MOLA Model 7200A

Moisture Online Analyzer
User Guide
P/N 717902

Revision K

Part of Thermo Fisher Scientific

MOLA Model 7200A

Moisture Online Analyzer
User Guide
P/N 717902

Revision K

Thermo
SCIENTIFIC

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Revision History

Revision Level	Date	Comments
A	10-2006	Initial release.
B	11-2006	Revised per ECO 5407.
C	12-2006	Revised per ECO 5434.
D	03-2007	Revised per ECO 5575.
E	08-2007	Revised per ECO 5920.
F	02-2008	Revised per ECO 6209.
G	05-2008	Revised per ECO 6363.
H	10-2009	Revised per ECO 7003.
J	08-2010	Revised per ECO 7456.
K	09-2010	Revised per ECO 7504.

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Contents

Safety Information & Guidelines

This chapter contains information that must be read and understood by all persons installing, using, or maintaining this equipment.

Safety Considerations

Failure to follow appropriate safety procedures or inappropriate use of the equipment described in this manual can lead to equipment damage or injury to personnel.

Any person working with or on the equipment described in this manual is required to evaluate all functions and operations for potential safety hazards before commencing work. Appropriate precautions must be taken as necessary to prevent potential damage to equipment or injury to personnel.

The information in this manual is designed to aid personnel to correctly and safely install, operate, and/or maintain the system described; however, personnel are still responsible for considering all actions and procedures for potential hazards or conditions that may not have been anticipated in the written procedures. **If a procedure cannot be performed safely, it must not be performed until appropriate actions can be taken to ensure the safety of the equipment and personnel.** The procedures in this manual are not designed to replace or supersede required or common sense safety practices. All safety warnings listed in any documentation applicable to equipment and parts used in or with the system described in this manual must be read and understood prior to working on or with any part of the system.

Failure to correctly perform the instructions and procedures in this manual or other documents pertaining to this system can result in equipment malfunction, equipment damage, and/or injury to personnel.

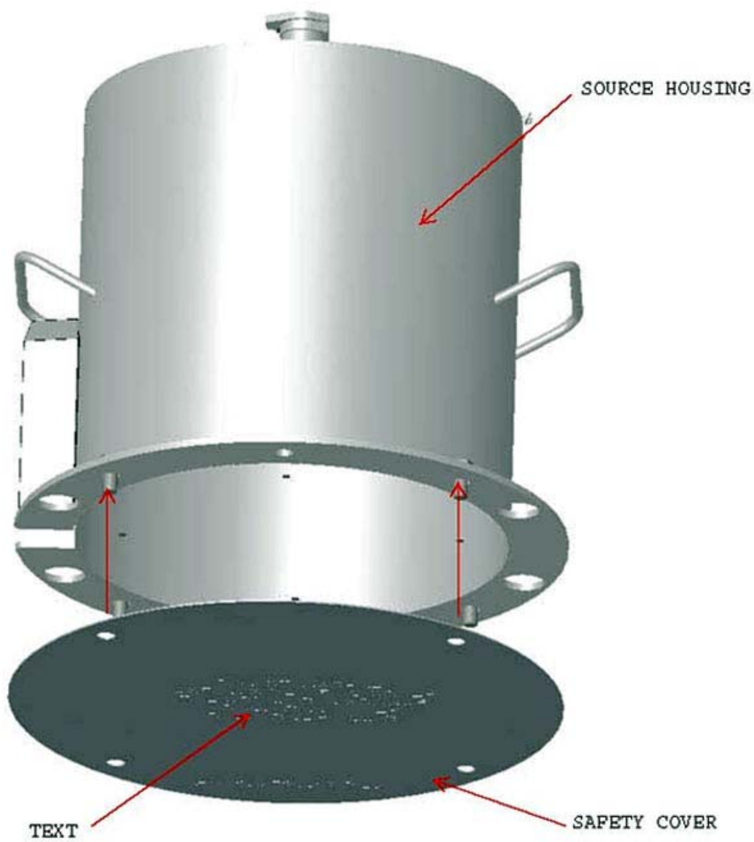
7200A Safety Cover Notice

Warning Read and abide by all safety precautions when handling nuclear devices. It is the operator’s responsibility to understand and follow all safety precautions. ▲

Each 7200A unit will be shipped with one safety cover with fastening hardware and packaged within the shipping container. The image below shows what this cover looks like when it is not installed and where it should be installed. The safety cover kit assembly part number is 341-720001 and includes the safety cover and fasteners. Install the safety cover only if removing the 7200A source housing unit for service or repair. Install the cover with the text facing outward.

Warning Since this top hat unit contains a nuclear source, the cover must be installed immediately after the source housing is removed. Failure to do so can result in exposure to radiation if you reach into the top hat, intentionally or unintentionally. ▲

Do not discard the safety cover and fasteners for any reason. If the safety cover and fasteners are missing, contact Thermo Fisher immediately to order a new safety cover kit.



Safety cover for 7200A unit

Boron Trifluoride Gas (BF3)

The ion chamber detector may be filled with Helium-3 (He3) or Boron Trifluoride (BF3) gas. If the detector is filled with BF3, it is critical to read this section carefully. The type of gas is identified on the instrument housing.

Warning BF3 is a pungent smelling, toxic, corrosive gas with a suffocating odor. Inhalation will cause moderate to severe irritation or burns to the respiratory system. Appropriate precautions must be taken to ensure the safety of personnel. ▲

Warning If exposed to extremely high temperatures, BF3 can decompose and generate irritating vapors and toxic gases. ▲

Warning Health risks vary depending on duration and level of exposure. Exposure to 50 ppm, for example, may be fatal if inhaled for 30–60 minutes (due to massive inflammation and congestion of the lungs). Inhalation of lower concentrations of BF3 can lead to nose and throat irritation. Respiratory equipment and other personal protection equipment must be used. ▲

BF3 is a colorless, fuming, pungent smelling gas. It is heavier than air and fumes strongly in moist air, producing a dense, white cloud of fluoroboric acid mist. The odor and dense, white appearance of this gas, upon release, are distinctive warning properties associated with it.

Warning Fluoroboric acid mist can burn the skin or eyes. Burns may not be immediately painful or visible. Depending on the exposure, effects can be immediate or delayed. Skin contact can lead to pain, redness, and burns. Eye contact may result in blindness. Personal protection equipment must be used. ▲

Warnings, Cautions, & Notes

The following admonitions are used throughout this manual to alert users to potential hazards or important information. **Failure to heed the warnings and cautions in this manual can lead to injury or equipment damage.**

Warning Warnings notify users of procedures, practices, conditions, etc. which may result in injury or death if not carefully observed or followed. The triangular icon displayed with a warning varies depending on the type of hazard (general, electrical, radiation). ▲

Caution Cautions notify users of operating procedures, practices, conditions, etc. which may result in equipment damage if not carefully observed or followed. ▲

Note Notes emphasize important or essential information or a statement of company policy regarding an operating procedure, practice, condition, etc. ▲

Chapter 1
Product Overview

Introduction

Thermo Fisher Scientific's MOLA (Moisture Online Analyzer) consists of the Thermo Scientific 7200 moisture sensor housing and 1400S transmitter. The sensor housing contains a neutron source, an ion chamber detector package, and electronics to condition the signal output. The transmitter is a microprocessor-based system that processes the signal from the moisture gauge and from an optional density gauge to provide a moisture signal output as well as readout and optional outputs.

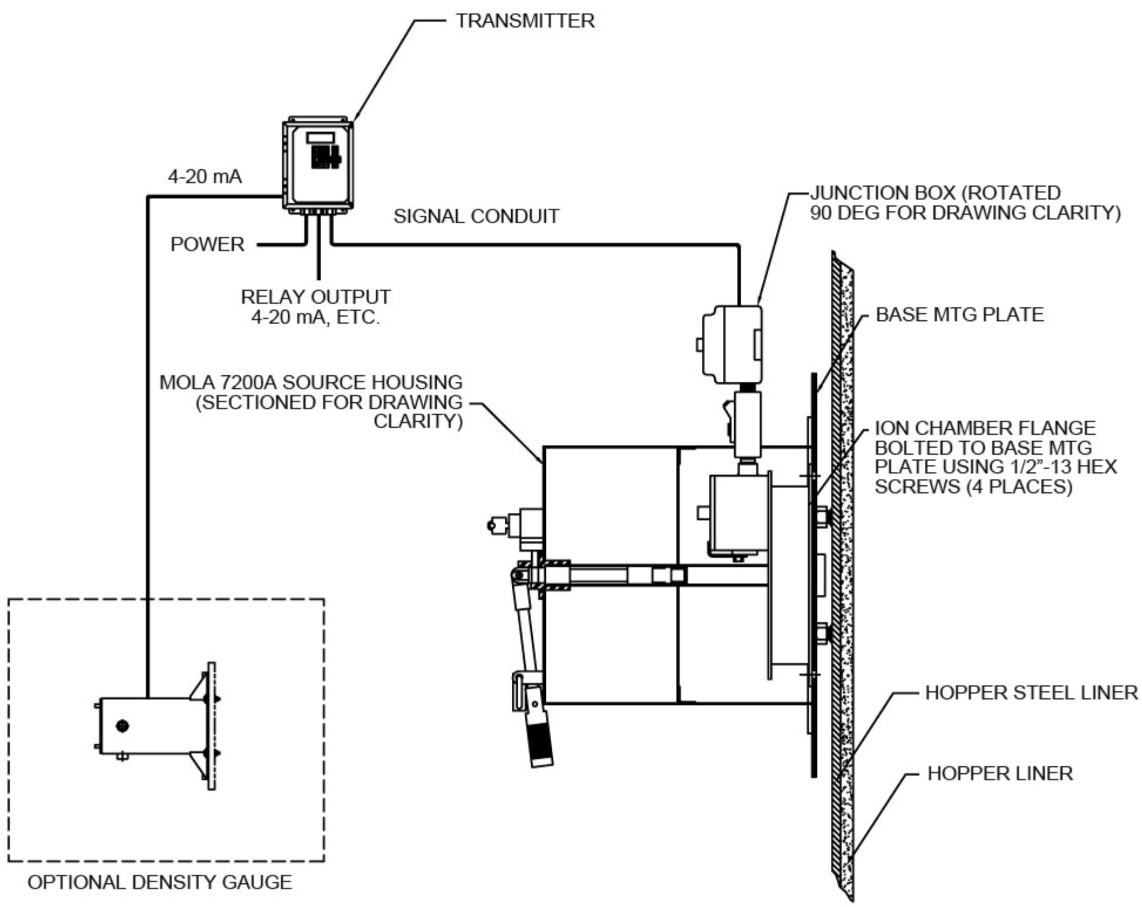


Figure 1–1. Typical installation (no wear liner)

