KAM® LRW™
LOW RANGE WATERCUT

User Manual
LRWMANUAL 0420

An ISO 9001 certified company

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1 INTRODUCTION

AVAILABLE MODELS and MOUNTING OPTIONS

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

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

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

<table>
<thead>
<tr>
<th>Range (water in oil)</th>
<th>0-3%</th>
<th>3-5%</th>
<th>5-10%</th>
</tr>
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<tbody>
<tr>
<td>Accuracy</td>
<td>±0.03%</td>
<td>±0.05%</td>
<td>±0.1% from 5-10% water</td>
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2 SPECIFICATIONS

Media: Crude oil and refined products
Wetted parts: 316 SS, hastelloy, & PEEK (Other materials available)
Fluid temp: To 176° F (80° C)
Electronics temp: -40° F to 158° F (-40° C to +70° 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/serial ports: 4–20 mA
Alarm relay
RS232 ASCII (calibration and diagnostics only)
RS485 Modbus
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
Temperature Correction: Automatic
Pressure ratings: ANSI 150, 300, 600, 900
Flow conditions: Well mixed in accordance with API MPMS Chapter 8.2 mixing requirements, vertical
installation strongly recommended
Hazardous area: PTB 08 ATEX 2016 Issue 01
IECEx PTB EX 19.0048
Ex db IIB T6 Gb
IP 68
Equivalent to Class I Div I Groups C and D

<Ex II 2 G CE 0102>
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: In all KAM LRW Installations, the user should ensure that the KAM LRW is installed in a turbulent flow with the Reynolds Number above 2000. Additionally, all KAM LRW's should be installed in accordance with API MPMS Chapter 8, Section 2, Table 1, and in accordance with KAM mixing recommendations.

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.
PRIOR TO INSTALLATION

Remove all the protective packaging materials, and ensure that the LRW® sensor was not damaged during transit. DO NOT discard provided cables and adaptors as they are required for ongoing calibration and troubleshooting.

It is always recommended that the LRW NOT be installed in direct sunlight, and in high-ambient-temperature installations that it be installed with recommended sunshade.

In cold weather, if 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 the pipeline is not going to flow for extended amount of time and the pipe is not heated, then LRW should be taken out to avoid damage to the sensor probe by freezing water.

LRW FLOWTHROUGH 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.

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.
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 location recommendations above). The LRW sensor should be inserted so that the window of the probe is located in the center of the diameter of the pipeline. Instructions for proper insertion distance on insertable models follow below.

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

1. Prior to mounting verify that the the probe is retracted as far as possible inside the seal housing. The tip of the probe will extend slightly from the end of the seal housing. FIGS. 3-4, 3-5.

2. If sensor is not retracted inside the seal housing, pull the shaft back until the probe rests against the mechanical stop inside the seal housing and use a 3/8” Allen wrench to tighten the Socket Cap Screws on the locking collar. This will prevent the LRW shaft from sliding and the probe from getting damaged during mounting.
3. 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. 3-6.

4. Calculate the minimum insertion distance for the LRW.

Minimum insertion distance (MID) =
D1 +
Pipe Wall Thickness (WT) +
Gasket Thickness +
3"

Example for D1=16", WT =1/4", Gasket Thickness=1/8"

MID = 16 + 1/4 + 1/8 + 3
MID = 19 3/8"

5. Measure the calculated MID from the top of the Locking Collar and place a mark with a permanent marker or tape on the Shaft. FIG. 3-7.

6. Bolt or screw the LRW sensor to the valve or designated installation location. (KAM CONTROLS recommends using thread sealant and not Teflon tape for the threaded LRW).

7. Open full opening valve.


9. Holding by the shaft, 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. DO NOT INSERT PROBE PAST MARK.
REMOVING THE LRW® SENSOR FROM FLOW THROUGH SPOOLS

To remove the LRW® sensor, first shut off power to the instrument. Discontinue flow in loop from the main line and drain fluid from loop. 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. 3-9. 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. 3-9

2’ LRW flow through model

3’ and 4’ LRW flow through models

1 3/4” wrench flat

REMOVING AN INSERTABLE LRW SENSOR

To remove the LRW sensor, first shut off power to the instrument. Loosen the Socket Cap Screws on the Lock Down Collar, using a 3/8” Allen wrench. Slide the LRW sensor upward until the probe rests inside the seal housing. There is a mechanical stop when the unit is fully retracted. Retighten the Socket Cap Screws. Next, close the Full-opening Ball Valve tightly. Drain oil from valve if possible. 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.

