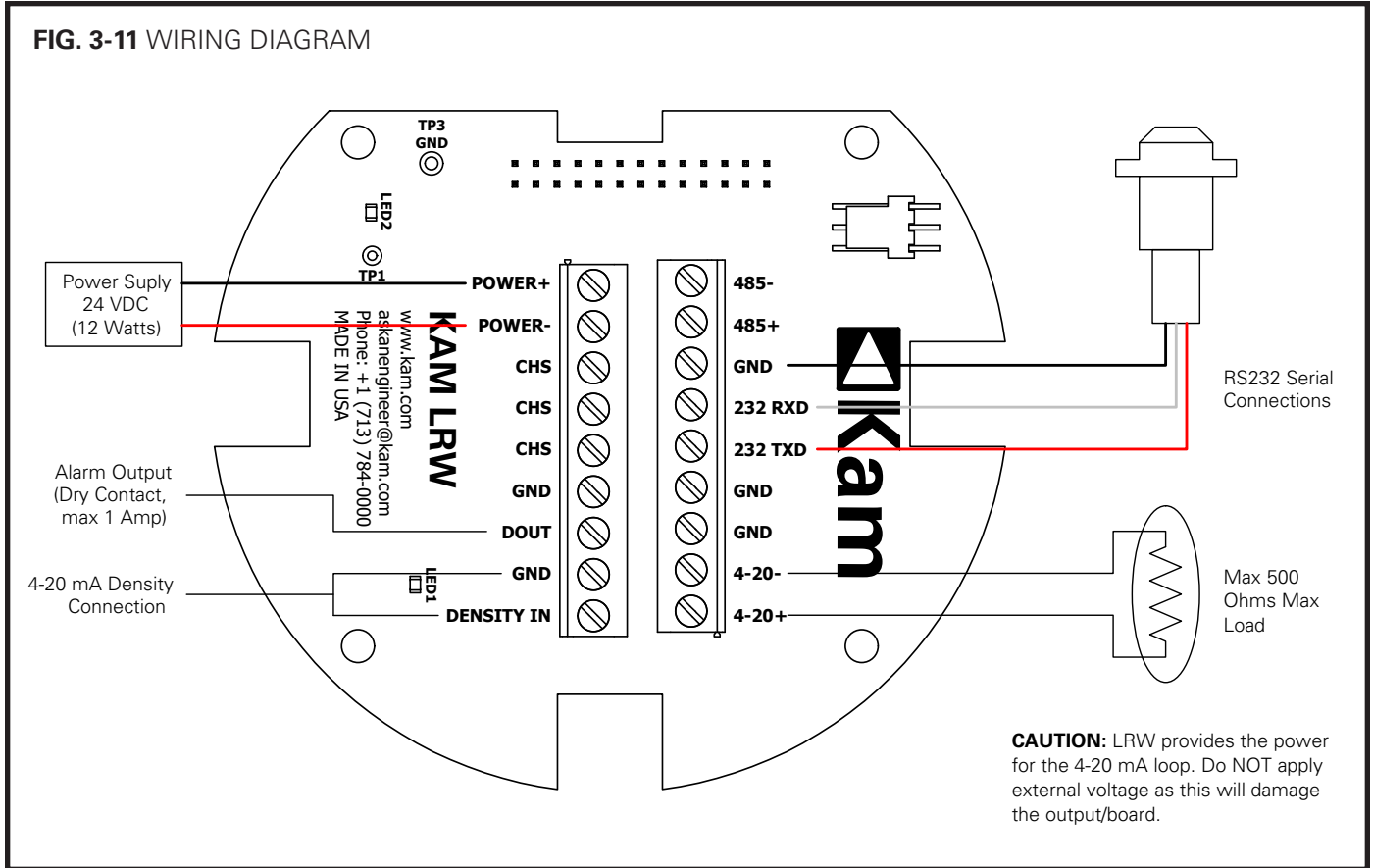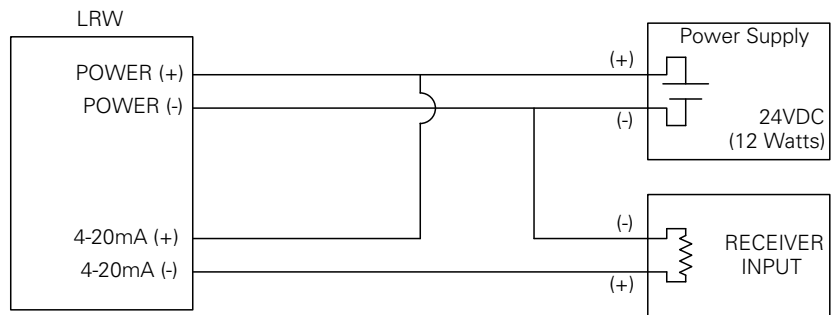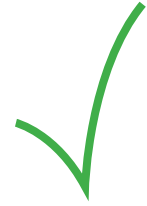
INSTALLATION CONTINUED

WIRING CONTINUED

TYPICAL POWER AND LOOP WIRING CONFIGURATION

FIG. 3-12

LRW

POWER (+)
POWER (-)

4-20mA (+)
4-20mA (-)

Power Supply
(+)
(-)
24VDC
(12 Watts)

(+)
(-)
ISOLATED
RECEIVER
INPUT

TYPICAL WIRING

LRW

POWER (+)
POWER (-)

4-20mA (+)
4-20mA (-)

Power Supply
(+)
(-)
24VDC
(12 Watts)

(-)
(+)
RECEIVER
INPUT
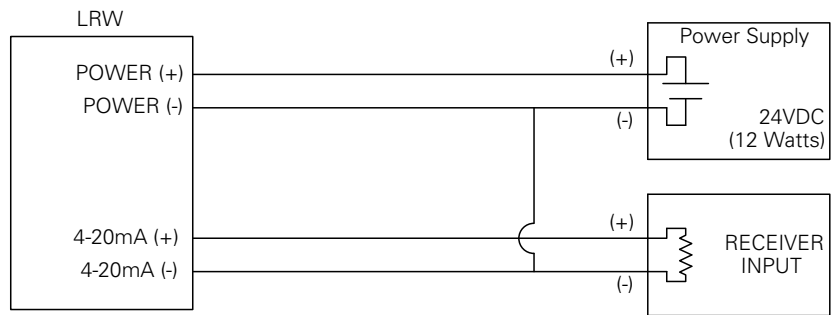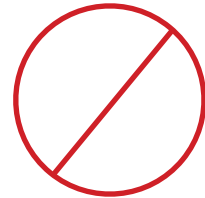
WRONG WIRING

The LRW provides power for the 4-20 mA loop. Adding external power can damage the 4-20 mA output.

LRW

POWER (+)
POWER (-)

4-20mA (+)
4-20mA (-)

Power Supply
(+)
(-)
24VDC
(12 Watts)
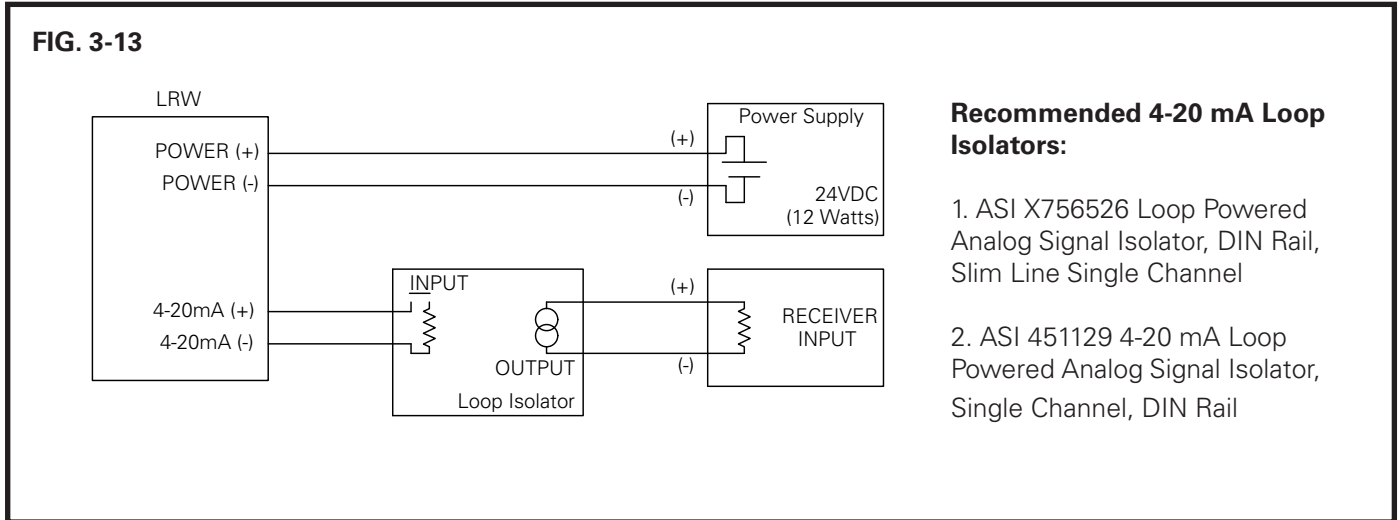
(+)
(-)
RECEIVER
INPUT

WRONG WIRING

The 4-20 mA (-) and power supply (-) cannot be the same or connected together.

INSTALLATION CONTINUED

WIRING CONTINUED

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

FIG. 3-13

Recommended 4-20 mA Loop Isolators:

1. ASI X756526 Loop Powered Analog Signal Isolator, DIN Rail, Slim Line Single Channel

2. ASI 451129 4-20 mA Loop Powered Analog Signal Isolator, Single Channel, DIN Rail

POWER SUPPLY AND OUTPUT WIRING WITH EXTERNAL POWERED ISOLATOR
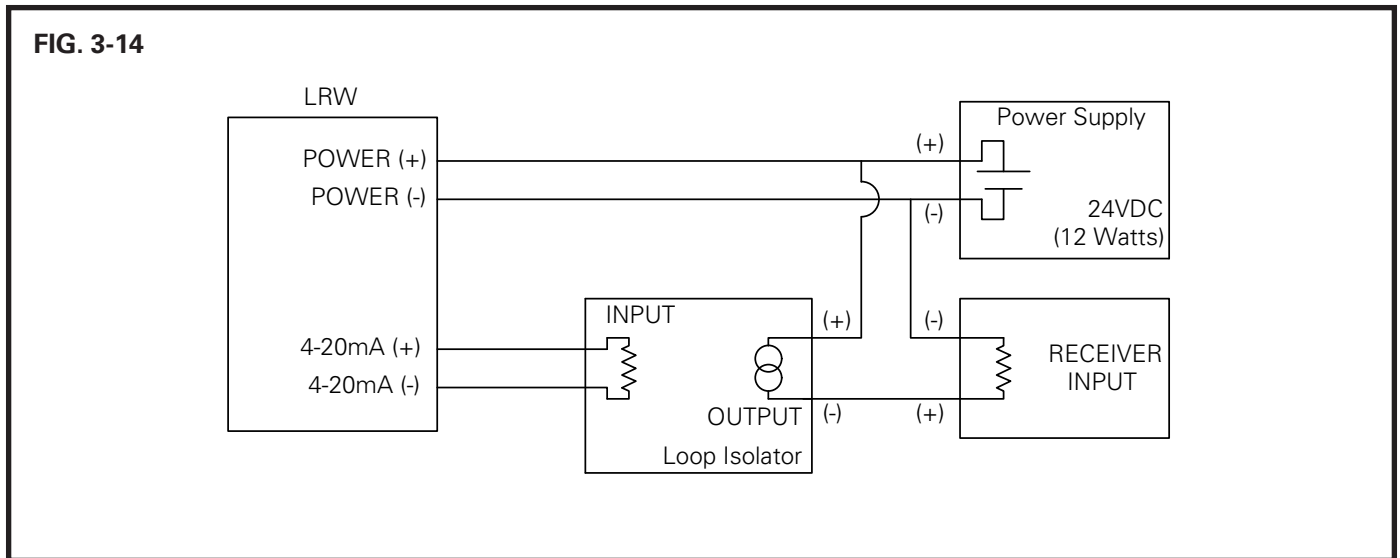
FIG. 3-14

INSTALLATION CONTINUED
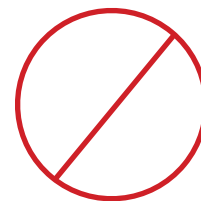
DIGITAL RELAY WIRING