Function

Moisture Sensor Overview

The neutron source is contained in a capsule and emits fast neutrons. A two-position lever controls the location of this capsule. In the OFF position, the capsule is located in the center of the housing and the radiation outside the housing is minimized. In the ON position, the capsule is located at the front edge of the housing close to the hopper wall. Fast neutrons go through the hopper wall and bounce off the bulk product and its moisture. The hydrogen of the moisture is a much better moderator than the bulk product itself and therefore, the number of slow neutrons being scattered back towards the detector will be proportional to the hydrogen density or moisture. The slow neutrons are detected with a gas-filled ionization chamber. The gas becomes ionized, and the charged ions are collected on the center electrode, producing a small picoamp (10^{-12} A, ρA) current. This current is amplified and sent to the transmitter as a 0–20 mA signal. The transmitter then calculates the percent moisture by weight from the signal and the calibration constants and provides a 4–20 mA DC output signal proportional to the percent moisture.

Neutron Source

The 7200A housing contains the neutron source. A two-position shutter mechanism controls the amount of energy that is radiated outside the housing. When the shutter is closed and locked, the source is retracted, allowing for the safe storage, shipping, and installation of the instrument. With the shutter open, the source is moved towards the vessel to be measured.

Thermo Fisher uses Americium 241: Beryllium (Am241:Be). The isotope is doubly encapsulated in stainless steel capsules. These capsules are Tungsten Inert Gas welded and nitrogen leak tested. They are then secured in the center of the housing.

Due to the precautions taken during manufacture, the chance of leakage is remote. However, the United States Nuclear Regulatory Commission (NRC) requires that the source housing be leak tested at regular intervals, not to exceed three years. Canadian regulations require that leak test intervals not exceed one year. Refer to the neutron radiation safety guide (p/n 717905) for further information. Thermo Fisher is licensed to perform these tests and can do so through contract services. The first test or "wipe" is done at start-up by licensed personnel or a qualified representative.

If the source housing is damaged or the system is abandoned, the source housing must be disposed of properly. Regulations for the NRC, U.S. Department of Transportation, and the Canadian Nuclear Safety Commission are continuously being updated; contact Thermo Fisher for information on proper source disposal.

Neutron Detector

The neutron sensor is contained within the 7200A housing nearest the vessel. It is a slow neutron ion chamber detector that is filled with He3 or BF3 gas.

Warning BF3 is a pungent smelling, toxic, corrosive gas with a suffocating odor. Inhalation will cause moderate to severe irritation or burns to the respiratory system. Appropriate precautions must be taken to ensure the safety of personnel. ▲

The geometry of the sensor provides maximum accuracy and sensitivity with a minimum of external radiated energy. The geometry also minimizes the effects of outside energy on the detectors.

A negative potential is applied to the inside wall of the ion chamber. When the neutrons strike the gas in the detector, it becomes ionized. The voltage potential forces the charged ions to collect on the center electrode, producing a ρA current directly proportional to the incident neutron intensity detected.

Transmitter

The 1400S transmitter uses the signal from the detector to calculate the percent moisture and related measurement values. These values can be displayed, sent to serial ports, or used to drive current outputs and alarms. The transmitter also monitors system performance and generates system fault and warning alarms.

The transmitter is supplied in a NEMA 4X enclosure that is CSA certified for use in Div. 2 hazardous locations.

Note Refer to the equipment tag on the instrument to verify the hazardous location certifications. ▲

Communications & the Display

The integral keypad on the transmitter is normally used as the primary means of communication with the instrument. Menu selections, commands, and parameter values are entered using the keypad. The transmitter has a four-line display which shows either one menu item or up to eight readouts in alternation (four at a time).

The RS232 serial port can also be used to communicate with the instrument using a PC with terminal emulation software.

Inputs & Outputs

Refer to the following table.

Table 1–1.

Type	Characteristics	Comments
Transmitter input power	AC power: 110/220 Vac (100–240 V), 50/60 Hz, 17.2 W (standard) DC power: 24 Vdc (20–28 V), 12 W (optional)	If AC supply is selected, a dedicated AC power supply assembly is used. If DC power is selected, the DC supply is via I/O board that must include this option.
Current output	3.8–20.5 mA DC (adjustable operating range) Configurable as: Isolated, self-powered or Isolated, loop-powered (user-supplied 24 Vdc loop power input) Maximum load: 700 ohms	Default range is 4–20 mA DC. One current output standard. Maximum of two additional current outputs. Self-powered configuration is standard. Configure as loop-powered by removing a jumper.
Serial communications	RS232: 1 terminal block	Full duplex communication with remote terminal or PC.
Relays	2 optional relays on each I/O board, Form C SPDT, isolated, 8 A, 220 Vac	Maximum of 6 relays. Assign process alarms to control relays.
Display	Backlit, 4-line x 20-character LCD	English language setup menus. Maximum of 8 measurement readouts displayed 4 at a time in alternation.

Associated Documents

In addition to this guide, the following documents must be read and understood by all persons installing, using, or maintaining this equipment:

- MOLA Model 7200A installation guide (p/n 717903)
- Neutron Radiation Safety (p/n 717905)

Chapter 2
Getting Started

Communication Setup

Keyboard

The integral keypad and display on the transmitter are normally used to communicate with the instrument.

Serial

Alternately, the RS232 serial port supports communication with the instrument via a PC with terminal emulation software.

Connect the serial port on a PC directly to the instrument's RS232 port. The default communication settings for the instrument are 7 data bits, even parity, 1 stop bit, and 9600 baud.

Menu Structure

The menus are grouped into main menus and submenus.

The main menus can be accessed by pressing the right or left arrow successively from the normal display mode. Not all menus or submenus are relevant to the MOLA application. The main menus are:

- Setup Density, Den Alarms & MOLA
- Setup Additional Measurements
- Gauge Fine Tuning
- Modify or Reassign Current Outputs
- Set up Fault Alarms or Change Process Alarm Assignments
- Action Items: Erase Memory, Clear Alarms, Hold Outputs etc..
- Set up Serial Ports, Contact Inputs or Special Functions
- Security Service and Diagnostic Functions

Gauge Operation

Checking Hardware Setup

Before you start programming the gauge, check the setup of the configuration jumpers on the transmitter VPI board.

The VPI board is usually installed at the right end of the transmitter. This is the board that connects to the moisture sensor and the density signals if that option is selected.

The selection is made via three jumpers located on the front edge of the board: JP1, JP2, and JP3, with JP3 being located at the top edge of the board.

Table 2–1.

JP1	JP2	JP3	Detector Type
Short	Short	Open	MOLA without density detector[1]
Open	Short	Short	MOLA with density detector
Short	Short	Short	Memory blow away[2]

Notes:

[1]For MOLA applications without density compensation the jumpers will be: JP1 = short, JP2 = short, JP3 = open.

[2]Memory blow away is available in the event that memory becomes corrupted and the transmitter no longer accepts input from the keypad. Use this configuration as a last resort.

Initial Power-Up

The first time you apply power to the instrument, a screen similar to the one below is displayed on the transmitter. The "****" will be values programmed at the factory so that the gauge arrives already set up.

```
**** %H2O
**** g/ml
```

Figure 2–1.

If the transmitter display is blank after you apply power, check the following:

1. Adjust the display contrast. Press the up or down arrow keys on the keypad several times to increase or decrease the contrast.

2. Verify the power supply at the source.

3. Disconnect all power to the transmitter. Open it and verify:
   a. The power supply is properly seated on the main board and is properly wired. Refer to the MOLA installation guide.
   b. The ribbon cable from the transmitter display is properly seated on the CPU board.
   c. All boards are properly seated on the transmitter main board.

4. If the display still appears blank, contact Thermo Fisher.

Entering Data

The following table provides descriptions of the keys used on the transmitter.

Table 2–2.

Key	Action
Right arrow	Press to enter the setup menus and to step through the top-level menu headings. Also use to scroll through the list of menu options.
Up arrow	Return to the previous menu item or scroll through menu items in the reverse direction.
Left arrow	Press to return to the previous option.
Down arrow	Press to select an option and continue to the next menu item.
Period	Press once to enter a decimal. Press twice to enter the decimal in scientific notation. If you are entering data from a terminal keyboard, you can press **E** or **e** before entering the exponent value rather than pressing the period key twice.
Number keys	Press to enter data values.
Minus sign	Press to indicate a negative number.

Using the Setup Menus

The setup menus provide you with step-by-step procedures for entering the data required for instrument operation. In each menu item, data values that can be entered or changed are flashing. When accessing the setup menus, the display times out and returns to the measurement display if no entries are made for five minutes. Changes or entries you made up to that point are saved and used by the instrument. Continue with the setup by using the arrow keys to return to the menu most recently accessed.

