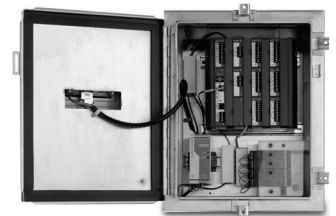# Micro Motion® Net Oil Computer Software

Micro Motion® Net Oil Computer Software, with Micro Motion Coriolis sensors and the ROC809 Remote Operations Controller from Remote Automation Solutions, performs simultaneous measurement of net oil, free water, total water, and gas. The NOC system handles a wide range of flow rates and water cuts, and is compatible with three-phase, two-phase, or compact separation technology.

Features and Benefits

- Operates in Well Test or Continuous measurement mode

- Stores up to six tests per well (Well Test mode) or 35 days of data plus historical summaries (Continuous mode)

- In-line density determination for both water and oil

- Transient bubble remediation

- Recalculation of well test or daily data

Micro Motion® Net Oil Computer Software

Overview

The Net Oil Computer (NOC) Software is designed for implementation in an NOC system built on the ROC809 Remote Operations Controller from Remote Automation Solutions, using inputs from one or more Micro Motion Coriolis sensors and other devices as desired.

The Net Oil Computer Software provides full-stream real-time measurements of water cut, net oil volume flow, net water volume flow, and gas. The NOC system measures mass and volume flow at rates ranging from a few barrels per day, requiring only a single sensor, through 200,000 barrels per day using three parallel sensors. Well production, measured by minute, hour, and day, is stored for use by allocation measurement and analysis tools.

Net oil calculations implement the Chevron Oil Field Research Company (COFRC) formulas, which incorporate temperature correction based on Chapter 11 of the *American Petroleum Institute (API) Manual of Petroleum Measurement Standards*. Water cut is determined by comparing the liquid density, as measured by a Micro Motion Coriolis meter, to standardized reference densities of free oil and water. Data from water cut probes may be used. Pressure correction and pressure compensation can be applied if desired.

The NOC system can operate in Continuous mode or Well Test mode:

- In Continuous mode, the system performs continuous measurement of flow from a well, separator, or pipeline, storing ten days of detailed data for recalculation, and one month of summary data.

- In Well Test mode, the system can perform well tests for 50 different wells, storing data for six tests per well.

Stored data may be viewed locally, saved to a file, or retrieved by a remote device.

Both Continuous mode data and Well Test data can be recalculated as required, for conversion of results to any desired reference values. Additionally, the recalculation feature enables data collection before precise reference density values are known.

The NOC system supports the use of water cut probes, supports pressure compensation, and leverages the power, flexibility, and customizability of the ROC809 platform, while providing the benefits that Micro Motion customers have come to expect: superior measurement accuracy and reduced costs of ownership.

Contents

Micro Motion® Net Oil Computer Software *continued*

Benefits

The NOC system with Net Oil Computer Software combines the functions of a Coriolis flowmeter, a flow computer, and a net oil computer in one housing. The system:

Is suitable for new or retrofitted oil production facilities

Is compatible with a variety of separator technologies:

- Enables use of simpler, less expensive, and more reliable two-phase separators

- Can be used with traditional three-phase test and production separators

- Supports compact or partial separator technologies (MultiPhase Measurement Systems)

Lowers installation, operation, and maintenance costs:

- Accepts and compiles input from up to four sensors, enabling parallel measurement, recording, and reporting of net oil, free water, total water, and gas in one system

- Measures multiple process variables in one device (the Coriolis sensor), enabling simultaneous flow measurement and water cut determination, and eliminating requirement for separate temperature and density measurement devices

- Maintains measurement accuracy over broad transition range (oil-continuous to water-continuous), eliminating requirement for different systems at different stages in the well's lifecycle

- Enables in-line density determination for both oil and water, eliminating expensive, time-consuming laboratory tests while increasing accuracy

- Enables inexpensive, industry-standard four-wire connectivity between device and sensor

- Supports remote communications for convenient application configuration and data collection

- Minimizes equipment repair or replacement due to damage caused by sand in line or harsh operating environments

- Supplies comprehensive diagnostics for both equipment and process

Provides more accurate data:

- Coriolis mass, density, volume, and water cut measurement based on full fluid stream

- Reduced water cut uncertainty, due to:
  - In-line real-time water cut calculations based on process density
  - Optional integration of data from one or two water cut probes
  - Automatic selection of water cut source based on user-configured ranges

- Volume measurement accuracy maintained through changes in fluid density, flow regimes, and fluid viscosity

- Automatic temperature correction to customer-selected reference value

- Optional pressure compensation and pressure correction

- Transient bubble remediation feature compensates for intermittent entrained gas

The bottom line: The NOC system with Net Oil Computer Software reduces costs while providing measurement benefits that enable more informed production management and more accurate allocation and accounting.

Micro Motion® Net Oil Computer Software *continued*

Architecture and implementation

The Net Oil Computer Software and NOC system can be used in a test or production system. The Net Oil Computer Software includes:

- Support for up to three Micro Motion sensors on the oil or water legs

- Support for one optional sensor (Micro Motion or other) on the gas leg

- Support for one or two external water cut probes

- Support for input from an external pressure and/or temperature device

The three figures here illustrate several possible installations, and highlight the versatility, scalability, and expandability of the system.

In Figure 1:

- The NOC system is installed with a two-phase test separator. One sensor is installed on the gas leg, and two sensors are installed in parallel on the liquid leg to accommodate higher flow rates. Data from each sensor is submitted to the NOC platform.

- A water cut probe is installed on one half of the liquid leg.

- Temperature correction is based on temperature data from the sensor; dynamic pressure compensation is not implemented.

- Net oil calculations are performed on data from the liquid leg. The Net Oil Computer Software dynamically selects the water cut data to use – density-based or data from the downstream probe.

- Net oil measurements from each half of the liquid leg are rolled up to the system level. The operator can view system-level data or data from each leg separately.
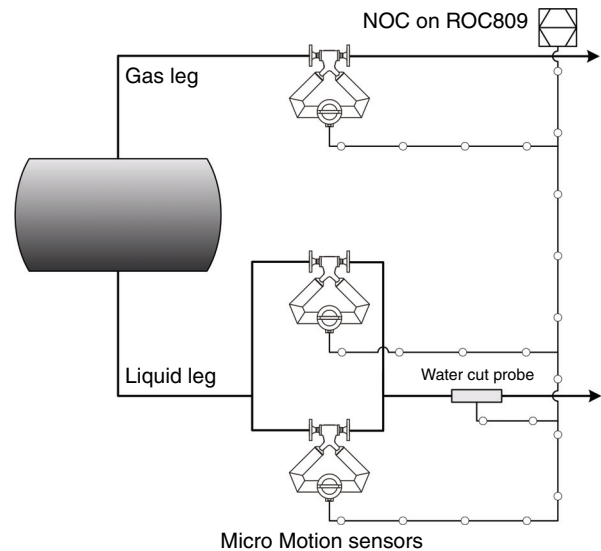

Figure 1 Two-phase separator (test)

In Figure 2:

- The NOC system is installed with a compact separator, in this case, a GLCC™ (Gas-Liquid Cylindrical Cyclone).

- Net oil calculations use density-based water cut data.

- Pressure compensation and temperature and pressure correction are based on data from external devices.

- A PID control loop in the ROC809 platform uses input from a level sensor to manage flow out of the separator.

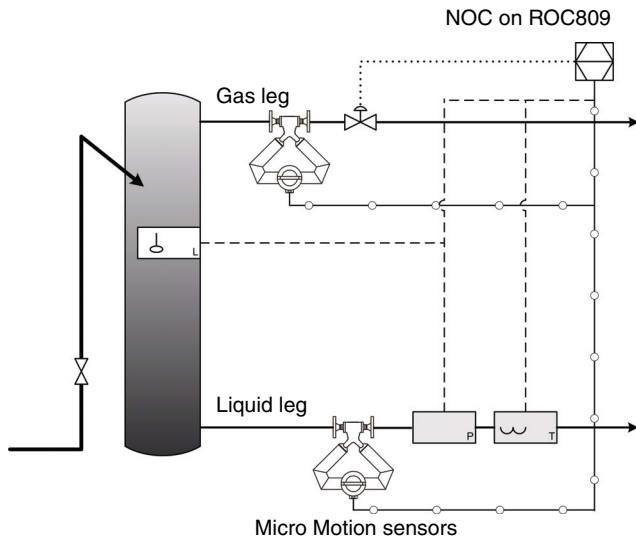# Micro Motion® Net Oil Computer Software *continued*

Figure 2 Compact separator

In Figure 3:

- The NOC system is installed with a traditional three-phase separator. One sensor is installed on each leg. Data from the water leg is reported as free water.