FIG. 3-15 DIGITAL RELAY CONFIGURATION
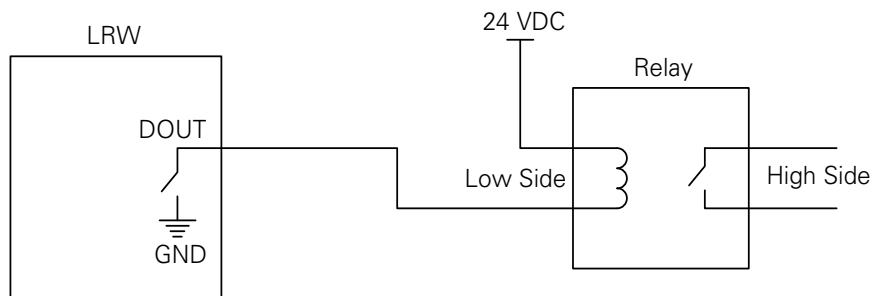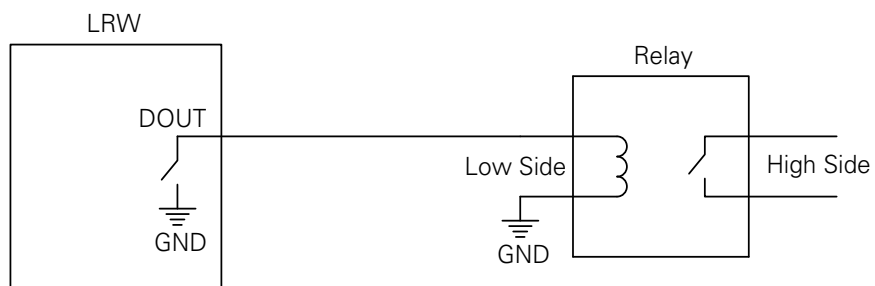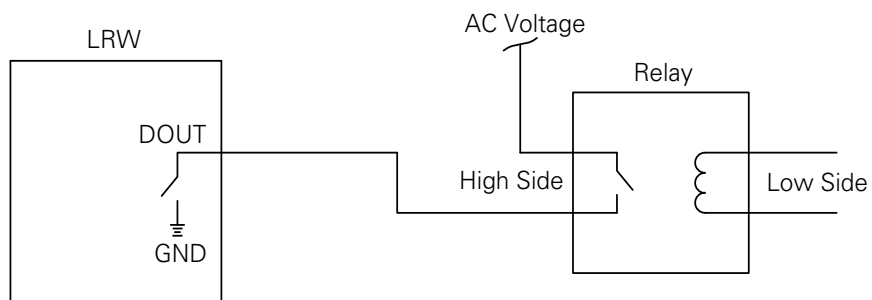
INSTALLATION CONTINUED

DENSITY INPUT WIRING

FIG. 3-16 DENSITY METER PROVIDES POWER FOR 4-20 mA DENSITY LOOP

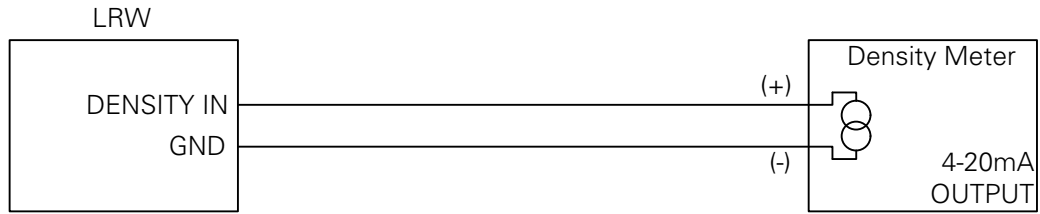LRW

DENSITY IN
GND

(+)

(-)

Density Meter

4-20mA
OUTPUT

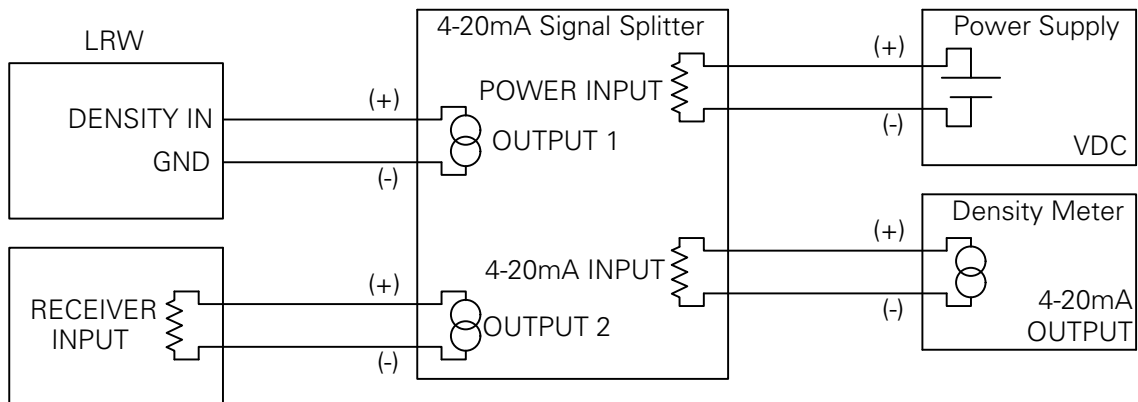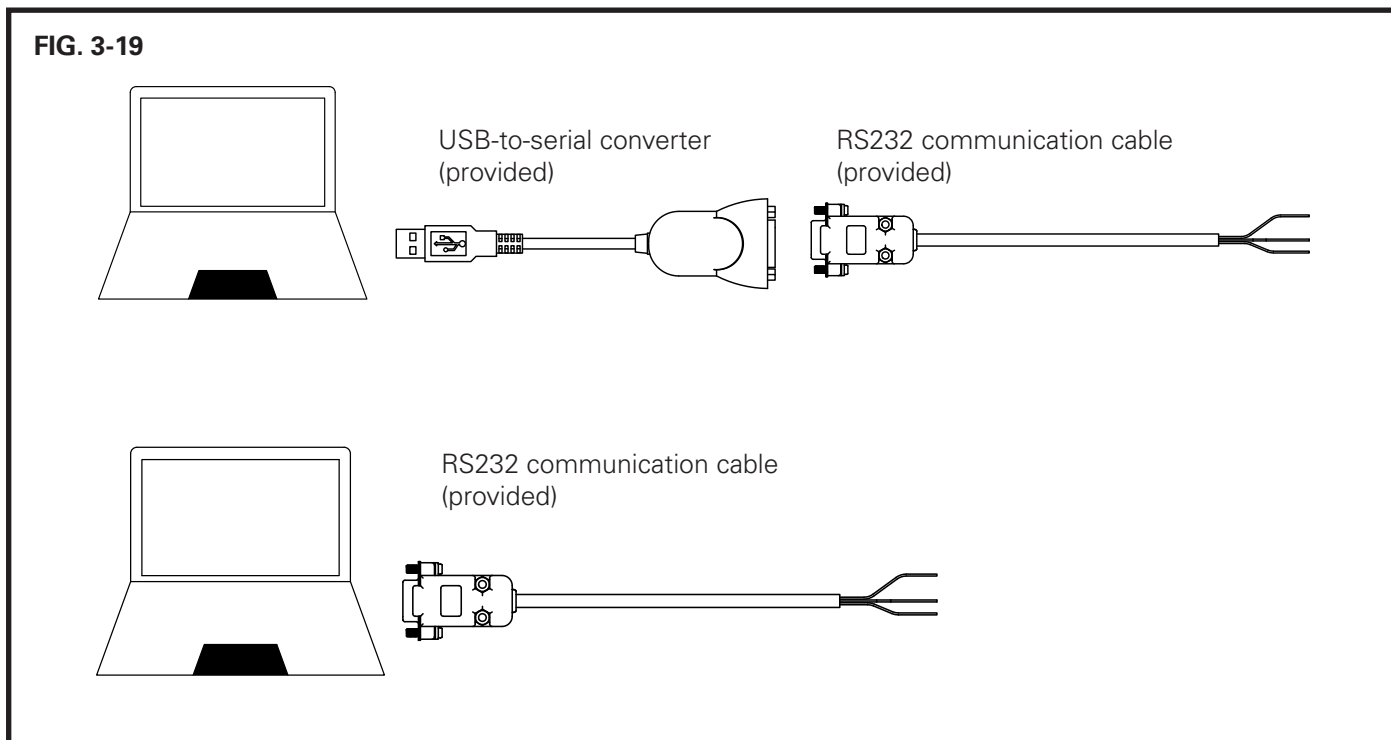**FIG. 3-17** DENSITY METER WITH A 4-20 mA SIGNAL SPLITTER
(WHEN A SECONDARY RECEIVER SHARES ONE DENSITY OUTPUT)

LRW

DENSITY IN
GND

RECEIVER
INPUT

4-20mA Signal Splitter

POWER INPUT
OUTPUT 1

4-20mA INPUT
OUTPUT 2

(+)

(-)

(+)

(-)

Power Supply

VDC

Density Meter

4-20mA
OUTPUT

(+)

(-)

(+)

(-)

INSTALLATION CONTINUED

WIRING CONTINUED

RS232 WIRING DIAGRAM

FIG. 3-18

LRW

DB9 Female Connector

232 TXD

232 RXD

GND

Pin 1 CD - Not connected
Pin 2 TxD
Pin 3 RxD
Pin 4 DTR - Not connected
Pin 5 GND
Pin 6 DSR - Not connected
Pin 7 CTS - Not connected
Pin 8 RTS - Not connected
Pin 9 RI - Not connected

232 TXD (Red)
232 RXD (White)
GND (Black)

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. 3-19

USB-to-serial converter (provided)

RS232 communication cable (provided)

RS232 communication cable (provided)

INSTALLATION CONTINUED

WIRING CONTINUED

RS485 WIRING DIAGRAM

FIG. 3-20

LRW		RS485 Converter (2-Wire)
485 -	——————————————	TDA(-)/ DATA -
485 +	——————————————	TDB(+)/ DATA +
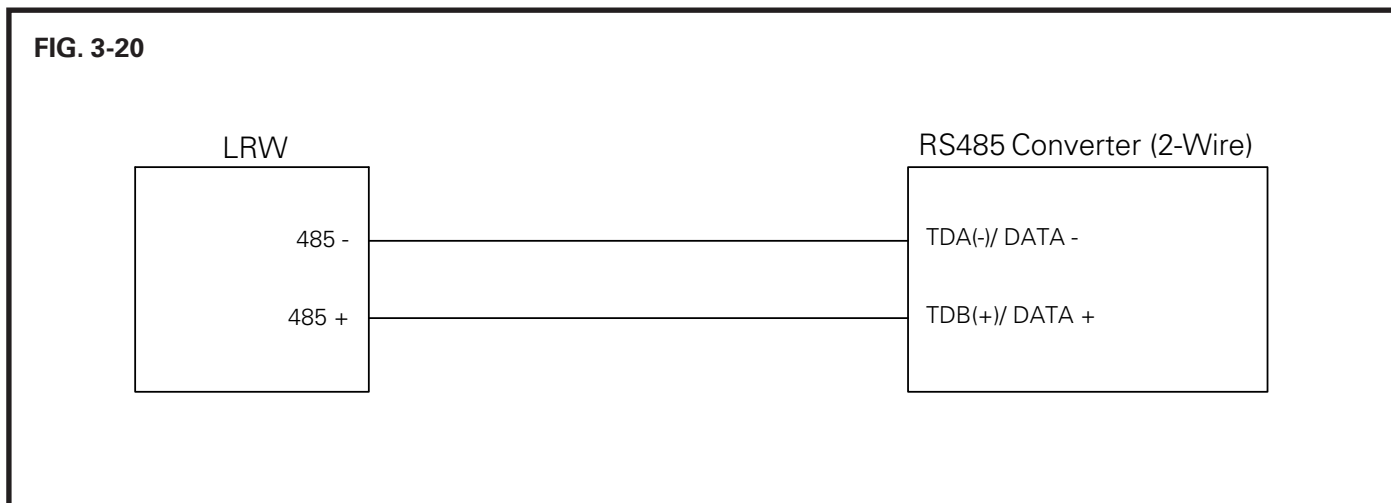
4 KAM LRW OPERATION REALTERM

REALTERM SOFTWARE CONFIGURATION

RealTerm software is used for calibration, debugging and configuration of the LRW. 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. If you haven't already done so, connect the RS232 cable to the LRW board as shown on page 12 of this manual. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

2. Connect the other end of RS232 cable to the serial port of your computer. An RS232 cable for connecting your PC to the LRW has been supplied with the LRW as well as a USB adaptor in case your computer does not have an RS232 serial port.

3. Open RealTerm software. A window will open as shown in FIG. 4-1.

4. The window will automatically default to the "Display" tab. Click on the up arrow beneath 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