To exit the setup menus, press **EXIT SETUP** on the transmitter keypad. This saves any changes you made and returns you to the measurement display.

Direct Access Method

The direct access method allows you to bypass the menu structure and directly access a specific menu item. Note that most menu items display a slightly different message when accessed directly. In order to use this method, you must know the direct access code (DAC or the keypad code). Parameter DACs have six digits, and commands DACs have one, two, or three digits.

To find the DAC for a particular menu item:

1. Scroll to the desired menu item.

2. If the menu item is not for a floating point number entry (an entry containing a decimal point), press the **period** key to display the DAC information screen.

   If the menu item is for a floating point entry, press the **period** key followed by the **up arrow** to display the DAC information screen.

Note Use the direct access method with caution. When entering or changing a parameter value for one menu item, you may also need to enter or modify the value of other menu items. ▲

Locating Direct Entry Codes

Following is an example of how to locate a DAC. The menu item displayed in Figure 2–2 is located within the Set up Density & MOLA menu. At this screen, press the **period** key. Figure 2–3 is then displayed. Note the keypad code: 015002. This is the number used to access this menu item via the direct access method. Press the **down arrow** to return to the previous screen.

Material Type is Single phase Continue ↓ Change →

Figure 2–2.

Value is 3 Item is data entry Keypad code 015002 (HEX = 0F0C) Press ↓

Figure 2–3.

Note If you have a menu with floating point entry, the method to get the DAC is to press the **period** key followed by the **up arrow** while at that menu. ▲

Using Direct Entry Codes

The following example will show you how to use the DAC.

1. From the measurement display, press **EXIT SETUP** on the keypad. Figure 2–4 is displayed.

Key in entry ID or command code then ↓ Press↑ to exit.

Figure 2–4.

2. In this example, you will access the density signal time constant. The DAC for this screen is 007004. Enter it and press the **down arrow**. Figure 2–5 is then displayed.

Density signal Time constant 4 seconds

Figure 2–5.

3. If the time constant value shown is correct, press **EXIT SETUP** to keep the current value and return to the measurement display. If not, correct the value and press the **down arrow**. Verify the value is correct and press **EXIT SETUP**. The corrected value is stored and used by the instrument.

Resetting Factory Defaults

If the display shown in Figure 2–1 is not displayed upon power-up, the instrument has been at least partially set up. If you do not want the instrument to use these settings or if the instrument has been moved to a new location, you can restore factory defaults.

Use command DAC 82 to reset all user entries except communication settings to factory defaults. Use command DAC 74 to reset all user entries including communication settings to factory defaults.

Additional Menu Items

The menu structure contains two “layers” of menu items. The user layer is the default layer and is adequate for most applications. The service layer provides numerous special purpose menu items and can be enabled using the Special Functions menu.

Saving Entries

If you exit the setup menus at any time, any changes or entries you made are automatically saved and used by the software. To exit the setup menus, press **EXIT SETUP** on the transmitter keypad.

If you do not exit the setup menus, entries or changes are stored and used by the software after five minutes of inactivity.

Chapter 3

MOLA without Density Compensation

Start-Up

Before programming the transmitter, the configuration jumpers in the transmitter must be set up as described earlier in this manual:

- JP1 (bottom jumper) = short
- JP2 (middle jumper) = short
- JP3 (top jumper) = open

Basic Configuration

From the measurement display, press the right arrow to move to the Set up Density & MOLA menu heading (Figure 3–1).

```
Set up density
& MOLA ↓
← Exit Setup
        Other functions →
```

Figure 3–1.

Press the **down arrow** to begin the setup process.

Meas #1 reading for 20mA output: 0.000 %H2O NEXT ↓	Meas #1 reading for 4mA output: 0.000 %H2O NEXT ↓

Figure 3–2.

By default, the 4–20 mA current output is assigned to the primary measurement (Meas #1). These menu items prompt you to specify the measurement values that correspond to the maximum and minimum current output values. Note that the range for the primary measurement value specified for the current output does not affect the range of the measurement values that are displayed.

MOLA Setup →

NEXT ↓

Figure 3–3.

This is the main submenu for setting up the MOLA. As the menu shows, press the **right arrow** key to enter the MOLA setup.

Hardware status:
NV Protect active

Next ↓

Figure 3–4.

This menu shows the status of the non-volatile memory. No entry is required. Press the **down arrow** to continue.

Hardware status:
MOLA No DenComp

Next ↓

Figure 3–5.

This menu shows the status of the configuration jumpers on the VPI board (see “Start-Up” at the beginning of this chapter). After verifying the configuration is correct, press the **down arrow** to continue.

Density Hold Value For MOLA .4800 g/ml Next ↓

Figure 3–6.

This item displays the fixed value for the bulk density in g/mL. Density (ρ) is how much mass (m) a material has for a given volume (v). Essentially, it is a measure of how tightly matter is packed together and is determined with the following formula:

$$\rho = \frac{m}{v}.$$

This value must be determined before the moisture calibration.

Example: If the average bulk density is 34 lb/ft^3, first convert the value to g/mL by dividing it by 62.43

$$\frac{34}{62.43} = 0.54446.$$

Then enter the value "0.5446" g/mL. Press the **down arrow**.

Note The bulk density of the measured material is assumed to be constant in this section since the application was set to use the MOLA without density compensation. The gauge will use this fixed value for the calibration and its calculations of percent moisture by weight. If the average bulk density is not known, enter "0.48" g/mL, which corresponds to a typical value of 30 lb/ft^3 for coke. ▲

MOLA signal Time constant 4 seconds Next ↓

Figure 3–7.

This item displays the time constant used by the transmitter to average the signal from the MOLA. You can adjust this parameter after calibration to suit the measurement requirements.

Reducing the time constant improves the response time to a process variation but decreases the precision of the reading (the standard deviation of the reading increases).

% Fixed Hyd.
in dry mat'l
0.000 %
Next ↓

Figure 3–8.

Specify the percent hydrogen by weight in the dry material to be measured. The default value is 0%. **Thermo Fisher recommends that you do not change this value.**

Atten. Coef Hy
.1530
Next ↓

Figure 3–9.

The attenuation coefficient for hydrogen is a physical constant used for density compensation. Its value is 0.1530 g/cm^2. **Do not change this value.**

% Bound Moisture
0.000 %
Next ↓

Figure 3–10.

The default for percent bound moisture is 0.000%. **Do not change this value.**

Background Intrcpt
50.00
Next ↓

Figure 3–11.

The default for the background intercept is 50. **Do not change this value.**

Backgnd Slope 0.000 Next ↓

Figure 3–12.

The default for the background slope is 0.000. For moisture in coke applications, set this value to 15000 prior to taking the initial calibration samples.

Moisture Cal Intrcpt 1.825E4 Next ↓

Figure 3–13.

The moisture cal intercept is the value of the MOLA signal when the moisture is 0%. This value and the moisture slope are the two main values constituting the moisture calibration. Enter "1.825E4" as a starting point.

Moisture Cal Slope 3.175E5 Next ↓

Figure 3–14.

The moisture cal slope is the slope of the moisture signal versus moisture density. This value will be determined in the calibration section with the cal intercept value. Enter "3.175E5" as a starting point.

MOLA CPS TO HYDEN Conv Factor 2222 (read only) Next ↓

Figure 3–15.

This read-only screen displays an engineering conversion factor. No entry is required. Press the **down arrow** to continue.

MOLA Atten. Coef.
Ratio
1.974
(read only) Next ↓

Figure 3–16.

This read-only screen displays an engineering conversion factor. No entry is required. Press the **down arrow** to continue.

Ave MOLA sig
0.000

(read only) Next ↓

Figure 3–17.

Average MOLA signal during calibration. This feature is not available in the current version. No entry required.

Press **EXIT SETUP** to return to the measuring display menu.

Caution In order for the calibration program to operate correctly, the transmitter must be displaying a moisture value near the actual value before samples are taken. In some situations the default parameters mentioned above will result in a calculated moisture value of less than 0.00, and this will be displayed as 0.00% moisture. In order to increase the displayed percent moisture to a more reasonable value, simply **decrease** the Moisture Cal Intercept and Moisture Cal Slope parameters **by the same percentage** until the displayed percent moisture value is near the expected value. ▲

Calibration

Calibration of a MOLA without density compensation consists of evaluating moisture cal intercept (c) and moisture cal slope (a_m). Two parameters are used to relate the MOLA output current (I) to the density of moisture (ρ_m):

$$I = c + a_m \rho_m . \qquad (3.1)$$

MCPP Program

The MOLA Cal Pro Plus (MCPP) calibration program enables you to easily calibrate the instrument. To run MCPP, copy the .exe file and the .txt files from the MOLA CD to any directory on a PC. Double-click the .exe file, and you will be prompted to choose whether the program should generate an input file template or perform a calibration and generate an output file.

Input Data Template

The input data template is called "CalInput.txt". The file must contain the old calibration constants (the ones used by the transmitter in the measurements) and calibration data (density and moisture reported by the lab, density gauge reading, and MOLA moisture reading). Note that the dry hydrogen content is fixed at 0.0000.

```
 Input File Template
Generated by 962-720001   Version 1.00
 Old Calibration Constants:

    317500.   Moisture Cal Slope
     15000.   Backgnd Slope
     18250.   Moisture Cal Intrcpt

 Data:

   Lab Density    Lab Moisture    Density Gauge    MOLA Moisture     Fixed Hyd.
     (g/ml)            %              (g/ml)             %          in Dry Matl %

     0.4460         16.1718          0.4460          27.3745          0.0000
     0.4460         16.1428          0.4460          27.1839          0.0000
     0.4460         11.1135          0.4460          22.0465          0.0000
     0.4460         16.3465          0.4460          27.5109          0.0000
     0.4460          8.5298          0.4460          19.3223          0.0000
```

Figure 3–18. Sample input file using MCPP

Use Microsoft® Notepad to open the .txt file. When editing the template, note that data values must be separated by tabs or spaces. Additionally, the correct number of lines, including blank lines, must be maintained. Refer to the sample shown in Figure 3–18. If you enter data on the blank line between the data header (Lab Density, etc.) and the first data line, the program will ignore it. If you insert another blank line so that there will be two between the data header and first data line, the program will crash.

