Technical Data Sheet No. TD-DPCM-MB-0319 **Date of Issue:** March 2019

OPERATING MANUAL

Modbus RTU Slave Interface for DPC/DPM Digital Mass Flow Instruments

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1 GENERAL INFORMATION

1.1 Introduction

This manual provides installation and confi guration instructions for AALBORG DPM/DPC digital mass-flow meters / controllers equipped with Modbus interface. The MODBUS Serial Line protocol is a Master-Slaves protocol. Only one master (at the same time) is connected to the bus, and one or several (247 maximum number) slaves nodes are also connected to the same serial bus. The AALBORG Modbus instrument is implemented as a slave device. A MODBUS communication is always initiated by the master. The slave nodes will never transmit data without receiving a request from the master node. The slave nodes will never communicate with each other. The master (usually implemented with PC or PLC) node initiates only one MODBUS transaction at the same time.

IMPORTANT: ***More detailed information about Modbus can be found at*** http://www.modbus.org

IMPORTANT: ***The implementation of the Modbus interface is based on the following standard:*** http://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf.

1.2 Electrical Interface

On standard MODBUS system, all the devices are connected (in parallel) on a trunk cable constituted by 3 conductors. Two of those conductors form a balanced twisted pair, on which bi-directional data are transmitted, typically at the bit rate of 9600 bits per second. A third conductor must also interconnect all the devices of the bus : the common (see Figure 1.2).

AALBORG Modbus instruments are implemented with a “Two-Wire” multi drop electrical interface in accordance with EIA/TIA-485 standard. Each AALBORG Modbus instrument integrates the isolated communication transceiver and must be connected to the trunk using a **Passive Tap [PT]** and a **Derivation Interface Cable [IDv]** (see Figure 1.1).

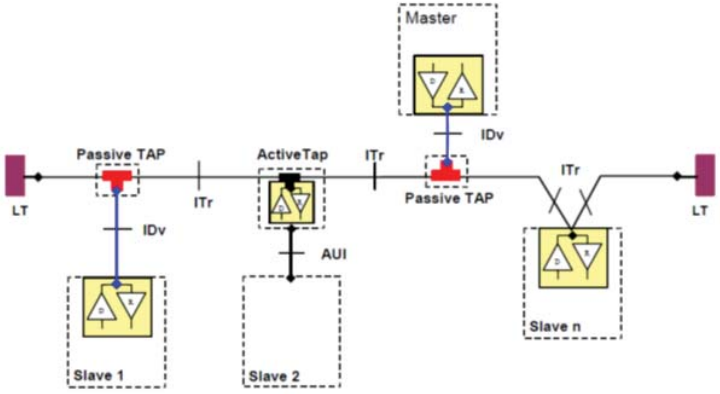


Figure 1.1 Serial bus infrastructure

The following conventions are adopted on the Figure 1.1 :

ITr - The interface with the trunk is named Trunk Interface

IDv - The interface between the device and the Passive Tap is named Derivation Interface

LT - Line Termination

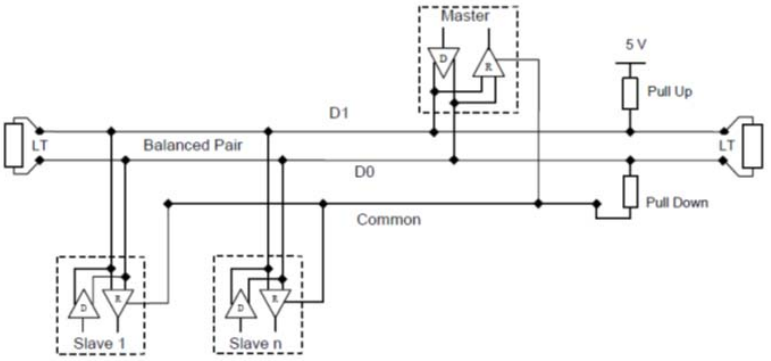


Figure 1.2 General 2-Wire Topology

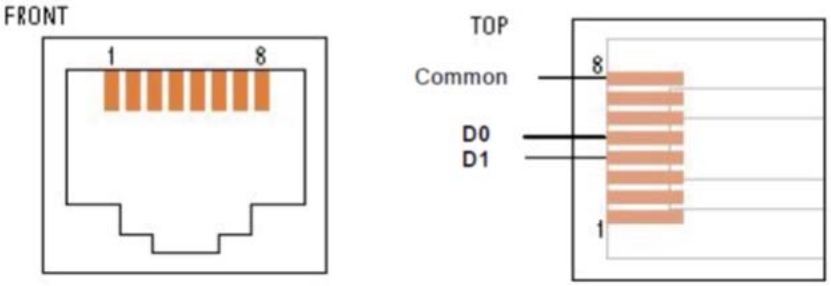
Table 1.1 2W-MODBUS Circuits Definition

Required Circuits		Type of Port For device	EIA/TIA-485 name	Description
on ITr	on IDv			
D1	D1	I/O	B/B'	**Transceiver terminal 1, V1 Voltage** (V1 > V0 for binary 1 [OFF] state)
D0	D0	I/O	A/A'	**Transceiver terminal 0, V0 Voltage** (V0 > V1 for binary 0 [ON] state)
Common	Common	---	C/C'	**Signal Common**

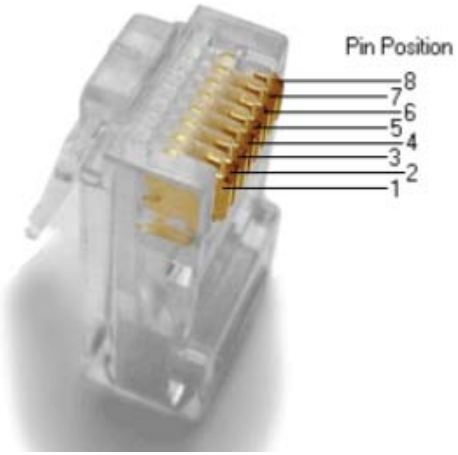
1.3 Modbus connector

AALBORG Modbus instruments are implemented with RJ45 shielded female connector. It is recommended to use shielded ITr and IDv cables (see Figure 1.1) to preserve signal integrity.

Device side - female connector



Pin number	Description
1	N/A
2	N/A
3	N/A
4	D1 Modbus (A/A')
5	D0 Modbus (A/A')
6	N/A
7	N/A
8	0V (Modbus common)



STP CAT.5e Cable RJ45 Connector

2. MULTIPOINT SYSTEM REQUIREMENTS

2.1 Maximum number of devices without repeater

AALBORG Modbus instruments are implemented with isolated RS485 transceiver which has minimum input impedance of 96 kOhm and therefore only loads the bus by 1/8 of the standard unit load UL. It means 8 times as many of these receivers can be connected to the RS485 bus (8 × 32 = 256 nodes). However since other receivers on the bus (including master device) may have different specification it is recommended do not exceed 127 instruments on the single bus segment.

NOTE: AALBORG recommends not using more than 127 instruments in one bus system.

2.2 Modbus Cables and Y-splitters

If more than two instruments are used in one system, they have to be connected as a daisy-chain. This means that the total Modbus system has only one begin (usually Master device) and one end. For connecting instruments to the bus, AALBORG offers special Y-splitter and Trunk Interface (ITr) cables which enable you to build a daisy chained network of Modbus devices. Depending on the required distance between instruments different Trunk Interface (ITr) cables can be used (see Figure 2.2). The length of the Trunk Interface (ITr) cables can be extended using RJ45 Modular Coupling (see Figure 2.3).

NOTE: AALBORG recommends with 9600 Baud Rate not exceed total length of the bus to more than 1000 meters (for higher Baud Rate total length has to be reduced).

Figure 2.2 Category 5E Patch Twisted Pair Cable (RJ45/RJ45). AALBORG part number: TRD815BL-2 (2 feet), TRD815BL-10 (10 feet), TRD815BL-25 (25 feet)

Figure 2.3 RJ45 Modular Coupler. AALBORG part number: TDG1026-8C

If 3 or more instruments are located in close proximity (within 20 meters) the JMOD45-1 four devices splitter (see Figure 2.4) may be used to connect them together.

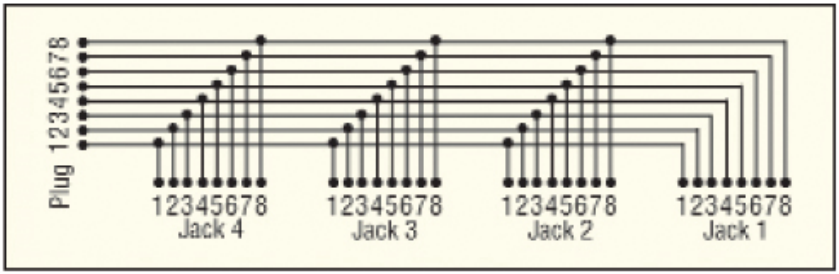


Figure 2.4 RJ45 Splitter fully shielded (5xRJ45, 1 input 4 output).
AALBORG part number: JMOD4S-1

2.3 Modbus Termination resistors

A reflection in a transmission line is the result of an impedance discontinuity that a travelling wave sees as it propagates down the line. To minimize the reflections from the end of the RS485 cable it is required to place a Line Termination (**LT**) near each of the 2 Ends of the Bus.