Display tab

Click until value reaches "120"
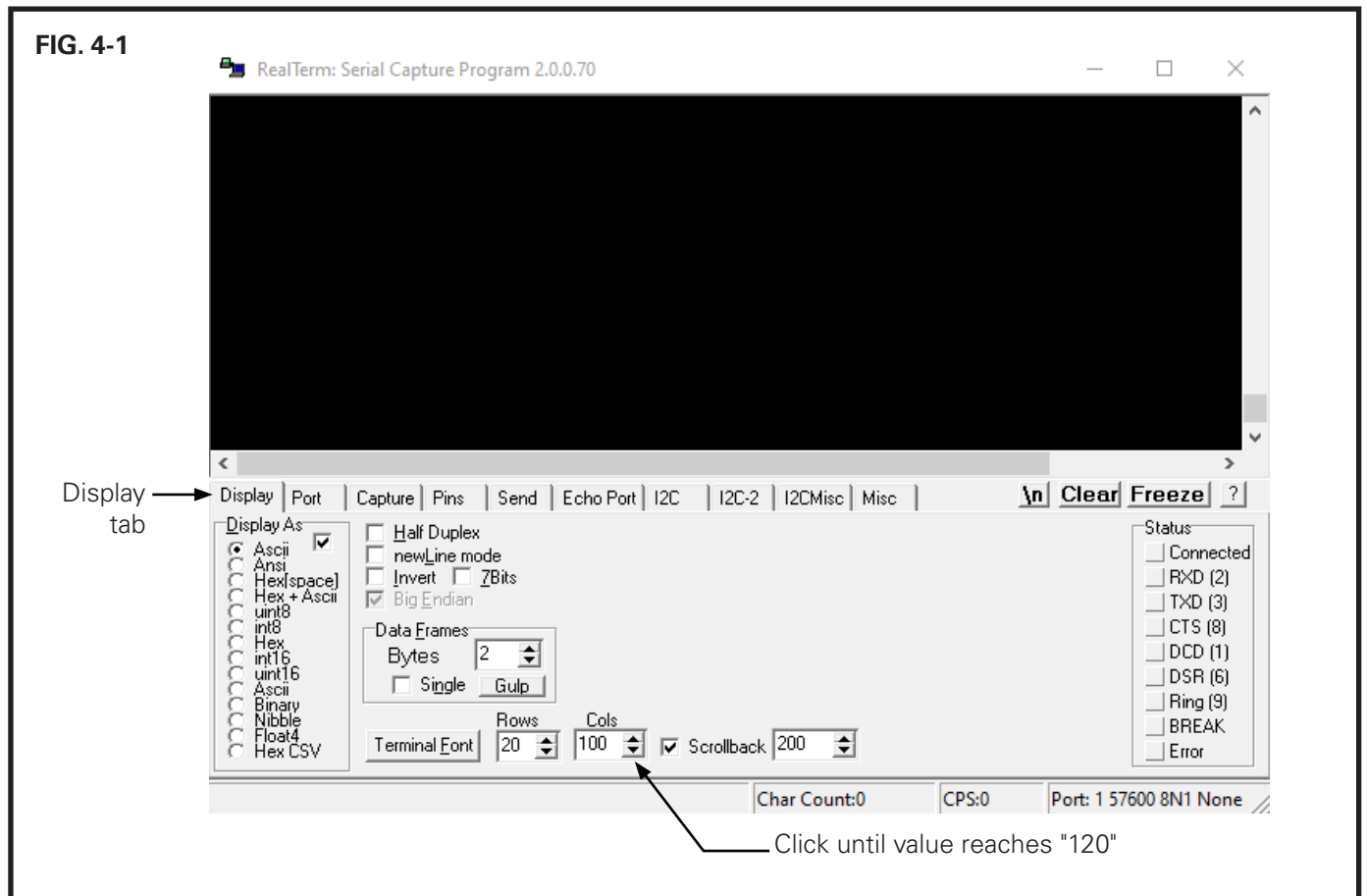
KAM LRW OPERATION REALTERM CONTINUED

5. Click on the "Port" tab (FIG. 4-2) and then configure settings to match below.

Baud: 115200
Parity: None
Data Bits: 8
Stop Bits: 1
Hardware Flow Control: None
Port: Select port number assigned to your serial port or USB port connected to converter. You can find this information in the Device Manager of your PC under "Ports." FIG. 4-3.

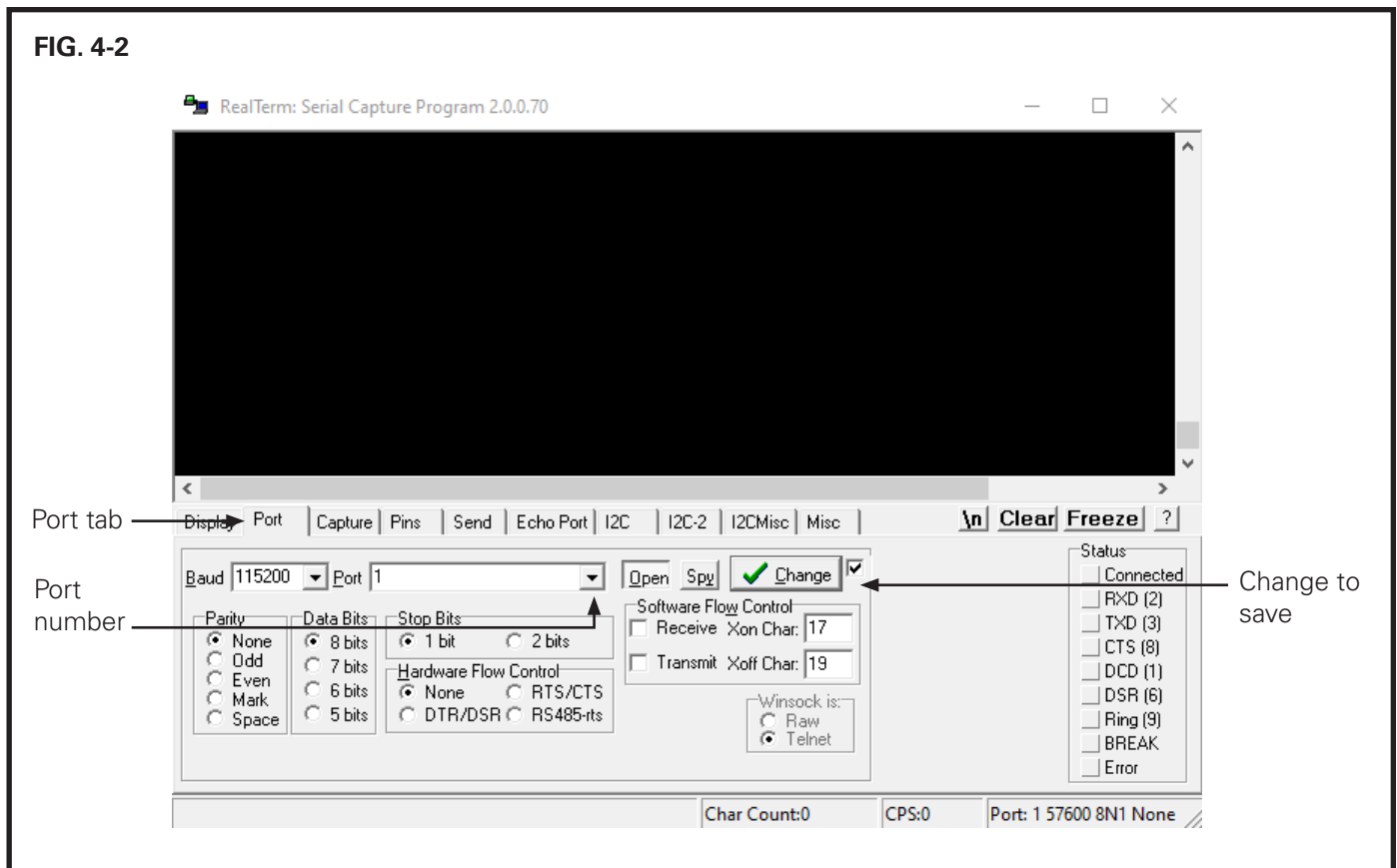**6.** Click on the "Change" button to save these settings.

FIG. 4-2

Port tab
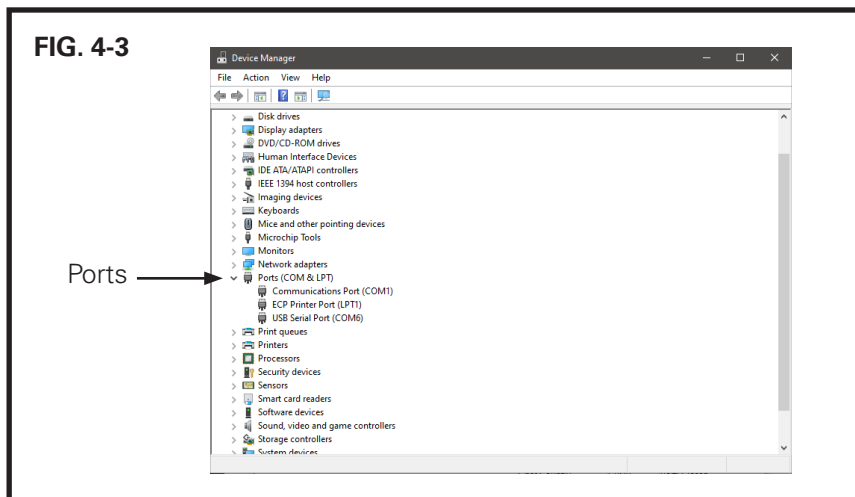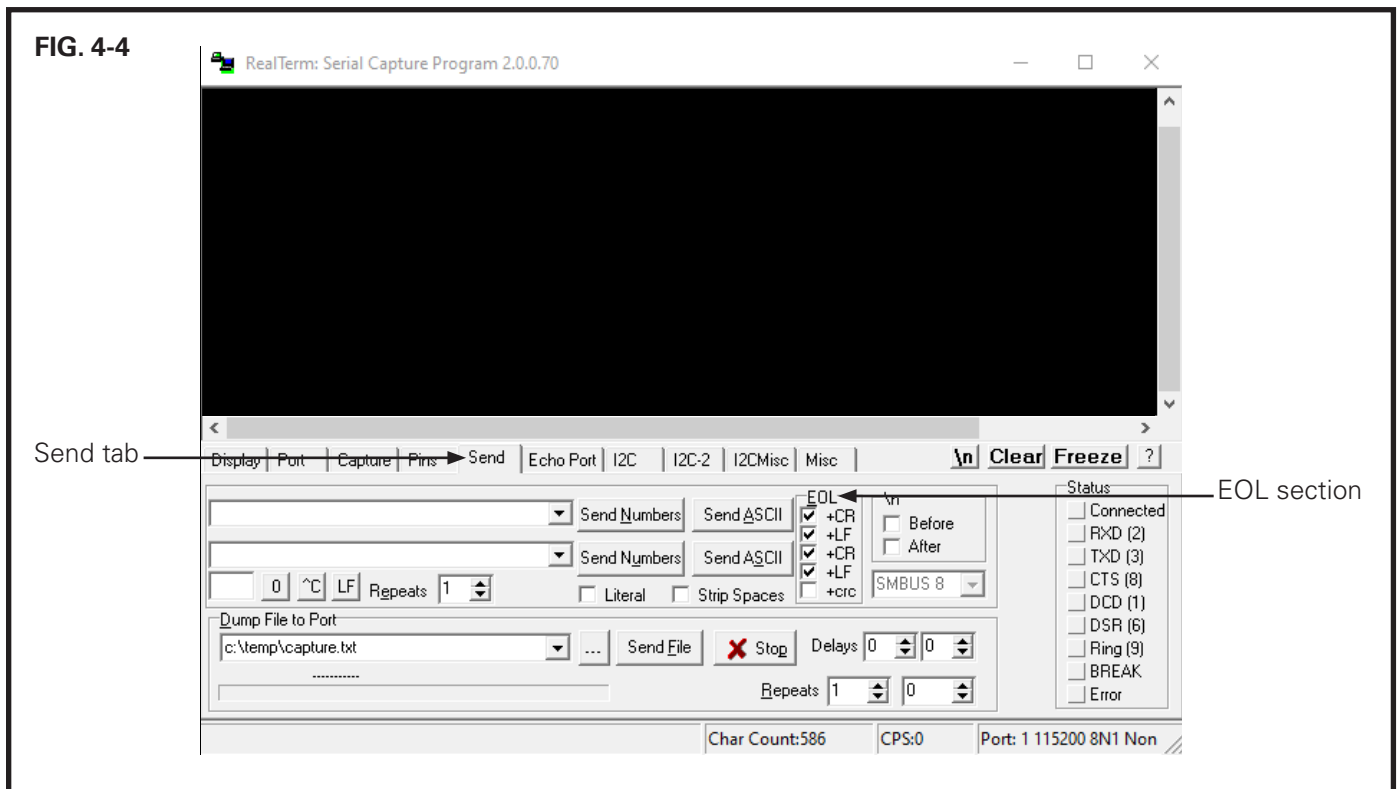
Port number

Change to save

FIG. 4-3

Ports

7. Click on the "Send" tab and select first four boxes under the "EOL" section. FIG. 4-4.

8. The RealTerm software configuration is complete.

**FIG. 4-4**

Send tab —

EOL section —

OUTPUT DATA

An RS232 cable for connecting your PC to the LRW has been supplied with the LRW 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 19–21 of this manual. Ensure your PC is connected to the LRW sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 12. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

Follow the steps below to view output data.

