

# SpartanPRO™ NOC

Instruction Manual SPARTAN CONTROLS LTD.

Experience Industrial Innovation

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# Table of Contents

	Overv	iew3
1	.1 Revis	ion History
1	.3 Getti	ng Help
1 1	.4 Warra .5 Appli	anty3 cation Overview
2	Introd	uction4
2	.1 Tech	nical Overview
2	.2 Sonw	are interface
3	Install	ation7
3	.1 Instal	lation Procedure7
3	.2 Licen .3 Comi	cing8 nissioning9
Λ		
Τ.	NOC	Configuration10
- 4	.1 Confi	Configuration       10         guration Options to Note       10
4	.1 Confi .2 NOC	Configuration       10         guration Options to Note       10         Configuration Info       10         10       10
4 4 4	.1 Confi .2 NOC .3 FB30	Configuration       10         guration Options to Note       10         Configuration Info       10         00 NOC Base Configuration       11         Index Configuration       12
- 4 4 4	.1 Confi .2 NOC .3 FB30 .4 Stand	Configuration10guration Options to Note10Configuration Info1000 NOC Base Configuration11lard Configuration (MicroMotion)12
- 4 4 4 5	.1 Confi .2 NOC .3 FB30 .4 Stand	Configuration10guration Options to Note10Configuration Info1000 NOC Base Configuration11lard Configuration (MicroMotion)12NS12
- 4 4 4 5 5	.1 Confi .2 NOC .3 FB30 .4 Stand Scree .1 NOC	Configuration10guration Options to Note10Configuration Info1000 NOC Base Configuration11lard Configuration (MicroMotion)12ns121 and NOC 2 Screens12
- 4 4 4 5 5	.1 Confi .2 NOC .3 FB30 .4 Stand Scree .1 NOC 5.1.1	Configuration10guration Options to Note10Configuration Info1000 NOC Base Configuration11lard Configuration (MicroMotion)12ns121 and NOC 2 Screens12NOC RUN13
- 4 4 4 5 5	NOC ( .1 Confi .2 NOC .3 FB30 .4 Stand Scree .1 NOC 5.1.1 5.1.2 5.1.2	Configuration10guration Options to Note10Configuration Info1000 NOC Base Configuration11dard Configuration (MicroMotion)12ns121 and NOC 2 Screens12NOC RUN13MODBUS COM PORT15
4 4 4 5 5 5	NOC ( .1 Confi .2 NOC .3 FB30 .4 Stand Scree .1 NOC 5.1.1 5.1.2 5.1.3 5.1.4	Configuration10guration Options to Note10Configuration Info1000 NOC Base Configuration11lard Configuration (MicroMotion)12ns12ns121 and NOC 2 Screens12NOC RUN13MODBUS COM PORT15Phase Dynamics16MODBUS Parametere10
4 4 4 5 5	NOC ( .1 Confi .2 NOC .3 FB30 .4 Stand Scree .1 NOC 5.1.1 5.1.2 5.1.3 5.1.4 2 NOC	Configuration10guration Options to Note10Configuration Info1000 NOC Base Configuration11lard Configuration (MicroMotion)12ns12ns12NOC RUN13MODBUS COM PORT15Phase Dynamics16MODBUS Parameters19SETUP20
4 4 4 4 5 5 5 5	NOC ( .1 Confi .2 NOC .3 FB30 .4 Stand Scree .1 NOC 5.1.1 5.1.2 5.1.3 5.1.4 .2 NOC 5.2.1	Configuration10guration Options to Note10Configuration Info1000 NOC Base Configuration11lard Configuration (MicroMotion)12ns121 and NOC 2 Screens12NOC RUN13MODBUS COM PORT15Phase Dynamics16MODBUS Parameters19SETUP20Al/BSW CALC INFO21
4 4 4 5 5 5 5 5 5 5	NOC ( .1 Confi .2 NOC .3 FB30 .4 Stand Scree .1 NOC 5.1.1 5.1.2 5.1.3 5.1.4 .2 NOC 5.2.1 .3 Well	Configuration10guration Options to Note10Configuration Info1000 NOC Base Configuration11lard Configuration (MicroMotion)12ns121 and NOC 2 Screens12NOC RUN13MODBUS COM PORT15Phase Dynamics16MODBUS Parameters19SETUP20AI/BSW CALC INFO21Configuration Screen23



5.5 MF History	27
6 Operation	
6.1 Accessing the Operation Screens	
6.2 Starting and Stopping a Test	
6.3 Viewing Historical Data and Well History	
6.4 Alarms/Events	
Appendix A: Standards	
Appendix B: Liquid Meter Configuration Guide	
Appendix C: Directive 17 Compliance	
NOTES:	42



## 1 Overview

#### **1.1 Revision History**

Revision 1.0 October 2024 by JRC – First Release

#### **1.2 How to Use this Manual**

Read this manual in its entirety to aid in setup, configuration, navigation and troubleshooting. This manual provides a basic overview of the Net Oil Calculator, and briefly describes how to install and configure the SpartanPRO<sup>™</sup> NOC program for an Emerson FB3000 using FBxConnect Configuration Interface Software.

#### **1.3 Getting Help**

If you have any questions, please don't hesitate to contact us at:

SPARTAN CONTROLS HEAD OFFICE 305 - 27 Street SE, Calgary, Alberta, Canada T2A 7V2 Phone: 403-207-0700 M-F 8am-5pm: 1-877-278-6404 After Hours: 1-877-278-6404

#### 1.4 Warranty

Please find Spartan Controls current terms and conditions here: <u>https://www.spartancontrols.com/terms/</u>

## **1.5 Application Overview**

The SpartanPRO<sup>™</sup> NOC application is a Net Oil Calculator that uses inputs from various end devices to calculate the water cut present in an emulsion stream. It is intended for use in parallel with Vinson's ProductionManager<sup>™</sup> Equipment (PMEQ) and ProductionManager<sup>™</sup> Well Test (PMWT) applications. This application has been developed for Emerson's FB3000 flow computer.



#### 2 Introduction

#### For quick installation and configuration go to Sections 3.2 and 3.3.

The Net Oil Calculator (NOC) uses a MicroMotion mass flow meter as a flow sensor to calculate the net water present in an emulsion stream (as a percentage). Water cut determination can be made by comparing the measured emulsion density to the reference densities of free oil and water. The system can also accept an input from a water cut analyzer.

The Net Oil Calculator calculates the volume correction factor using the temperature effect on the densities of oil and water, as well as the pressure effect on the density of oil, if pressure compensation is enabled. Using the water cut and volume correction factors, the emulsion flow is factored to determine the net oil and water at standard conditions. This program provides up to two net oil calculations.