- Net oil calculations are performed on data from the oil leg, using water cut data from the water cut probe. Water cut monitoring allows detection of process upsets.
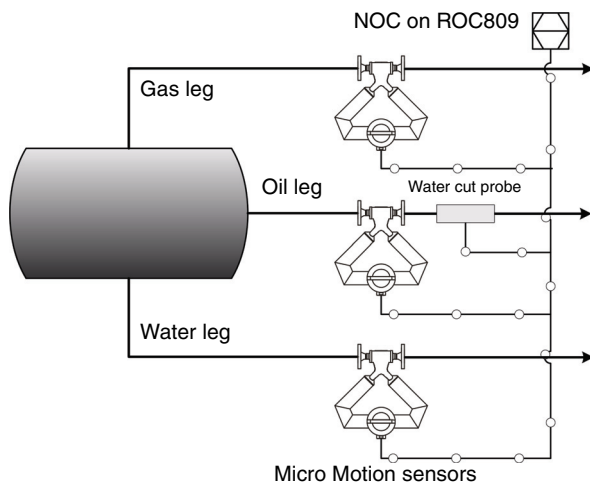

Figure 3 Three-phase separator (test or production)

Sensor selection

The Net Oil Computer Software and the NOC system are compatible with almost all Micro Motion sensors and sensor sizes, allowing you to choose the right sensor for your process and environment.

Each Micro Motion sensor to be used with the Net Oil Computer Software requires the Micro Motion MVD™ Direct Connect™ I.S. barrier, which provides intrinsically safe DC power and data communications to the sensor in the field.

The barrier uses standard 4-wire cable and can be located up to 500 feet (150 meters) from the core processor.

Hazardous areas

The Net Oil Computer platform must be installed in a safe area. The MVD Direct Connect I.S. barrier enables installation of Micro Motion sensors in the following areas:

- United States and Canada:
  - Class I, Division 1, Groups C and D
  - Class I, Division 2, Groups A, B, C and D
- Europe: Zone 1, EEx ib IIB/IIC

Installation

The Net Oil Computer Software is loaded to the ROC809 platform as a standard user program. Both the ROC809 platform installation and the Micro Motion sensor installation are standard.

System installation costs are reduced as a result of several factors:

- The multiple-function NOC system replaces several single-function devices.
- Micro Motion sensors' immunity to swirl and flow profile eliminates requirement for flow conditioning or straight pipe runs.

Micro Motion® Net Oil Computer Software *continued*

Measurement and recording

The Net Oil Computer Software and NOC system automatically measure and record the process data listed below.

Averages and totals are calculated for each measurement period (contract period or well test). The operator can view or retrieve raw data from each sensor, data from each sensor input, and data rolled up from the sensors to the station.

Instant values

- Oil density
- Water density
- Liquid density
- Temperature
- Liquid mass flow
- Liquid volume flow, uncorrected
- Reverse liquid volume flow, uncorrected
- Liquid volume flow, corrected
- Water cut (density-based)
- Water cut (from water cut probe)
- Gas volume flow (AGA11)

Total values

- Oil, uncorrected
- Oil, corrected
- Total water, uncorrected
- Total water, corrected
- Free water, uncorrected
- Free water, corrected
- Liquid, uncorrected
- Liquid, corrected
- Reverse liquid, uncorrected
- Liquid mass
- Reverse liquid mass
- Gas (in SCFT, as per AGA calculations)