It is important that the line be terminated at both ends since the propagation is bi-directional, but it is not allowed to place more than 2 **LT** on one passive D0-D1 balanced pair. Never place any **LT** on a derivation cable. The value of **LT** resistor describes the intrinsic impedance of the transmission line and is not a function of the line length. Common characteristic impedance for category 5E patch twisted pair cable could be between 90 and 150 Ohm. AALBORG offers compact **LT** resistors embedded in to the RJ45 connector (AALBORG part number: MOD27T, see Figure 2.5).

Figure 2.5 RJ45 Line Terminator (AALBORG part number: MOD27T).

NOTE: When low baud rate (9600 or below) is used and total length of the RS485 bus is below 400 meters AALBORG does not recommend installation of the Line Termination on any side of the bus.

2.4 Line Polarization

When there is no data activity on an RS485 balanced pair, the lines are not driven and, thus susceptible to external noise or interference and the receiver output is undefined. This can cause random data to be received on the UART, which in turn can cause false start bits, false interrupts, and framing errors. This problem can be solved by placing a combination of pull-up and pull-down resistors at one position on the bus (typically on the master device or on its Tap). The disadvantage of this method is that the value of the bias resistors is dependent on termination and number of nodes in the system and it introduces additional load on the bus.

AALBORG Modbus instruments are implemented with isolated RS485 transceivers which have an improved feature that includes true fail-safe receiver inputs. This eliminates the need for pull-up/pull-down resistors when all devices on the RS485 bus support fail-safe feature. For master device (PC or PLC with USB ports) AALBORG offers USB to RS485 converters (AALBORG Part Number: USB-RS485) which support fail-safe feature.

NOTE: AALBORG Modbus instruments are implemented with transceivers which have true fail-safe feature and therefore do not need a line polarization. However if one or more other devices on the same RS485 bus do not support fail-safe feature, the implementation of the line polarization using bias resistors is required (see operation manual for these devices).

2.5 Galvanic isolation

In RS485 Modbus applications, there are often long links, which can cause the ground potential at different nodes on the bus to be slightly different. This causes ground currents to flow through the path of least resistance through either the common earth ground or the ground wire. If the same electrical system is used to connect the power supplies of all nodes to the same earth ground, the ground connection may have reduced noise. Note, however, that motors, switches, and other electrically noisy equipment can still induce ground noise into the system.

When different nodes are situated in different buildings, different power systems are required. This is likely to increase the impedance of the earth ground and the ground currents from other sources are more likely to find their way into the link's ground wire. Isolating the link reduces or even eliminates these problems. Galvanic isolation is a perfect solution if there is no guarantee that the potential at the earth grounds at different nodes in the system are within the common-mode range of the transceiver. Galvanic isolation allows information flow, but prevents current flow.

AALBORG Modbus instruments are implemented with galvanically isolated RS485 transceiver with high common-mode transient immunity.

3. CHANGING SLAVE ADDRESS AND BAUD RATE

NOTE: By default instruments delivered to customers are set for Modbus slave address 11 and a baud rate of 9600 baud.

The slave address and baud rate of the AALBORG Modbus slave device can be changed to fit the instrument in your existing Modbus network environment. Standard baud rates for Modbus are 9600, 19200 and 38400. Modbus configurable addresses are from 1 to 247.

3.1 Using local key-pad and display interface (if present)

If AALBORG Modbus instruments are equipped with Modbus interface **General Settings / "Modbus Interface"** menu selection allows change Modbus device ID (address) and communication parameters. By pressing **Up** or **Dn** button user can select following parameters:

3.1.1 "Baud Rate Settings"

Once new Baud Rate value is selected the power to the instrument must be cycled in order for new settings to take effect.

NOTE: If multiple instruments are connected to Modbus Master controller device, they all should have the same baud rate settings as the Master.

3.1.2 "Dev. Modbus Address"

Decimal representation (range from 1 to 247). Once new Modbus Address value is selected the power to the instrument must be cycled in order for new settings to take effect.

NOTE: Do not assign the same ID address for two or more devices on the same Modbus segment. If two or more devices with the same address are connected to the one Modbus network, a communication collision will take place on the bus and communication errors will occur.

3.1.3 "Modbus Com. Party"

This parameter can be set to one of the following: "None", Odd, Even.

Parity parameter by default is set to "None". In real application this parameter should follow "Parity" settings used in Modbus Master controller.

3.1.4 "Modbus Com. StopBit"

This parameter can be set to one of the following: One (1) or Two (2). **Stop Bit parameter by default is set to 2.** In real application this parameter should follow Stop Bit settings used in Modbus Master controller.

3.2 Via RS232 using "Instrument Configuration Utility" software

Connect your Aalborg Modbus slave instrument to a PC RS232 COM-port using the supplied communication cable. Start "Instrument Configuration Utility" software (supplied on CD with the instrument). **Navigate to Properties / Device Setting** menu selection and select **"Modbus Interface"** folder from the three-view panel on the left of the screen. The screen similar to Figure 3.1 will appear. Enter desired **Device Address** and **Baud Rate** parameters and press ***"Set Values"*** button.

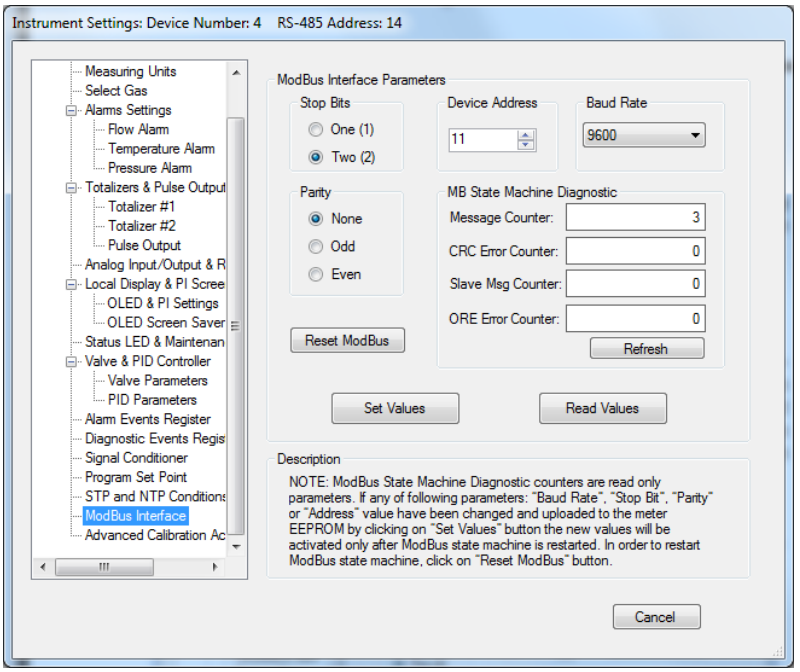


Figure 3.1 Modbus Interface Settings and Diagnostic

NOTE: If any of Modbus Interface parameters was changed (by clicking on “Set Values” button) in order to new parameters to take affect it is required to reset Modbus state machine by clicking on “Reset Modbus” button.

3.3 Via RS232 using “ASCII Commands Set”

It is also possible to read and or change the Modbus Communication parameters by means of any communication terminal program via RS232 using the COM-port of your PC and “ASCII Commands Set” supplied with Aalborg Modbus slave instrument. More information about “ASCII Commands Set” can be found in your Aalborg Modbus slave instrument general operating manual (supplied on the CD with the instrument).

4 Functional Description

NOTE: ***The implementation of the Modbus interface for Aalborg Modbus Instruments is based on the following standard:***
http://www.modbus.org/docs/Modbus_over_serial_line_V1_02.pdf.

4.1 Implementation Class

The following options have been implemented:

General Settings		
Parameter	**Options**	**Remarks**
Addressing	address configurable from 1 to 247 (default 11)	
Broadcast support	Yes	
Baud Rate	1200 2400 4800 **9600 (default)** 19200 38400 57600 115200	
Electrical Interface	RS485 2 Wire cabling (half duplex)	
Data Bits	8	
Stop Bits	1 or 2 (2 is default)	Configurable
Parity	None, odd, even (None is default)	Configurable, The use of no parity requires 2 stop bits!
Transmission mode	RTU	

4.2 Response time

This slave device will respond on each valid request from the master within 200ms. This means that the response timeout setting of the master should be set to a value larger than 200ms.

4.3 Supported Modbus functions

This section describes all Public Modbus Functions supported by Aalborg Modbus slave instrument.

4.3.1 Read Holding Register 03 (0x03)

This function code is used to read the contents of a contiguous block of holding registers in a remote device. The request Process Data Unit (PDU) specifies the starting register address and the number of registers. In the PDU Registers are addressed starting at zero.

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Request

Function code	1 Byte	**0x03**
Starting Address	2 Bytes	**0x0000 to 0xFFFF**
Quantity of Registers	2 Bytes	**1 to 125 (0x7D)**

Response

Function code	1 Byte	**0x03**
Byte count 1 Byte 2 x N*	1 Byte	**2 x N***
Register value	N* x 2 Bytes	

*N = Quantity of Registers

Error code 0x83

Possible exception code responses		
Code	**Name**	**Description**
02	ILLEGAL DATA ADDRESS	reading of non-existing address, or reading a part of a multi register parameter (float, long, etc)
03	ILLEGAL DATA VALUE	reading less than 1 or more than 125 registers
04	SLAVE DEVICE FAILURE	An unrecoverable error occurred

⚠ **CAUTION:** The maximum message size for the Read Holding Registers function is 128 bytes at 9600 baud.