INSTALLATION continued

10. Re-tighten the Socket Cap Screws.

11. Using a 3/4” wrench, 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.

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.
INSTALLATION continued

WIRING

The KAM LRW Low Range Watercut 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 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 LRW has to be included into the local equipotential bonding.

The connecting wire of the 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. 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.

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 LOOP+ and LOOP- are isolated inputs from the chassis/earth. Do not connect either to a common ground. Use an isolator if necessary.

INPUTS/OUTPUTS/SERIAL

| POWER (-)   | GND        |
| POWER (+)   | 24-30 VDC  |
| DENSITY IN  | Current loop output from mass flow or densitometer. |
| GND         |            |
| 4-20 mA (-) | Current output, **source (LRW) powered**. Set to requisite percent water at factory. |
| 4-20 mA (+) |            |
| DIG OUT (-) | Alarm or relay (digital contact closure / max 50 W) |
| DIG OUT (+) |            |
| RS232       | Console port – communication interface for calibration, connection to PLC |
| RS485       | Modbus interface |
CAUTION: Do not connect power to 4-20 mA output. This will damage the board and void product warranty.

**FIG. 3-10 WIRING DIAGRAM**

- **Density input (4-20 mA)**
  - See page 13 for greater detail

- **4-20 mA current loop output**
  - **CAUTION:** LRW provides the power for the 4-20 mA load. Do NOT apply external voltage as this will damage the output/board.

- **Digital relay output open drain (max 50 W)**
  - See page 14 for greater detail

- **To grounding rod (preferred) or enclosure**

- **12 or 24 VDC/1 amp power supply**

- **MODBUS/RS485 serial connections**
  - Optional ground

- **RS232 serial connections**

- **500 OHM max Isolated load**
TYPICAL POWER AND LOOP WIRING CONFIGURATIONS

**FIG. 3-11 Power and loop with isolated receiver**

![Diagram showing power and loop wiring with isolated receiver]

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

**WRONG:**
LRW provides power for the 4-20 mA loop. Adding external power can damage the 4-20 mA output.
DENSITY INPUT WIRING

FIG. 3-13 Density meter provides power for 4-20 mA density loop

FIG. 3-14 Density meter with signal splitter
INSTALLATION continued

DIGITAL RELAY WIRING

FIG. 3-15 Digital relay configuration
4 KAM LRW OPERATION REALTERM

CONFIGURATION

RealTerm software is used for testing and calibration of the LRW. RealTerm is available as a free download.

To download RealTerm, go to http://sourceforge.net/projects/RealTerm/ and click on download button.

Follow on screen instructions to install RealTerm.

1. If you haven’t already done so, connect the RS232 cable to the LRW board as shown on page 11, FIG. 3-10 of this manual.

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

![RealTerm Configuration Window]
5. Click on the "Port" tab (FIG. 4-2) and then configure setting to match below.

Baud: 115200
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 converter

6. Click on the "Change" button to save these settings.
KAM LRW OPERATION REALTERM continued

7. If not already turned on, turn on power to LRW™. The initial greeting message will appear if the unit is newly powered up. FIG. 4-3

8. Click on the “Send” tab and select first four boxes under “EOL” (FIG. 4-4)
9. LRW output will start automatically in CSV (comma separated values) format. FIG. 4-5

Data can be exported using the capture function. See next page (19) for instructions.

FIG. 4-5

**Column 1:** percent water

**Column 2:** minimum voltage (V)

**Column 3:** maximum voltage (V)

**Column 4:** minimum frequency (Hz)

**Column 5:** frequency offset (Hz)

**Column 6:** electronics temperature (°C)

**Column 7:** fluid temperature at probe (°C)

**Column 8:** density in volts

**Column 9:** density in API gravity

**Column 10:** density in g/cm³

**Column 11:** density correction frequency (Hz)
DATA CAPTURE IN REALTERM

1. Click on the "Capture" tab. FIG 4-6
2. Uncheck the "Direct Capture" option
3. Click on the button marked with the ellipses: "..."
4. A new window will open. If a folder is not already selected, choose a folder and click open. Name the data file and save to selected folder. FIG 4-7. Click on "Open".
5. Press the "Start: Overwrite" button. The screen will clear and start continuously capturing all data. Fig. 4-6.