The SpartanPRO<sup>™</sup> NOC application utilizes Vinson ProductionManager<sup>™</sup> applications (Equipment: PMEQ and Well Test: PMWT) to provide a set of complimentary user interfaces. The operator can start and stop tests, monitor production numbers, and enter other key parameters through the Vinson applications using FBxConnect software. Refer to Vinson's documentation for further information on equipment setup and well testing.

#### 2.1 Technical Overview

There has been one program version used for the SpartanPRO<sup>™</sup> NOC software. All future supported software versions will be listed below.

# of NOCs or LACT	Latest Version	# of Liquid Runs	# of Gas Compositions	Gas Composition Type	# of History Points
1 or 2	Contact Spartan Controls	24	24	Per Well	FB3000 History: Transactional History for well testing (256 records/PMWT) Standard periodic history for LACT (default 730 days, user defined)

**Note:** FB3000 Firmware revision required is 2.17 or greater. Field Tools version 3.17 or greater.



The SpartanPRO<sup>™</sup> NOC system has two operating modes available. The modes are PMWT (ProductionManager<sup>™</sup> Well Test) or LACT (continuous mode). In PMWT mode, the system will allow daily production to be tested for oil, water and gas production. The system has a database for each well containing oil density, water density and well identifiers. The well test mode prorates measurement to a 24 hour period. If the test is stopped prior or extended beyond 24 hours, the production data will be prorated to a 24 hour test. In LACT mode, the system will run the well test continuously. Daily production numbers will be recorded based on the contract hour configured in the FB3000.

Both PMWT and LACT modes allow measurement of either a 2 phase or a 3 phase separator. The liquid emulsion measurement is made by Micro Motion Coriolis meter. If a 3 phase separator is used, a turbine meter may be used for the water measurement. The gas measurement is made using a differential pressure or linear meter (software configurable).

The system can provide water cut measurement by several methods. The most common method is using a MicroMotion Coriolis meter density measurement for the inferred water cut. Alternately, a Drexelbrook BS&W monitor can be added in the range of 0-5% ( $\pm 0.5\%$  deadband) and an alternate technology such as a Phase Dynamics Microwave analyzer can be added for a high water cut range (0% to ~60%).

Low Range	High Range	Cut Method
0%	5%*	Drexelbrook
0%	100%	Net Oil Calculator
0%	~60%**	Phase Dynamics

\*±0.5% Deadband

\*\*Depends on emulsion Phase

#### 2.2 Software Interface

The software used for configuration of the FB3000 is the Emerson FBxConnect program included within Field Tools. The instructions provided in this manual are directed specifically for the use of the FBxConnect program. There are additional utility programs available for use with the SpartanPRO<sup>™</sup> NOC user program, the FBxVue and FBxDesigner software. This additional software also allows the user



to make most configuration changes to the user program as done with FBxConnect. It is recommended to use the FBxConnect for all set up and configuration, then use the FBxVue or FBxDesigner program utilities to assist in diagnostics when required.

Emerson FBxConnect software is used to download the user program into an FB3000. By default, an application file (.zap) that includes the SpartanPRO<sup>™</sup> NOC will be downloaded into any slot on the FB3000 according to site conditions. Alternatively, a solution (.zsl) file that includes all three applications can be used. However, in this case, application slot 1 will be designated for the SpartanPRO<sup>™</sup> NOC application, slot 2 the Vinson PMEQ application, and slot 3 the Vinson PMWT application. Refer to Vinson documentation for licensing/activation of the PMEQ/PMWT applications.

The programs are as follows:

User Program	Application Slot (Recommended)	Description
SpartanPRO™ NOC	1	Net Oil Calculator
PMEQ v5	2	Equipment Manager
PMWT v5	3	Well Tester



# 3 Installation

#### 3.1 Installation Procedure

The following outlines the recommended steps to download the SpartanPRO<sup>™</sup> NOC Application file (.zap) or solution file (.zsl).

Step	Description
1	If this is a new FB3000 with no previous history to collect, you may skip
	to step 2.
	Backup History / Alarms / Events
	Select the Reports tab on the FBxConnect main screen.
	Under the History section, generate a set of the History, Events and Alarms
	reports. Define the relevant collection period, time, sorting and file format.
	Select Generate.
2	Perform a Factory Default Cold Start
	Select the Services tab on the FBxConnect main screen.
	Under the Restart section, select Cold Start. Select 'Database is re-initialized
	with factory defaults and any other relevant options to clear during the cold
	start as needed, select OK.
3	Pick 1 or 2, not both.
	1 Application (.zap) Download
	An application download will only bring the SpartanPRO <sup>™</sup> NOC application into the FB3000.
	Select the Applications tab on the FBxConnect main screen.
	Under the Main section, select Management. Select an empty slot to load the
	application into and select Import Application. Browse to the location of and
	select the SpartanPRO NOC zap file.
	2 Solution (.zsl) Download
	A solution download will bring all three applications into the FB3000.
	Select the File tab on the FBxConnect main screen.
	Under the Solution section, select Download Solution. Browse to the location
	of and select the SpartanPRO NOC.zsl file. Select Download.



#### 3.2 Licensing

Once installed the SpartanPRO<sup>™</sup> NOC application will require a license to operate. If the application was loaded prior to the FB3000 shipping from Spartan Controls, it will be licensed already.

If the application is installed in the field, a call to contact Spartan Controls will be required for the license key. You will require:

- 1. Purchase order used to purchase SpartanPRO<sup>™</sup> NOC
- 2. FB3000 Serial number located in Field Tools FBxConnect, Services, Board Info

		10.1	1	
🖿 File 🛛 🛸 Mo	nitor 💿 Configure	X Services	C Reports	⊡ Ap
Service Info	Firmware Update	Ġ Warm	Start	2
Board Info	🛃 File Transfer	Cold S	itart	•
	Main		Restart	
Madula 1				
Module_1	-	· ·		
General				
General				
Tag :	Module	_1		
Tag : Description :	Module	1		



Spartan Controls will return a "License Key" which is entered into the Licensing page of the application.



## 3.3 Commissioning

The SpartanPRO<sup>™</sup> NOC application should be configured and commissioned by a Spartan Service Technician unless the user is familiar with the application and this manual. It is strongly recommended that a Spartan Service technician be involved in the first implementation of this product.



# 4 NOC Configuration

## 4.1 Configuration Options to Note

- The Net Oil Calculations are performed using well specific constants for oil and water density and shrinkage factors.
- Modbus is used to transmit density, emulsion flowrate and temperature. Accumulation is performed over the duration of the test for oil, water, and gas flow AGA calculation.
- A pressure input is optionally provided for pressure compensation of oil density. If pressure input is not chosen, a fixed pressure must be used in API liquids correction application. An estimate of the vessel pressure will suffice.
- Water cut can be directly monitored, with up to two monitoring ranges defined: a low range equipped with either an S&W or % analog monitor, and a high range that can be supplied by Phase Dynamics from a Modbus connection.