Note The default value for the Fixed Hydrogen in Dry Material % column is 2.0000%. For moisture in coke applications you must change the default to the actual value of 0.0000%. ▲

Note When the program generates a new template, the file is called "InputTemplate.txt". Rename this file to "CalInput.txt" otherwise the program will not use the file to calculate the new calibration. ▲

Calibration Output

To use the program to perform a calibration, enter the values for the calibration parameters (c and a_m). The recommended initial values for coke are:

- $\chi_{Hdry} = 0$
- $a_m = 317500$
- $c = 18250$

Take at least 20 measurements with moisture content and record the density and moisture reported by the transmitter and the density and moisture reported by the lab. Then run the program to update the calibration constants. When run, the program generates an output data file called "CalOutput.txt". If the calibration is successful, the file will contain:

- Date and time
- Data used in calibration
- Old and new values for the three calibration constants
- Average error
- Warning messages

Figure 3–19 is an example of a completely successful calibration output file, although it contains a warning that data was insufficient for a complete calibration. This is because only two calibration constants (c and a_m) were used. If you had performed a calibration with density compensation, you would have used a third constant, Backgnd Slope (a_d). See Chapter 4 for instructions on calibration with density compensation.

```
**************************************************
***                                            ***
***           Calibration Report               ***
***                                            ***
***     Produced  1Mar 2007    14:25:51        ***
***   Generated by 962-720001    Version 1.00  ***
***                                            ***
**************************************************

 Input Template
Generated by 962-720001   Version 1.00

 Data Points:           5
   Lab Density   Lab Moisture    Density Gauge   MOLA Moisture     Fixed Hyd.
     (g/ml)          %              (g/ml)            %            in Dry Matl %

     0.4460       16.1718          0.4460          27.37           0.0000
     0.4460       16.1428          0.4460          27.18           0.0000
     0.4460       11.1135          0.4460          22.05           0.0000
     0.4460       16.3465          0.4460          27.51           0.0000
     0.4460        8.5298          0.4460          19.32           0.0000
******************************************************************

 Calibration Constants

                         Old          New

Moisture Cal Slope     3.175E+05    3.131E+05
Backgnd Slope          1.500E+04    1.500E+04
Moisture Cal Intrcpt   1.825E+04    3.231E+04
******************************************************************

Average Current Error        0.11%

Lab Moisture %   MOLA Moisture %   MOLA Moisture %   Error %
                      Old               New

 16.1718            27.37             16.63           0.46
 16.1428            27.18             16.44           0.30
 11.1135            22.05             11.35           0.23
 16.3465            27.51             16.76           0.42
  8.5298            19.32              8.64           0.11

Average Moisture Error   0.146%

 Calibration Completed Successfully
******************************************************************

 Warning: Data Insufficient for Complete Calibration
 Possible Data Deficiencies:

Moisture Density Spread:       0.0145
Dry Density Spread:            0.0145
Moisture-Dry Correlation:     -1.0000

 Calibration Constants Updated:

 Moisture Cal Slope
 Intrcpt
```

Figure 3–19. Sample of a successful calibration output file

If the calibration is not successful, the file will report an error, as shown in Figure 3–20.

```
**************************************************
***                                            ***
***           Calibration Report               ***
***                                            ***
***     Produced 28Feb 2007    15:11: 5        ***
***   Generated by 962-720001    Version 1.00  ***
***                                            ***
**************************************************

 ***********************
     Input Data Format Error
 ***********************
```

Figure 3–20. Sample of a failed calibration output file

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Chapter 4
MOLA with Density Compensation

Start-Up

Before programming the transmitter, the configuration jumpers in the transmitter must be set up as described earlier in this manual:

- JP1 (bottom jumper) = open
- JP2 (middle jumper) = short
- JP3 (top jumper) = short

Basic Configuration

From the measurement display, press the right arrow to move to the Set up Density & MOLA menu heading (Figure 4–1).

```
Set up density
& MOLA ↓
← Exit Setup
        Other functions →
```

Figure 4–1.

Press the **down arrow** to begin the setup process.

```
Meas #1 reading for
20mA output:
0.000 %H2O
                NEXT ↓
```

```
Meas #1 reading for
4mA output:
0.000 %H2O
                NEXT ↓
```

Figure 4–2.

By default, the 4–20 mA current output is assigned to the primary measurement (Meas #1). These menu items prompt you to specify the measurement values that correspond to the maximum and minimum current output values. Note that the range for the primary measurement value specified for the current output does not affect the range of the measurement values that are displayed.

```
MOLA Setup →

             NEXT ↓
```

Figure 4–3.

This is the main submenu for setting up the MOLA. As the menu shows, press the **right arrow** key to enter the MOLA setup.

```
Hardware status:
NV Protect active

        Next ↓
```

Figure 4–4.

This menu shows the status of the non-volatile memory. No entry is required. Press the **down arrow** to continue.

```
Hardware status:
MOLA SCINT DenComp

        Next ↓
```

Figure 4–5.

This menu shows the status of the configuration jumpers on the VPI board (see "Start-Up" at the beginning of this chapter). After verifying the configuration is correct, press the **down arrow** to continue.

```
Density Hold Value
For  MOLA
.4800 g/ml
          Next ↓
```

Figure 4–6.

This item displays the fixed value for the bulk density in g/mL. Density (ρ) is how much mass (m) a material has for a given volume (v). Essentially, it is a measure of how tightly matter is packed together and is determined with the following formula:

$$\rho = \frac{m}{v}.$$

This value must be determined before the moisture calibration.

Example: If the average bulk density is 34 lb/ft^3, first convert the value to g/mL by dividing it by 62.43

$$\frac{34}{62.43} = 0.54446.$$

Then enter the value "0.5446" g/mL. Press the **down arrow**.

Note Verify density output of the density gauge is set at 4–20 mA, representing 0.3–0.8 g/mL. ▲

```
MOLA signal
Time constant
32 seconds
          Next ↓
```

Figure 4–7.

For systems with density compensation, it is important to select a time constant that provides quick response to change in process levels and, at the same time, offers the most stable density signal to the input on the MOLA. Selecting a time constant that is too long may result in the density reading not settling properly after a process level change, and selecting a time constant that is too short may result in an overall noisy density signal. Both types of selections can cause erroneous density values to be passed to the MOLA.

A time constant of 32 seconds is recommended, as it provides an adequately quick response and maximizes the integration time.

```
% Fixed  Hyd.
in dry mat'l
0.000 %
            Next ↓
```

Figure 4–8.

This entry is used to specify the percent hydrogen by weight in the dry material to be measured. The default value is 0%, the correct value for coke. For other materials, refer to the calibration discussion later in this chapter.

```
Atten. Coef Hy
.1530

            Next ↓
```

Figure 4–9.

The attenuation coefficient for hydrogen is a physical constant used for density compensation. Its value is 0.1530 g/cm^2. **Do not change this value.**

```
% Bound Moisture
0.000 %

            Next ↓
```

Figure 4–10.

The default for percent bound moisture is 0.000%. **Do not change this value.**

```
Background Intrcpt
50.00

            Next ↓
```

Figure 4–11.

The default for the background intercept is 50. **Do not change this value.**

Backgnd Slope
0.000
Next ↓

Figure 4–12.

The default for the background slope is 0.000. For moisture in coke applications, set this value to 15000 prior to taking the initial calibration samples.

Moisture Cal
Intrcpt
1.825E4
Next ↓

Figure 4–13.

The moisture cal intercept is the value of the MOLA signal when the moisture is 0%. This value and the moisture slope are the two main values constituting the moisture calibration. Enter "1.825E4" as a starting point.

Moisture Cal
Slope
3.175E5
Next ↓

Figure 4–14.

The moisture cal slope is the slope of the moisture signal versus moisture density. This value will be determined in the calibration section with the cal intercept value. Enter "3.175E5" as a starting point.

MOLA CPS TO HYDEN
Conv Factor
2222
(read only) Next ↓

Figure 4–15.

This read-only screen displays an engineering conversion factor. No entry is required. Press the **down arrow** to continue.

MOLA Atten. Coef.
Ratio
1.974
(read only) Next ↓

Figure 4–16.

This read-only screen displays an engineering conversion factor. No entry is required. Press the **down arrow** to continue.

Ave MOLA sig
0.000

(read only) Next ↓

Figure 4–17.

Average MOLA signal during calibration. This feature is not available in the current version. No entry required.

Press **EXIT SETUP** to return to the measurement display menu.

Caution In order for the calibration program to operate correctly, the transmitter must be displaying a moisture value near the actual value before samples are taken. In some situations the default parameters mentioned above will result in a calculated moisture value of less than 0.00, and this will be displayed as 0.00% moisture. In order to increase the displayed percent moisture to a more reasonable value, simply **decrease** the Moisture Cal Intercept and Moisture Cal Slope parameters **by the same percentage** until the displayed percent moisture value is near the expected value. ▲

Calibration

Perfectly dry material can contain hydrogen in forms other than water. For example, coal may contain methane (CH_4). Since the atomic weight of carbon is 12 and the atomic weight of hydrogen is 1, the total atomic weight of methane is

$$12 + (1 \times 4) = 16.$$

Divide the atomic weight of the hydrogen by the total atomic weight to determine the % by weight of hydrogen in methane:

$$\frac{4}{16} = \frac{1}{4}.$$

So the percent by weight of hydrogen in methane is 1/4. If 1 kg of coal has 50 g of methane, the dry hydrogen content is:

$$\chi_{Hdry} = \frac{50\text{ g}}{1000\text{ g}} \times \frac{1}{4} = 0.0125 = 1.25\%. \quad (4.1)$$

χ_{Hdry} for coal typically runs between 4.25% and 4.75%. For coke, χ_{Hdry} is zero. The calibration procedure described here cannot determine χ_{Hdry} so it must be measured separately.