4.3.2 Read Input Register 04 (0x04)

This function code is used to read from 1 to 125 contiguous input registers in a remote device. The Request Process Data Unit (PDU) specifies the starting register address and the number of registers. In the PDU Registers are addressed starting at zero.

The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Request

Function code	1 Byte	**0x04**
Starting Address	2 Bytes	**0x0000 to 0xFFFF**
Quantity of Registers	2 Bytes	**0x0001 to 0x007D**

Response

Function code	1 Byte	**0x04**
Byte count	1 Byte	**2 x N***
Input Registers	N* x 2 Bytes	

*N = Quantity of Input Registers

Error code 0x84

Possible exception responses		
Code	**Name**	**Description**
02	ILLEGAL DATA ADDRESS	reading of non-existing address, or reading a part of a multi register parameter (float, long, etc)
03	ILLEGAL DATA VALUE	reading less than 1 or more than 125 registers
04	SLAVE DEVICE FAILURE	An unrecoverable error occurred

⚠ **CAUTION:** The maximum message size for the Read Holding Registers function is 128 bytes at 9600 baud.

4.3.3 Write Single Register 06 (0x06)

This function code is used to write a single holding register in a remote device. The Request PDU specifies the address of the register to be written. Registers are addressed starting at zero.

The normal response is an echo of the request, returned after the register contents have been written.

Request

Function code	1 Byte	**0x06**
Register Address	2 Bytes	**0x0000 to 0xFFFF**
Register Value	2 Bytes	**0x0000 to 0xFFFF**

Response

Function code	1 Byte	**0x06**
Register Address	2 Byte	**0x0000 to 0xFFFF**
Register Value	2 Bytes	**0x0000 to 0xFFFF**

Error code 0x86

Possible exception responses		
Code	**Name**	**Description**
02	ILLEGAL DATA ADDRESS	writing to non-existing address, or writing to a part of a multi register parameter (float, long, etc)
04	SLAVE DEVICE FAILURE	writing to read-only register
04	SLAVE DEVICE FAILURE	An unrecoverable error occurred

4.3.4 Write Multiple Registers 16 (0x10)

This function code is used to write a block of contiguous registers (1 to 123 registers) in a remote device. The requested written values are specified in the request data field. Data is packed as two bytes per register. The normal response returns the function code, starting address, and quantity of registers written.

Request

Function code	1 Byte	**0x10**
Register Address	2 Bytes	**0x0000 to 0xFFFF**
Quantity of Registers	2 Bytes	**0x0001 to 0x007B**
Byte Count	1 Byte	**2 x N***
Registers Value	N* x 2 Bytes	**Value**

*N = Quantity of Registers

Response

Function code	1 Byte	**0x10**
Starting Address	2 Byte	**0x0000 to 0xFFFF**
Quantity of Registers	2 Bytes	**1 to 123 (07B)**

Error code 0x90

Possible exception responses		
Code	**Name**	**Description**
02	ILLEGAL DATA ADDRESS	writing to non-existing address, or writing to a part of a multi register parameter (float, long, etc)
03	ILLEGAL DATA VALUE	writing less than 1 or more than 123 registers
04	SLAVE DEVICE FAILURE	writing to read-only register
04	SLAVE DEVICE FAILURE	An unrecoverable error occurred

4.3.5 Diagnostic 08 (0x08)

Request

Function code	1 Byte	**0x08**
Sub-function	2 Bytes	
Data	N x 2 Bytes	

Response

Function code	1 Byte	**0x08**
Sub-function	2 Bytes	
Data	N x 2 Bytes	

Error code 0x88

Possible exception responses		
Code	**Name**	**Description**
01	ILLEGAL FUNCTION	invalid diagnostic function code
03	ILLEGAL DATA QTY	incorrect quantity of the byte in the data field
04	ILLEGAL DATA VALUE	incorrect value for the data field

Following Sub-functions are supported:

Sub-function code (dec)	Description
00	Return Query Data
10	Clear Counters and Diagnostics Register
11	Return Bus Message Count
12	Return Bus Communication Error Count
13	Return Bus Exception Error Count
14	Return Slave Message Count
15	Return Slave No Response Count

4.4 Modbus Registers and Parameters

Modbus registers (in the data model) are numbered from 1 to 65536. In a Modbus PDU (Protocol Data Unit) these registers are addressed from 0 to 65535.

Aalborg Modbus instruments support two types of the 32 bits data mapping:

1. Standard Modbus data mapping (see Table 4.1):

    a) Long integer parameters have a length of 4 bytes and are mapped on two consecutive Modbus registers. The fi rst register contains bit 31-16, the second register contains bit 15-0.

    b) Floating point parameters have a length of 4 bytes and are mapped on two consecutive Modbus registers. Floats are in single precision IEEE format (1 sign bit, 8 bits exponent and 23 bits fraction). The first register contains bit 31-16, the second register contains bit 15-0.

2. Enron or “Daniel’s Extension” data mapping as specified by Daniel Flow Products (see Table 4.2): When floating point variable is requested the slave reply returning 4-bytes per register instead of the 2-bytes implied by the term "register" in the standard Mod bus specification. That means that Floating point parameters have a length of 4 bytes and are mapped on one Modbus registers. Floats are in single precision IEEE format (1 sign bit, 8 bits exponent and 23 bits fraction). The register contains bits 31-0.

CAUTION: Do not change calibration related EEPROM variables (PDU 354 - 461, 2118 - 2421 and 7050 - 7210) unless instructed by factory technical support representative! Any alteration of the calibration related variables in the EEPROM will VOID calibration warranty supplied with the instrument.

Table 4.1 Modbus Register addresses for Standard Modbus data mapping

Register (PDU) address Range	Modbus R/W Function	Type of the Register	Description
10 - 209 (**see Table 4.3**)	0x03/0x06,0x10	Holding Register	Main EEPROM **char[]** (string) variables
307-461 (**see Table 4.3**)	0x03/0x06,0x10	Holding Register	Main EEPROM 16-bit **unsigned int** variables
700-701 (**see Table 4.3**)	0x03/0x06,0x10	Holding Register	RAM 16-bit **unsigned int** variables
2016-2421 (**see Table 4.3**)	0x03/0x06,0x10	Holding Registers	RAM 32-bit IEEE-754 floating-point variables
2540-2541 (**see Table 4.3**)	0x03/0x06,0x10	Holding Registers	User Gas Table EEPROM table 32-bit IEEE-754 floating-point variables
2600-2631 (**see Table 4.3**)	0x04/No write	Input Registers (Read only)	RAM 32-bit IEEE-754 floating point variables and integers (**diagnostic parameters**)
2700-2713 (**see Table 4.3**)	0x04/No write	Input Registers (Read only)	RAM 32-bit IEEE-754 fl oating-point variables (**Process Information parameters**)
3000-3016 (**see Table 4.3**)	0x04/No write	Input Registers (Read only)	RAM 16-bit **unsigned int** (diagnostic parameters)

NOTE: When a **char** parameter is read, the upper 8-bits of the Modbus register will be 0. When a **char** parameter is written, the upper 8-bits must be set to 0.

Table 4.2 Modbus Register addresses for "Daniel's Extension" data mapping (see Table 4.4)

Register (PDU) address Range	Modbus R/W Function	Type of the Register	Description
7008 - 7210 (**see Table 4.4**)	0x03/0x06,0x10	Holding Register	Main EEPROM table 32-bit IEEE-754 floating-point variables
7500 - 7515 (**see Table 4.4**)	0x04/No write	Input Registers (Read only)	RAM 32-bit IEEE-754 floating-point variables **(diagnostic parameters)**
7600 -7606 (**see Table 4.4**)	0x04/No write	Input Registers (Read only)	RAM 32-bit IEEE-754 floating-point variables **(Process Information parameters)**

NOTE: Parameters in the tables 4.3 and 4.4 designated with (C) mark in the [Access] column, applicable only for DPC controllers instruments.

NOTE: Registers designated for "Daniel's Extension" data mapping only provide access to 32-bit IEEE-754 floating-point variables. All 32 bits [31-0] of the IEEE-754 floating-point variable are assigned to one register (see Table 4.4).

NOTE: For DPC controllers use register 700 for Valve Mode control (see page 28) and registers (2540-2541) for Set Point control (see page 38). Make sure the "Set Point Source" parameter (register 433) is set to 1 (Digital Interface).

CAUTION: Typically EEPROM memory endurance is 1,000,000 cycles. Registers (PDU 10-209, 307- 461, 2540-2541, 7008 - 7210) grouped to "Holding Register" type are mapped to the EEPROM memory. In order preserve EEPROM endurance user must limit write cycles to no more than 200 per day.