FIG. 4-6

Capture tab
Start: Overwrite (overwrites existing data)
Start: Append (resumes data capture)
Ellipses button (pauses data capture)
Direct capture

FIG. 4-7

Click here
DATA CAPTURE IN REALTERM CONTINUED

6. While capturing data, the "Capture" window turns red. FIG 4-8

7. Press Stop Capture to stop data capturing. The saved file can be opened either in MS Excel or in Notepad.
ON-LINE CALIBRATION AND VERIFICATION OF THE KAM® LRW®

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.

1. Connect PC to the LRW sensor via supplied RS232 serial port or RS232/USB adapter. Launch RealTerm and follow steps indicated on pages 15-18 to configure RealTerm.

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

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

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

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

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

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

8. 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 Realterm to calibrate the LRW. See Calibration Example on page 22.

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
ON-LINE CALIBRATION OF THE KAM® LRW™ continued

10. Type the calculated percent of water (i.e. 1.58 for 1.58%) and click on the Send ASCII button. FIG. 4-10. Calibration results will be displayed in the RealTerm menu. FIG. 4-11

**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.

1. Connect PC to the LRW™ sensor via supplied RS232 serial port or RS232/USB adapter and launch RealTerm. If not already done, follow steps indicated on pages 15-18 to configure RealTerm.

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

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

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

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

6. 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.

7. 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. 4-12

8. Calibration results will be displayed. FIG. 4-13 If not, run the numbers again or contact KAM for further assistance.

FIG. 4-12

FIG. 4-13
Values for the 4-20mA loop (water %) and density range can be viewed by following the prompts below.

1. Connect PC to the LRW sensor via supplied RS232 serial port or RS232/USB adapter.

2. Launch RealTerm. Type "?ppv" in the command port under the "Send" tab and click on "Send ASCII." The configured values for process parameters will be displayed. FIG. 4-14

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.

1. Connect PC to the LRW sensor via supplied RS232 serial port or RS232/USB adapter.

2. 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. 4-15
3. If the density is disabled (FIG 4-16), enable it by typing the command "=don" and clicking on "Send ASCII." FIG. 4-17. The density input should only ever be disabled in situations where process density remains constant. Density can be disabled by typing "=doff" and clicking on "Send ASCII."

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 0.8 g/cm³ and the desired high end of the range was 0.95 g/cm³, you would enter "=den4,0.8" and "=den20,0.95." FIG. 4-18. Values can be entered in either command port, but you must click the "send ASCII" button associated with each port.
DENSITY INPUT VERIFICATION AND RE-CONFIGURATION continued

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

1. Enter "+api" into the command port and click on "Send ASCII." Current input units will be displayed. Fig. 4-19

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 "+api20,20" and "+api20, 70". FIG. 4-19.

NOTE: For manual calibration instructions please contact KAM Controls.

---

**FIG. 4-19**

**PROCESS PARAMETER VALUES**

API Input Max: 20.000 API
API Input Min: 70.000 API
API Instant 0-20mA
Percent Water Output 4mA: 0.000 Percent Water
Percent Water Output 20mA: 10.000 Percent Water

---

**CHANGING THE TEMPERATURE UNITS**

To change the temperature unit:

1. Enter "+degf" for farenheit and "+degc" for Celsius. The change will be confirmed in the main window.

---

**FIG. 4-20**

**RealTerm Serial Capture Program 2.0.0.70**

**Changed Temperature to Degree Celsius**
5 KAM LRW OPERATION SOFTWARE

LRW SOFTWARE INSTALLATION

1. The LRW software is included on the CD shipped with your unit. To install, please open the folder containing the LRW PC program. This may be labelled LRW_PC_X_X_X. For example: LRW_PC_1_1_7.

2. Double-click on the file “setup.exe”. FIG. 5-1.

3. Click “Install” when prompted by the Windows Operating System. See FIG. 5-2.

4. In newer versions of Windows (8, 10 or later), Windows Smart Screen will generate additional warnings. Please click on “More info” and then the “Run anyway” button. See FIG. 5-3.

5. The installation wizard will pop up and start installing the LRW software on your computer. Select “I accept the License Agreement” and click on “Next” when prompted until installation is complete.
6. Connect the supplied RS232 cable to the LRW board as shown on page 11, FIG. 3-10 of this manual.

7. Connect the other end of RS232 cable to the serial port of your computer. If necessary, a USB adaptor has been supplied in case your computer does not have an RS232 serial port.