Three parameters are used to relate the MOLA output current (I) to the densities of dry material (ρ_d) and moisture (ρ_m):

$$I = c + a_d\rho_d + a_m\rho_m. \quad (4.2)$$

There are four parameters involved in the calibration of MOLA with density compensation:

Table 4–1.

Parameter	Direct Entry Code	Equation Variable
% Fixed Hyd. in Dry Matl	081003	χ_{Hdry}
Backgnd Slope	147003	a_d
Moisture Cal Intrcpt	154003	c
Moisture Cal Slope	155004	a_m

MCPP Program

The MOLA Cal Pro Plus (MCPP) calibration program enables you to easily calibrate the instrument. The purpose of calibration is to obtain three of the calibration parameters discussed earlier: c, a_d, and a_m.

To run MCPP, copy the .exe file and the .txt files from the MOLA CD to any directory on a PC. Double-click the .exe file, and you will be prompted to choose whether the program should generate an input file template or perform a calibration and generate an output file.

Input Data Template

The input data template is called “CalInput.txt”. The file must contain the old calibration constants (the ones used by the transmitter in the measurements) and calibration data (density and moisture reported by the lab, density gauge reading, MOLA moisture reading, and dry hydrogen content).

```
 Input File Template
Generated by 962-720001   Version 1.00
 Old Calibration Constants:

     317500.   Moisture Cal Slope
      15000.   Backgnd Slope
      18250.   Moisture Cal Intrcpt

 Data:

   Lab Density   Lab Moisture   Density Gauge   MOLA Moisture     Fixed Hyd.
     (g/ml)           %             (g/ml)            %          in Dry Matl %

     0.4273        16.1718         0.4422         27.4111          2.0000
     0.6420        16.1428         0.6643         26.3168          2.0000
     0.5539        11.1135         0.5704         21.4688          2.0000
     0.5860        16.3465         0.6066         26.7992          2.0000
     0.7155         8.5298         0.7350         18.2755          2.0000
```

Figure 4–18. Sample input file using MCPP (with material that is not coke)

```
 Input File Template
Generated by 962-720001   Version 1.00
 Old Calibration Constants:

     317500.   Moisture Cal Slope
      15000.   Backgnd Slope
      18250.   Moisture Cal Intrcpt

 Data:

   Lab Density   Lab Moisture   Density Gauge   MOLA Moisture     Fixed Hyd.
     (g/ml)           %             (g/ml)            %          in Dry Matl %

    0.4273        16.1718        0.4351          27.49          0.0000
    0.6420        16.1428        0.6535          26.39          0.0000
    0.5539        11.1135        0.5606          21.53          0.0000
    0.5860        16.3465        0.5968          26.87          0.0000
    0.7155         8.5298        0.7219          18.32          0.0000
```

Figure 4–19. Sample input file using MCPP (with coke)

Use Microsoft® Notepad to open the .txt file. When editing the template, note that data values must be separated by tabs or spaces. Additionally, the correct number of lines, including blank lines, must be maintained. Refer to the sample shown in Figure 4–18 or 4–19. If you enter data on the blank line between the data header (Lab Density, etc.) and the first data line, the program will ignore it. If you insert another blank line so that there will be two between the data header and first data line, the program will crash.

Note The default value for the Fixed Hydrogen in Dry Material % column is 2.0000%. For moisture in coke applications you must change the default to the actual value of 0.0000%. ▲

Note When the program generates a new template, the file is called “InputTemplate.txt”. Rename this file to “CalInput.txt” otherwise the program will not use the file to calculate the new calibration. ▲

Calibration Output

To use the program to perform a calibration, enter the values for the calibration parameters (c, a_d, and a_m). The recommended initial values for coke are:

- $\chi_{Hdry} = 0$
- $a_m = 317500$
- $a_d = 15000$
- $c = 18250$

For materials other than coke, a_d may be considerably larger if the dry material contains hydrogen.

Take at least 20 measurements with moisture content and record the density and moisture reported by the transmitter and the density and moisture reported by the lab. Then run the program to update the calibration constants.

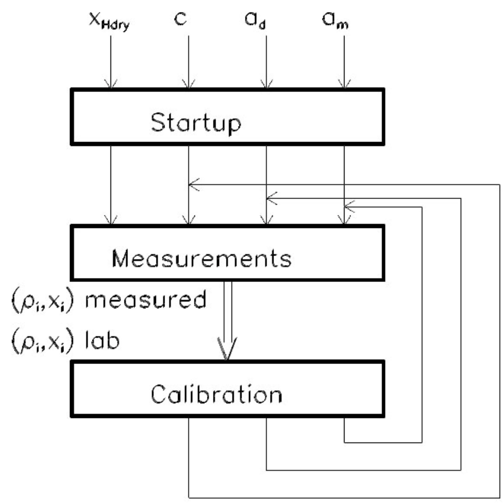

Figure 4–20. Sequence of operations

When run, the program generates an output data file called "CalOutput.txt". If the calibration is successful, the file will contain:

- Date and time
- Data used in calibration
- Old and new values for the three calibration constants
- Average error
- Warning messages

Figure 4–21 is an example of a completely successful calibration output file. In this case, all three constants were updated. Figure 4–22 is an example of a partially successful calibration output file, as only two constants were updated. If the calibration is not successful, the file will report an error, as shown in Figure 4–23.

```
  *************************************************
  ***                                           ***
  ***         Calibration Report                ***
  ***                                           ***
  ***   Produced 28Feb 2007    15: 7:24         ***
  ***  Generated by 962-720001    Version 1.00  ***
  ***                                           ***
  *************************************************

 Input Template
Generated by 962-720001   Version 1.00

 Data Points:             5
   Lab Density    Lab Moisture    Density Gauge    MOLA Moisture     Fixed Hyd.
     (g/ml)            %              (g/ml)             %          in Dry Matl %

      0.4273        16.1718          0.4422            27.41          2.0000
      0.6420        16.1428          0.6643            26.32          2.0000
      0.5539        11.1135          0.5704            21.47          2.0000
      0.5860        16.3465          0.6066            26.80          2.0000
      0.7155         8.5298          0.7350            18.28          2.0000
******************************************************************

 Calibration Constants

                          Old         New

Moisture Cal Slope     3.175E+05   3.480E+05
Backgnd Slope          1.500E+04   3.775E+04
Moisture Cal Intrcpt   1.825E+04   2.213E+04
******************************************************************

Average Current Error        0.06%

Lab Moisture %   MOLA Moisture %   MOLA Moisture %   Error %
                      Old               New

 16.1718            27.41             16.16          -0.01
 16.1428            26.32             16.11          -0.04
 11.1135            21.47             11.11          -0.01
 16.3465            26.80             16.38           0.04
  8.5298            18.28              8.54           0.01

Average Moisture Error    0.011%

 Calibration Completed Successfully
******************************************************************

 All 3 Calibration Constants Updated
```

Figure 4–21. Sample of a successful calibration output file

```
***************************************************
***                                             ***
***          Calibration Report                 ***
***                                             ***
***   Produced 28Feb 2007    15: 9:33           ***
***  Generated by 962-720001    Version 1.00    ***
***                                             ***
***************************************************

 Input Template
Generated by 962-720001   Version 1.00

 Data Points:           2
   Lab Density    Lab Moisture    Density Gauge    MOLA Moisture      Fixed Hyd.
     (g/ml)           %               (g/ml)             %           in Dry Matl %

      0.5539         11.1135           0.5704            21.47          2.0000
      0.5860         16.3465           0.6066            26.80          2.0000
******************************************************************

 Calibration Constants

                          Old         New

Moisture Cal Slope      3.175E+05   3.495E+05
Backgnd Slope           1.500E+04   1.500E+04
Moisture Cal Intrcpt    1.825E+04   3.322E+04
******************************************************************

Average Current Error         0.01%

Lab Moisture %    MOLA Moisture %    MOLA Moisture %    Error %
                       Old                New

 11.1135             21.47               11.12             0.00
 16.3465             26.80               16.34            -0.01

Average Moisture Error    0.004%

 Calibration Completed Successfully
******************************************************************

 Warning: Data Insufficient for Complete Calibration
 Less Than 3 Data Points Supplied

 Calibration Constants Updated:

 Moisture Cal Slope
 Intrcpt
```

Figure 4–22. Sample of a partially successful calibration output file

```
***************************************************
***                                             ***
***          Calibration Report                 ***
***                                             ***
***   Produced 28Feb 2007    15:11: 5           ***
***  Generated by 962-720001    Version 1.00    ***
***                                             ***
***************************************************

 **********************
     Input Data Format Error
 **********************
```

Figure 4–23. Sample of a failed calibration output file

Additional Notes on Calibration Output Files

Average Error

The average error is the average (σ) of the difference between formula (4.2) and the actual measured MOLA current:

$$\Delta = \frac{c^{new} + a_d^{new}\rho_d + a_m^{new}\rho_m}{I} - 1. \qquad (4.3)$$

The error is expressed as a percentage and normalized to the number of degrees of freedom (number of data points minus number of free parameters). The error must be zero for the number of data points $N \leq 3$.