Table 4.3 Lists of the most commonly used parameters (standard Modbus mapping)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min – max value)
				Read	Write	
Serial Number	String 20 byte	R	10-29	0x03	N/A	ASCII equivalent decimal code (0-127)
Model Number	String 20 byte	R	30-49	0x03	N/A	ASCII equivalent decimal code (0-127)
Calibrated By	String 20 byte	R	50-69	0x03	N/A	ASCII equivalent decimal code (0-127)
Date Calibrated	String 12 byte	R	70-81	0x03	N/A	ASCII equivalent decimal code (0-127)
Calibration Gas Identifier	String 20 byte	R	82-101	0x03	N/A	ASCII equivalent decimal code (0-127)
RS485 Address (2 hex charact.)	String 4 byte	R/W	206-209	0x03	0x06,0x10	ASCII equivalent decimal code (48-57, 65-70)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Device RFE Style	Unsigned short	R	307	0x03	N/A	(0-9)
Device RFE configuration	Unsigned short	R	308	0x03	N/A	(0-99)
ADC PGA Gain	Unsigned short	R	309	0x03	N/A	(0-5)
ADC Filter Mode	Unsigned short	R	310	0x03	N/A	(0-1)
CalSensZero-Counts	short	R	311	0x03	N/A	(-31000 - 31000)
PFC_ Reserved1	Unsigned short	R	312	0x03	N/A	(0-1)
PFC_ Reserved2	Unsigned short	R	313	0x03	N/A	(0 - 32767)
PFC_ Reserved5	short	R	314	0x03	N/A	(-32767 - 32767)
PFC_ Reserved6	short	R	315	0x03	N/A	(-32767 - 32767)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
PFC_ Reserved7	short	R	316	0x03	N/A	(-32767-32767)
Primary Gas Table SensCnts[0]	Unsigned short	R	317	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[1]	Unsigned short	R	318	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[2]	Unsigned short	R	319	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[3]	Unsigned short	R	320	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[4]	Unsigned short	R	321	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[5]	Unsigned short	R	322	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[6]	Unsigned short	R	323	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[7]	Unsigned short	R	324	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[8]	Unsigned short	R	325	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[9]	Unsigned short	R	326	0x03	N/A	(0-65535)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Primary Gas Table SensCnts[10]	Unsigned short	R	327	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[11]	Unsigned short	R	328	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[12]	Unsigned short	R	329	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[13]	Unsigned short	R	330	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[14]	Unsigned short	R	331	0x03	N/A	(0-65535)
Primary Gas Table SensCnts[15]	Unsigned short	R	332	0x03	N/A	(0-65535)
Factory reserved	Unsigned short	R	333	0x03	N/A	(0-65535)
Factory reserved	Unsigned short	R	334	0x03	N/A	(0-65535)
Factory reserved	Unsigned short	R	335	0x03	N/A	(0-65535)
Factory reserved	Unsigned short	R	336	0x03	N/A	(0-65535)
Factory reserved	Unsigned short	R	337	0x03	N/A	(0-65535)
Factory reserved	Unsigned short	R	338	0x03	N/A	(0-65535)
Factory reserved	Unsigned short	R	339	0x03	N/A	(0-65535)
Factory reserved	Unsigned short	R	340	0x03	N/A	(0-65535)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
MGT_Reserved	Unsigned short	R	341	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	342	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	343	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	344	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	345	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	346	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	347	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	348	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	349	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	350	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	351	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	352	0x03	N/A	(0-65535)
MGT_Reserved	Unsigned short	R	353	0x03	N/A	(0-65535)
Local Interface Program Protection code	Unsigned short	R/W	354	0x03	0x06, 0x10	(0-999)
Test/Configuration Port Baud Rate Ind	Unsigned short	R/W	355	0x03	0x06, 0x10	(0-7)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Modbus Device Address	Unsigned short	R/W	356	0x03	0x06,0x10	(1-247)
Modbus Baud Rate Index	Unsigned short	R/W	357	0x03	0x06,0x10	(0-7)
Modbus Parity Index	Unsigned short	R/W	358	0x03	0x06,0x10	(0-2)
Modbus Stop Bits	Unsigned short	R/W	359	0x03	0x06,0x10	(1-2)
Gas Temperature Damping	Unsigned short	R/W	360	0x03	0x06,0x10	(1-255)
UART Mode: 0-SHDN 1-RS-232, 2-RS-485	Unsigned short	R/W	361	0x03	0x06,0x10	(0-2)
Flow Rate Measure Units Index	Unsigned short	R/W	362	0x03	0x06,0x10	(0-43)
User Defined Unit Time Base Index	Unsigned short	R/W	363	0x03	0x06,0x10	(0-3)
User Defined Unit use Density	Unsigned short	R/W	364	0x03	0x06,0x10	(0-1)
Number of User Defined Mixtures	Unsigned short	R/W	365	0x03	0x06,0x10	(0-20)
User Defined Mixture Index	Unsigned short	R/W	366	0x03	0x06,0x10	(0-19)
Active Gas Index	Unsigned short	R/W	367	0x03	0x06,0x10	(0-128)
Diagnostic Events Mask	Unsigned short	R/W	368	0x03	0x06,0x10	(0-65535)
Diagnostic Events Latch Mask	Unsigned short	R/W	369	0x03	0x06,0x10	(0-65535)
Alarm Events Mask	Unsigned short	R/W	370	0x03	0x06, 0x10	(0-65535)
Gas or Mixture Selector	Unsigned short	R/W	371	0x03	0x06, 0x10	(0-1)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Temperature Units Index	Unsigned short	R/W	372	0x03	0x06, 0x10	(0-3)
Pressure Alarm Mode	Unsigned short	R/W	373	0x03	0x06, 0x10	(0-1)
Volumetric Flow Units	Unsigned short	R/W	374	0x03	0x06, 0x10	(0-15)
Alarm Events Latch Reg. Mask	Unsigned short	R/W	375	0x03	0x06, 0x10	(0-65535)
Pressure Alarm Action Delay	Unsigned short	R/W	376	0x03	0x06, 0x10	(0-3600)
Pressure Units Index	Unsigned short	R/W	377	0x03	0x06, 0x10	(0-14)
Temp Aver Counts @ Calibrated Cond.	Unsigned short	R/W	378	0x03	0x06, 0x10	(0-65535)
Pressure Alarm Latch	Unsigned short	R/W	379	0x03	0x06, 0x10	(0-1)
Relay Output Configuration	Unsigned short	R/W	380	0x03	0x06, 0x10	(0-9)
Pres. Alarm Power Up Delay	Unsigned short	R/W	381	0x03	0x06, 0x10	(0-3600) seconds
OLED Mode	Unsigned short	R/W	382	0x03	0x06, 0x10	(0-1)
OLED Static Mode	Unsigned short	R/W	383	0x03	0x06, 0x10	(0-5)
OLED Auto Mode Mask	Unsigned short	R/W	384	0x03	0x06, 0x10	(0-128)
OLED Screen Cycle Time	Unsigned short	R/W	385	0x03	0x06, 0x10	(1-3600) seconds
OLED Contrast	Unsigned short	R/W	386	0x03	0x06, 0x10	(1-255)
OLED Screen Saver Time Out	Unsigned short	R/W	387	0x03	0x06, 0x10	(1-36000) seconds