8. Open the LRW software by clicking on the shortcut icon automatically generated on the desktop. FIG. 5-4.

9. You can also go to the Windows “Start Menu,” search for the file “KAM LRW Connect” and open it.

10. The initial window will pop up. FIG. 5-5. Please select the RS232 Communication port to which the LRW is connected, click OK.

11. The initial window will start showing the LRW readings. FIG. 5-6.

12. Setup is complete.
ON-LINE CALIBRATION

Live calibration or on-line calibration is conducted during initial installation, during routine verification procedures, or when LRW readings indicate a slight drift off acceptable accuracies in continuous operation.

1. If you haven’t done so already, connect the RS232 cable to the LRW board as shown on page 11, FIG. 3-11 of this manual.

2. Connect PC to the LRW™ sensor via supplied RS232 serial port or RS232/USB adapter and launch the LRW software.

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

4. Each time a sample is drawn, note or take a screenshot of the current “Water Content %” in the “Live Data” tab on the LRW Software. FIG. 5-6 previous page.

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

6. Average the water content calculated by KAM KF from the three samples.

7. Average the water content from the three LRW screenshots.

8. Calculate the difference between both averages and take note of this value.

9. Check the current reading of the LRW in the “Live Data” tab on the LRW Software and note the “Water Content %”.

10. Calculate the difference between the current LRW water content % and the value of the difference between averages. The result is the calculated water percentage value to be entered in the LRW. Go to the “Configuration” tab on the LRW software.

11. Type the calculated water percentage value (i.e. 1.00 for 1%) in the Live Calibration field and click on “Calibrate” FIG. 5-7.

12. The “Calibrate” button will turn into “Processing” and calibrate.

13. The calibration values will automatically appear on the corresponding fields and on the Command Log. FIG. 5-8.

14. Live calibration is complete.
LAB CALIBRATION

This type of calibration is intended for cases where on-site reference measurement (Karl Fischer or centrifuge) is not available, and the LRW™ is to be verified after obtaining results of manual sample analysis at a laboratory.

1. If not done so already, connect PC to the LRW™ sensor via supplied RS232 serial port or RS232/USB adapter and launch the LRW software.

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

3. Each time a sample is drawn, note or take a screenshot of the current LRW reading on the “Live Data” tab on the LRW Software. FIG. 5-6 page 28.

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

5. Once results have been received from the lab, average the water content from the three samples. This value is the “Lab Observed Water %.”

6. 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. If not, run the numbers again or contact KAM for further assistance.

7. Go to the “Configuration” tab on the LRW software.

8. Enter the calculated values for “LRW Observed Water %” and “Lab Observed Water %” in the corresponding fields under the “Post Calibration” section. FIG. 5-9.

9. Click on “Calibrate”.

10. The button will show “Processing” and calibrate.

11. The calibration values will appear on the Command Log box. Fig. 5-10.

12. Post Calibration is complete.
DENSITY INPUT

The LRW will arrive with density input already enabled. 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.

If not done so already, connect PC to the LRW™ sensor via supplied RS232 serial port or RS232/USB adapter and launch the LRW software.

ENABLING DENSITY INPUT

1. Go to the “Configuration” tab.
2. Click “Enable” under “Density status.” The status indicator will turn yellow while activating. FIG. 5-11
3. The Density Status indicator will turn to green indicating density is enabled, and the Process Parameters box will show the current density range and unit. FIG. 5-12.

CHANGING DENSITY UNITS

1. Go to the “Configuration” tab.
2. Click on “API” or “S.G. (gm/cm3)” under “Density Mode” to select the desired density unit. The status indicator will turn yellow while activating, then it will turn back to green indicating the setting was enabled. FIG. 13
3. The Process Parameters box will show the revised density units and the 4-20mA units will change accordingly (“4mA Density” and “20mA Density” for S.G. and “4mA API” and “20mA API” for API density units).
CHANGING THE 4-20 mA OUTPUT RANGE

1. Go to the “Configuration” tab.

2. Under “Process Parameters,” move the slider to the desired value on the “4-20mA Output Range (%).” FIG. 5-14.

3. The status indicator will turn yellow while activating, then it will turn back to green confirming the change.

4. The Process Parameters box will show a confirmation message.

CALIBRATION LOG

1. Go to the “Configuration” tab.

2. Click on “Display Calibration Log.” FIG. 5-15.

3. The Calibration Log will display the history of all calibrations with the corresponding dates and times. Fig. 5-15.

SET DATE AND TIME

1. Go to the “Configuration” tab.

2. Click on “Set Date and Time.” FIG. 5-16.

3. The Date and Time box will show the date and time set according to the computer’s time zone settings. Fig. 5-16.
CHANGE TEMPERATURE UNITS

1. Go to the “Configuration” tab.

2. Click on desired temperature unit. Indicator light will turn yellow. FIG. 5-17.

3. The status indicator will then turn green and the change will be confirmed under "Display Process Parameters." Fig. 5-18.
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.
TROUBLESHOOTING

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) if not already done.
11. Turn on power to LRW.

