

**DENSITY COMPENSATION  
ADDENDUM**

**INSTALLATION  
AND  
INSTRUCTION  
MANUAL**

Phase Dynamics, Inc.

*Water in Hydrocarbon Analyzer*

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Revision A

Phase Dynamics has incorporated the work done in the 1960's on line density correction as referenced at the end of this Addendum to allow our customers to more easily utilize corrections for density effects. This work shows how a simple mathematical equation (0.16% offset in water per one (1) degree change in API gravity) is used to correct for density effects on a water analyzer measurement. This is a linear equation with a slope and intercept as shown in the Phase Dynamics write up on density correction that has been distributed to our customer's since 1992. Phase Dynamics uses calibration oil with an average API gravity of 32 as the zero point for density compensation.

In the past, our customers have included these corrections as a part of their DCS or flow computer. This option will simply move the long established calculation into the water cut analyzer where it will be more easily utilized by the end user. The Phase Dynamics Water in Hydrocarbon Analyzer optional Density Compensation feature allows the user to automatically compensate the analyzer's water cut measurement for changes in product density. This new feature affects both the digital and analog representations of the water-cut value (i.e. LCD Display, Modbus Registers, and 4-20 mA Current Loop).

The Density Compensation requires an input signal from an online densitometer that has been corrected to standard temperature conditions. The user can select a 4-20 mA input or an RS-485 Modbus input from a Micro Motion Coriolis Meter with the Measurement Application Software option. For debugging purposes the analyzer can also read and display the uncorrected density from the Micro Motion Coriolis Meter.

The 4-20 mA signal is connected to the Analyzer's Motherboard at the terminal locations labeled CURRENT INPUT + and – (numbers 11 and 12 respectively). This current input has usually been identified as a flow meter input and has typically been utilized for other input variables such as stream select in the past. Note that this input is NOT SELF-POWERED and it is NOT ISOLATED from system ground. Therefore, it should be the final termination of this signal if it is also being sent to any other devices.

The user can select whether the 4-20 mA signal represents API gravity or kg/m<sup>3</sup> density. The values for the 4 mA and 20 mA endpoints are entered to complete the setup.

The RS-485 Modbus input is connected to the Analyzer's Motherboard at the terminal locations labeled Comm 0 RS-422/RS-485 R+ and R- (numbers 1 and 2 respectively). The user must enable the Modbus Master on Comm 0 and configure the communications port. The user can then select whether the Micro Motion Coriolis Meter is configured for API gravity or kg/m<sup>3</sup> density at 60 F.

The Analyzer's Frequency Board has DIP switches that must be configured for an RS-485 Modbus Master. The 4 position DIP switches for Comm 0 are label SW1 and SW2. Switch SW1 position 1 should be OFF and switches SW1 positions 2-4 and SW2 positions 1-4 should be ON.

The Micro Motion Coriolis Meter's RS-485 port should be configured for Modbus RTU at 9600 Baud Rate, No Parity and One Stop Bit. The API Setup should be configured for the Generalized Crude (API Chapter 11.1 "A" Tables) correction with the Units set to either Degrees API or Relative Density/SG with a Reference Temperature of 60 F.

There are additional menu items that control these features. Default values are shown in square brackets [ ].

## **MENU items for the Normal, Technician and User Mode**

Density Compensation [Disabled]	This menu item selects the Density Compensation mode. SELECT and VALUE change the Density Compensation mode between Disabled, 4-20 mA API, 4-20 mA kg/m <sup>3</sup> , Coriolis API, Coriolis kg/m <sup>3</sup> , Coriolis API@60F and Coriolis kg/m <sup>3</sup> @60F. ENTER stores the specified Density Compensation mode.
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4-20 mA API gravity mode includes the following two menu items:

4 mA = XXX.X API [10.0]	This menu item changes the 4 mA API gravity endpoint. SELECT and VALUE change the 4 mA API gravity endpoint. ENTER stores the specified 4 mA API gravity endpoint.
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20 mA = XXX.X API [50.0]	This menu item changes the 20 mA API gravity endpoint. SELECT and VALUE change the 20 mA API gravity endpoint. ENTER stores the specified 20 mA API gravity endpoint.
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4-20 mA kg/m<sup>3</sup> density mode includes the following two menu items:

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|---|---|
| 4 mA = XXX.X kg/m <sup>3</sup><br>[800.0]   | This menu item changes the 4 mA kg/m <sup>3</sup> density endpoint. SELECT and VALUE change the 4 mA kg/m <sup>3</sup> density endpoint. ENTER stores the specified 4 mA kg/m <sup>3</sup> density endpoint.    |
| 20 mA = XXX.X kg/m <sup>3</sup><br>[1000.0] | This menu item changes the 20 mA kg/m <sup>3</sup> density endpoint. SELECT and VALUE change the 20 mA kg/m <sup>3</sup> density endpoint. ENTER stores the specified 20 mA kg/m <sup>3</sup> density endpoint. |

Additional MENU items for the Technician Mode only:

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|------------------------------------|--|
| API A1 = X.XXX %/API<br>[0.160]    | This menu item changes the API Compensation Coefficient A1. SELECT and VALUE change the API Compensation Coefficient A1. ENTER stores the specified API Compensation Coefficient A1. |
| API A0 = X.XX %<br>[0.00]          | This menu item changes the API Compensation Coefficient A0. SELECT and VALUE change the API Compensation Coefficient A0. ENTER stores the specified API Compensation Coefficient A0. |
| API Cal = XX.XX API<br>[32.00]     | This menu item changes the API Calibration set point. SELECT and VALUE change the API Calibration set point. ENTER stores the specified API Calibration set point.                   |
| Comm 0 Status<br>[Comm 0 Disabled] | Communication Channel 0 options. The SELECT switch toggles between Comm 0 Disabled or Comm 0 Enabled. Press ENTER to execute the desired Comm 0 Status.                              |

When Comm 0 is Enabled, the user will be asked to define the following additional items:

Comm 0 Baud Rate [9600]	Comm 0 Baud Rate option. The SELECT switch cycles through the available Baud Rates of 110 through 9600. Press ENTER to execute the selected Comm 0 Baud Rate.
Comm 0 Parity [None]	Comm 0 Parity option. The SELECT switch cycles through the available Parity options of None, Even, and Odd. Press ENTER to execute the selected Comm 0 Parity.
Comm 0 Stop Bits [One]	Comm 0 Stop Bits option. The SELECT switch toggles between the available Stop Bits options of One or Two. Press ENTER to execute the selected Comm 0 Stop Bits.

### **MENU item for the Supervisor Mode**

Density Compensation [is: DISABLED]	This menu item determines whether the Density Compensation menu item is available in the User Menu. SELECT and VALUE toggle between the choices of ENABLED or DISABLED. ENTER executes the desired choice.
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### **References**

- 1.) Kite, George, "Instrumentation for Simplified Commingling and Well-Testing Operations," Journal of Petroleum Technology, March, 1964, Pages 732-738.
- 2.) Zimmerman, C.W., Hammond, J., "Instrumentation for Net Oil Measurement in Well Testing," Journal of Petroleum Technology, October, 1968, Pages 1141-1146.