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
OLED Screen Saver Level	Unsigned short	R/W	388	0x03	0x06, 0x10	(0-3)
OLED Screen Saver Contrast	Unsigned short	R/W	389	0x03	0x06, 0x10	(1-255)
OLED Flow Rate DP Precision	Unsigned short	R/W	390	0x03	0x06, 0x10	(0-1)
Analog Output Mode	Unsigned short	R/W	391	0x03	0x06, 0x10	(0-2)
Temp. Alarm Action Delay	Unsigned short	R/W	392	0x03	0x06, 0x10	(0-3600) seconds
Analog SP Input Mode	Unsigned short	R/W	393	0x03	0x06, 0x10	(0-2)
Analog Input Damping	Unsigned short	R/W	394	0x03	0x06, 0x10	(0-32)
Flow Alarm Mode	Unsigned short	R/W	395	0x03	0x06, 0x10	(0-1)
Flow Alarm Action Delay	Unsigned short	R/W	396	0x03	0x06, 0x10	(0-3600) seconds
Flow Alarm Action Latch Mode	Unsigned short	R/W	397	0x03	0x06, 0x10	(0-1)
Flow Alarm Power Up Delay	Unsigned short	R/W	398	0x03	0x06, 0x10	(0-3600) seconds
Totalizer#1 Mode	Unsigned short	R/W	399	0x03	0x06, 0x10	(0-1)
Temperature Alarm Mode	Unsigned short	R/W	400	0x03	0x06, 0x10	(0-1)
Totalizer#1 Power Up Delay	Unsigned short	R/W	401	0x03	0x06, 0x10	(0-3600) seconds
Totalizer#1 Value Lock	Unsigned short	R/W	402	0x03	0x06, 0x10	(0-1)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Totalizer#1 Auto Reset @ Event	Unsigned short	R/W	403	0x03	0x06, 0x10	(0-1)
Totalizer#1 Auto Reset Delay	Unsigned short	R/W	404	0x03	0x06, 0x10	(0-3600) seconds
Tot#1 DP precision relative to Flow	Unsigned short	R/W	405	0x03	0x06, 0x10	(0-5)
Totalizer#2 Mode	Unsigned short	R/W	406	0x03	0x06, 0x10	(0-1)
Totalizer#2 Value Lock	Unsigned short	R/W	407	0x03	0x06, 0x10	(0-1)
Totalizer#2 Power Up Delay	Unsigned short	R/W	408	0x03	0x06, 0x10	(1-3600) seconds
Totalizer#2 Auto Reset @ Event	Unsigned short	R/W	409	0x03	0x06, 0x10	(0-1)
Totalizer#2 Auto Reset Delay	Unsigned short	R/W	410	0x03	0x06, 0x10	(0-3600) seconds
Totalizer#2 Valve Over Limit Action	Unsigned short	R/W	411	0x03	0x06, 0x10	(0-1)
Tot#2 DP precision relative to Flow	Unsigned short	R/W	412	0x03	0x06, 0x10	(0-5)
Flow Pulse Mode	Unsigned short	R/W	413	0x03	0x06, 0x10	(0-1)
Pulse Active Low Time	Unsigned short	R/W	414	0x03	0x06, 0x10	(50-6553)
Totalizer#1 Valve Over Limit Action	Unsigned short	R/W	415	0x03	0x06, 0x10	(0-1)
Status LED Function	Unsigned short	R/W	416	0x03	0x06, 0x10	(0-5)
Temperature Alarm Latch	Unsigned short	R/W	417	0x03	0x06, 0x10	(0-1)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Temp. Alarm Power Up Delay	Unsigned short	R/W	418	0x03	0x06, 0x10	(0-3600) seconds
Local Interface Lock Active	Unsigned short	R/W	419	0x03	0x06, 0x10	(0-1)
Volumetric Flow 100% Flow Counts	Unsigned short	R/W	420	0x03	0x06, 0x10	(0-65535)
Display Flow Reading Aver.	Unsigned short	R/W	421	0x03	0x06, 0x10	(0-25) samples
Flow Reading Damping	Unsigned short	R/W	422	0x03	0x06, 0x10	(0-255)
DP Sensor NLES Mode	Unsigned short	R/W	423	0x03	0x06, 0x10	(0-1)
AP Sensor NLES Mode	Unsigned short	R/W	424	0x03	0x06, 0x10	(0-1)
AP Sensor Temp. Damping	Unsigned short	R/W	425	0x03	0x06, 0x10	(0-255) (default 0)
AP Sensor Pressure Damping	Unsigned short	R/W	426	0x03	0x06, 0x10	(0-255) (default 0)
RS-485 Bus Termination	Unsigned short	R/W	427	0x03	0x06, 0x10	(0-1)
SC Reserved	Unsigned short	R/W	428	0x03	0x06, 0x10	(0-65535)
SC Reserved	Unsigned short	R/W	429	0x03	0x06, 0x10	(0-65535)
SC Reserved	Unsigned short	R/W	430	0x03	0x06, 0x10	(0-65535)
Valve Control Loop Type	Unsigned short	R/W (c)	431	0x03	0x06, 0x10	(0-2)
AP Reading Channel Location	Unsigned short	R/W	432	0x03	0x06, 0x10	(0-1)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Set Point input source	Unsigned short	R/W (c)	433	0x03	0x06, 0x10	(0-3)
Digital and Local SP Merge	Unsigned short	R/W (c)	434	0x03	0x06, 0x10	(0-1)
Local SP Auto Start	Unsigned short	R/W (c)	435	0x03	0x06, 0x10	(0-1)
Flow Alarm Valve Action	Unsigned short	R/W (c)	436	0x03	0x06, 0x10	(0-2)
Program Set Point Mode	Unsigned short	R/W (c)	437	0x03	0x06, 0x10	(0-1)
Program Set Point Stem Mask	Unsigned short	R/W (c)	438	0x03	0x06, 0x10	(0-65535)
Program Set Point Loop Mode	Unsigned short	R/W (c)	439	0x03	0x06, 0x10	(0-1)
Factory Reserved	Unsigned short	R/W (c)	440	0x03	0x06, 0x10	(0-1)
Factory Reserved	Unsigned short	R/W (c)	441	0x03	0x06, 0x10	(0-1)
Factory Reserved	Unsigned short	R/W (c)	442	0x03	0x06, 0x10	(0-1)
Auto Tune PID Scaling	Unsigned short	R/W (c)	443	0x03	0x06, 0x10	(0-1)
Background Auto Tare	Unsigned short	R/W (c)	444	0x03	0x06, 0x10	(0-1)
Program Set Point Loop Mode	Unsigned short	R/W (c)	445	0x03	0x06, 0x10	(0-1)
Program SP Time[0]	Unsigned short	R/W (c)	446	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[1]	Unsigned short	R/W (c)	447	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[2]	Unsigned short	R/W (c)	448	0x03	0x06, 0x10	(0-65535) (seconds)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Program SP Time[3]	Unsigned short	R/W (c)	449	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[4]	Unsigned short	R/W (c)	450	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[5]	Unsigned short	R/W (c)	451	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[6]	Unsigned short	R/W (c)	452	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[7]	Unsigned short	R/W (c)	453	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[8]	Unsigned short	R/W (c)	454	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[9]	Unsigned short	R/W (c)	455	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[10]	Unsigned short	R/W (c)	456	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[11]	Unsigned short	R/W (c)	457	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[12]	Unsigned short	R/W (c)	458	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[13]	Unsigned short	R/W (c)	459	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[14]	Unsigned short	R/W (c)	460	0x03	0x06, 0x10	(0-65535) (seconds)
Program SP Time[15]	Unsigned short	R/W (c)	461	0x03	0x06, 0x10	(0-65535) (seconds)
Valve Control Mode: 'C', 'A', 'O'	Unsigned char	R/W (c)	700	0x03	0x06, 0x10	(decimal 67,65,79)
PSP Run / Stop mode control	Unsigned short	R/W (c)	701	0x03	0x06, 0x10	(0-1)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	**Parameter Type**	**Access**	**PDU Address**	**Modbus Function**		**Remark, (parameter min = max value)**
				Read	**Write**	
Single precision 32-bit IEEE-754 floating-point Device Dependent EE parameters (each floating-point parameters represented by 2 registers: first register contains bit 31-16, second 15-0)						
Device Nominal FS Range [sl/min] N_2	float	R	2016 - 2017	0x03	N/A	(0.0125-1000.0) sl/min N_2
AmbTemp. During PRM Calibration˚C	float	R	2018 - 2019	0x03	N/A	(0.0– 50.0)˚C
Sensor Calibration Temp	float	R	2020 - 2021	0x03	N/A	(0.0– 50.0)˚C
Factory Reserved	float	R	2022 - 2023	0x03	N/A	(N/A)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
PGT PFS[0]	float	R	2026 - 2027	0x03	N/A	(0.0-1.0)
PGT PFS[1]	float	R	2028 - 2029	0x03	N/A	(0.0-1.0)
PGT PFS[2]	float	R	2030 - 2031	0x03	N/A	(0.0-1.0)
PGT PFS[3]	float	R	2032 - 2033	0x03	N/A	(0.0-1.0)
PGT PFS[4]	float	R	2034 - 2035	0x03	N/A	(0.0-1.0)
PGT PFS[5]	float	R	2036 - 2037	0x03	N/A	(0.0-1.0)
PGT PFS[6]	float	R	2038 - 2039	0x03	N/A	(0.0-1.0)
PGT PFS[7]	float	R	2040 - 2041	0x03	N/A	(0.0-1.0)
PGT PFS[8]	float	R	2042 - 2043	0x03	N/A	(0.0-1.0)
PGT PFS[9]	float	R	2044 - 2045	0x03	N/A	(0.0-1.0)
PGT PFS[10]	float	R	2046 - 2047	0x03	N/A	(0.0-1.0)
PGT PFS[11]	float	R	2048 - 2049	0x03	N/A	(0.0-1.0)
PGT PFS[12]	float	R	2050 - 2051	0x03	N/A	(0.0-1.0)
PGT PFS[13]	float	R	2052 - 2053	0x03	N/A	(0.0-1.0)
PGT PFS[14]	float	R	2054 - 2055	0x03	N/A	(0.0-1.0)
PGT PFS[15]	float	R	2056 - 2057	0x03	N/A	(0.0-1.0)
Instrument Configurable FS Range (sl/min)	float	R	2058-2059	0x03	N/A	(0.0005 – 1000.0) sl/min
STD Temperature	float	R	2060-2061	0x03	N/A	(0.0-122.0) ˚F
STD Pressure	float	R	2062-2063	0x03	N/A	(0.0 100.0) PSIA
Fluid Density @ STD conditions	float	R	2064-2065	0x03	N/A	(0.0001-15.0) g/l
MGT PFS[0]	float	R	2066-2067	0x03	N/A	(0.0-1.0)
MGT PFS[1]	float	R	2068-2069	0x03	N/A	(0.0-1.0)
MGT PFS[2]	float	R	2070-2071	0x03	N/A	(0.0-1.0)
MGT PFS[3]	float	R	2072 - 2073	0x03	N/A	(0.0-1.0)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
MGT PFS[4]	float	R	2074 - 2075	0x03	N/A	(0.0-1.0)
MGT PFS[5]	float	R	2076 - 2077	0x03	N/A	(0.0-1.0)
MGT PFS[6]	float	R	2078 - 2079	0x03	N/A	(0.0-1.0)
MGT PFS[7]	float	R	2080 - 2081	0x03	N/A	(0.0-1.0)
MGT PFS[8]	float	R	2082 - 2083	0x03	N/A	(0.0-1.0)
MGT PFS[9]	float	R	2084 - 2085	0x03	N/A	(0.0-1.0)
MGT PFS[10]	float	R	2086 - 2087	0x03	N/A	(0.0-1.0)
MGT PFS[11]	float	R	2088 - 2089	0x03	N/A	(0.0-1.0)
MGT PFS[12]	float	R	2090 - 2091	0x03	N/A	(0.0-1.0)
MGT PFS[13]	float	R	2092 - 2093	0x03	N/A	(0.0-1.0)
MGT PFS[14]	float	R	2094 - 2095	0x03	N/A	(0.0-1.0)
MGT PFS[15]	float	R	2096 - 2097	0x03	N/A	(0.0-1.0)
Time Since Last Cal. (Pilot Timer)	float	R/W	2098-2099	0x03	0x06, 0x10	(0.0-4.3E+38) [Hr]
User Defined Unit K-Factor to liter	float	R/W	2100-2101	0x03	0x06, 0x10	(0.0001-1000000.0)
Temp . Alarm Low [˚K]	float	R/W	2102-2103	0x03	0x06, 0x10	(253.15-333.15) ˚K
Factory Reserved	float	R/W	2104-2105	0x03	0x06, 0x10	(N/A)
Pressure Alarm Low [PSIA]	float	R/W	2106-2107	0x03	0x06, 0x10	(0.1-60.0) PSIA
Pressure Alarm High [PSIA]	float	R/W	2108-2109	0x03	0x06, 0x10	(0.1-100.0) PSIA
Temp . Alarm High [˚K]	float	R/W	2110-2111	0x03	0x06, 0x10	(253.2-343.2) ˚K