Average values

- Water cut
- Oil, uncorrected
- Oil, corrected
- Total water, uncorrected
- Total water, corrected
- Free water, uncorrected
- Free water, corrected
- Liquid, uncorrected
- Liquid, corrected
- Oil density, pressure-corrected
- Liquid density, uncorrected
- Temperature
- Mass flow rate
- Gas flow rate
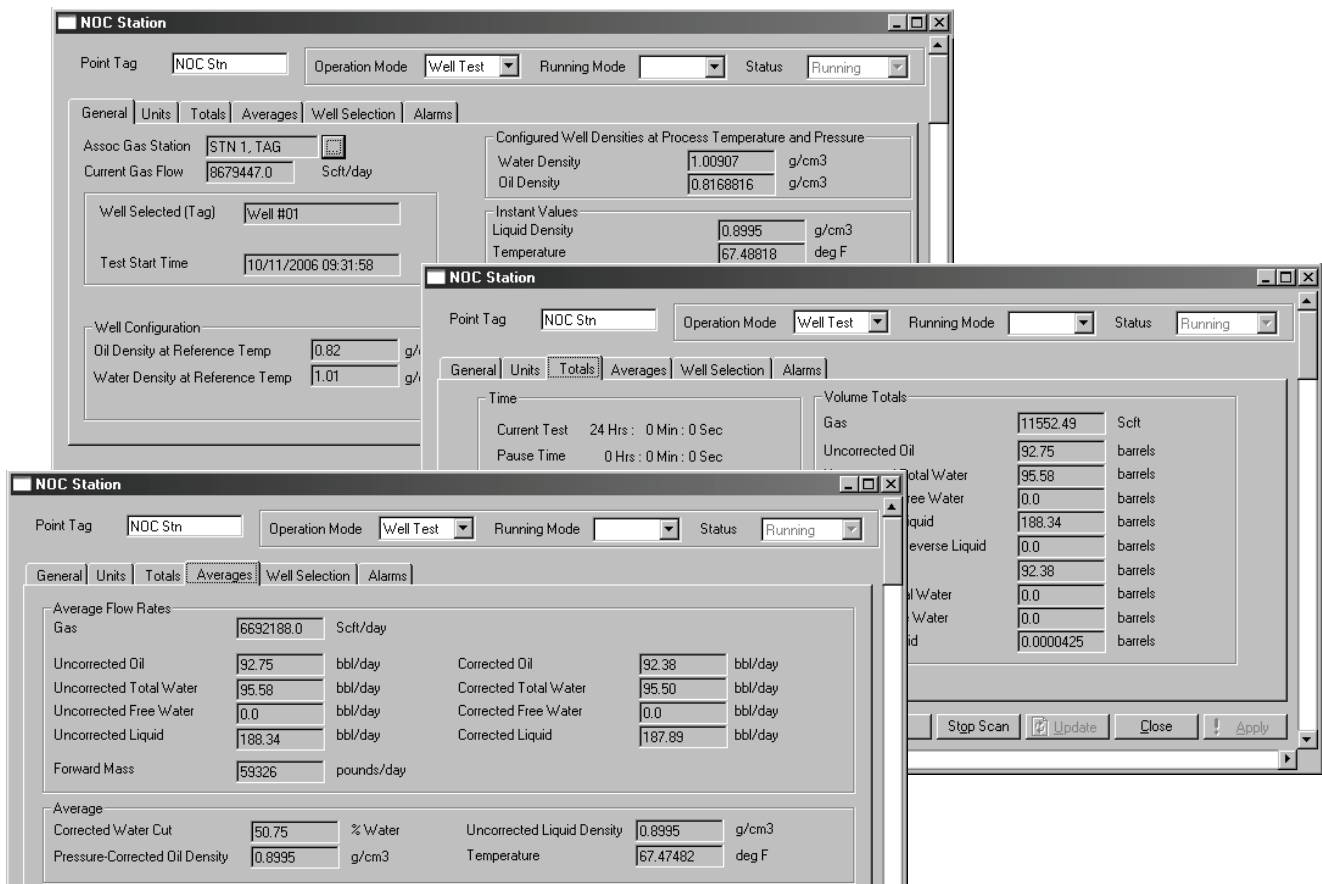
Micro Motion® Net Oil Computer Software *continued*

Net Oil Computer Software features

- User-selectable U.S. or metric units
- Automatic temperature correction of net oil data
- Automatic pressure correction of net oil data (with pressure input)
- Optional compensation for pressure effect on sensor (with pressure input)
- Independent configuration of each sensor in NOC system

In-line determination of water density and live oil density

For net oil calculations, the Net Oil Computer Software requires two values for each well: water density at reference temperature and oil density at reference temperature. The Net Oil Computer Software supplies in-line density determination routines for both. The density determination routine for water requires no laboratory analysis; the density determination routine for oil requires laboratory values for water cut and water temperature.