Warning Messages

No warning messages are generated if all three calibration constants can be derived from the data. If the data is insufficient, the program generates a warning message after performing the following steps:

- Fix a_d at its current value and updates a_m and c.
- If the previous step fails due to insufficient data, fix a_d and a_m at their current values and update c.

Typical reasons for insufficient data include:

- Less than three data points.
- The values of p_m or p_d are very close across the data set. The variations (σ) across the data set are reported as **Moisture Density Spread** and **Dry Density Spread**. For good calibration, these values should be much more than the precision of the laboratory analysis.
- Dry and moisture densities are strongly correlated (correlation coefficient close to ± 1). This is an unusual possibility, but the program still watches for it. Condition is reported as **Moisture-Dry Correlation**.

Three measurements with sufficient variability in density and moisture are enough for a successful calibration. If there are less than three measurements or if the data is insufficient in one of the ways discussed above, only some of the calibration constants will be updated; however, it is always best to provide at least three measurements.

Note The calibration program does not update the constants in the transmitter. The user must enter the new constants manually. ▲

Note Partially successful calibration output files will report the calibration as “successful” if at least one calibration constant was updated. ▲

Chapter 5
Additional Measurements

Up to seven additional measurements can be defined using the Set up Additional Measurements menu group.

Note Record the measurements you set up so you have a list of them available for future reference. ▲

Menu Items

From the normal display screen, press the **right arrow** twice. The screen below is displayed.

Set up additional
measurements
(readouts). ↓
Other functions →

Figure 5–1.

Press the **down arrow** to continue.

NOTE: Meas. #1 is the
Primary measurement
See “Set up density”
to modify. NEXT↓

Figure 5–2.

Measurement 1 is assigned to the density measurement by default. You should use the Setup Density & MOLA menu to modify this measurement. Access this menu group to set up measurements 2–8. Press the **down arrow**.

```
Assign & set up
measurement 2 →

              NEXT↓
```

Figure 5–3.

The first time you access this menu, you are prompted to set up measurement 2. After setting up each additional measurement, you are prompted to assign and set up the next measurement.

```
Reading represented by
measurement 2 is
Dry Den
    NEXT↓  CHANGE→
```

Figure 5–4.

To change the readout type to %H2O, press the **right arrow**. To continue without changing the readout, press the **down arrow**.

```
Dry Den
units = g/ml
  To change, press →
         NEXT↓
```

Figure 5–5.

Select the units for this measurement then press the **down arrow**.

```
Set up alarm 2
(Alarm point, etc. →

         NEXT↓
```

Figure 5–6.

By default, all alarms are assigned to the primary measurement, but once you have set up additional measurements, you can assign alarms to them. Press the **right arrow** to assign an alarm to this measurement.

```
Do  display mea 2
% H2O
change to  "Do not"→
           NEXT↓
```

Figure 5–7.

This menu allows you to choose whether to display the measurement or not. Press the **down arrow** to continue.

```
Highest expected
reading
0.000% H2O
         NEXT↓
```

```
Lowest expected
reading
0.000% H2O
         NEXT↓
```

Figure 5–8.

If the reading goes above 9999 for any measurement, these menu items become active. See "Display Scaling" later in this chapter.

```
Position of decimal in
readout 2         0000.
(%H2O)                |
  NEXT↓  ←CHANGE→
```

Figure 5–9.

Use the left or right arrow to change the decimal point position. The readout value is limited to four digits plus the decimal point.

```
←Exit from:
Modify setup of
Measurement 2
%H2O
```

Figure 5–10.

Press **left arrow** to finish. Then press **EXIT SETUP**.

Display Scaling

Measurement readout values are displayed using four numeric digits and a decimal point. The Highest Expected Reading and Lowest Expected Reading menu items allow you to scale the displayed readout values. The display scaling menu items are enabled when a value greater than 9999 is entered for the highest expected reading menu item. Display scaling does not change the units displayed for the readout.

If the measurement is assigned to drive the current output, the reading for 20.00 mA output and reading for 4.000 mA output menu items (Figure 4–2) are displayed instead of the highest expected and lowest expected reading menu items. For display scaling purposes, these menu items are equivalent. Display scaling only affects the displayed readout value, not the actual measurement value computed by the gauge. The actual values (not scaled) are used for any alarms you assign to this measurement.

Highest expected reading 0.000% H2O NEXT↓	Lowest expected reading 0.000% H2O NEXT↓

Figure 5–11.

Highest expected reading: If you expect the maximum measurement readout to exceed four digits (value greater than 9999), enter an estimate of the maximum measurement value in the highest expected reading menu item. If you set a highest expected reading value of 10000 or greater (more than four digits), three additional menu items are displayed, allowing you to set up display scaling so the gauge's display is meaningful throughout the expected range. The value for the highest expected reading is not critical; pick a convenient number with the correct order of magnitude. If the actual measurement exceeds the range you expect, the readout still displays the correct, scaled measurement value as long as the scaled value can be displayed in four digits. Any value up to 99990 can be displayed correctly (divided by 1000 and displayed as 99.99).

Lowest expected reading: This menu item is displayed if you set a highest expected reading value greater than 9999 for a measurement. To scale the displayed value by a constant factor (displayed value = actual value/10), leave this parameter and the Scale Actual to Low End Readout menu item set to zero. If you scale both the highest expected and lowest expected readings, the gauge performs an interpolation to scale the actual measured value from the range specified by the highest and lowest expected readings to the range specified by the scale high end and low end readout values.

Scale actual 4.000E4 { gal/d } to high end readout of 40.00 NEXT↓ HELP →

Scale actual 0.000 { gal/d } to low end readout of 0.000 NEXT↓ HELP →

Figure 5–12.

Scale to high end readout: This menu item is displayed if you set a highest expected reading value greater than 9999 for a measurement. Enter the desired readout value to be displayed for the highest expected reading.

Scale to low end readout: This menu item is displayed if you set a highest expected reading value greater than 9999 for a measurement. Enter the desired readout value to be displayed for the lowest expected reading. To scale the displayed value by a constant factor (displayed value = actual value/1000), leave this parameter and the lowest expected reading parameter set to zero. If you scale both the highest expected reading and the lowest expected reading, the gauge performs an interpolation to scale the actual measured value from the range specified by the highest and lowest expected readings to the range specified by the scale high end and low end readout values.

Custom Units Messages

This menu item is displayed if you set a highest expected reading value greater than 9999 for a measurement. By default, the original units are displayed for the scaled value on the measurement display. This menu item allows you to set up a units message up to ten characters long. Up to eight custom messages can be defined using any combination of ASCII characters up to ten characters in length.

Set up custom units messages → NEXT↓

Figure 5–13.

Chapter 6
The Current Output

The primary measurement (density) is assigned to the current output by default. To assign a measurement other than the primary measurement to a current output, the measurement must first be set up using the Set up Additional Measurements menu (Chapter 5). You can then use the Modify or Reassign Current Output menu to assign the current output to the desired measurement. Finally, to specify the measurement range for the current output, return to the Set up Additional Measurements menu, enter the setup menu for the desired measurement number, and enter the measurement values corresponding to the maximum and minimum current output values.

Two different measurements can be assigned to control the current output, with one assigned to the current output in normal mode and the second assigned to the current output in alternate mode. The current output can be set up to switch from normal mode to alternate mode when an alarm is triggered. You can also directly enter a command to force a switch between normal and alternate modes.

Modify or re-assign
current output↓

Other functions→

Figure 6–1.

Press the **down arrow** to access the menu items.

Maximum current output 20.00 mA (4.000 to 20.00) NEXT↓	Minimum current output 4.00 mA (.001 to 20.00) NEXT↓

Figure 6–2.

The maximum current output values ranges from the minimum current output value to 20.00 mA (default). Enter the value and press the **down arrow**.

The minimum current output value ranges from 0.0001 mA to the maximum current output. The default is 4.000 mA. The value should be set to 2.0 mA or greater. Entering “0.0” sets the minimum current output to its default.

Mea 1: g/ml is sent to current out 1 in normal mode. NEXT↓ CHANGE→	Mea 1: g/ml is sent to current out 1 in alternate mode. NEXT↓ CHANGE→

Figure 6–3.

These menu items are only displayed if you set up two or more measurements. Assign a measurement to the current output in normal and alternate modes. Select from the primary measurement (Mea 1) and any additional measurements that you have set up.

Correction factor for current output 1 at maximum: 1.000 NEXT→	Correction factor for current output 1 at minimum: 1.000 NEXT→

Figure 6–4.

You can fine tune the maximum and minimum current output values to correct for any variation among systems. The current output value is scaled by the value you enter.

```
Current output
hold mode value
50.00 % of scale
          NEXT↓
```

Figure 6–5.

Enter the desired value for the midrange hold value for the current output. Value is entered as a percentage of the maximum current output value. The default is 50 percent.

Chapter 7

Set up Alarms

The Set up Alarm menus allow you to assign and set up a process alarm for the primary measurement selected in the previous menu item. You can set up to 16 process alarms. We recommend keeping a written record of the setup (assigned measurement, set point, clear point, etc.) for each alarm. After you set up alarm 1, the menu to set up alarm 2 will become available.

```
Set up alarm 1
(Alarm point, etc.) →

          NEXT↓
```

Figure 7–1.

Press the **right arrow** to enter the menu.

```
←Exit alarm 1 setup
Alarm 1 set point
2.000 g/ml
      NEXT↓ HELP→
```

Figure 7–2.

Enter a set point, the measurement value at which the alarm activates. You must enter a set point to activate the rest of the menu.

```
Alarm 1 clear based
on clr point
Chng to "dead band" →
Continue as is. ↓
```

Figure 7–3.

An alarm is defined with either a set point/clear point or a set point/dead band configuration. The set point defines the measurement value at which the alarm is activated. The clear point or dead band defines the measurement value at which the alarm is cleared (alarm ceases).