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Analog Output 4-20mA Scale	float	R/W	2112-2113	0x03	0x06,0x10	(1000.0-5000.0) counts/mA
Analog Output 4-20mA Offset	float	R/W	2114-2115	0x03	0x06,0x10	(-99.9 to 99.9) counts/mA
Local Set Point PFS (normalized)	float	(c) R/W	2116-2117	0x03	0x06,0x10	(0.0 - 1.25
NLES_D	float	R/W	2118-2119	0x03	0x06,0x10	(0.0 - 1.0
Analog Output 0-5 Vdc Scale	float	R/W	2120-2121	0x03	0x06,0x10	(5000.0-65000.0)
Analog Output 0-10 Vdc Scale	float	R/W	2122-2123	0x03	0x06,0x10	(5000.0-65000.0)
DP Sensor Full Saale [PSID]	float	R/W	2124-2125	0x03	0x06,0x10	(0.0-5.0) PSID
AP Sensor Full Saale [PSIA]	float	R/W	2126-2127	0x03	0x06,0x10	(0.0-100.0) PSIA
Flow Alarm Low PFS	float	R/W	2128-2129	0x03	0x06,0x10	(0.0 – 1.1) Normalized PFS [0-1.0] units
Flow Alarm High PFS	float	R/W	2130-2131	0x03	0x06,0x10	(0.0 – 1.1) Normalized
Totalizer#1 Start @ Flow PFS	float	R	2132-2133	0x03	N/A	0.0-1.0 Normalized

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Totalizer#1 Event Volume	float	R/W	2134-2135	0x03	0x06,0x10	(0.0 - 4.3E+38)
Totalizer#1 Backup Volume	float	R	2136-2137	0x03	N/A	(0.0 - 4.3E+38)
Totalizer#2 Start @ Flow PFS	float	R/W	2138-2139	0x03	0x06,0x10	(0.0 – 1.0) Normalized PFS [0-1.0]
Totalizer#2 Event Volume	float	R/W	2140-2141	0x03	0x06,0x10	(0.0 - 4.3E+38)
Totalizer#2 Backup Volume	float	R	2142-2143	0x03	N/A	(0.0 - 4.3E+38)
Pulse Output Start @ Flow	float	R/W	2144-2145	0x03	0x06,0x10	(0.0 – 1.0) Normalized
Pulse Output Units per one Pulse	float	R/W	2146-2147	0x03	0x06,0x10	(0.0 - 4.3E+38) units/pulse
Temp During Gas Temp Cal	float	R/W	2148-2149	0x03	0x06,0x10	(263.2-333.15) °K
Sensor Raw NLES_A0	float	R/W	2150-2151	0x03	0x06,0x10	(0.0-1.0)
Sensor Raw NLES_A1	float	R/W	2152-2153	0x03	0x06,0x10	(0.0-1.0)
Sensor Raw NLES_D0	float	R/W	2154-2155	0x03	0x06,0x10	(0.0-1.0)
Sensor Raw NLES_D1	float	R/W	2156-2157	0x03	0x06,0x10	(0.0-1.0)
Sensor Compens. NLES_A0	float	R/W	2158-2159	0x03	0x06,0x10	(0.0-1.0)
Sensor Compens. NLES_A1	float	R/W	2160-2161	0x03	0x06,0x10	(0.0-1.0)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Sensor Comp. NLES_D0	float	R/W	2162-2163	0x03	0x06,0x10	(0.0-1.0)
Sensor Comp. NLES_D1	float	R/W	2164-2165	0x03	0x06,0x10	(0.0-1.0)
Sensor DRC KlagUp[0]	float	R/W	2166-2167	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KlagUp[1]	float	R/W	2168-2169	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KlagUp[2]	float	R/W	2170-2171	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KgainUp[0]	float	R/W	2172-2173	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KgainUp[1]	float	R/W	2174-2175	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KgainUp[2]	float	R/W	2176-2177	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KlagDn[0]	float	R/W	2178-2179	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KlagDn [1]	float	R/W	2180-2181	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KlagDn [2]	float	R/W	2182-2183	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KgainDn [0]	float	R/W	2184-2185	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KgainDn [1]	float	R/W	2186-2187	0x03	0x06,0x10	(0.0-25.0)
Sensor DRC KgainDn [2]	float	R/W	2188-2189	0x03	0x06,0x10	(0.0-25.0)
AP Tare Maximum Deviation	float	R/W	2190-2191	0x03	0x06,0x10	(0.0 to 1.0) PSIA
AP Sensor Tare Counts	float	R/W	2192-2193	0x03	0x06,0x10	(- 4.3E+38 to 4.3E+38)
AP Sensor Tare Offset	float	R/W	2194-2195	0x03	0x06,0x10	(- 4.3E+38 to 4.3E+38)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
AP Tare Temp. Counts	float	R/W	2196-2197	0x03	0x06,0x10	(- 4.3E+38 to 4.3E+38) counts
Normal Units Temperature [˚F]	float	R/W	2198-2199	0x03	0x06,0x10	(14.0-100) ˚F
Normal Units Pressure PSIA	float	R/W	2200-2201	0x03	0x06,0x10	(0.1-60.0) PSIA
PID KpM Activation Level	float	(c) R/W	2202-2203	0x03	0x06,0x10	(0.0 – 1.0) Normalized
LCD Flow Reading Dead Band	float	R/W	2204-2205	0x03	0x06,0x10	(0.0 – 0.01) Normalized
Valve PID Proportional Term	float	(c) R/W	2206-2207	0x03	0x06,0x10	(0.0-2.5)
Valve PID Integral Term	float	(c) R/W	2208-2209	0x03	0x06,0x10	(0.0-2.5)
Valve PID Derivative Term	float	(c) R/W	2210-2211	0x03	0x06,0x10	(0.0-2.5)
Solenoid Valve PID bias	float	(c) R/W	2212-2213	0x03	0x06,0x10	(0.0-1.0)
PID Proportional Maltiplier	float	(c) R/W	2214-2215	0x03	0x06,0x10	(0.0 – 10.0)
Auto Tune Kp high limit	float	(c) R/W	2216-2217	0x03	0x06,0x10	(0.0 – 5.0)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Auto Tune Ki high limit	float	(c) R/W	2218-2219	0x03	0x06,0x10	(0.0 – 5.0)
Auto Tune Kd high limit	float	(c) R/W	2220-2221	0x03	0x06,0x10	(0.0 – 5.0)
Valve PID Kp2PFS Coeff.	float	(c) R/W	2222-2223	0x03	0x06,0x10	(0.0 – 5.0)
DP NLES A Parameter	float	R/W	2224-2225	0x03	0x06,0x10	(0.0 – 1.0)
Factory Reserved Registers (do not change)	float	(c) R	2226-2377	0x03	N/A	N/A
Flow Tare Counts	float	R/W	2378-2379	0x03	0x06,0x10	(- 4.3E+38 to 4.3E+38)
Factory Reserved	float	R/W	2380-2381	0x03	0x06,0x10	(- 4.3E+38 to 4.3E+38)
Factory Reserved	float	R/W	2382-2383	0x03	0x06,0x10	(- 4.3E+38 to 4.3E+38)
STD Units Temperature [˚F]	float	R/W	2384-2385	0x03	0x06,0x10	(14.0-100) ˚F units