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

FIG. 4-5
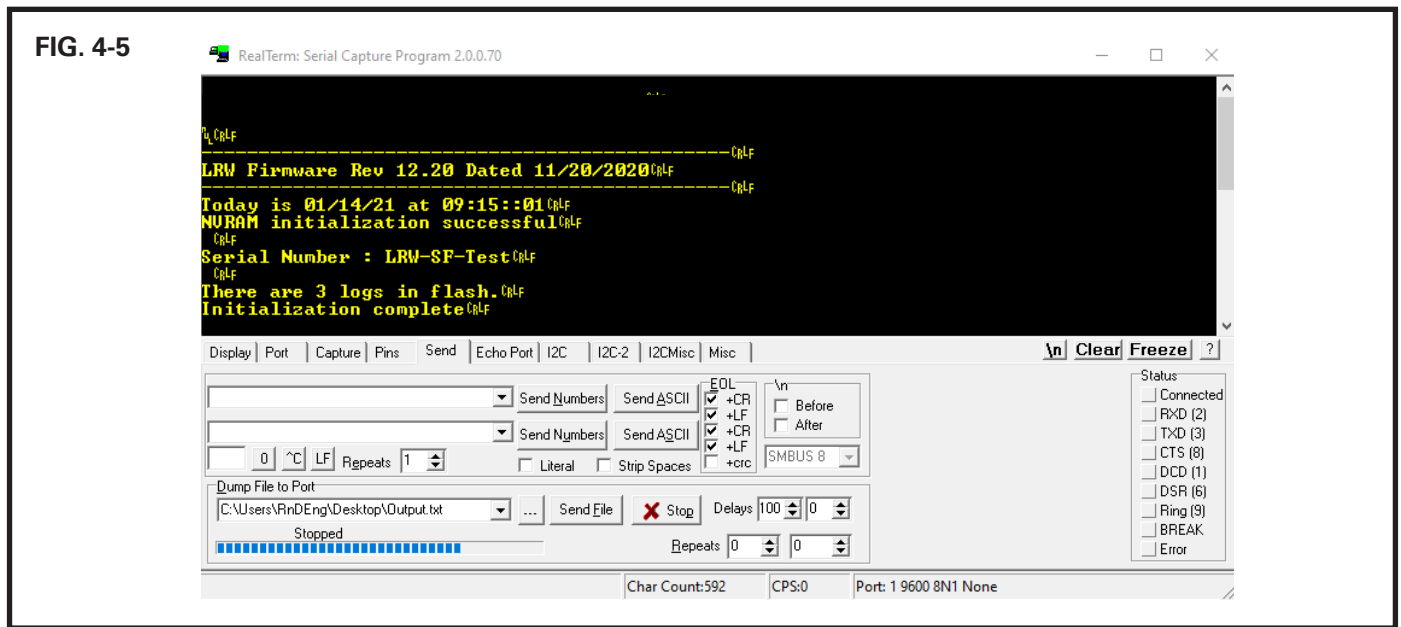
2. Go to the "Send" tab, type "=ostart" on either command box for continuous data output every second, and click on the "Send ASCII" button on the same line as the text box where the command is entered to send the command. FIG. 4-6.
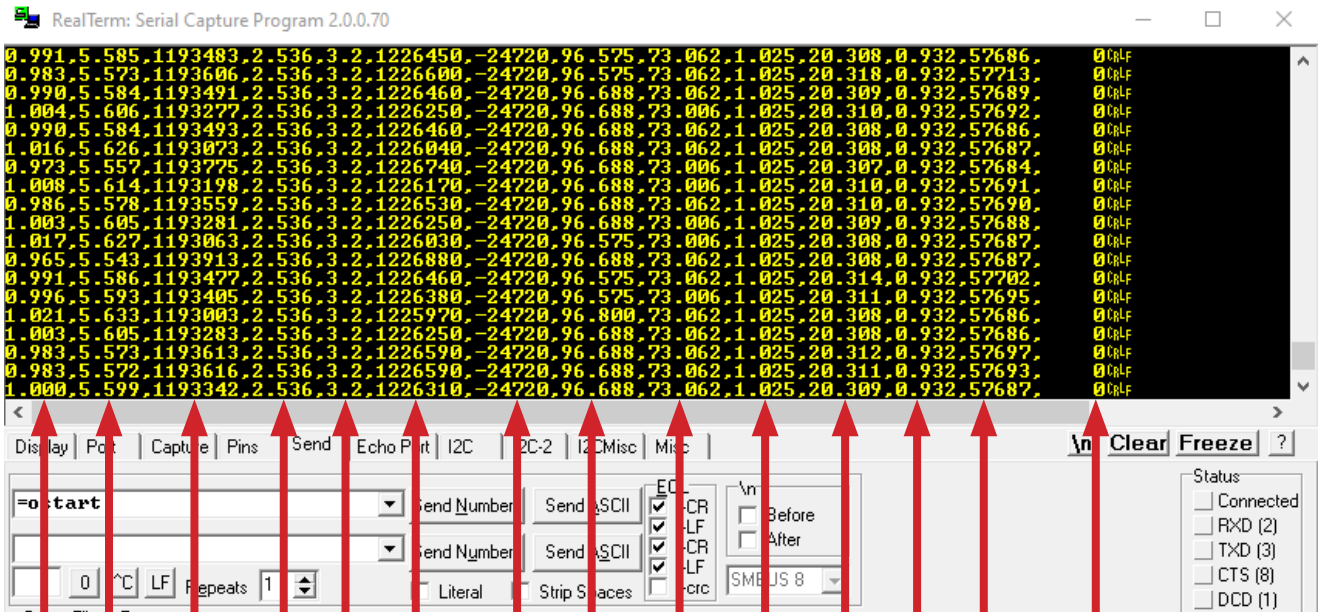
FIG. 4-6

Send tab
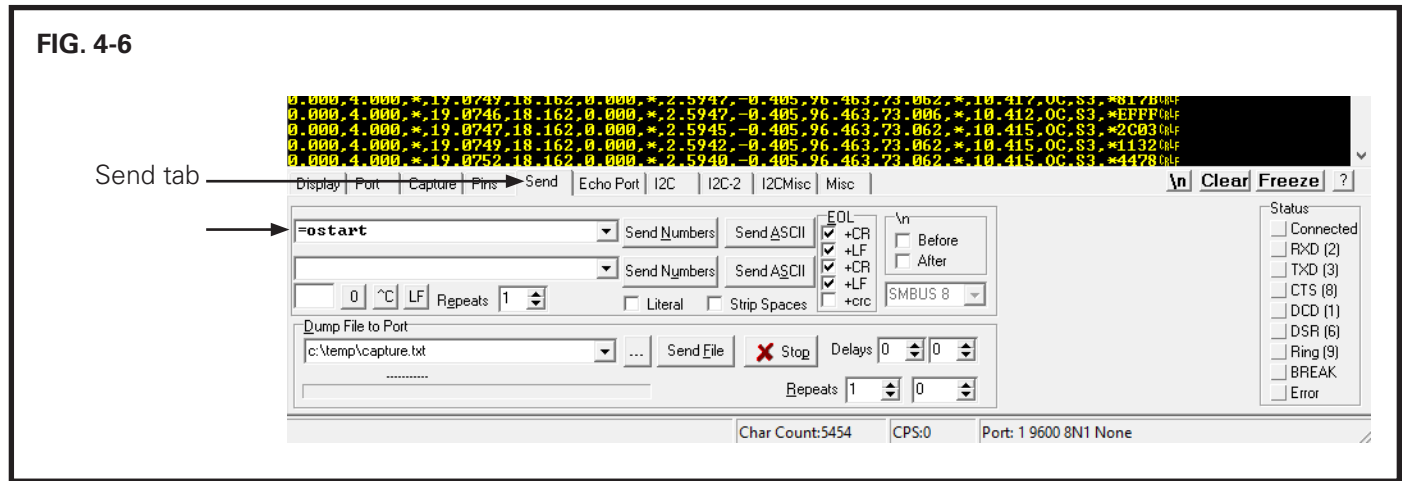
3. The output will start automatically in CSV (comma separated values) format. See FIG. 4-7 on page 24 for output data definitions.

   If the output readings do not display in the RealTerm menu, proceed to the "RS232 Troubleshooting" section on page 42 of this manual.

FIG. 4-7 OUTPUT DATA

Column 14: temperature compensation (kHz)

Column 13: density input correction frequency (kHz)

Column 12: specific gravity 4-20mA input

Column 11: API 4-20mA input

Column 10: density input voltage

Column 9: probe temperature. Range: 0 to 149 °C

Column 8: board temperature. Range: 0 to 70 °C

Column 7: frequency offset (kHz)

Column 6: minimum frequency (kHz)

Column 5: maximum voltage

Column 4: minimum voltage

Column 3: adjusted frequency (kHz)

Column 2: 4-20mA output

Column 1: percent water output

4. Type "=ostop" and click on "Send ASCII" to stop the continuous output. **Always do this before disconnecting**. FIG. 4-8.

FIG. 4-8
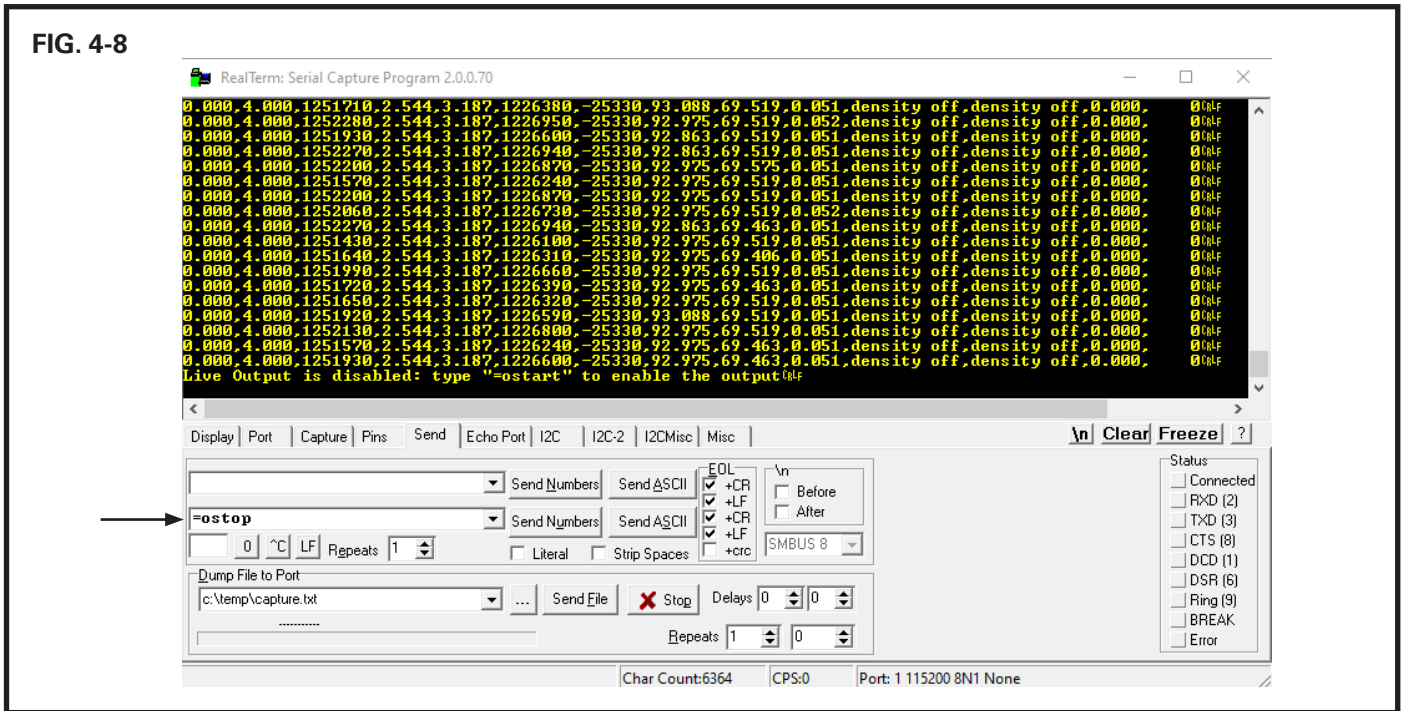
IN-LINE CALIBRATION AND VERIFICATION

PLEASE NOTE: The following calibration steps are to be conducted during initial installation with existing process conditions; during routine verification procedures; or when LRW readings indicate a slight drift off acceptable accuracies in continuous operation. You will need an RS232 cable (supplied) or an RS232/USB adapter (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 19–21 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 12. To access the boards,unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

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

2. Each time a sample is drawn, note value or take a screenshot of the current % water LRW reading in the Real-Term window.

3. Determine water percentage in each sample using a KAM Karl Fischer Moisture Analyzer (recommended), or other available method.

4. Average the water content from the three manual samples.

5. Average the water content from the three LRW readings or screenshots (first data column in RealTerm). FIG. 4-9.

6. Take note of the current reading of the LRW in RealTerm.

7. Calculate the difference between manual sample averages and LRW averages and add or subtract that value to the current reading of the LRW in Realterm. This value is the calculated percent of water to be entered on

8. Realterm to calibrate the LRW. See Calibration Example on page 27.

9. Type "lcal" (lower case L) in either command port under the "Send" tab and click on "Send ASCII."
    The "Calibration Mode" message will appear. FIG. 4-9.

FIG. 4-9
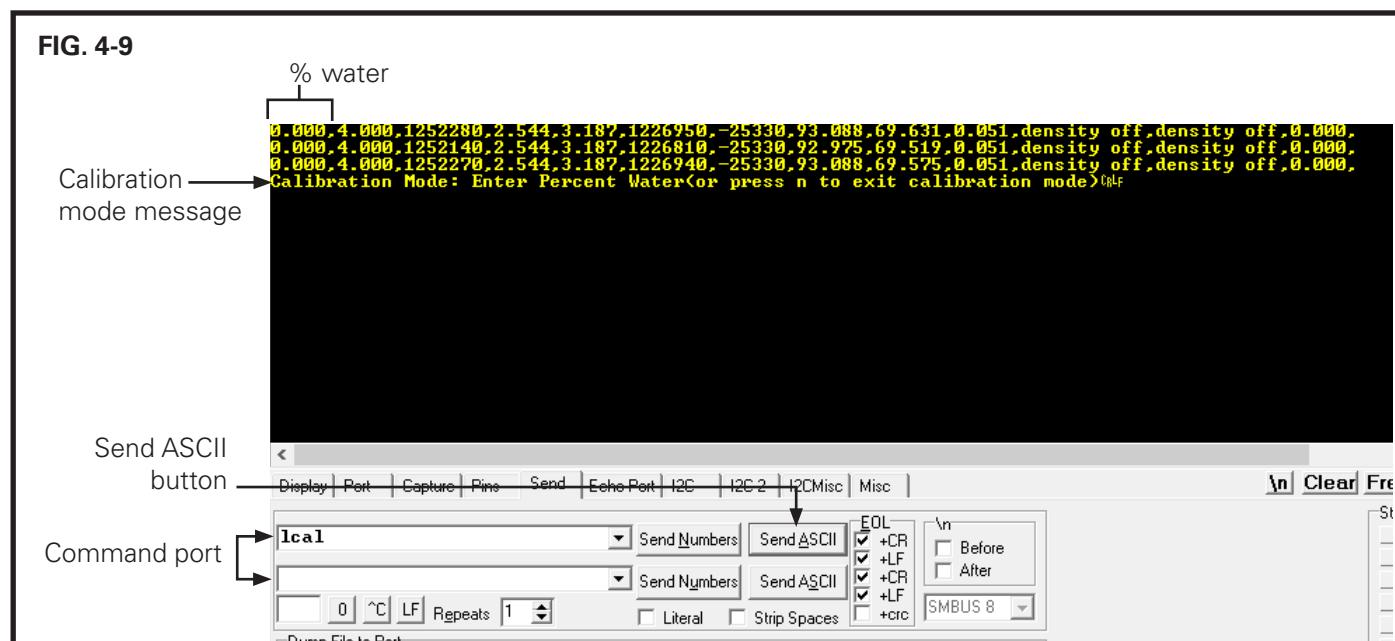
10. Type the calculated percent of water (i.e. 2.89 for 2.89%) and click on "Send ASCII." Calibration results will be displayed. FIG. 4-10.