## 4.2 NOC Configuration Info

The NOC program uses 5 sets of user defined points.

The User Defined Points are summarized in the following table:

UDP Title	Purpose
NOC	Modbus, configuration, calculation registers
NOC_Well	Well database registers
NOC MF Hst	Meter factor history registers
NOC RZR	Phase Razor registers
NOC PRO	NOC licencing registers



#### 4.3 FB3000 NOC Base Configuration

The following are the typical configuration settings for the FB3000 when in use with the SpartanPRO<sup>™</sup> NOC application. Note the settings may vary dependent on application.

Parameter	Description
MicroMotion Configuration	Metric Units:
	Volume = m³/min
	Mass = kg/min,
	Temperature = Deg C,
	Density = $g/cm^3$
	Communications:
	Address 1, 19.2K baud, 1SB, 8DB, No parity
I/O Setup	3 AI, or 1 4088 MVS per NOC separator for gas flow
	1 AI for low range water cut (Drexelbrook)
Program Setup for MicroMotion	Set Modbus address = 1
	Enter well database – as per site information provided
FB3000 Units	Units – Set all to Metric
	Re Station Contract Hour – Site Specific
NOC Comms	19.2k Baud Rate, 8 Data Bits, No Parity, 1 Stop Bit
	Port Owner = Modbus Master
Modbus Access Configure / Communications / NOC Comms	Using the COM Port config tool (NOC Config screen), the FB3000 port number and Modbus register start value can be defined by the user.
	<b>Note:</b> the desired FB3000 port must be configured as a <u>Modbus</u> <u>Master</u> .



#### 4.4 Standard Configuration (MicroMotion)

SpartanPRO<sup>™</sup> NOC is designed for use with a MicroMotion Coriolis meter communicating over Modbus RS485. The following is a list of the basic parameters when using a MicroMotion Coriolis meter.

Parameter	Description
Volume Units	m <sup>3</sup> / min
Mass Units	kg / min
Density Units	g / cm <sup>3</sup>
Temperature Units	°C
Modbus Address	1 (NOC 1) / 2 (NOC 2)
Communications	19.2k Baud Rate, 8 Data Bits, No Parity, 1 Stop Bit

## **5** Screens

## 5.1 NOC 1 and NOC 2 Screens

In the Applications tab select **SpartanPRO™ NOC / NOC Config.** The NOC 1 screen is now available with a NOC SETUP tab. NOC 2 is available from the pulldown list on the top left.





#### 5.1.1 NOC RUN

SCREEN SECTION (Box)	Parameter Description
WELL TESTING METHOD Enable PMWT Toggle (1 = Toggle)	Toggle this on to enable <b>PMWT Mode</b> . Toggle this off to enable <b>LACT Mode</b> . NOC 1 and NOC 2 are independent.
LACT CONTROL	This text box displays the current well data to be used in LACT mode. It also provides a Start/Stop button to start LACT mode.
PMWT CONTROL	This text box displays the current well on test and which PMWT test separator is being used. Zero (0) as test separator means that well testing mode is not running.
	Gas Meter Type: defines type of gas meter (DP or Linear).
	<b>Current Well in Test</b> : This read only field displays the well number currently being tested or of the well last tested. Refer to the Vinson applications for additional information.
	<b>Test Well LSD:</b> This read only field displays the Legal Site Descriptor of the well currently in test.



MODBUS	Enable MicroMotion Polling toggle
	COM PORT CONFIG: See section 5.1.2
	<b>Enable Phase Dynamics</b> : See section 5.1.3
	<b>Phase Dynamics:</b> button to configure specific parameters of the Phase Dynamics. See Section 5.1.3
	<b>Phase Dynamics Type:</b> Selection of Phase or Razor devices. See section 5.1.3
	Switch to NOC (%): Value of Water cut to switch to NOC from Phase Dynamics. NOTE: Emulsion Phase needs to be "Oil" for water cut to be selected from Phase.
	<b>Parameters Greyed Out:</b> Modbus parameters from MicroMotion. See section 5.1.4
	Status values of Communications: Micromotion coms, PHD coms, Port active
NOC WATER CUT	All read only parameters indicating water cut measurement and/or calculations.
	Applied % Water Cut: Value to be applied to liquid flow calculation as water cut.
	<b>V2.xx.xx:</b> Displays the current NOC application version on the FB3000.



#### 5.1.2 MODBUS COM PORT

Allows the user to define a desired COM port for MicroMotion/Phase Dynamics communications and adjust Modbus mapping requirements.

ComPortConfig					×
MODBUS COM PORT					
MODBUS REGISTER TABL	E LOAD				
MB MASTER STARTING REGISTER	3500				
MB MASTER TABLE START	TABLE 1	•	LOAD MAP	CLEAR MAP	
		0			
PORT LOAD/CLEAR					
MB MASTER COM PORT	NONE	•	LOAD PORT	CLEAR PORT	
	СОМ	PORT 4	ACTIVE		
					_
		Refi	resh Save	Cancel	



#### **5.1.3 Phase Dynamics**

Phase Dynamics Type:

- Unselected No PHD selected. (Recommended to turn off Modbus Coms)
- Full Range Select this for the Phase "Classic" models.
- Razor Select this for the new Razor insertion models.

#### If Selected = "Full Range"

∇C_1 (NOC1) ▼			
Full Range Analyzer			
Local Oil Adjust (to Send to Remote)	0.0	Emulsion Phase (0=OIL 1=UNC 2=WATER)	1.0
Remote Oil Adjust	0.0	Slope for Density Correction (0.0=Disabled)	0.0
Flow Temperature	15.0	Density Corrected Cut	40.78
Unclipped Water Cut	15.0	]	
Zero Clipped Water Cut	40.78	]	
Water Cut Offset (%)	0.0		

Parameter	Description
Local Oil Adjust (to send to Remote)	Allows the user to adjust oil locally. Saving this value will adjust the remote oil if phase dynamics is enabled.
Remote Oil Adjust	This read only parameter displays the oil adjustment setting from the Phase Dynamics.
Flow Temperature	This read only parameter displays the current flow temperature used in phase dynamics if enabled.



Unclipped Water Cut	This read only parameter displays the current unclipped water cut from phase dynamics if enabled.
Zero Clipped Water Cut	This read only parameter displays the current zero clipped water cut from phase dynamics if enabled.
Water Cut Offset %	Allows the user to enter a water cut offset for phase dynamics if enabled. This offset is applied to the unclipped water cut.
Emulsion Phase	Allows the user to specify the emulsion phase of the mixture if phase dynamics is enabled and the high PHD range is selected. This parameter is typically set to 0 for continuous oil.
Slope for Density Correction	Allows the user to specify a slope to be used in the NOC calculation to correct the water cut. The slope must be less than zero for density correction to occur. <b>Note: -0.0286 is a good number to start with</b> <b>when density compensation is required</b>
Density Corrected Water Cut	This read only parameter displays the density corrected water cut.