The recalculation feature, described below, enables data collection with approximate density values. Final density values, when available, are used to revise the interim results.

Operation modes

In Well Test mode, the base oil density, the base water density, and purge time are stored for up to 50 wells. By default, well tests are started and stopped manually; however, a user-defined program can be implemented for automated operation. Data is recorded every fifteen minutes during the well test. When the well test is stopped, a summary record is written to the history database.

In Continuous mode, data from a single well is recorded every fifteen minutes, and a summary record is written at the end of each contract period. Summary records can also be written upon operator request.

User-configurable water cut source

By default, the Net Oil Computer Software derives water cut from in-line density data as measured by the Micro Motion sensor. Because the density-based water cut values are accurate over oil-continuous, transition, and water-continuous phases, the NOC system adapts to the changes in fluid composition over the course of a well's life.

To handle special conditions (e.g., low API-gravity oils), the Net Oil Computer Software supports input from one or two water cut probes. The net oil values used in NOC measurement can then be sourced from either the density-based value or the water cut probe. User-configured water cut ranges are used to control which source is used. For example, probe data can be used for water cuts above 90% or below 10%, with density-based data used for all values in between.

Recalculation

The recalculation feature allows you to avoid the delays typically associated with offsite determination of oil density and water density at reference values. The recalculation feature generates revised water cut and net oil data from the raw sensor data, using updated values for reference densities or reference temperature. The system stores both the original and the recalculated results.

- In Continuous mode, data from the ten most recent contract periods can be recalculated.
- In Well Test mode, data from the ten most recent well tests within the ten most recent contract periods can be recalculated.

Micro Motion® Net Oil Computer Software *continued*

Transient bubble remediation (TBR)

The TBR feature enables accurate measurement through intermittent entrained gas conditions. When sensor drive gain varies outside user-configured limits, the Net Oil Computer Software can post an alarm, activate a discrete output, or continue measurement using a density value that was measured earlier in the process.

To help identify the extent of the entrained gas problem, the Net Oil Computer Software automatically measures and records total time spent in TBR mode.

ROC809 features

The NOC system utilizes the features and functions of the ROC809 platform, including:

- Standard RS-232 Local Operator Interface (LOI) port
- Standard RS-232 and Ethernet communications ports
- RS-485 communications module(s)
- Module slots for expansion modules (RS-232, RS-485, dial-up modem, analog input, analog output, discrete input, discrete output, discrete output relay, RTD input)
- Password security
- Measurement audit logging of 240 alarms and 240 events
- Extensive diagnostics and configurable alarm handling

PID control loops

The ROC809 can monitor and control up to sixteen different PID control loops. For example, a PID control loop could open or close a valve, or start or stop a pump, based on time, process conditions, or error conditions.

In a typical application, data from a level sensor is input to the control loop, and the control loop then manages the liquid level in the separator.

User-defined programs

The ROC809 platform can run multiple supplementary programs simultaneously with the Net Oil Computer Software. These programs can perform a variety of tasks including executing special calculations, retrieving data from lookup tables, monitoring, analysis, and control.

For example, a user-defined program could stop measurement when water cut exceeds a certain value, recheck water cut every four hours, then resume measurement when water cut drops below the threshold.

ROC809 communications

The built-in LOI port on the ROC809 platform is typically used for local connections. Remote connections can be made via network cable, telephone, or radio, through the standard communications ports, the RS-485 module, or the optional expansion modules.

A customized version of ROCLINK™ 800 Software, shipped with the Net Oil Computer Software, enables local or remote configuration, operation, and troubleshooting from a PC.