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
STD Units Pressure (PSIA)	float	R/W	2386-2387	0x03	0x06,0x10	(0.1-60.0) PSIA
PID Oscillations Criteria	float	(c) R/W	2388-2389	0x03	0x06,0x10	(0.0 – 0.3) Normalized
PSP PFS[0]	float	(c) R/W	2390-2391	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[1]	float	(c) R/W	2392-2393	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[2]	float	(c) R/W	2394-2395	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[3]	float	(c) R/W	2396-2397	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[4]	float	(c) R/W	2398-2399	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[5]	float	(c) R/W	2400-2401	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[6]	float	(c) R/W	2402-2403	0x03	0x06,0x10	(0.0 – 1.0)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
PSP PFS[7]	float	(c) R/W	2404-2405	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[8]	float	(c) R/W	2406-2407	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[9]	float	(c) R/W	2408-2409	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[10]	float	(c) R/W	2410-2411	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[11]	float	(c) R/W	2412-2413	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[12]	float	(c) R/W	2414-2415	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[13]	float	(c) R/W	2416-2417	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[14]	float	(c) R/W	2418-2419	0x03	0x06,0x10	(0.0 – 1.0)
PSP PFS[15]	float	(c) R/W	2420-2421	0x03	0x06,0x10	(0.0 – 1.0)
Dig.Set Point (Enginering Units)	float	(c) R/W	2540-2541	0x03	0x06,0x10	0.0 to 4.3E +38)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Input Registers (Read only, use Modbus Function 0x04)						
32-bit unsigned and signed int (RAM Diagnostic Parameters) (each 32-bit int parameters represented by 2 registers: first register contains bit 31-16, second 15-0)						
DP Temp. Counts Aver.	Signed int	R	2600-2601	0x04	N/A	-65535 to 65535 (counts)
AP Temp. Counts Aver.	Signed int	R	2602-2603	0x04	N/A	-65535 to 65535 (counts)
Reference Voltage Counts	Signed int	R	2604-2605	0x04	N/A	-65535 to 65535 (counts)
Temp. Sensor Counts Aver.	Signed int	R	2606-2607	0x04	N/A	-65535 to 65535 (counts)
DP ADC Counts Average	Signed int	R	2608-2609	0x04	N/A	-8388607 to 8388607 (counts)
AP ADC Counts Average	Signed int	R	2610-2611	0x04	N/A	-8388607 to 8388607 (counts)
DP Sensor Temperature [˚C]	float	R	2612-2613	0x04	N/A	-10 to 80 ˚C
AP Sensor Temp. [˚C]	float	R	2614-2615	0x04	N/A	-10 to 80 ˚C
2.5Vdc Refer. voltage	float	R	2616-2617	0x04	N/A	(0.0-3.3) Vdc
CPU die Temperature	float	R	2618-2619	0x04	N/A	(0.0 – 125.0) ˚C
Gas Temp. Sensor Counts	float	R	2620-2621	0x04	N/A	-65535 to 65535
Gas Temperature [˚K]	float	R	2622-2623	0x04	N/A	(270 – 365) ˚K

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	**Parameter Type**	**Access**	**PDU Address**	**Modbus Function**		**Remark, (parameter min = max value)**
				Read	**Write**	
Input Registers (Read only, use Modbus Function 0x04)						
32-bit unsigned and signed int (RAM Diagnostic Parameters) (each 32-bit int parameters represented by 2 registers: first register contains bit 31-16, second 15-0)						
DP Sensor Pressure [PSID]	float	R	2624-2625	0x04	N/A	-3.0 to 3.0 (PSID)
AP Sensor Pressure [PSIA]	float	R	2626-2627	0x04	N/A	0.0 to 120.0 (PSIA)
Analog Input PFS	float	R	2628-2629	0x04	N/A	0.0 to 110.0 (%FS)
Solenoid Current PFS	float	R	2630-2631	0x04	N/A	0.0 - 1.0 (normalized)
Single precision 32-bit IEEE-754 floating-point **Process Information (PI)** Parameters (each floating-point parameters represented by 2 registers: first register contains bit 31-16, second 15-0)						
Mass Flow RateReading in current MEU	float	R	**2700-2701**	0x04	N/A	(- 4.3E+38 to 4.3E+38)
Vol. Flow RateReading in current VEU	float	R	**2702-2703**	0x04	N/A	(- 4.3E+38 to 4.3E+38)
Totalizer#1 Reading	float	R	**2704-2705**	0x04	N/A	(0.0 to 4.3E+38)
Totalizer#2 Reading	float	R	**2706-2707**	0x04	N/A	(0.0 to 4.3E+38)
Gas Temp. [˚C]	float	R	**2708-2709**	0x04	N/A	(- 10.0 to 85.0 ˚C)
Gas Absolute Pressure [PSIA]	float	R	**2710-2712**	0x04	N/A	(0.0 to 120 PSIA)
Mass Flow Average in current MEU	float	R	**2712-2713**	0x04	N/A	(- 4.3E+38 to 4.3E+38)

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Input Registers (Read only, use Modbus Function 0x04)						
16-bit unsigned short (RAM Diagnostic Parameters) (each 16-bit unsigned short parameters represented by 1 registers: [15-0])						
Factory Reserved	Unsigned short	R	3000	0x04	N/A	0 - 4095 (counts)
Analog Input ADC Average	Unsigned short	(c) R	3001	0x04	N/A	0 - 65535 (counts)
Solenoid Current DAC counts	Unsigned short	(c) R	3002	0x04	N/A	0 - 65535 (counts)
DPM / DPC H/W status	Unsigned short	R	3003	0x04	N/A	0 - 1 0 - DPM 1 - DPC
CPU Temperature raw counts	Unsigned short	R	3004	0x04	N/A	0 - 4095 (counts)
AP Auto Zero status	signed short	R	3005	0x04	N/A	-1to 2
Analog Out. DAC Data Register	Unsigned short	R	3006	0x04	N/A	0 - 65535 (counts)
Diagnostic Events Status Register	Unsigned short	R	3007	0x04	N/A	0 - 65535
Alarm Events Status Register	Unsigned short	R	3008	0x04	N/A	0 - 65535
UART#1 Error Register	Unsigned short	R	3009	0x04	N/A	0 - 65535
UART#2 Error Register.	Unsigned short	R	3010	0x04	N/A	0 - 65535
Modbus Overrun Error Counter	Unsigned short	R	3011	0x04	N/A	0 - 65535

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	**Parameter Type**	**Access**	**PDU Address**	**Modbus Function**		**Remark, (parameter min = max value)**
				Read	**Write**	
DP Auto Zero status	Signed short	R	3012	0x04	N/A	-1 - Failed 0 - Not Started 1 - In Process 2 - Completed
Modbus Total RAM Size	Unsigned short	R	3013	0x04	N/A	0 - 65535
Flow Alarm Status	Signed short	R	3014	0x04	N/A	'D' - Disabled 'N' - No Alarm 'H' - High Alarm 'L' - Low Alarm
Temperature Alarm Status	Signed short	R	3015	0x04	N/A	'D' - Disabled 'N' - No Alarm 'H' - High Alarm 'L' - Low Alarm
Pressure Alarm Status	Signed short	R	3015	0x04	N/A	'D' - Disabled 'N' - No Alarm 'H' - High Alarm 'L' - Low Alarm
Action Registers (Write Only) Writing 0 to the corresponding address initiate following actions:						
Reserved	Unsigned short	W	0	N/A	0x06	Do not Use (Factory reserved)
Totalizer#1 Reset	Unsigned short	W	1	N/A	0x06	
Totalizer#2 Reset	Unsigned short	W	2	N/A	0x06	
Start Auto Zero	Unsigned short	W	3	N/A	0x06	**Make Sure Absolutely No Flow Conditions!!!**
Instrument Software Reset	Unsigned short	W	4	N/A	0x06	
Calibration Pilot Timer Reset	Unsigned short	W	5	N/A	0x06	

Table 4.3 (continue)

Modbus Registers (standard mapping: one register holds 16 bit of data)						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min = max value)
				Read	Write	
Reserved	Unsigned short	W	6	N/A	0x06	Do not Use (Factory reserved)
Save EEPROM for MGT String	Unsigned short	W	7	N/A	0x06	Instrument Test Port RS485 bus address save
Reserved	Unsigned short	W	8	N/A	0x06	Do not Use (Factory reserved)

Table 4.4 Lists of the most commonly used parameters ("Daniel's Extension" data mapping)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min – max value)
				Read	Write	
Device Nominal FS Range [sl/min] N2	float	R	7008	0x03	N/A	(0.0125-1000.0) sl/min N_2
AmbTemp. During PRM Calibration˚C	float	R	7009	0x03	N/A	(0.0– 50.0) ˚C
Sensor Calibration Temp	float	R	7010	0x03	N/A	(0.0– 50.0) ˚C
Factory Reserved	float	R	7011	0x03	N/A	N/A
Reserved	float	R	7012	0x03	N/A	N/A
PGT PFS[0]	float	R	7013	0x03	N/A	(0.0-1.0)
PGT PFS[1]	float	R	7014	0x03	N/A	(0.0-1.0)
PGT PFS[2]	float	R	7015	0x03	N/A	(0.0-1.0)
PGT PFS[3]	float	R	7016	0x03	N/A	(0.0-1.0)
PGT PFS[4]	float	R	7017	0x03	N/A	(0.0-1.0)
PGT PFS[5]	float	R	7018	0x03	N/A	(0.0-1.0)
PGT PFS[6]	float	R	7019	0x03	N/A	(0.0-1.0)
PGT PFS[7]	float	R	7020	0x03	N/A	(0.0-1.0)