#### If Selected = "Razor"

		×
NOC RZR_1 (PDI Razor)	T	
PHD RAZOR		
Water Cut	0.0	
Temperature	0.0	
Emulsion Phase	0.0	
Oil Ref Power	0.0	
Freq F0	0.0	
Freq F1	0.0	
Refresh	Save	Cancel

Parameter	Description
Water Cut	Read Only parameter of measured water cut.
Temperature	Read Only parameter of measured temperature.
Emulsion Phase	Read Only parameter of emulsion phase.
Oil Ref Power	Read Only parameter of measured Oil Reference Power (used for diagnostics).
Freq F0	Read Only parameter of measured frequency (used for diagnostics).
Freq F1	Read Only parameter of measured frequency (used for diagnostics).



#### **5.1.4 MODBUS Parameters**

Read only parameters

Parameter	Description
Mass Flow Rate	This read only parameter displays the instantaneous mass flow rate from the MicroMotion if Modbus polling is enabled.
Flow Density	This read only parameter displays the instantaneous flow density from the MicroMotion if Modbus polling is enabled.
Flow Temperature	This read only parameter displays the instantaneous flow temperature from the MicroMotion if Modbus polling is enabled.
Volume Flow Rate	This read only parameter displays the instantaneous volumetric flow rate from the MicroMotion if Modbus polling is enabled.
Flow Rate	These read only parameters display the instantaneous volumetric flow rate and the prorated (PMWT only) flow rate for a 24 hour period.



#### 5.2 NOC SETUP

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SCREEN SECTION (Box)	Parameter Description
TEMPERATURE	Flow Temperature Source: Allows the user to configure the flow temperature source to be either the MicroMotion or an analog input.
	<b>Raw Temperature:</b> This read only parameter displays the raw temperature from the source.
	<b>+/- Temperature Adjust:</b> Allows the user to apply a temperature adjustment to the raw temperature (if required).
	<b>Applied Temperature:</b> This read only parameter displays the temperature used in NOC calculations. Applied Temperature = Raw Temperature +/- Temperature Adjust.
Flow Pressure Source Toggle	Allows the user to select if flow pressure is used in NOC calculation. Flow pressure compensation is optional. Note: a value is required for Liquid Meter calc to operate (simulate in necessary)
	Flow Pressure Source: This read only parameter displays the analog input currently configured to read flow pressure if enabled.
	Al Pressure EU Reading: This read only parameter displays the current pressure reading from the pressure source if enabled.
Pressure From Source	This read only parameter displays the current pressure reading from the pressure source if enabled.



Water Cut	Allows the user to select if the water cut source from an analog input is used.
AI Water Cut Source Toggle	Al Reading Type: Defines Al EUs as Dielectric or %Water Cut
	Al Cut Source: Defines Al to be used as water cut source
	AI Cut EU Reading: This read only parameter displays the selected Engineering Unit (EU) value of the water cut input.
	<b>Switch to NOC/PHD (%):</b> Point to switch out of AI cut source, default 5.0, deadband is 0.5%.
	Well Water Density @ 15°C: Read only value of well data
	Well Oil Density @ 15°C: Read only value of well data
AI/BSW CALC INFO	All read only values for AI water cut either dielectric or % water cut. Only to be modified by qualified Spartan Controls technician. See section 5.1.5.

#### 5.2.1 AI/BSW CALC INFO

Parameter	Description
BSW Well bTrim	This read only parameter displays the ±bTrim value in dielectric units if an analog input is selected as the water cut source. This value is set in the Edit Wells screen.
BSW k_mix + Well bTrim	This read only parameter displays the sum of the k mix and bTrim values in dielectric units if an analog input is selected as the water cut source.



BSW Dielectric K of Oil	This read only parameter displays the dielectric of oil at operating temperature if an analog input is selected as the water cut source.
BSW Dielectric K of Water	This read only parameter displays the dielectric of water at operating temperature if an analog input is selected as the water cut source.
Oil Density at Flow Temperature	This read only parameter displays the oil density at flowing temperature. This value is found by taking the well oil density at 15°C and correcting to the current flow temperature.
Oil Correction Factor (CTL)	This read only parameter displays the density ratio of oil. coFac = density of oil at operating temperature / density of oil at 15°C and operating pressure (if enabled).
Water Density at Flow Temperature	This read only parameter displays the water density at flowing temperature. This value is found by taking the well water density at 15°C and correcting to the current flow temperature.
Water Correction Factor (WCF)	This read only parameter displays the density ratio of water. cwFac = density of water at operating temperature / density of water at 15°C.
BSW Water Cut %	This read only parameter displays the instantaneous water cut percentage at operating temperature if an analog input is selected as the water cut source.



## 5.3 Well Configuration Screen

In the Applications tab select **SpartanPRO<sup>™</sup> NOC** / **Edit Wells**. The well configuration has 24 wells and must be complete for the well testing to function properly. Enter the gas composition for each well, the sum of all components must be 100%. Default values are set for the five parameters on the left of the screen, however, they are not process-backed. Confirm site specific values for these parameters during initial setup.

NOC Well_1 (NOC Well)								
Well 1								
Well Information	Gas Composition -							
LSD LSD 1	Nitrogen N2	0.0	n-Heptane C7H16	0.0				
	Carbon Dioxide CO2	1.0	Octane C8H18	0.0				
Oil Density G/CC at STP 0.8 G/CC	Methane CH4	99.0	n-Nonane C9H2O	0.0				
Water Density G/CC at STP 1.0 G/CC	Ethane C2H6	0.0	n-Decane C10H22	0.0				
Pressure Coefficient of Oil 0.0	Propane C3H8	0.0	Hydrogen Sulphide H2S	0.0				
BS&W A Constant (ie:0.57) 0.57	n-Butane C4H10	0.0	Water H2O	0.0				
BS&W +/- bFactor in Dielectric Units 0.0	i-Butane C4H10	0.0	Helium He	0.0				
Oil Shrinkage Factor 1.0	n-Pentane C5H12	0.0	Oxygen O2	0.0				
	i-Pentane C5H12	0.0	Carbon Monoxide CO	0.0				
	n-Hexane C6H14	0.0						
		SUM	CLEAR Total	0.0				
						Re	efresh	Save

Parameter	Description					
LSD	A 20 character identifier which can be used as a Legal Site Description or another description of the well. This identifier is displayed on the NOC Config screen when this well is in test.					
Oil Density G/CM <sup>3</sup> at STP	Allows the user to specify the oil density at 15°C to be used in the NOC calculation. Default value is 0.8 g/cm <sup>3</sup> .					