A clear point sets a fixed measurement value at which the alarm clears. The value of the clear point is independent of the set point and remains the same even if the set point is moved.

A dead band defines a fixed distance between the set point and an implicit clear point. If the set point is moved, the implicit clear point moves also, maintaining a distance from the set point specified by the dead band. For example, if a set point is defined at 2.5 g/mL and the dead band is set at 1.0 g/mL, the implicit clear point would be at 3.5 g/mL. Changing the set point from 2.5 g/mL to 3.5 g/mL will move the implied clear point from 3.5 g/mL to 4.5 g/mL. The relative distance between the implied clear point and the set point remains fixed at 1.0 g/mL, the dead band value.

Use a clear point configuration if you want to be able to change the alarm set point in the future without affecting the alarm clear point. Use a dead band configuration if you want the alarm clear point to remain at a fixed distance relative to the set point.

```
Alarm 1 clear point
2.500 g/ml
{Makes alarm "Low"
limit}     NEXT↓ HELP→
```

Figure 7–4.

If you selected a clear point configuration, enter the clear point value, or if you selected a dead configuration, enter the span of the dead band relative to the set point.

An alarm is activated when the measurement value reaches the specified set point. The relative values assigned to the set point and the clear point determine whether the alarm is a low limit or high limit alarm. If the set point value is less than the clear point value (or if the dead band value is positive), the alarm is a low limit alarm. In this case, the alarm is activated as the measurement value decreases below the set point value. The alarm stays active until the measurement value again increases above the clear point value.

Similarly, if the set point value is greater than the clear point (or if the dead band value is negative), the alarm is a high limit alarm. In this case, the alarm is activated when the measurement value increases beyond the set point value. The alarm stays active until the measurement value again decreases below the clear point value.

Alarm 1: g/ml is indicated by controlling relay 1 NEXT↓ HELP→

Figure 7–5.

Select the action used to indicate that alarm 1 has been triggered. The default is **Nothing**. Other actions are listed in the following table.

Table 7–1.

Action	Description
Controlling relay 1	Turn relay 1 on while the alarm is active. This selection is repeated for all installed relays.
Meas #1 dspy flash	Flash measurement number 1 on the display while the alarm is active. This selection is repeated for each measurement that has been defined.
Out1 to FAULT LOW	Hold current output 1 at the FAULT LOW level (3.6 mA or less) while the alarm is active. This selection is repeated for all installed current outputs.
Out1 to FAULT HIGH	Hold current output 1 at the FAULT HIGH level (20.8 mA or greater) while the alarm is active. This selection is repeated for all installed current outputs.
#1 act on ALM action	Execute the command assigned as the #1 action when the alarm is activated if an alarm action has been assigned.

Relay 1 turns on when alarms occurs. Change to “off” → ← Exit alarm 1 setup.

Figure 7–6.

This menu item is displayed if you selected **Controlling relay 1** as the alarm indicator. By default, relays are turned on when an alarm is activated and turned off when the alarm clears.

Set up alarm 1
(Alarm point, etc.) →

NEXT↓

Figure 7–7.

After you set up an alarm, the menu to set up the next alarm is displayed. Press the **right arrow** to set up the next alarm or the **down arrow** to go to the next menu item.

Chapter 8
Service

Getting Help

The local representative is the first contact for support and is well equipped to answer questions and provide application assistance. Your representative also has access to product information and current software revisions. You can also contact Thermo Fisher directly at the following locations:

1410 Gillingham Lane Sugar Land, TX 77478 **USA** Tel: +1 713-272-0404 Fax: +1 713-272-2272	14 Gormley Industrial Avenue Gormley, Ontario L0H 1G0 **CANADA** Tel: +1 905-888-8808 Fax: +1 905-888-8828
Ion Path, Road Three Winsford, Cheshire, CW7 3GA **UNITED KINGDOM** Tel: +44 (0) 1606 548700 Fax: +44 (0) 1606 548711	Room 1010-1019 Ping An Mansion No 23 Jing Rong St Beijing 100032 **CHINA** Tel: +86 (10) 5850-3588 Fax: +86 (10) 6621-0847
A-101, 1CC Trade Tower Senapati Bapat Road Pune 411 016 **INDIA** Tel: +91 (20) 6626 7000 Fax: +91 (20) 6626 7001	On the Web www.thermoscientific.com

Warranty

Thermo Scientific products are warranted to be free from defects in material and workmanship at the time of shipment and for one year thereafter. Any claimed defects in Thermo Scientific products must be reported within the warranty period. Thermo Fisher shall have the right to inspect such products at Buyer's plant or to require Buyer to return such products to Thermo Fisher's plant.

In the event Thermo Fisher requests return of its products, Buyer shall ship with transportation charges paid by the Buyer to Thermo Fisher's plant. Shipment of repaired or replacement goods from Thermo Fisher's plant shall be F.O.B. Thermo Fisher plant. A quotation of proposed work will be sent to the customer. Thermo Fisher shall be liable only to replace or repair, at its option, free of charge, products which are found by Thermo Fisher to be defective in material or workmanship, and which are reported to Thermo Fisher within the warranty period as provided above. This right to replacement shall be Buyer's exclusive remedy against Thermo Fisher.

Thermo Fisher shall not be liable for labor charges or other losses or damages of any kind or description, including but not limited to, incidental, special or consequential damages caused by defective products. This warranty shall be void if recommendations provided by Thermo Fisher or its Sales Representatives are not followed concerning methods of operation, usage and storage or exposure to harsh conditions.

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Appendix A
Ordering Information

Table A–1. 1400S transmitter

Part Number	Description
MTXR-MOLA-SS	1400S stainless steel transmitter
886767	Kit, MOLA / MOLA-LS CPU
886712	Detector interface module (VPI card)
886420-1	4-line display
886650	100–240 Vac power supply
886675-1	I/O board, 24 Vdc input power, no relays
886675-2	I/O board, 24 Vdc input power, 2 Form C relays
886675-5	I/O board, without DC power, no relays
886675-6	I/O board, without DC power, 2 Form C relays

Table A–2. 7200A detector

P/N	Description
262-720001	Detector, 500 mCi Am241:Be source, commissioning
7690-XXXX	Detector cable, 25 ft min. / 500 ft max., in 1-ft increments

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Appendix B
Specifications

Results may vary under different operating conditions.

Table B–1. Overall system specifications

Accuracy	Up to ±0.25% of moisture depending on applications
Stability	Drift less than 0.1% absolute radiation change per 6 months

Table B–2. 1400S transmitter

System architecture	Multiprocessor-based electronics for uninterrupted output during data entry and system interrogation. All user data doubly stored in non-volatile memory with no battery backup required.
Display	Four-line backlit display Displays up to eight readouts simultaneously
Current output	One standard. Maximum of three current outputs available, with each representing independent span channels Standard configuration: Isolated, self-powered, 800-ohm max. load Alternate configuration: Isolated, loop-powered, 24 Vdc nominal supply voltage, 800-ohm max. load
Serial outputs	RS485 half-duplex; RS232 full duplex
Contact closure outputs	Up to 16 available 115 Vac / 28 Vdc SPDT @ 10 amps (230 Vac SPDT @ 8 amps)
Inputs	Up to three additional I/O available. Dry contact closure
Programming options	Menu-driven, direct keypad entry
Power supply	Standard AC power: 110/220 Vac (100–240 V), 50/60 Hz, 17.2 W Optional DC power: 24 Vdc (20–28 V), 12 W
Dimensions	See Figure B–1

Table B–2, cont.

Approvals	NEMA 4X / IP65 ATEX: II 3 G Ex nA IIC T6 (-40°C ≤ Ta ≤ 60°C) DC version, EPSILON 08 ATEX 2387: II 3 G Ex nA nC IIC T4 (-20°C ≤ Ta ≤ 50°C) AC version, EPSILON 08 ATEX 2387 CSA: Class I, Div. 2, Groups A, B, C, and D; Class II, Div. 2, Groups F and G; Class III Enclosure type 4X, Temperature code T3C / T4 Power = 20–28 Vdc, 12 W, 100–240 Vac, 50/60 Hz, 2 A, 25 VA maximum Ambient temperature variation: -40°C to +60°C (-40°F to +140°F) CE compliant Low Voltage Directive compliant EMC Directive compliant

Table B–3. 7200A detector specifications

Supply voltage & consumption	Power supplied from 1400S transmitter
Operating temperature	-40°F to +185°F (-40°C to + 85°C)
Humidity	0–95 % RH, non-condensing
Enclosure	ANSI 300 Series, stainless steel
Connections	1 x 3/4" NPT conduit entry
Output	0–20 mA loop powered 0–10 volts DC
Interconnecting cable	Maximum 5000 ft depending on wire gauge
ATEX Approvals **(tag shown in Figure B–2)**	ITS10ATEX17103X II 2 G Ex s IIC T3-T6 Gb (T6: Tamb -20ºC to +40ºC) (T4: Tamb -20ºC to +55ºC) (T3: Tamb -20ºC to +70ºC) IP66
CSA & CSA (US) Approvals (tag shown in Figure B–2)	Class I, Div. 1, Groups B, C, & D Class I, Div. 2, Groups A, B, C, & D Class II, Div. 1, Groups E, F, & G Class III Temp Code: T6 Type 4X Ta: -40ºC to +80ºC