FIG. 4-10

Calibration results
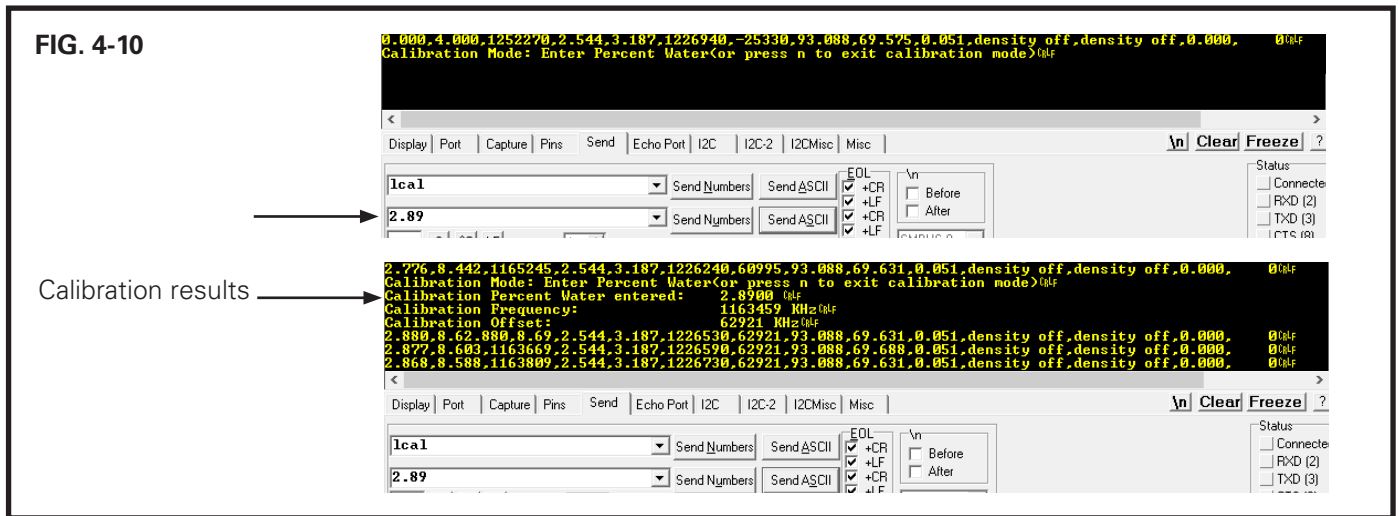
CALIBRATION EXAMPLE

Manual samples water content:	LRW screenshots water content:
1. 2.51%	1. 2.60%
2. 2.75%	2. 2.91%
3. 2.62%	3. 2.70%
Average = 2.63%	Average = 2.74%

Difference of averages:

2.74% − 2.63% = 0.11%

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

Current reading: 3.0%

To adjust the LRW, 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 LRW.

CALIBRATION WITH LABORATORY RESULTS

In cases where on-site reference measurement (Karl Fischer or centrifuge) is not available, the LRW™ can be verified after obtaining results of manual sample analysis at a laboratory.

Before proceeding, install and configure RealTerm as per instructions on pages 19–21 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 12. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

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

2. Each time a sample is drawn, note or take a screenshot of the current LRW reading in the RealTerm window.

3. Send the samples to the lab for water content determination.

4. Once results have been received from the lab, average the water content from the three samples. This value is the "Lab observed % water."

5. Average the water content from the three LRW screenshots. This value is the "LRW observed % water." NOTE: The "LRW observed % water" should be more than 0 and less than the maximum water % on the calibration table.

6. Type "=pcal,<LRW observed % water>, <Lab observed % water>" in the command port under the "Send" tab and click on "Send ASCII." In other words, if the LRW observed water was 1.5% and the Lab observed % water was 1.75%, you would input "=pcal,1.5,1.75". FIG. 4-11.

7. Calibration results will be displayed. FIG. 4-12. If not, run the numbers again or contact KAM for further assistance.

FIG. 4-11

FIG. 4-12
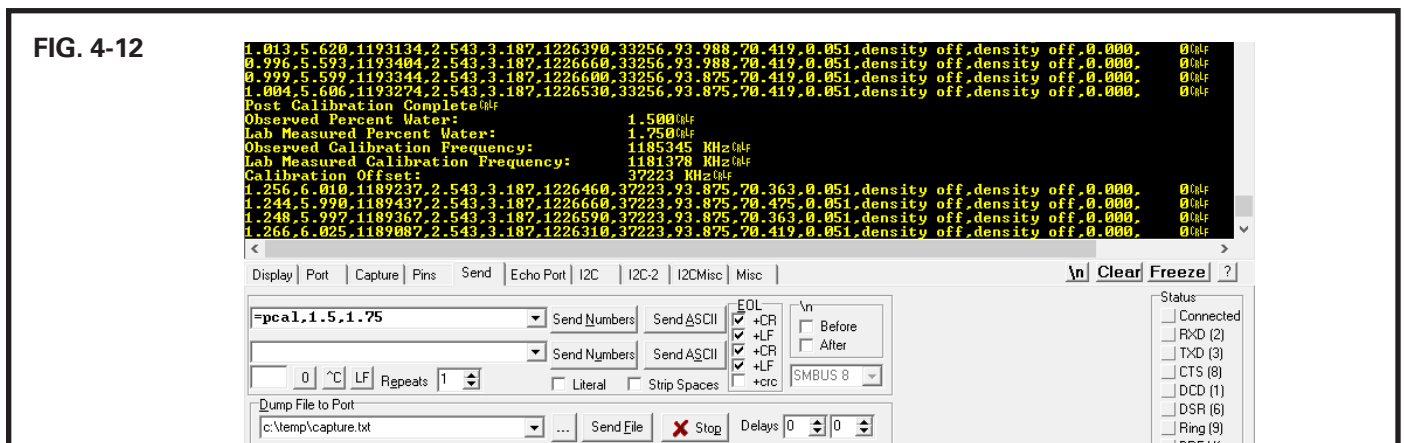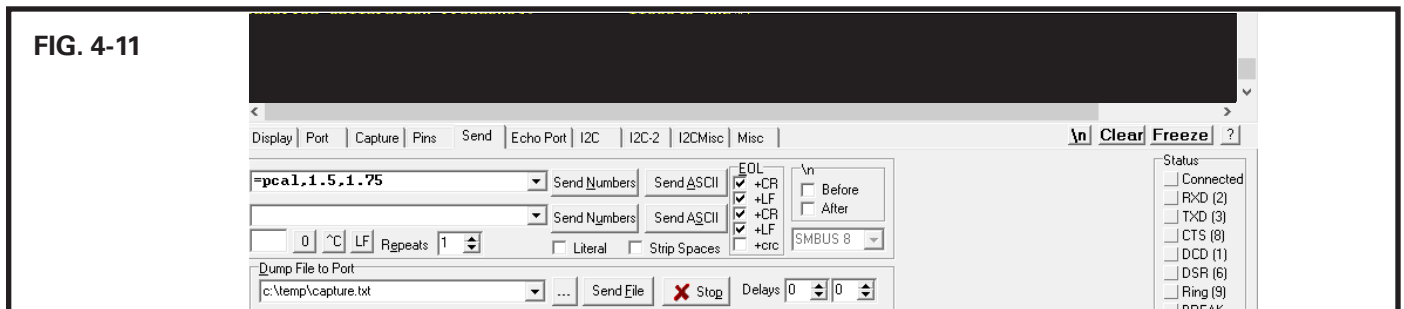
PROCESS PARAMETER VALUES

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 19–21 of this manual. Ensure your PC is connected to the LRW sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 12. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

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. 4-13.

FIG. 4-13
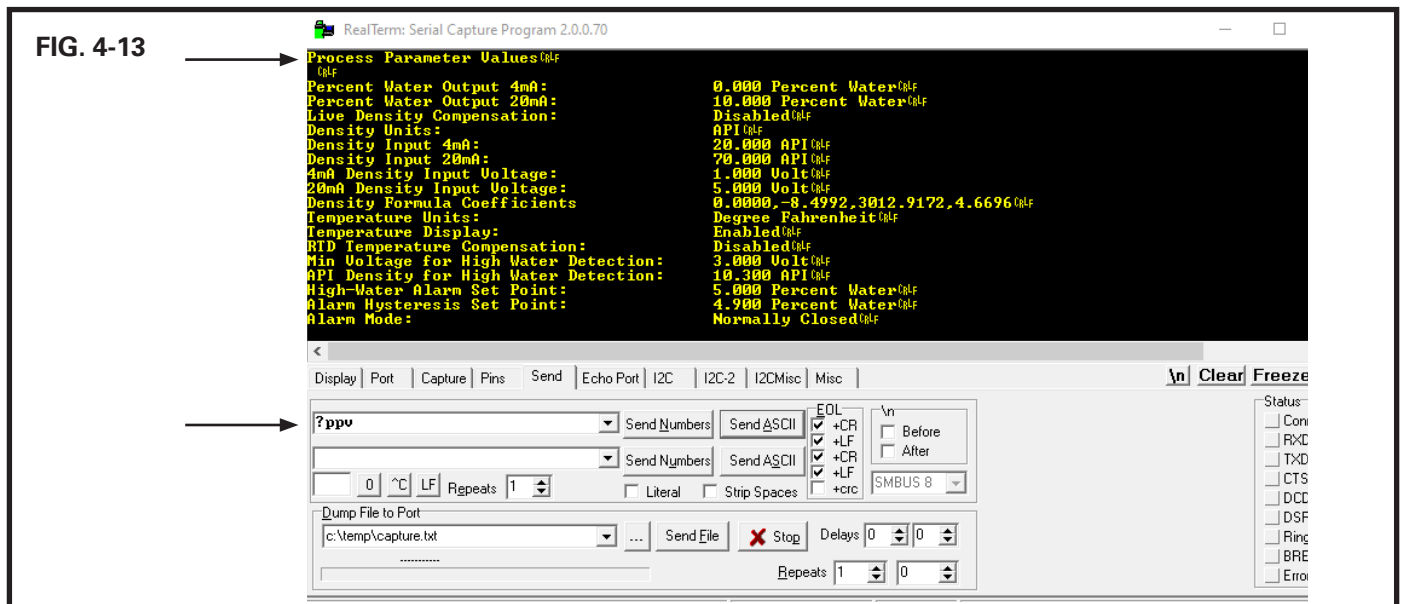
KAM LRW OPERATION REALTERM CONTINUED

DENSITY INPUT VERIFICATION AND RE-CONFIGURATION

Density input values are configured at the factory according to information provided by the customer. These values must match output values from the mass flow meter/densitometer for accurate operation of the LRW.

KAM Controls recommends contacting the factory before changing these settings.

Before proceeding, install and configure RealTerm as per instructions on pages 19–21 of this manual. Ensure your PC is connected to the LRW sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 12. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

1. Launch RealTerm. Verify the low and high end of the density loop by typing "?ppv" in the command port and clicking on "Send ASCII." The parameters will show the current values for 4mA and 20mA with their respective units (API or g/cm3). FIG. 4-14.
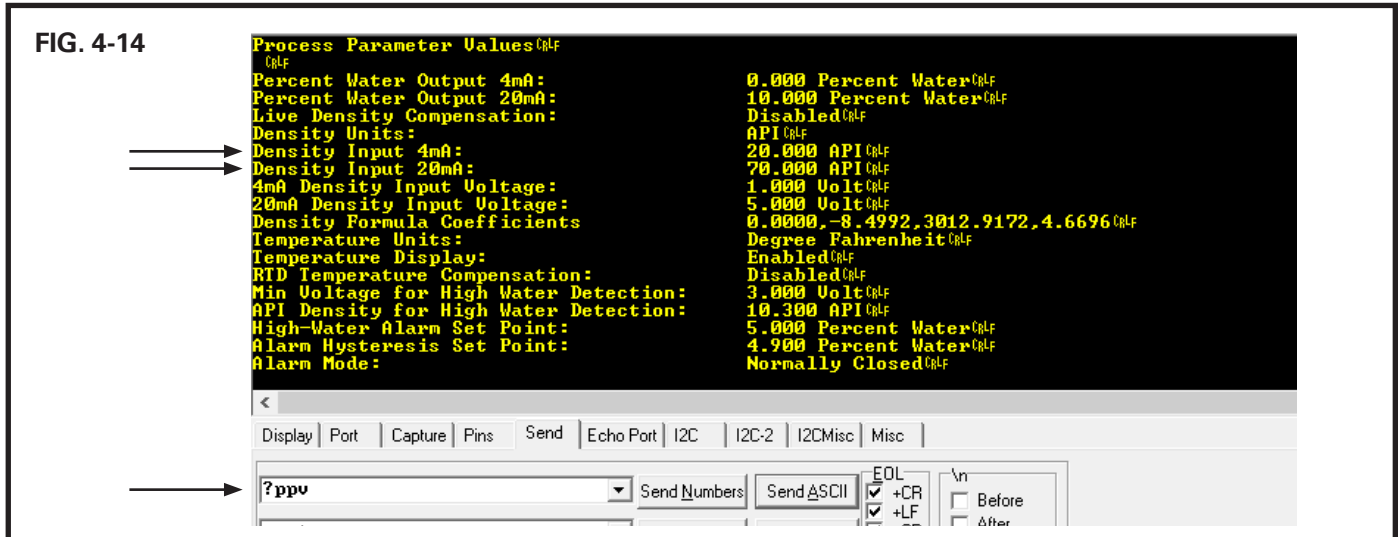
FIG. 4-14

2. If the density is disabled, enable it by typing the command "=don" and clicking on "Send ASCII." FIG. 4-15. The density input should only be disabled in situations where process density remains constant. Density can be disabled by typing "=doff" and clicking on "Send ASCII."