For implementation with a PLC or in a SCADA system, the ROC809 platform supports Modbus and ROC Plus protocol. Other communications features include Modbus master capabilities, spontaneous report by exception, and store-and-forward functionality.

For on-site operation, a display panel can be added to the ROC809 platform.

Specifications

ROC809 Remote Operations Controller

For ROC809 specifications, see the documentation supplied by Remote Automation Solutions.

Optional components

For specifications for optional components such as water cut probes, pressure sensors, temperature sensors, level sensors, turbine meters, etc., see the vendor documentation.
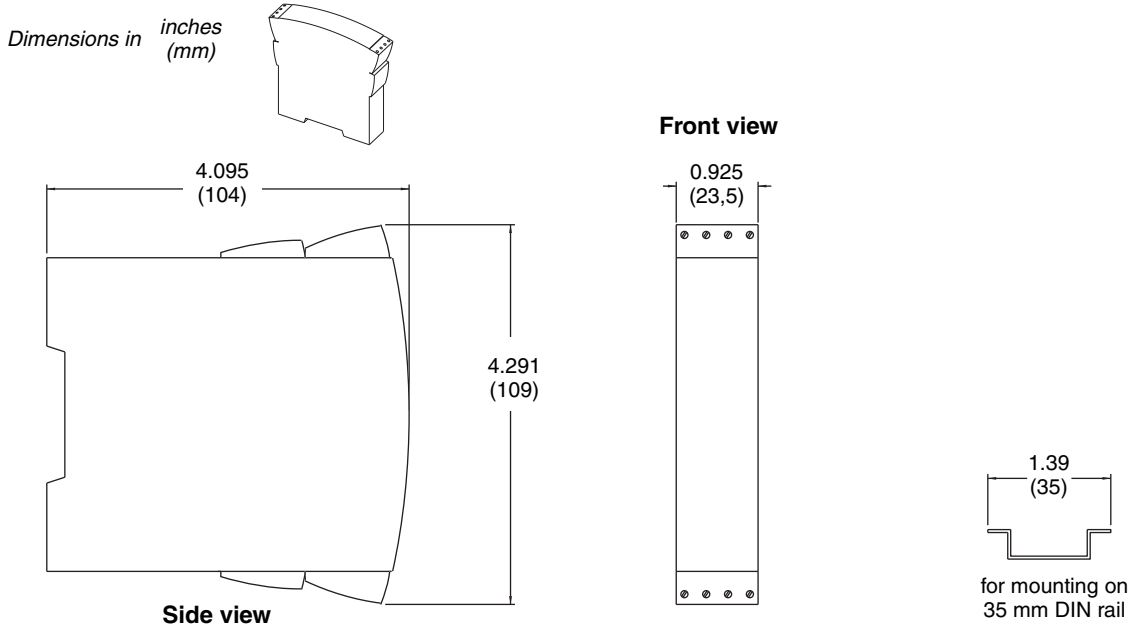
Micro Motion sensors

For sensor specifications, see the product data sheet provided with the sensor.

Specifications *continued*

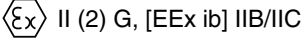## MVD Direct Connect I.S. barrier

I.S. barrier dimensions

Dimensions in inches (mm)

4.095 (104)

4.291 (109)

Side view

Front view

0.925 (23,5)

1.39 (35)

for mounting on 35 mm DIN rail

I.S. barrier specifications

Electrical	Supply voltage	24 VDC ± 20%
	Maximum consumption	3.5 W
	Protection	Polarity
	Isolation test voltage • Supply to safe side • I.S. to supply/safe side	 • 500 VAC • 3750 VAC
	Sensor supply	15.3 V nominal
	Sensor current limit	145 mA nominal
Communications	Power LED	Standard
	RS-485 LED	Standard
	Baud rate half-duplex	1200 to 38,400
	Protocol	TIA/EIA-485 (RS-485)