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

If you have not already checked the Terminal board for physical defects, please do so according to the instructions on page 34 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.
LED 2 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 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 5V DC 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

LED1: Touch red wire to this side of LED
TP1
LED2
TP3/GND (black wire)
CHECKING 5V DC SUPPLY

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

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

2. Proceed to verify the level of this 5V 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 4.95V and 5.05V. 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 5V power supply is nonfunctional. Return to the factory for repair.

5. If LED2 does not light up, the 5V DC 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 34 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 LOOP+ and LOOP- 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 LOOP+ and LOOP- terminals on the Terminal Board. It should read between 10V and 12V. 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 4-20mA wire from the LRW to the PLC may be damaged.
   If it doesn’t, contact KAM Technical Support for further assistance.
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 16 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 11 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.

   RS232 RXD (LRW data input line) to GND terminal should be between -5V and -12V
   RS232 TXD (LRW output line) to GND terminal should be between -5V and -12V.

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

If either the RS232 RXD or the RS232 TXD terminal voltages read 0V with respect to the GND terminal and the wire connections are good, try reversing the RS232 RXD and RS232 TXD wires and check the output on the LRW PC software (If using RealTerm, follow configuration procedure on pages 15 to 18).

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 RS585+ 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.

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 4 on the "Loop Troubleshooting" section on the previous page to access the terminal board on the LRW. Proceed to use a voltmeter and connect the red wire on RS485+ and the black wire on the RS485- terminal. Measure and take note of the voltages. Call KAM Technical Support for further assistance.
# APPENDIX A: MODBUS INTERFACE REGISTERS

## MODBUS SETTINGS

<table>
<thead>
<tr>
<th></th>
<th>RTU</th>
</tr>
</thead>
<tbody>
<tr>
<td>MODE</td>
<td>RTU</td>
</tr>
<tr>
<td>BAUD RATE</td>
<td>9600</td>
</tr>
<tr>
<td>DATA BITS</td>
<td>8</td>
</tr>
<tr>
<td>STOP BITS</td>
<td>1</td>
</tr>
<tr>
<td>PARITY</td>
<td>NONE</td>
</tr>
<tr>
<td>SLAVE ID</td>
<td>1</td>
</tr>
<tr>
<td>OFFSET</td>
<td>0</td>
</tr>
</tbody>
</table>

## MODBUS REGISTERS

<table>
<thead>
<tr>
<th>Register Data</th>
<th>Type of Data</th>
<th>Register number</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW ALARM</td>
<td>BOOLEAN</td>
<td>1</td>
</tr>
<tr>
<td>HIGH ALARM</td>
<td>BOOLEAN</td>
<td>2</td>
</tr>
<tr>
<td>TEMPERATURE HIGH ALARM</td>
<td>BOOLEAN</td>
<td>3</td>
</tr>
<tr>
<td>TEMPERATURE LOW ALARM</td>
<td>BOOLEAN</td>
<td>4</td>
</tr>
<tr>
<td>WATER CONTENT IN %</td>
<td>32 BIT FLOAT</td>
<td>42000</td>
</tr>
<tr>
<td>CALIBRATED % WATER</td>
<td>32 BIT FLOAT</td>
<td>42001</td>
</tr>
<tr>
<td>BOARD TEMPERATURE</td>
<td>32 BIT FLOAT</td>
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</tr>
<tr>
<td>API GRAVITY</td>
<td>32 BIT FLOAT</td>
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</tr>
<tr>
<td>DENSITY</td>
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</tr>
<tr>
<td>MINIMUM FREQUENCY</td>
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</tr>
<tr>
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<td>32 BIT FLOAT</td>
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<td>MAXIMUM VOLT</td>
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</tr>
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<td>RTD OUTPUT</td>
<td>32 BIT FLOAT</td>
<td>42009</td>
</tr>
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</table>