Water Density G/CM <sup>3</sup> at STP	Allows the user to specify the water density at 15°C to be used in the NOC calculation. Default value is 1.0 g/cm <sup>3</sup> .
Pressure Coefficient of Oil	The pressure coefficient of oil used in the pressure compensation of the oil density. Units: E-7 g/cm <sup>3</sup> /kPA.
	Pressure Coefficient of Oil =
	(standard density – operating density) /
	(standard pressure – operating pressure)
	Note: Typically, in test separator applications, the pressure coefficient is set to 0 because the difference in standard density and operating density is minimal and pressure compensation on density does not have to be performed. Default value is 0.0.
BS&W A Constant	The BS&W A constant. This value is 0.57 by default and should not ever be changed unless advised by Spartan Controls. A change will impact the accuracy of the BS&W monitor if in use.
BS&W +/- bFactor in Dielectric Units	The BS&W B constant which is the change in % water per unit change in dielectric of the mixture. This entry is essentially an offset for the BS&W monitor. Default value is 0.0.
Oil Shrinkage Factor	The shrinkage factor of oil. API 20.1 is calculation required by emulsion meter in order for this factor to be enabled.



#### 5.4 Modbus TBR Screen

In the Applications tab select **SpartanPRO™ NOC** / **Modbus TBR**. NOC 1 and NOC 2 can be configured independently. This configuration must be complete for the well testing to function properly. These settings are used if a TBR event occurs (entrained gas is carried through the meter).

SpartanPRO NOC V1 -	PMEQ v5 • PMWT v5	-	
Edit Wells			
n Modbus TBR Ap	plications		
NDC Config			
TBR			
		N	NOC 2
nsity G/CC 0.82		FI	Flow Density G/CC
nsity G/CC 0.82		Т	TBR Density G/CC
Drive Gain 23.0		Ci	Current Drive Gain
iain Alarm 50.0		۵	Drive Gain Alarm
LPO Volts 21.0			Jurrent LPO Volts
Low Level 0.1	U		O TBR Low Level Alarm

Parameter	Description
Flow Density G/CM <sup>3</sup>	This read only parameter displays the instantaneous flow density from the MicroMotion if Modbus polling is enabled.
TBR Density G/CM <sup>3</sup>	This read only parameter displays the density to be used in the NOC calculation.
Current Drive Gain	This read only parameter displays the current drive gain.



Drive Gain TBR Alarm Level	Setting used to define a high alarm limit of the coriolis meter drive gain. If the drive gain TBR alarm level is exceeded an alarm will be generated and displayed on the screen and recorded in the FB3000 alarm log. If this alarm occurs regularly then process operational changes may be required to minimize the amount of gas breakout accruing in the coriolis meter. Additional features on the Micro Motion transmitter may be employed like Advanced Phase Measurement.
Current LPO Volts	This read only parameter displays the current LPO volts.
LPO TBR Low Level Alarm	Also an indicator of the presence of entrained gas. Alarm is generated if the LPO is below this level.



#### 5.5 MF History

When MF is entered into the emulsion flow meter calculation in the FB3000, this application records the last 10 of them for easy reference. The FB3000 Audit logs will also record this parameter change. Use caution to only apply a single meter factor to either the flow computer (FB3000) or the MicroMotion coriolis transmitter.





## 6 Operation

## 6.1 Accessing the Operation Screens

All screens can be accessed directly through FBxConnect under the SpartanPRO<sup>™</sup> NOC application.



## 6.2 Starting and Stopping a Test

Tests are controlled through a combination of Spartan and Vinson applications. A test can be started in LACT mode on NOC 1 and NOC 2 directly from the NOC Config screen. PMWT tests can also be enabled from these screens. PMWT tests can be setup and controlled through the Vinson (PMEQ and PMWT) applications, see Vinson for additional information and documentation regarding test setup. Test separators 1 and 2 are available for use in the NOC application and can accommodate up to 12 wells each. Only one of either LACT or PMWT testing modes may be running on each NOC at one time. The test status will display as 'Running Continuous' if in LACT mode, 'Pre-Purge' / 'Running Well Test' / 'Post-Purge' if in PMWT mode or 'Stopped' if NOC is not running. The



screen will display the current well in test as well as the well's LSD for both modes of operation.

e Monitor @Configure Services Reports	PMIVT v5 -				
formation					
Main Applications					
C_1 (NOC1)					
DC RUN NOC SETUP					
WELL TESTING METHOD	MODBUS			NOC WATER CUT	
Enable PMWT	Enable MicroMotion Polli	ing COM PC	ORT CONFIG	Oil Corr Factor	1.0
LACT CONTROL	Enable Phase Dynamics F	Polling PHASE	DYNAMICS	Water Corr Factor	1.0
	Phase Dynamics Type	Full Range	•	NOC Calc % Water Cut	42.49999
Run this Well in LACT 0	Switch to NOC (%)	60.0			
PMWT CONTROL	MMI Mass Flow Rate	800.0	kg/min	PHD % Water Cut	40.78
	MMI Flow Density	0.885	g/cc	Emulsion Phase	Uncertain
PMWI lest Sep # 1	MMI Flow Temperature	15.0	°C	Applied % Water Cut	42.49999
PMWT Well Selected 12	MMI Volume Flow Rate	0.904	m³/min		
Gas Meter Type DP Meter 🔻	NOC Volume Flow Rate	1301.695	m³/day		
Current Well in Test Well 12					
	MicroMotion Comms	сомм ок		PMWT Ga	s In Use
Test Well LSD LSD 12	PHD Comms	сомм ок			
POST-PURGE	Status Message	COM PORT 4 A	CTIVE	1/2 00 04	

When PMWT is enabled, the screen will display the current separator and well being tested, as well as a status message for the test. The selection of the well in test must be done through the PMWT application. To enable or disable PMWT, use the toggle button in the top left of the screen.

If PMWT is disabled, the user will have the option to start and stop LACT testing. To start or stop a test in LACT mode, press the START/STOP button and ensure the test status is 'Running Continuous'.