FIG. 4-15

DENSITY INPUT VERIFICATION AND RE-CONFIGURATION CONTINUED

Units for the density input range can either be API gravity or g/cm3. Current input units are indicated under Process Parameter Values (FIG. 4-14). If the input units on the LRW do not match the output units of the densitometer or PLC, both units and values must be changed to match the output from the densitometer/PLC.

To change the density input range to **specific gravity units**:

1. Enter "=den" in the command port and click on "Send ASCII." Current input units will be displayed.

2. To change the values, enter "=den4,<4mA Density value>" and "=den20,<20mA Density value>" in the command ports and then click "send ASCII." For instance, if the desired low end of the range was 0.80 g/cm3 and the desired high end of the range was 0.95 g/cm3, you would enter "=den4,0.80" and "=den20,0.95". FIG. 4-16. Values can be entered in either command port, but you must click the "Send ASCII" button associated with each port.

FIG. 4-16

To change the density input range to **API Gravity units**,

1. Enter "=api" into the comman port and click on "Send ASCII." Current input units will be displayed.

2. To change the values, enter "=api4,<4mA Density value (API)>" and "=api20,<20mA Density value (API)>" into the command ports and click on "Send ASCII". For instance, if the desired low end of the range was API 20 and the desired high end of the range was API 70, you would enter "=api4,20" and "=api20, 70". FIG. 4-17.

NOTE: For manual calibration instructions please contact KAM Controls.

FIG. 4-17

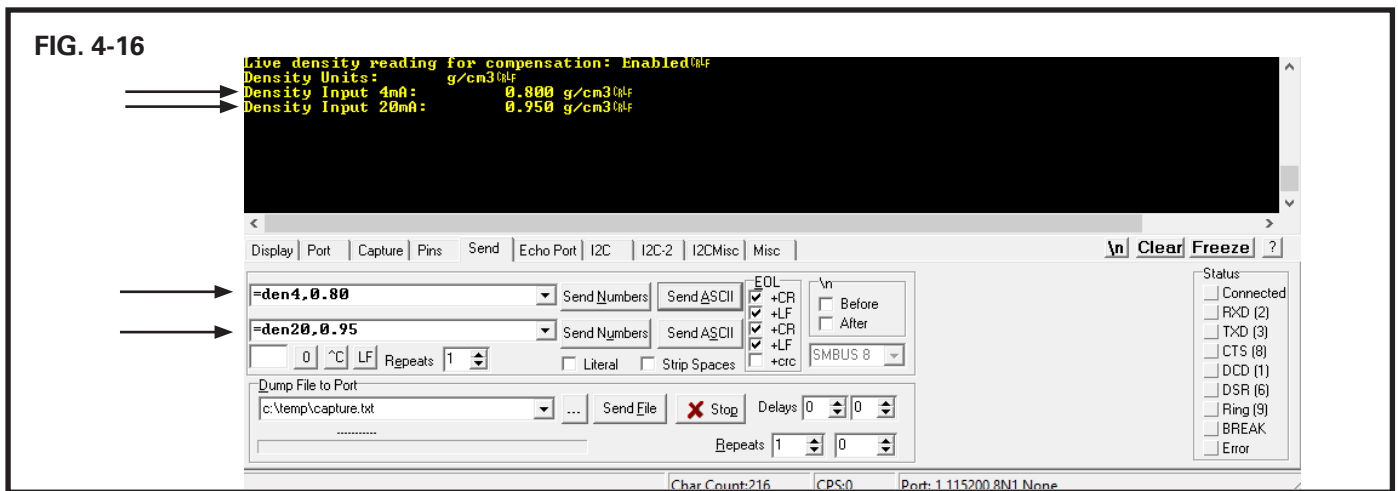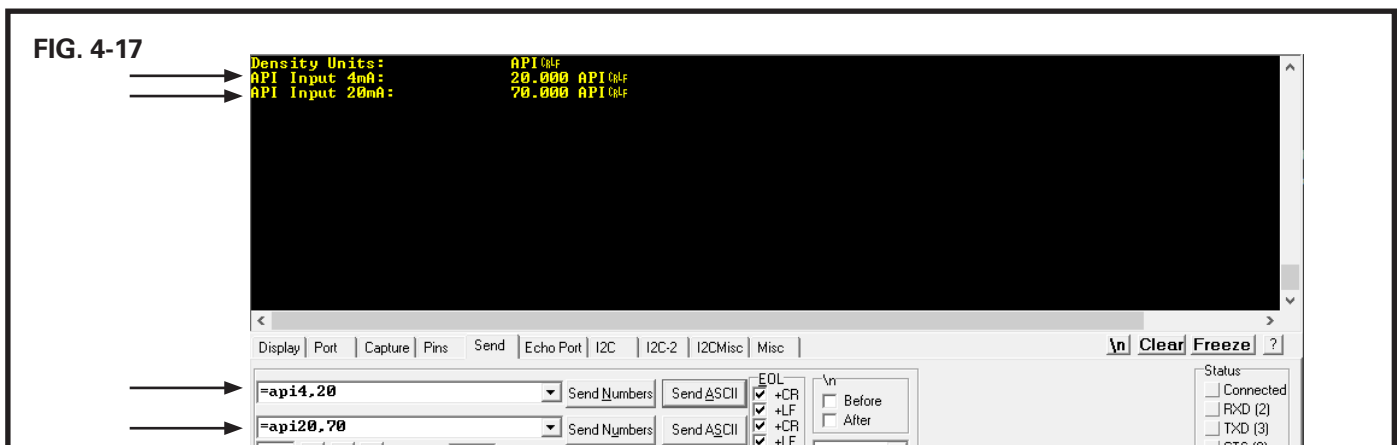# KAM LRW OPERATION REALTERM CONTINUED

CHANGING THE TEMPERATURE UNITS

Before proceeding, install and configure RealTerm as per instructions on pages 19–21 of this manual. Ensure your PC is connected to the LRW sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 12. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

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

1. Launch RealTerm. Type "=degc" for Celsius or "=degf" for Fahrenheit 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.

FIG. 4-18

KAM LRW OPERATION REALTERM CONTINUED

SETTING THE ALARM SETPOINTS

Ensure RealTerm is installed and configured as per instructions on pages 19–21 of this manual. Ensure your PC is connected to the LRW sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 12. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

To set the alarm [DOUT]:

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 3, you would enter "=alarm,3". The configured values will be displayed. FIG. 4-19.

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 2.8, you would type "=alhy,2.8". The new hysteresis alarm value will be displayed. FIG. 4-20.
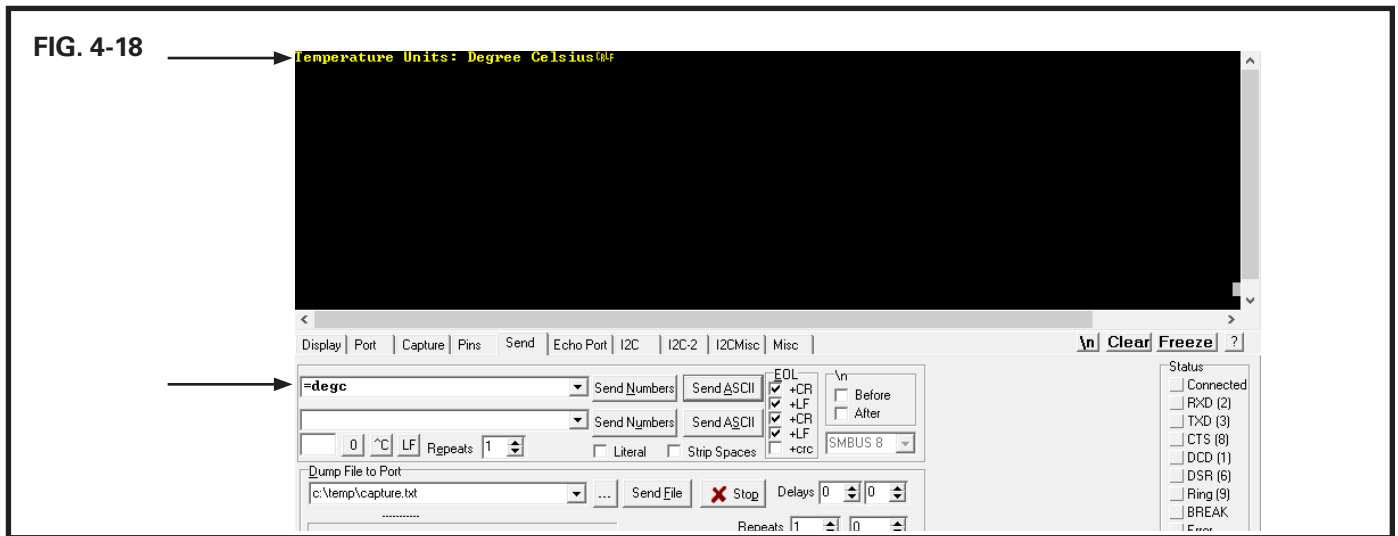

FIG. 4-20
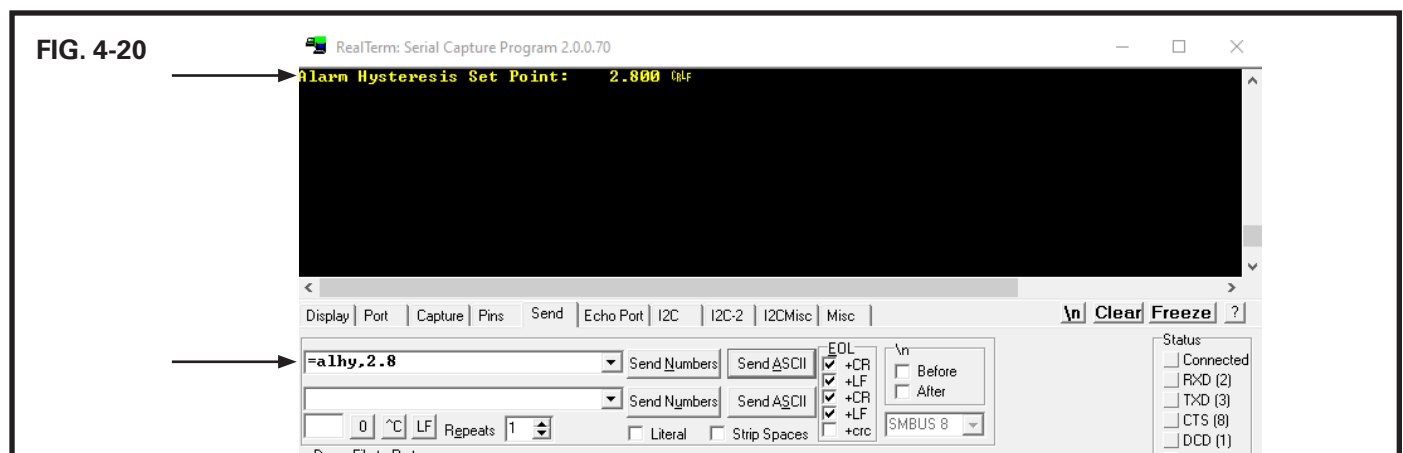
KAM LRW OPERATION REALTERM CONTINUED

SETTING THE ALARM MODE

Before proceeding, install and configure RealTerm as per instructions on pages 19–21 of this manual. Ensure your PC is connected to the LRW sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 12. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

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.