Specifications *continued*

I.S. barrier specifications *continued*

Physical	Dimensions	4.291 × 0.925 × 4.095 in (109 × 23.5 × 104 mm)
	Weight	0.34 lb (152 g)
	Tightness enclosure	IP50
	Tightness terminal	IP20
	Screw terminal torsion	0.5 N-m
Environmental	Temperature	–40 to +140 °F (–40 to +60 °C)
	Relative humidity	< 95% (non-condensing)

I.S. barrier approvals

CSA, C-US, UL	Installation	Class I, Div. 2, Groups A, B, C, and D	
	Terminals 41–44 (intrinsically safe output)	Class I, Div. 1, Groups C and D Class II, Div. 1, Groups E, F, and G	
	Protection	Polarity	
	Isolation test voltage • Supply to safe side • I.S. to supply/safe side	 • 500 VAC • 3750 VAC	
	Sensor supply	15.3 V nominal	
	Sensor current limit	145 mA nominal	
ATEX	Installation	Safe area with I.S. outputs	
		$\langle\text{Ex}\rangle$ II (2) G, [EEx ib] IIB/IIC	
	Terminals 11–14	U_m	250 V
	Terminals 41–44	U_o I_o P_o	17.22 VDC 484 mA DC 2.05 W
	[EEx ib] IIB	L_o C_o	607 µH 2.04 µF
	[EEx ib] IIC	L_o C_o	151.7 µH 0.333 µF

Ordering information

Net Oil Computer Software

Model	Product description
DNOC	Micro Motion Coriolis Net Oil Computer Software
Code	**Sensor interface**
0	None
Code	**Remote core processor conduit conections**
Z	None
Code	**Language**
E	Local display: English; Installation manual: English; Configuration manual: English
Code	**Future hardware**
Z	No additional hardware
Code	**Future software**
Z	No additional software
Code	**Factory options**
Z	Standard product
X	ETO product
R	Restocked product (if available)
Typical model number: DNOC 0 Z E Z Z Z	

Other components

In addition to the Net Oil Computer Software, the following components are required for the NOC system, and must be ordered separately:

Vendor	Component
Micro Motion	One or more Coriolis sensors with 4-wire interface (standard core processor)
	One MVD Direct Connect I.S. barrier for each sensor (order with sensor)
Remote Automation Solutions	ROC809 Remote Operations Controller
	ROC809 RS-485 communications module
	AGA license (if NOC system will include gas measurement)

Additional components may be required for specific installations and applications.

Micro Motion—The undisputed leader in flow and density measurement

World-leading Micro Motion measurement solutions from Emerson Process Management deliver what you need most:

Technology leadership

Micro Motion introduced the first reliable Coriolis meter in 1977. Since that time, our ongoing product development has enabled us to provide the highest performing measurement devices available.

Product breadth

From compact, drainable process control to high flow rate fiscal transfer—look no further than Micro Motion for the widest range of measurement solutions. With the addition of Solartron® liquid and gas density meters, Micro Motion truly is the world leader.

Unparalleled value

Benefit from expert phone, field, and application service and support made possible by more than 750,000 meters installed worldwide and 30 years of flow and density measurement experience.

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Emerson Process Management
Micro Motion Americas
Worldwide Headquarters
7070 Winchester Circle
Boulder, Colorado USA 80301
T: 800 522 6277
T: +1 (303) 527 5200
F: +1 (303) 530 8459
Mexico   T: 52 55 5366 2622
Argentina   T: 54 11 4837 7000
Brazil   T: 55 15 3238 3677
Venezuela   T: 58 26 1731 3394

Emerson Process Management
Micro Motion Europe/Middle East
Central & Eastern Europe   T: +41 41 7686 111
Dubai   T: 971-4 8835235
France   T: 0800 917 901
Germany   T: 0800 182 5347
Italy   T: 0800 77334
The Netherlands   T: +1 (31) 318 495 555
U.K.   T: 0870 240 1978
Russia/CIS   T: +7 495 981 9811

Emerson Process Management
Micro Motion Asia Pacific
Australia   T: +1 (61) 3 9721 0200
China   T: +1 (86) 21 3895 4788
India   T: +1 (91) 22 5662 0566
Japan   T: +1 (81) 3 5769 6803
South Korea   T: +1 (82) 2 3438 4600
Singapore   T: +1 (65) 6 777 8211

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