File File	Monitor	Configure	Services	Reports	5
Mana	gement	- Spart	anPRO NOC 👻	PMEQ v5 -	PN
() Inform	nation				
	Main		Ap	plications	
NOC_1	(NOC1)		•		
NOC	RUN	NOC SET	UP		
<b>_</b> \	VELL TEST	ING METH	OD		
	C	Enable	PMWT		
	LACT CO	NTROL			h
		Sta	rt/Stop		
	Run this	s Well in LACT	0		
	Run this	Sta s Well in LACT	rt/Stop 0		



#### 6.3 Setting Up Historical Data

#### 6.3.1 Well Test Mode (with PMWT)

Transactional History must be setup for each Well being tested. This is completed with the following steps:

#### Step 1

- Select <History> <Advanced Setup>
- Enable Transaction History
- Set number of wells (max 24 for PMWT) that will need transactional history
- Click <Save>
- Select <Transaction History Group Details>

File	📽 Monito	or Oconfigure	Services	Reports	Application	16 🖬	FBxVue	🕜 Help						
Home Guided	Fi Setup	C Engr Units Point Picker	<ul><li>✔ I/O Setup</li><li>✔ Pass Thru</li></ul>	•	Summary Meter Setup	♠ Ga	as quid	<ul> <li>Station</li> <li>X Averages</li> </ul>	∑Totals ∎ਊGC	(A)	Alarms History	Elogs	•	PID Loops
	Mair	n	1/0				M	easurement		11 11 11 11 11 11 11 11 11 11 11 11 11	Group Confi Default Histo	guration   ory Setup	- A	lvanceo
ansa	action H	istory Sizing	Standard Per	iodic Hist	tory									
N	umber O	f Transaction G	oups:											
				Cu	irrent	Reque	ested	_						
	Number	of Transaction	History Groups	: 24			24 💂	$\leftarrow$						
	Number	of Transaction	History Groups	: 24			24 🛓							
Tr	Number	of Transaction	History Groups	: 24			24							
Tr	Number ansaction Select Nu	of Transaction	History Groups	: 24	nsaction Group	.:	24 🛓	ansaction Histo	ory Group Detail	5				



Step 2

- Select <Group Type> pull down box, select <PMWT Well Test Report>
- Select <Use Instance> to equal Trans Hist Grp #
- Change Requested < Transaction Records> if desired
- Click <Save>

SPARTAN CONTROLS

			Application Assign	ment		Current				Requested		
Number	Grou	ip Tag	Group Type	Use Instance	String Points	Numeric Points	Transaction Records	String Points	Numeric Points	Transaction Records	Memory Used (9	1)
1	Trans Hist Grp 1		PMWT Well Test Report	1	10	30	400	10	30	400	0.4967	
2	Trans Hist Grp 2		General	2	10	30	400	10	30	400	0.4967	
3	Trans Hist Grp 3		PMWT Well Test Report PMWD Cycle Record	3	10	30	400	10	30	400	0.4957	
4	Trans Het Grp 4		PMINO Gas Lift Test Record	4	10	30	400	10	30	400	0.4957	
5	Trans Hat Grp 5		PMFL Auto-Haul Record	5	10	30	400	10	30	400	0.4967	
6	Trans Hist Grp 6		PMWT Well Test Report	6	10	30	400	10	30	400	0.4967	
7	Trans Hist Grp 7		PMWT Well Test Report	7	10	30	400	10	30	400	0.4967	
8	Trans Hist Grp 8		PMWT Well Test Report	8	10	30	400	10	30	400	0.4967	
9	Trans Hat Grp 9		PMWT Weil Test Report	9	10	30	400	10	30	400	0.4967	
10	Trans Hist Grp 10		PMWT Well Test Report	10	10	30	400	10	30	400	0.4967	
11	Trans Hist Grp 11		PMWT Well Test Report	11	10	30	400	10	30	400	0.4967	
12	Trans Hist Grp 12		PMWT Well Test Report	12	10	30	400	10	30	400	0.4967	
13	Trans Hist Grp 13		PMWT Well Test Repot	13	10	30	400	10	30	400	0.4967	
14	Trans Het Grp 14		PMWT Well Test Report	14	10	30	400	10	30	400	0.4967	
15	Trans Het Grp 15		PMWT Wel Test Repot	15	10	30	400	10	30	400	0.4967	
16	Trans Hat Grp 16		PMWT Well Test Report	16	10	30	400	10	30	400	0.4967	
17	Trans Hist Grp 17		PMWT Well Test Report	17	10	30	400	10	30	400	0.4967	
+0	+ 1+			+0	+8		inn.	+h		inh	A 1000	
			Liquid Linear Meter Batchin	g for a Transact	ion History Gr	oup can only be	configured from the	Liquid Linear	Meter display			
4												*
	1	lequested Men	nory Used (%)									
ransacti	ion History	11 9205										
td Perio	dir History	22 9642										
	-	32,0042								Concel	Clara	

#### Step 3

- Under Applications, select <PMWT v5> <Well Testers>
- Select <Hamburger> <PMWT Well Testers>

🖬 File 🔹 Monitor 🕴	🖗 Configure 🛛 🔭 Servic	es 🗋 Reports	Applications	E FBxVue	() Help
Management	SpartanPRO NOC	- PMEQ v5 -	PMWT v5 ·		
Information  Main		Applications	00-PM\v/T Base 01-\v/ell TestOv	Config verview	
			02-Well Testers		
PMwtTester_1 (NOC1)	Ψ		03-Wells		
Testers					
=	Tag: NOC1				
	Description: Tester_1				



#### Step 4

- Select < Gear with wrench >Tab "Logging Configuration"

🖿 File 🔹 Monitor 🔇	Configure 💦 Services	Reports Applications
Management Information Main	SpartanPRO NOC - (	
PMwtTester_1 (NOC1) Testers	Tag: NOC1 Description: Tester_1	Well Testing Base Configuration General Setup Logging Configuration Logging Log Alarms Log Gas Correction Factor Events

- Select <Auto-Configure> for Transaction History on each well that is used

Logging					Licensing		
Log Alarm	15				Licensed Testers:	б	Watchdo
Log Gas C	Correction Factor Events				24 (PMEQ)	5819	
Well #9	Well #10	Well #11	Well #12	Well #13	Well #14	Well #15	Well #16
Well #17	Well #18	Well #19	Well #20	Well #21	Well #22	Well #23	Well #24
Well #1	Well #2	Well #3	Well #4	Well #5	Well #6	Well #7	Well #8
Well 1 — Loggi	ng			Tran	saction History	Error Code:	
Quan 256	tity of Reports to Log to	File System:		н	story Group: 1		
Last S	Gerial Number: Rec	ords Available:			Configured		
23/4	4 25	10					



#### 6.3.2 LACT Mode (without PMWT)

It is recommended to setup periodic history as a "Default History Setup".

lome PIC' E Suided Setup [ F	Engr Units Point Picker	VO Setup Pass Thru VO	<ul> <li>Summary</li> <li>Meter Setup</li> </ul>	A Gas	Station     X Averages	∑ Totals	(A) Alarms     (A) History     (     Group Configure	Logs
Maili		10			medsulement		Default History     Advanced Setu	Setup
- Gas Meters Se Number of Gas Do you want to	Meters : s Meters defau	It history for all Gas	meters?			2 Yes	Ţ	
Do you want co Enter the numb	omponents to per of spare h	be averaged and a istory points (if any	archived? ) you want to setup pe	r Gas Meter:	Numeric :	Yes - Standard	Composition V	
Liquid Meters	Setup							
Number of Liqu	uid Meters :					2		
Do you want to	o setup defau	It history for all Liqu	uid meters?			Yes	•	
F-1-1				- Linuid Mater	N	0		

Ensure to set the specific contract hour required in the appropriate Station.