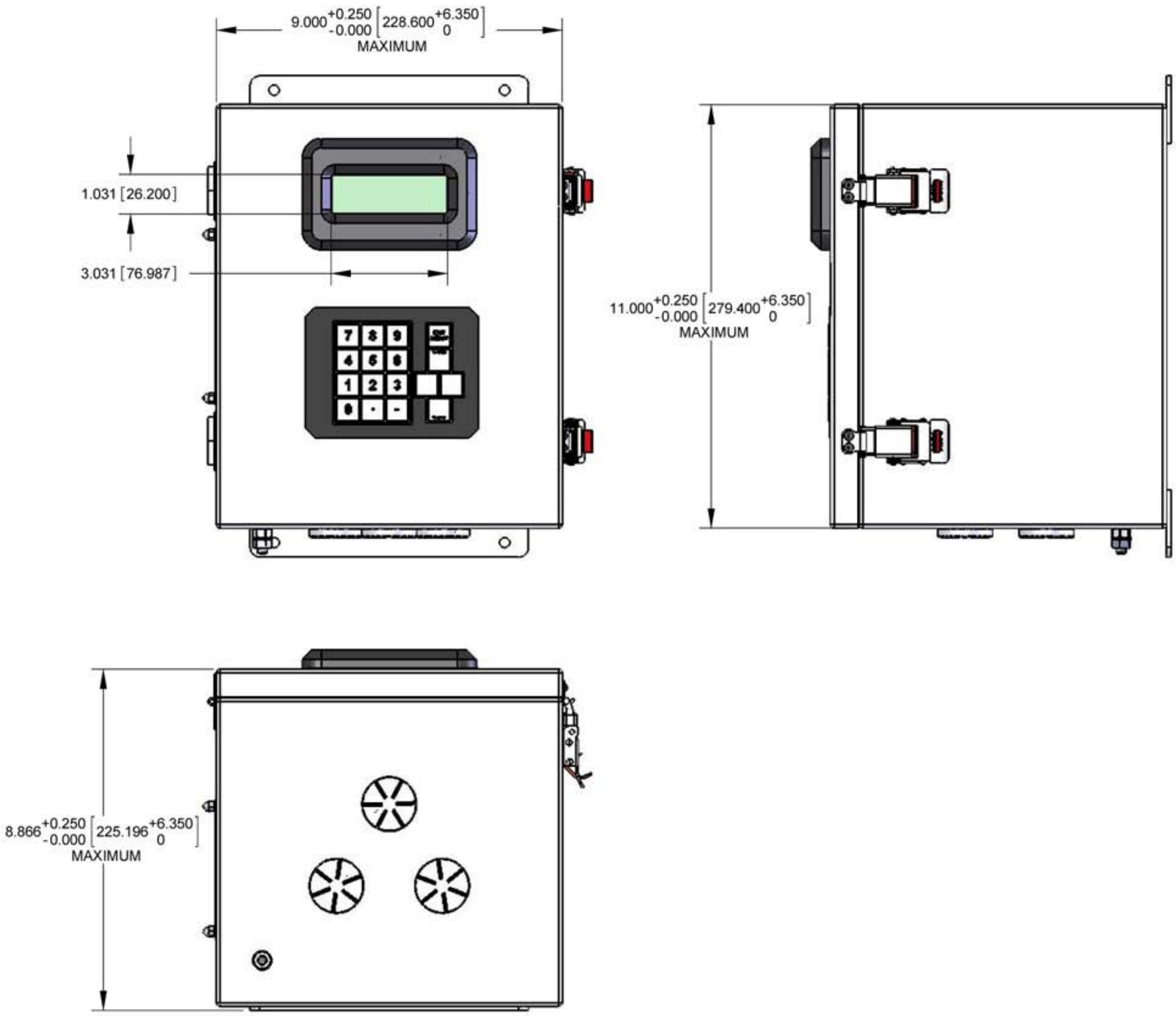

Figure B–1. 1400S transmitter dimensional diagram

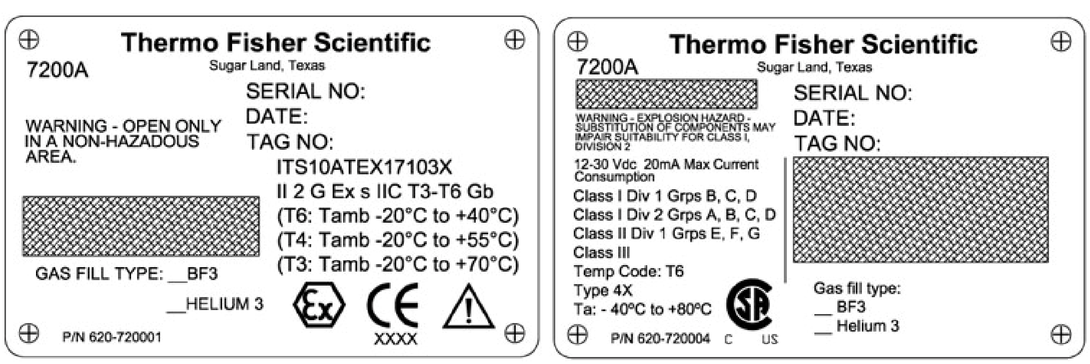

Figure B–2. ATEX and CSA certification tags

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Appendix C
Toxic & Hazardous Substances Tables

The English and Chinese versions of the Toxic and Hazardous Substances tables are shown below.

Toxic & Hazardous Substances Table – MOLA

For Chinese Regulation: Administrative Measure on the Control of Pollution Caused by Electronic Information Products

Names and Content of Toxic and Hazardous Substances or Elements

Parts Name	Toxic and Hazardous Substances or Elements (MOLA)					
	Pb	Hg	Cd	Cr6+	PBB	PBDE
Housing	o	o	o	o	o	o
Ion Chamber	x	o	o	o	o	o
Customer Connection Interface	o	o	o	x	o	o
M-Transmitter	x	o	x	o	o	o
Cabling	o	o	o	o	o	o

○: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in **SJ/T11363-2006**
x: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in **SJ/T11363-2006**

有毒有害物质名称及含量的标识格式

部件名称	有毒有害物质或元素 (MOLA)					
	铅（Pb）	汞（Hg）	镉（Cd）	六价铬（Cr6+）	多溴联苯（PBB）	多溴二苯醚（PBDE）
外壳	o	o	o	o	o	o
离子腔	x	o	o	o	o	o
客户连接接口	o	o	o	x	o	o
M-发射机	x	o	x	o	o	o
缆线连接	o	o	o	o	o	o

○：表示该有毒有害物质在该部件所有均质材料中的含量均在**SJ/T 11363-2006**标准规定的限量要求以下
x: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出**SJ/T 11363-2006**标准规定的限量要求

Appendix D
Site Readiness Form

The Site Readiness form on the following pages must be completed and submitted to Thermo Fisher before an installation engineer travels to the customer site.

MOLA Site Readiness Form

It is company policy that this form must be completed and returned by the customer before the installation engineer travels to the customer site.

To be completed by Thermo Fisher personnel:

Instrument Type	MOLA	Serial No.	
Proposed installation start date		Duration	

To be completed by Customer:-

No.	Requirement	Yes/No	If No, Date Available	Numeric Data
1	Were there any visible signs of damage to crate or instrument? If yes attach or note details below, and ensure all packing materials are retained.			
2	Are the transmitters mounted?			
3	Are the analyzer heads mounted?			
4	Is the power and interconnection wiring between the heads and the transmitters complete?			
5	Do any of the analyzers include density compensation? If so how many?			
5a	If density compensation is included are the density gauge sources mounted?			
5b	If density compensation is included are the density gauge detectors mounted?			
5c	If density compensation is included are the density gauge outputs wired to the MOLA transmitters?			
5d	Have arrangements been made with a lab to analyze numerous process samples for density to 2 decimal places of accuracy? (X.XX g/cc).			
5e	If density compensation is included please confirm the length of the radiation beam through the process material (path length)?			
5f	If density compensation is included please confirm the makeup of the vessel walls – including liner materials?			
6	Will process material be in the vessel during the commissioning visit?			

7	Have arrangements been made with a lab to analyze numerous process samples for % by weight moisture to 2 decimal places of accuracy? (X.XX % Moisture).			
8	How much sample is required by the lab to perfom a moisture analysis?			
9	How much sample is required by the lab to perfom a density analysis?			
10	Has a sampling point been established near each MOLA?			
11	Will plant or lab staff be available to perform sampling functions?			
12	What is the expected turn around time for moisture and density samples?			
13	Are suitable sealed sample containers available to transport sample from the sampling point to the lab.			
14	Are necessary personnel from the customer site available to work with our engineer to receive familiarization training on the analyzer?	*		
15	Will personnel with appropriate authority (technical and financial) be available for instrument acceptance?	*		
16	(i) Will our engineer be able to take personal laptop onsite? (ii) Will our engineer be able to use laptop alongside instrument?			
17	Please detail below any Health and Safety requirements for entry to your site. Please also indicate the time required for any special training or induction courses required on arrival.			
18	Please detail below any national holidays, or similar, that fall into the installation period. Would site access be affected?			

*If personnel will not be available during the whole installation period please give dates when available.

Note 1: The Vendor reserves the right to charge the Purchaser, at the normal prevailing rates, for any time lost by the employees of the Vendor due to delays in providing a suitably prepared job site in accordance with the above points. (This will include the cost of any return visit, if the installation is aborted).

Note 2: Once the checklist is signed, any “site deficiencies” found during installation should not delay acceptance of the system.

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Note 3: Complete calibration requires representative samples over the majority of the moisture range. Depending on process conditions, and site sampling capabilities, it may take days, or even weeks, to get samples over a wide enough range to provide the best possible calibration. Although we are glad to assist with the calibration, the commissioning visit does not include our personnel remaining on site until all samples have been collected and analyzed. Once the necessary information is available our Technical Support group will be glad to provide telephone assistance to complete the calibration.

Comments by Customer:

Completed By ____________________________

Signature ____________________________

Company ____________________________

Position ____________________________

Date ____________________________

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Thermo Fisher Scientific
81 Wyman Street
P.O. Box 9046
Waltham, Massachusetts 02454-9046
United States

www.thermofisher.com