FIG. 4-21

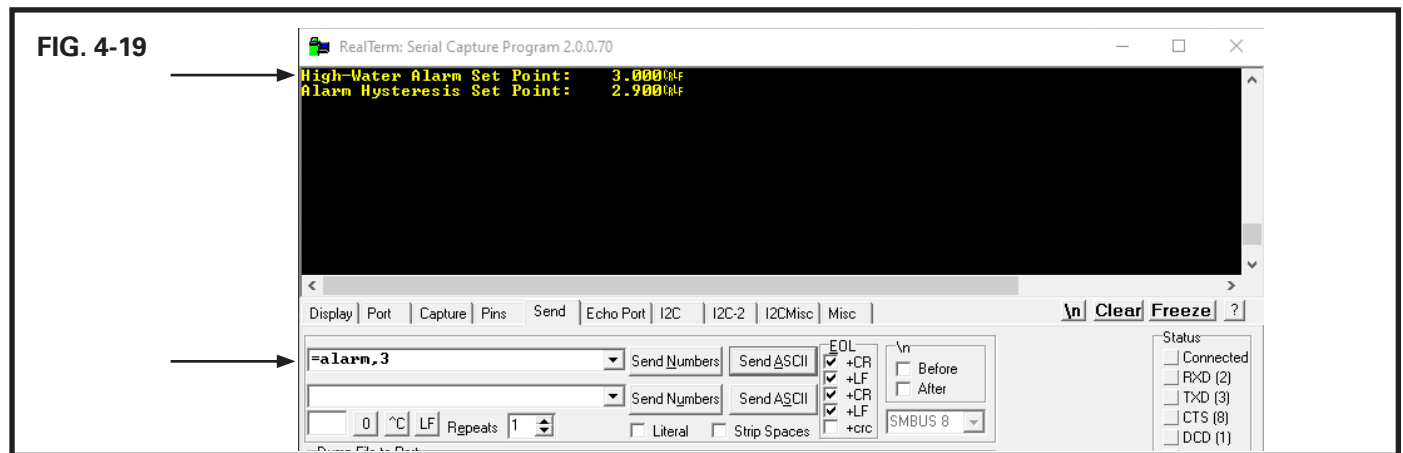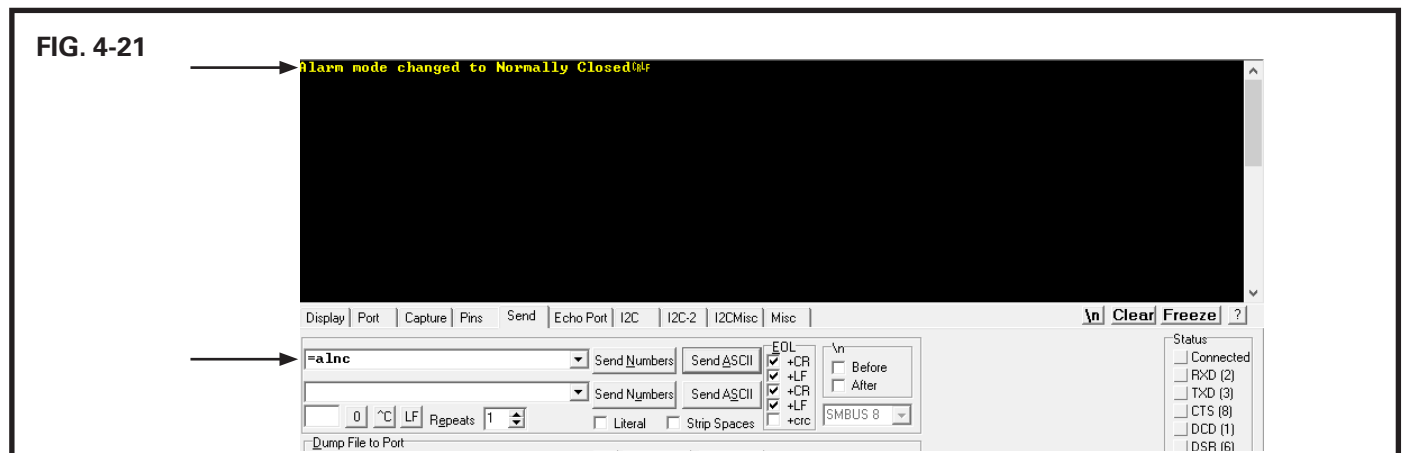2. To change the alarm mode back to "Normally Open", type the command "=alno" and click on "Send ASCII."

SETTING THE DATE AND TIME

Before proceeding, install and configure RealTerm as per instructions on pages 19–21 of this manual. Ensure your PC is connected to the LRW sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 12. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

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. 4-23.

2. To set the time, type the command "=time,<HR>:<MM>::<SS>" on either command box under the "Send" tab. Click on "Send ASCII." 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.

FIG. 4-22
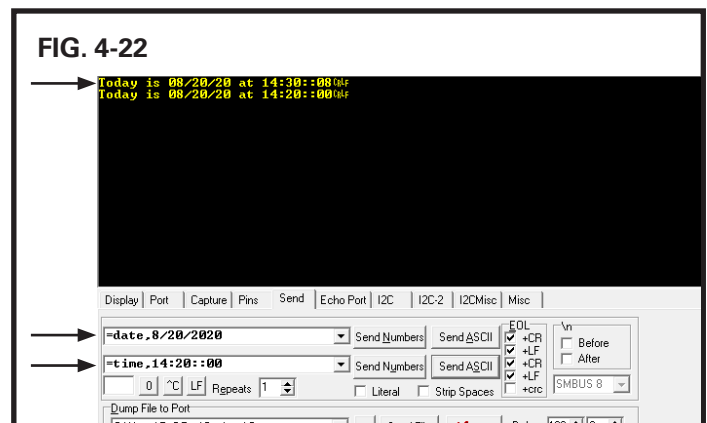
KAM LRW OPERATION REALTERM CONTINUED

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 19–21 of this manual. Ensure your PC is connected to the LRW sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 12. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

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.
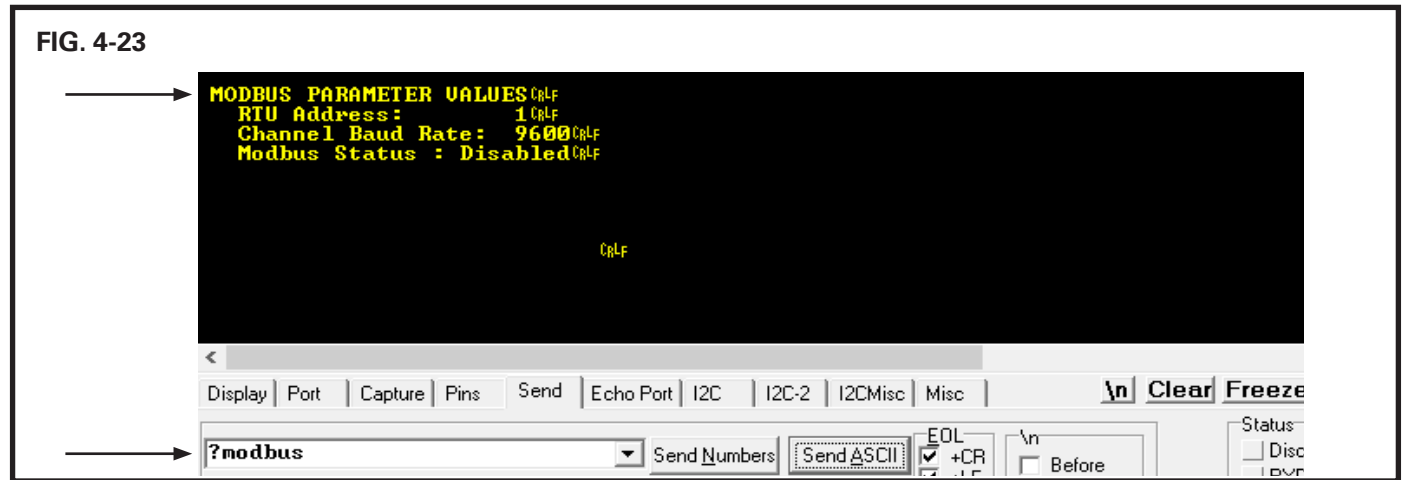
FIG. 4-23

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
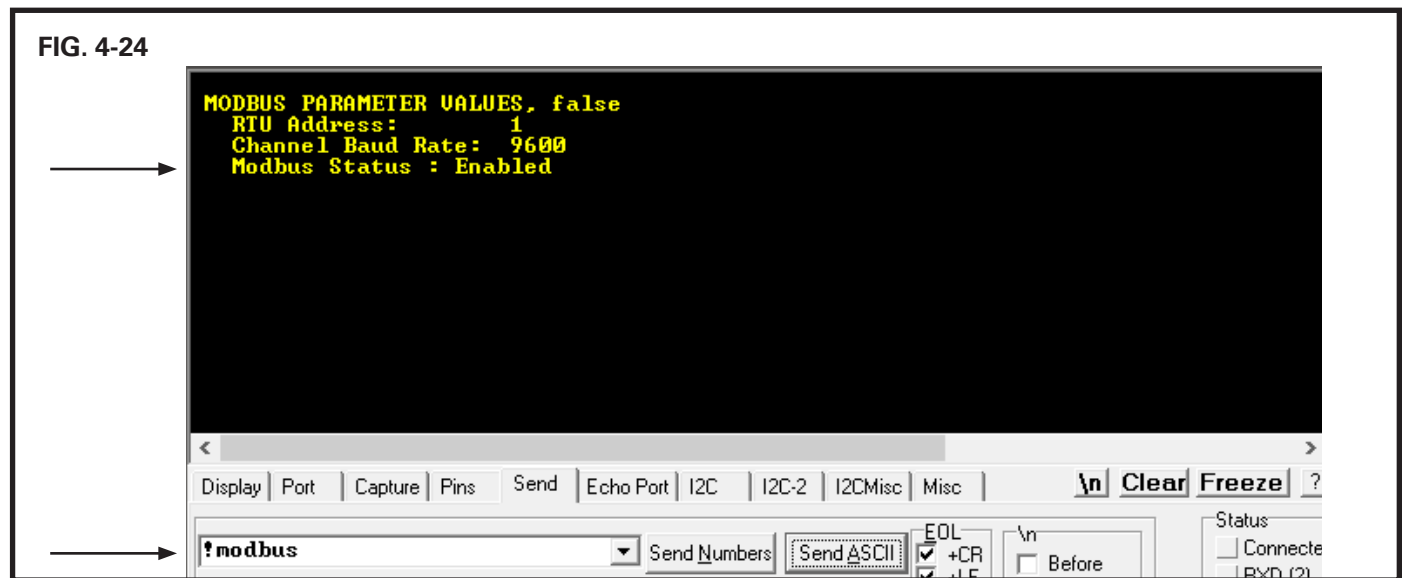
3. Power cycle (turn off and on) the LRW to start the Modbus communication.

4. To disable Modbus, use the same command "!modbus" and click on "Send ASCII." Modbus status will change to "Disabled" confirming the change.

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 19–21 of this manual. Ensure your PC is connected to the LRW sensor via the supplied RS232 serial cable and USB-to-serial converter as per wiring diagram on page 12. To access the boards, unscrew the cover from the Explosion Proof electronics enclosure, unscrew the LCD Display plate and carefully unplug the LCD connector.

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.

FIG. 4-25
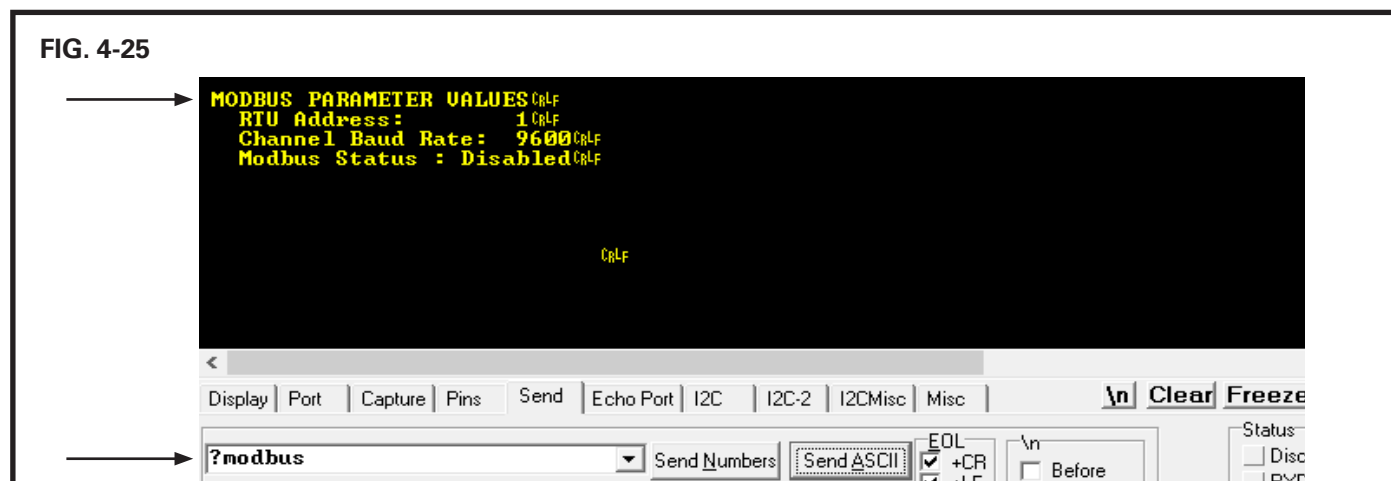
2. To complete the change, turn the LRW power off, wait two to three seconds, and turn it back on.

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
^pcal,<value>,<value2>	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.

5 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 antennas. Do NOT power wash the unit.