🖿 File 🛛 🛸 Mon	itor 🙆 Configu	re 🄀 Services	Reports	Application	s 🔹 FBx	Vue	() Help				
A Home	FIC' Engr Units	VO Setup	- 1	Summary	A Gas		Station	∑ Totals			
🐨 Guided Setup	Point Picker	💙 Pass Thru	90	Meter Setup	Liquid		$\overline{\chi}$ Averages	GC			
М	lain	1/0				Measu	urement				
Station_3		Ŧ									
General											
Tag :	Station_3			Flow Alarm O	Alarm	Alarm_1803					
Description :				History Group	Hist G	Hist Grp_6					
Operation Status :	Batch Idle		1	Liquid Produc	od_1						
	Engineer	ing Units →									
Fluid Type			Batch Op	otion			Base	emperature			
Natural Gas	: 🔘 Liq	uid	Disable	C	Enable		O 0°C				
							() 60°F				
Contract Pr	operties						● 15°C				
Contract Day of	Week : Sunda	iy.	Ŧ					Select			
Contract Hour :	7						-				



# 6.4 Reports – Transactional (Well Testing)

A CSV report can be downloaded from the FB3000 that contains 400 transactions per well/transaction record. This will include:

- Site Identifier (typically LSD)
- Test Date with start and end times
- Test Duration (hours)
- 24 Hour Equivalent oil, water and gas volumes
- Test oil, water and gas volumes

File File	Monitor	Configure	🗙 Services		Reports	Appli	ications 😫	FBxVue	🕜 Hel				
EFM	Report	History -	Events		Configur	ation	[	🗋 Gas Cor					
CFX I	Report	Alarms			Config C	omparis	on [	Paramet	er Status				
		History					Configur	ration					
	Local FB3	000 ip112 - Transad	tion History Re	port					×				
		estination											
		Location: C:\Us	ers\Public\Doo	umer	nts\Emerson	n\Fi\Tr	ansHistory						
	-	options											
		History Group: All TransHGrp_1 (Trans Hist Grp 1)											
				Tra	nsHGrp_2 (	Frans H	ist Grp 2)						
		Sub Tupo		Tra	nsHGrp_4 (	Trans H	ist Grp 4)	-					
		Batch	Hourly 🗌 Da	aily	Weekly	Mo	onthly 🔲 Sn	apshot					
	-	Collection perio	d										
		Since Last Col	lection F	rom:	09/19/202	4 ~	12:00:00 AN	Å N					
		By Last Seque	nce No	To:	10/24/202	4 ~	1:35:05 PN	r N					
		○Time Range				_		_					
		All			Sorti	ng:	🕹 Oldest F	first					
		Filter											
		Transaction Id:				₩ S	atch whole wor	ds only					
	-1	Columns	[	Z Sec	uence No								
		Oefault	6	Z Beg	in Timestar	np							
		Customized	6	End Tra	Timestam	o b-Type		-					
	F	ormat CSV	•										
	Statu	5:											
		Generate			View		Clo	se					



## 6.5 Reports – Periodic (LACT)

A CSV report can be downloaded from the FB3000 that contains the flowing volumes for Oil, Water and gas for the 24 hour period defined by the Station contract hour.

File	A Monitor	Configure	Services	Reports	Applications	EBxVue	🕜 Help
EFM	Report	History -	Events	Confi	guration	Gas Co	mposition
	Report	Alarms		Confi	g Comparison	Parame	ter Status
		History			C	onfiguration	
	Local FB300	0 ip112 - Periodic	History Report				×
	Des	stination					
	Lo	ocation: C:\User	s\Public\Docu	ments\Emerso	n\FieldTo\Histo	ry	
	Op	tions					
	н	istory Group:	All	Hist Grp_1 (Us	er Periodic 1)	-	
				Hist Grp_3 (Ge	eneral History)		
				Hist Grp_4 (St Hist Grp_5 (St	ation 1 History) ation 2 History)		
				Hist Grp_6 (St	ation 3 History)	-	
	In	terval					
		2 Hourly	Daily	□ We	ekly 🗌 M	onthly	
	Co	ollection period					
	C	Since Last Colle	ection Fro	m: 09/19/202	24 ~ 12:00:0	O AM	
	C	By Last Sequen	ce No	To: 10/24/202	24 ~ 1:33:5	0 PM 🗘	
	۲	) Time Range		Sort		ost First	
	Co	olumns		5010	ing. void	coernoe	
		Default	5	Sequence No Begin Timesta	mp		
	C	Customized	1	End Timestam	ip	-	
	For	mat					
		CSV	-				
	Status:						
		Coporato		View		Close	
		Generate		VIEW		ciose	

## 6.6 Alarms/Events

The system maintains an event record for any configuration changes that occur. This report can be accessed through **Reports / Events**. The system also maintains an alarm record for any alarm codes that occur. This report can be accessed through **Reports / Alarms**. The FB3000 also includes other reports for users, available under the reports tab.



## **Appendix A: Standards**

The NOC calculations are based on the following specifications and standards:

- Algorithm of Net Oil Computation using MicroMotion Flow Meter and FB3000
- Manual of Petroleum Measurement Standards, Chapter 11.1 Volume Correction Factors, API Standard 2450, 2004 Edition.

# **Appendix B: Liquid Meter Configuration Guide**

#### FUTURE RELEASE

# **Appendix C: Directive 17 Compliance**

The following is a summary of the Directive 17 compliance requirements and confirmation on what Spartan believes provides system compliance.