Instead, to remove any oil residue 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: AskAnEngineer@Kam.com

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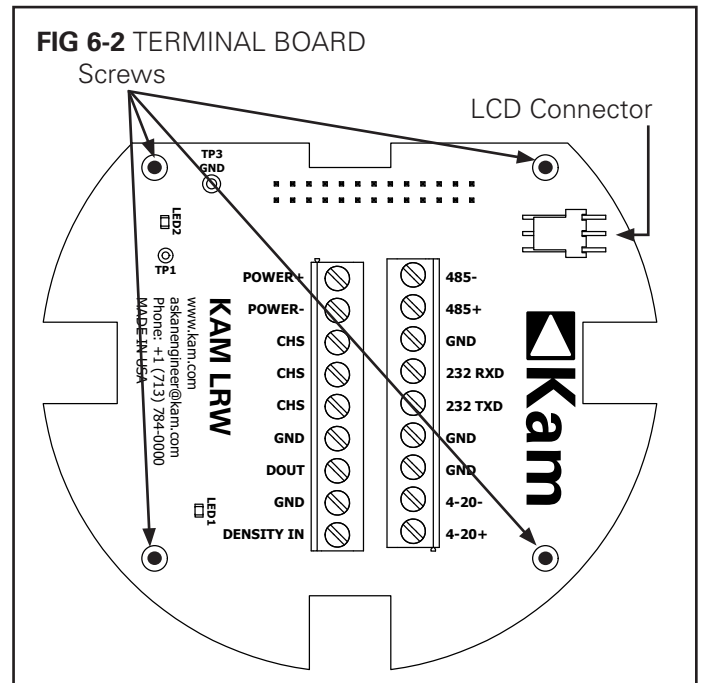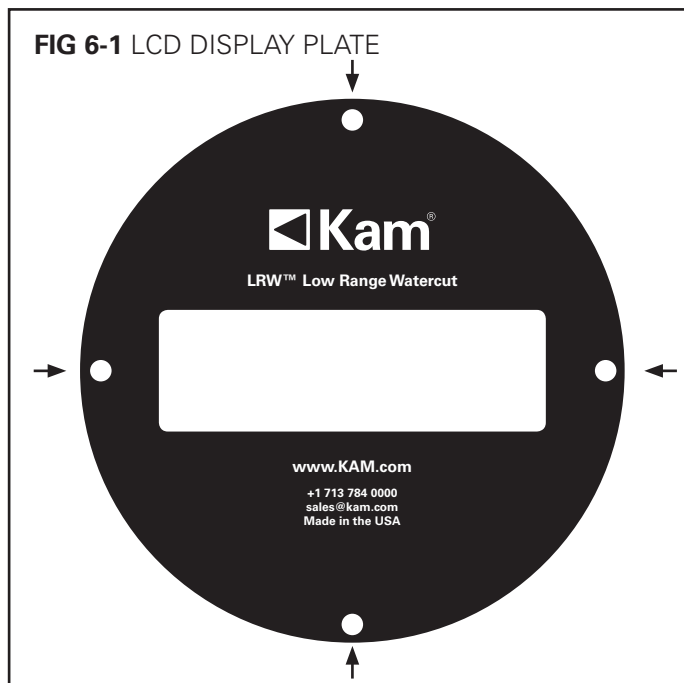
6 TROUBLESHOOTING

CHECKING THE LCD DISPLAY

If the LCD display is off despite the LRW being powered on, please follow these instructions:

1. Turn off the field power supply to the LRW.

2. Use a 5/64 Allen wrench to remove the set screw on the display cover.

3. Turning it counterclockwise by hand, remove the display cover.

4. Remove the four (4) screws on the LCD display plate with a Phillips screwdriver (FIG 6-1).

5. Unplug the LCD connector from the terminal board (FIG 6-2) and set LCD display plate aside.

6. Remove the four (4) screws on the Terminal PCB with a Phillips screwdriver. FIG 6-2.

7. Carefully pull the Terminal Board away from the Processor board by firmly holding it on the edges and pulling straight up. Pulling the unit sideways or at an angle may damage the 26-pin connection.

8. Check for any fuses or surge protection devices visibly damaged on the bottom side of the Terminal PCB.

9. If the board passes a visual check, reinstall the Terminal PCB on the LRW by carefully aligning the 26-pin header with its corresponding mating connector on the Processor board. Push directly down and then install four (4) screws.

10. Connect the POWER+ and POWER- pins to the field power supply between 12-30V DC (+24V DC power is preferred.

11. Turn on power to LRW.

    If the issue continues, please contact KAM technical support at askanengineer@kam.com or call +1 713-784-0000.

FIG 6-1 LCD DISPLAY PLATE

Kam®

LRW™ Low Range Watercut

www.KAM.com

+1 713 784 0000
sales@kam.com
Made in the USA

FIG 6-2 TERMINAL BOARD

Screws

LCD Connector

TP3
GND

LED2

TP1

KAM LRW
www.kam.com
askanengineer@kam.com
Phone: +1 (713) 784-0000
MADE IN USA

POWER+	485-
POWER-	485+
CHS	GND
CHS	232 RXD
CHS	232 TXD
GND	GND
DOUT	GND
GND	4-20-
DENSITY IN	4-20+

LED1

◁Kam

TROUBLESHOOTING CONTINUED

POWER CONNECTIONS

If you have not already checked the Terminal board for physical defects, please do so according to the instructions on page 39 of this manual.

The LRW TERMINAL PCB has LEDs to indicate the status of the input power and on board voltages of the LRW. The sections below provide instructions to verify if the LRW is powered up with the right voltages.

Please note:

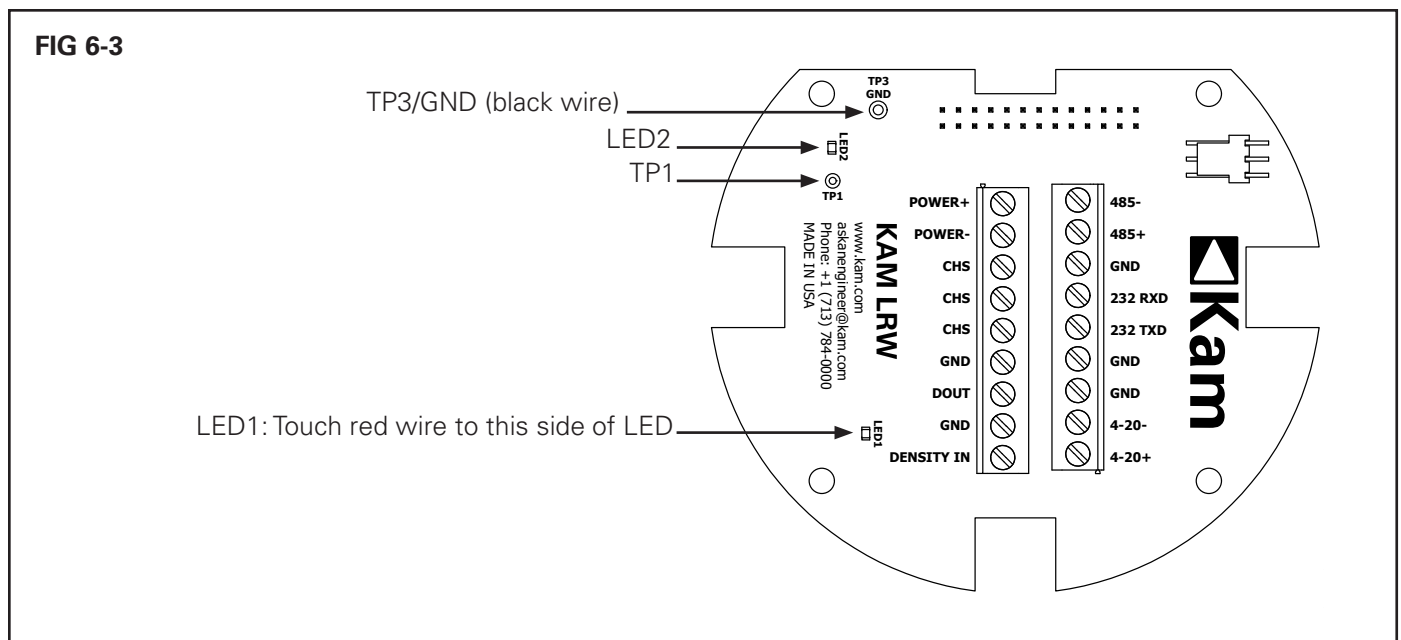LED1 Indicates voltage presence at the input voltage terminals.
LED2 Indicates voltage presence at the 5V supply.
Lit LEDs do not necessarily indicate proper voltage.

CHECKING THE INPUT POWER

1. Use a voltmeter to check the POWER+ and POWER- terminals and ensure that the voltage across them is between 12–30 V DC (24 V DC is recommended).

2. If voltage is not within this range, check the field power supply and bring it within the limits above. Check again. If it is still not within limits, contact KAM Controls for further assistance.

3. If the voltage across the input power terminals is within the specified limits, connect the red wire of a voltmeter on the side of LED1 and the black wire to TP3/GND. FIG. 6-3. It should show the input voltage (12–30 V). This means the LRW input power is working properly, proceed to next section ("Checking 5 VDC supply").

   If it does not show this voltage, either the fuse is blown or the lightning protection has been activated. The instrument electronics need to be checked for additional damage. Please contact KAM Controls at +1 713 784 0000 or email askanengineer@kam.com for further assistance.

FIG 6-3

TP3/GND (black wire)
LED2
TP1

TP3 GND
LED2
TP1

KAM LRW
www.kam.com
askanengineer@kam.com
Phone: +1 (713) 784-0000
MADE IN USA

POWER+
POWER-
CHS
CHS
CHS
GND
DOUT
GND
DENSITY IN

485-
485+
GND
232 RXD
232 TXD
GND
GND
4-20-
4-20+

LED1: Touch red wire to this side of LED
LED1

◢Kam

TROUBLESHOOTING CONTINUED

CHECKING 5 VDC SUPPLY

Once the LRW input power has been verified as per instructions above, proceed to check the 5 VDC supply:

1. Check LED2. If lit, power is flowing to the 5 V circuit.

2. Proceed to verify the level of this 5 V supply by connecting the red wire of the multimeter to TP1 and black wire to TP3 (GND) Terminal. FIG. 6-3.

3. The DC voltage should read between 4.95 V and 5.05 V. This means the power supplies are operational, there could be a fault in the other systems of the instrument. Contact KAM Technical Support for further assistance.

4. If the voltage is not within limits, the 5 V power supply is nonfunctional. Return to the factory for repair.

5. If LED2 does not light up, the 5 VDC supply may be damaged. Please contact KAM Technical Support at +1 713 784 0000 or askanengineer@kam.com for further assistance.

LOOP TROUBLESHOOTING

If you have not already done so, follow the steps on page 39 of this manual to remove LCD cover and faceplate.

If the Loop water reading does not match the water % reading on the LRW local display, please follow these instructions:

1. The LRW supplies power for the loop. Make sure the device that receives data from the LRW does not have a power source of its own switched on. Also, the 4-20+ and 4-20- are isolated inputs from the chassis/earth. Do not connect either to a common ground. Use an isolator if necessary.

2. Check the voltage across the 4-20+ and 4-20- terminals on the Terminal Board. It should read between 10 V and 12 V. If not, contact KAM Controls for further assistance.

3. If the voltage across the Loop terminals is within the specified limits, make sure the loop is working properly by switching the multimeter to ammeter mode and checking the current running through it without a load. The current must correspond with the readings on the LCD display:

   If it does, the 4-20 mA wire from the LRW to the PLC may be damaged.
   If it doesn't, contact KAM Technical Support for further assistance.

TROUBLESHOOTING CONTINUED

RS232 TROUBLESHOOTING

If experiencing either blank or a non-alphanumeric output on the LRW PC software or on the RS232 terminal (e.g. RealTerm), please follow these instructions:

1. Make sure the communication settings are set as described on page 20 of this manual. Ensure the communication port is opened in the terminal software.

2. Follow steps 1 through 4 on the previous section ("Loop Troubleshooting") to access the terminal board of the LRW.

3. Check the RS232 wires connected to the LRW terminals for damage and ensure they are installed as per the wiring diagram on page 12 of this manual. Replace wires if necessary.

4. Use a multimeter to measure voltage as described below. Please note the red wire on the multimeter should be connected to RS232 terminals and the black wire to GND.

   232 RXD (LRW data input line) to GND terminal should be between -5 V and -12 V.
   232 TXD (LRW output line) to GND terminal should be should be between -5 V and -12 V.

If the voltages are not within this range, the RS232 circuit may be damaged. Contact KAM Technical Support for further instructions.

If either the 232 RXD or the 232 TXD terminal voltages read 0 V with respect to the GND terminal and the wire connections are good, try reversing the 232 RXD and 232 TXD wires and check the output on the LRW PC software (If using RealTerm, follow configuration procedure on page 19).

If the issue continues, please contact KAM Technical Support for further assistance.

RS485 TROUBLESHOOTING

If not able to read MODBUS registers, please follow the instructions below.

NOTE: The 485+ and 485- lines in two wire mode are differential, so their voltage needs to me measured with respect to each other to conform to the RS485 standards. The bias is provided by the master device.

1. RS485 is intended for MODBUS output. Check the activity LEDs on any RS485 converter connected to the RS485 terminals on the LRW.

   If lit, verify the MODBUS registers and call KAM Technical Support for further assistance.

   If not lit, follow steps 1 through 5 on the "Checking the LCD Display" section to access the terminal board on the LRW. Proceed to use a voltmeter and connect the red wire on 485+ and the black wire on the 485- terminal. Measure and take note of the voltages. Call KAM Technical Support for further assistance.

APPENDIX A: MODBUS INTERFACE REGISTERS

MODBUS SETTINGS

MODE	RTU
BAUD RATE	9600
DATA BITS	8
STOP BITS	1
PARITY	NONE
SLAVE ID	1
OFFSET	0

MODBUS REGISTERS

Register	Data	Type of Register	Type of Data
42000	Percent Water	Read	32 Bit Float
42001	Calibrate % Water	Write	32 Bit Float
42002	Board Temperature	Read	32 Bit Float
42003	API Gravity	Read	32 Bit Float
42004	Density g/cm3	Read	32 Bit Float
42005	Minimum Frequency (Factory Debugging)	Read	32 Bit Float
42006	Minimum Voltage (Factory Debugging)	Read	32 Bit Float
42007	Maximum Voltage (Factory Debugging)	Read	32 Bit Float
42008	Current Output	Read	32 Bit Float
42009	Probe Temperature	Read	32 Bit Float
42010	Adjusted Frequency (Factory Debugging)	Read	32 Bit Float
42011	Offset (Factory Debugging)	Read	32 Bit Float
42012	Density Compensation (Factory Debugging)	Read	32 Bit Float