Requirement	Compliance	Reference					
Single point oil production uncertainty requirement: 2%	MicroMotion volume accuracy: 0.1%. Typical water cut accuracy for 2 phase separator applications: 1%	Section 1 of Directive 17					
Single point gas production uncertainty requirement: 3%	Rosemount 4088B accuracy: 0.1% of span for 1:1 to 10:1 turn down.	Section 1 of Directive 17					
Calibration and proving requirement: Annually	MicroMotion requires proving annually unless Meter Verification (MV) is in use. With MV, proving is not required provided MV testing confirms meter performance is good.	Section 2 of Directive 17 See Exceptions Note 1 for information on meter verification					
Calibration of density for water cut calculation requirement: Annually	The MicroMotion density can be calibrated against a known density of liquid if required.	Section 2.11 of Directive 17					

#### **Application: Well Production Testing**



Accounting for shrinkage	The NOC software has an	Section 2.7.1
	individual shrinkage factor for	of Directive 17
	each well in the database.	Section 6.3.2.3
		of Directive 17
Calculation requirement for	The FB3000 NOC program	Section 6.3.2
volume	complies to 2 decimal places.	of Directive 17
Calculation requirement for daily	The system provides daily	Section 6.3.2.4
volume	volumes and non-resettable	of Directive 17
	running totalizers.	
Temperature correction	The system provides real time	Section 6.3.2.1
requirement	CTL using an electronic flow	of Directive 17
	measurement system.	
Pressure correction requirement	The system provides real time	Section 6.3.2.2
(not required for test production	CPL using an electronic flow	of Directive 17
measurement)	measurement system.	
Water cut calculation	The FB3000 NOC program	Section 6.3.2.4
requirement	computes water cut using an	of Directive 17
The percentage of water in the	inferred density calculation in the	
gross volume is determined by	range of 0% to 100% water cut.	
measuring the percentage of	(U.S. patent # 4,689,989 and #	
sediment (% S&W) of a	4,773,257)	
representative sample or by	The system optionally computes	
continuous on-line	water cut in the low range (0% to	
measurement.	5%) based on a density	
	corrected water cut probe.	
	(U.S. patent # 5,325,066 and	
	Canadian patent # 2,074,017)	
Calculation performance	The API liquids correction is	Section 6.8 of
evaluation	contained within the firmware of	Directive 17
	the FB3000. This calculation	
	should be verified to PC based	
	reference software recognized by	
	the regulator.	
Electronic Flow Measurement	FB3000 NOC has 24 wells and	Section 6.8 of
tor Oil Systems	maintains 256 (PMWT) or a user-	Directive 17
Hardware and software	configurable amount (with	
requirements: The memory on	I ransactional History) of well test	
board the EFM must allow for at	records. History records are	
least 32 days of storage of the	dependent on user set up.	
required flow data before being		
overwritten or erased.		



Electronic Flow Measurement for Oil Systems Hardware and software requirements: The EFM must be equipped with its own on-board battery to protect the memory in the event of a power failure.	FB3000 NOC has on board battery back up.	Section 6.8 of Directive 17
Electronic Flow Measurement for Oil Systems Hardware and software requirements: The system must have various levels of system security, with the highest level of access to the program restricted to authorized people.	The FB3000 permits device- based security. You can define and store custom log-on identifiers (IDs). In order for the unit to communicate, the log-on ID supplied to FBxConnect software must match one of the IDs stored in the FB3000. This security feature is enabled by default.	Section 6.8 of Directive 17
Electronic Flow Measurement for Oil Systems Hardware and software requirements: The communication system must use a data integrity error checking routine to ensure that the data transmitted is correct.	FB3000 NOC communications protocol is DNP3 which has integrated error checking.	Section 6.8 of Directive 17
Electronic Flow Measurement for Oil Systems Hardware and software requirements: The EFM must be set to alarm on high and low differential pressure, if applicable, over the range of any end devices, low power and communication failures.	FB3000 NOC can be configured to provide alarms for any device failure, under/over range condition, low power or communications failure. Alarm related conditions are also automatically logged to an event log in the FB3000.	Section 6.8 of Directive 17



Electronic Flow Measurement	FB3000 NOC does not allow flow	Section 6.8 of
for Oil Systems	data records to be edited. Any	Directive 17
Hardware and software	changes to the system	
requirements: Any changes	configuration are logged in the	
made to the data or any	event log for tracking purposes.	
manually entered values that		
affect the flow calculation must		
be flagged so it is clear that		
these are estimated, not actual,		
readings. This flagging must		
carry through to values		
calculated from the data.		
Electronic Flow Measurement	The FB3000 firmware has a	Section 6.8 of
for Oil Systems	database for events, alarms, and	Directive 17
Hardware and software	history that stores the last 8000	
requirements: When any	events, the last 8000	
parameter that affects the flow	alarms, and six months of hourly	
calculation is changed, such as	records as per API	
meter factor, fluid densities, or	Chapter 21.1 and 21.2.	
transmitter range, a signoff	Additional off-RTU storage may	
procedure or an event log must	be required.	
be set up to ensure that the		
change is made in the EFM		
system. All data and reports		
must be retained for a minimum		
of 12 months.		



The Daily Report	FB3000 NOC daily records are	Section 6.8 of
The daily report must include:	available and are compliant.	Directive 17
<ul> <li>Meter identification</li> </ul>		
Daily accumulated flow with		
indicating flags for estimated		
flow made by the system or		
manual inputs and alarms		
that have occurred for over		
ranging of end devices		
Hours on production or hours		
of flow (specify)		
• Flow data audit trail – include		
at least one of the following:		
<ul> <li>Instantaneous values for</li> </ul>		
flow rate, operating		
pressure (if applicable),		
and temperature taken at		
the same time each day		
<ul> <li>Average daily values for</li> </ul>		
volumes, operating		
pressure (if applicable),		
and temperature, or		
hourly accumulated flow		
rate and average hourly		
values for operating		
pressure (if applicable)		
The monthly report is for the	FR2000 NOC boo oll the listed	Section 6.9 of
ontire system, providing data for	FB3000 NOC has all the listed	Directive 17
entire system, providing data for	non-resettable totalizers event	Directive 17
contain the following at each	logs and well test history	
measurement point as		
applicable:		
<ul> <li>Monthly cumulative flow</li> </ul>		
Flags indicating any change		
made to flow volumes		
Total hours on production or		
hours of flow (specify)		



The Meter Report	FB3000 NOC allows all	Section 6.8 of
The meter report details the	instantaneous data for the meter	Directive 17
configuration of each meter and	report to be accessed through	
the flow calculation information.	Modbus or DNP3 registers.	
These values are used as part	C C	
of the audit trail to confirm that		
the flow calculation is		
functioning correctly. The meter		
report must include the following		
as applicable and be produced		
upon request:		
<ul> <li>Instantaneous flow data</li> </ul>		
- Instantaneous flow rate		
- Instantaneous operating		
pressure		
- Instantaneous flowing		
temperature		
- OFL		
Current conliguration     information		
Information:		
- Meter identification		
- Date and time		
- Atmospheric pressure		
- Pressure base		
- Temperature base		
<ul> <li>Calibrated operating</li> </ul>		
pressure range		
<ul> <li>Calibrated temperature</li> </ul>		
range		
<ul> <li>Meter factor and/or k-</li> </ul>		
factor		
<ul> <li>Shrinkage factor</li> </ul>		



# NOTES:

<u> </u>		 				 	 	 	 	 	 		 	 			
		 				 	 	_	 	 		_	 	 		_	
		 	 		 	 	 	 _	 	 	 _	_	 	 	_	 _	

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