Table 4.4 Lists of the most commonly used parameters ("Daniel's Extension" data mapping)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min – max value)
				Read	Write	
PGT PFS[8]	float	R	7021	0x03	N/A	(0.0-1.0)
PGT PFS[9]	float	R	7022	0x03	N/A	(0.0-1.0)
PGT PFS[10]	float	R	7023	0x03	N/A	(0.0-1.0)
PGT PFS[11]	float	R	7024	0x03	N/A	(0.0-1.0)
PGT PFS[12]	float	R	7025	0x03	N/A	(0.0-1.0)
PGT PFS[13]	float	R	7026	0x03	N/A	(0.0-1.0)
PGT PFS[14]	float	R	7027	0x03	N/A	(0.0-1.0)
PGT PFS[15]	float	R	7028	0x03	N/A	(0.0-1.0)
MGT Configurable FS Range (sl/min)	float	R	7029	0x03	N/A	(0.0005 – 1000.0) sl/min
STD Temperature	float	R	7030	0x03	N/A	(0.0-122.0) ˚F
STD Pressure	float	R	7031	0x03	N/A	(0.0 100.0) PSIA
MGT Fluid Density @ STD conditions	float	R	7032	0x03	N/A	(0.0001-15.0) g/l
MGT PFS[0]	float	R	7033	0x03	N/A	(0.0-1.0)
MGT PFS[1]	float	R	7034	0x03	N/A	(0.0-1.0)
MGT PFS[2]	float	R	7035	0x03	N/A	(0.0-1.0)
MGT PFS[3]	float	R	7036	0x03	N/A	(0.0-1.0)
MGT PFS[4]	float	R	7037	0x03	N/A	(0.0-1.0)
MGT PFS[5]	float	R	7038	0x03	N/A	(0.0-1.0)
MGT PFS[6]	float	R	7039	0x03	N/A	(0.0-1.0)
MGT PFS[7]	float	R	7040	0x03	N/A	(0.0-1.0)
MGT PFS[8]	float	R	7041	0x03	N/A	(0.0-1.0)
MGT PFS[9]	float	R	7042	0x03	N/A	(0.0-1.0)

Table 4.4 (continue)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min – max value)
				Read	Write	
MGT PFS[10]	float	R	7043	0x03	N/A	(0.0-1.0)
MGT PFS[11]	float	R	7044	0x03	N/A	(0.0-1.0)
MGT PFS[12]	float	R	7045	0x03	N/A	(0.0-1.0)
MGT PFS[13]	float	R	7046	0x03	N/A	(0.0-1.0)
MGT PFS[14]	float	R	7047	0x03	N/A	(0.0-1.0)
MGT PFS[15]	float	R	7048	0x03	N/A	(0.0-1.0)
Time Since Last Cal. (Pilot Timer)	float	R/W	7049	0x03	0x06, 0x10	(0.0-4.3E+38) [Hr]
User Defined Unit K-Factor to liter	float	R/W	7050	0x03	0x06, 0x10	(0.0001-1000000.0)
Temp . Alarm Low [˚K]	float	R/W	7051	0x03	0x06, 0x10	(253.15-333.15) ˚K
Factory Reserved	float	R/W	7052	0x03	0x06, 0x10	(N/A)
Pressure Alarm Low [PSIA]	float	R/W	7053	0x03	0x06, 0x10	(0.1-60.0) PSIA
Pressure Alarm High [PSIA]	float	R/W	7054	0x03	0x06, 0x10	(0.1-100.0) PSIA
Temp . Alarm High [˚K]	float	R/W	7055	0x03	0x06, 0x10	(253.2 to 343.2) ˚K
Analog Output 4-20mA Scale	float	R/W	7056	0x03	0x06, 0x10	(1000.0-5000.0) counts/mA
Analog Output 4-20mA Offset	float	R/W	7057	0x03	0x06, 0x10	(-99.9 to 99.9) counts/mA
Local Set Point PFS	float	R/W (c)	7058	0x03	0x06, 0x10	0.0 - 1.25 (normalized)

Table 4.4 (continue)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	**Parameter Type**	**Access**	**PDU Address**	**Modbus Function**		**Remark, (parameter min – max value)**
				Read	**Write**	
NLES_D	float	R/W	7059	0x03	0x06, 0x10	0.0 - 1.0
Analog Output 0-5 Vdc Scale	float	R/W	7060	0x03	0x06, 0x10	(5000.0-65000.0)
Analog Output 0-10 Vdc Scale	float	R/W	7061	0x03	0x06, 0x10	(5000.0-65000.0)
DP Sensor Full Saale [PSID]	float	R/W	7062	0x03	0x06, 0x10	(0.0 - 5.0 PSID)
AP Sensor Full Saale [PSIA]	float	R/W	7063	0x03	0x06, 0x10	(0.0 - 100.0 PSIA)
Flow Alarm Low PFS	float	R/W	7064	0x03	0x06, 0x10	(0.0 – 1.1) Normalized PFS
Flow Alarm High PFS	float	R/W	7065	0x03	0x06, 0x10	(0.0 – 1.1) Normalized PFS
Totalizer#1 Start @ Flow PFS	float	R/W	7066	0x03	0x06, 0x10	(0.0 – 1.0) Normalized PFS
Totalizer#1 Event Volume	float	R/W	7067	0x03	0x06, 0x10	(0.0 - 4.3E+38)
Totalizer#1 Backup Volume	float	R/W	7068	0x03	0x06, 0x10	(0.0 - 4.3E+38)
Totalizer#2 Start @ Flow PFS	float	R/W	7069	0x03	0x06, 0x10	(0.0 – 1.0) Normalized PFS [0-1.0] units
Totalizer#2 Event Volume	float	R/W	7070	0x03	0x06, 0x10	(0.0 - 4.3E+38)
Totalizer#2 Backup Volume	float	R/W	7071	0x03	0x06, 0x10	(0.0 - 4.3E+38)
Pulse Output Start @ Flow	float	R/W	7072	0x03	0x06, 0x10	(0.0 – 1.0) Normalized PFS [0-1.0] units

Table 4.4 (continue)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	**Parameter Type**	**Access**	**PDU Address**	**Modbus Function**		**Remark, (parameter min – max value)**
				Read	**Write**	
Pulse Output Units per one Pulse	float	R/W	7073	0x03	0x06, 0x10	(0.0 - 4.3E+38) units/pulse
Temp. During Gas Temp Calibration	float	R/W	7074	0x03	0x06, 0x10	(263.2 to 333.15) °K
Sensor Raw NLES_A0	float	R/W	7075	0x03	0x06, 0x10	(0.0-1.0)
Sensor Raw NLES_A1	float	R/W	7076	0x03	0x06, 0x10	(0.0-1.0)
Sensor Raw NLES_D0	float	R/W	7077	0x03	0x06, 0x10	(0.0-1.0)
Sensor Raw NLES_D0	float	R/W	7078	0x03	0x06, 0x10	(0.0-1.0)
Sensor Compens. NLES_A0	float	R/W	7079	0x03	0x06, 0x10	(0.0-1.0)
Sensor Compens. NLES_A1	float	R/W	7080	0x03	0x06, 0x10	(0.0-1.0)
Sensor Compens. NLES_D0	float	R/W	7081	0x03	0x06, 0x10	(0.0-1.0)
Sensor Compens. NLES_D1	float	R/W	7082	0x03	0x06, 0x10	(0.0-1.0)
Sensor DRC KlagUp[0]	float	R/W	7083	0x03	0x06, 0x10	(0.0-25.0)
Sensor DRC KlagUp[1]	float	R/W	7084	0x03	0x06, 0x10	(0.0-25.0)
Sensor DRC KlagUp[2]	float	R/W	7085	0x03	0x06, 0x10	(0.0-25.0)

Table 4.4 (continue)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min – max value)
				Read	Write	
Sensor DRC KgainUp[0]	float	R/W	7086	0x03	0x06, 0x10	(0.0-25.0)
Sensor DRC KgainUp[1]	float	R/W	7087	0x03	0x06, 0x10	(0.0-25.0)
Sensor DRC KgainUp[2]	float	R/W	7088	0x03	0x06, 0x10	(0.0-25.0)
Sensor DRC KlagDn[0]	float	R/W	7089	0x03	0x06, 0x10	(0.0-25.0)
Sensor DRC KlagDn [1]	float	R/W	7090	0x03	0x06, 0x10	(0.0-25.0)
Sensor DRC KlagDn [2]	float	R/W	7091	0x03	0x06, 0x10	(0.0-25.0)
Sensor DRC KgainDn [0]	float	R/W	7092	0x03	0x06, 0x10	(0.0-25.0)
Sensor DRC KgainDn [1]	float	R/W	7093	0x03	0x06, 0x10	(0.0-25.0)
Sensor DRC KgainDn [2]	float	R/W	7094	0x03	0x06, 0x10	(0.0-25.0)
AP Tare Maximum Deviation	float	R/W	7095	0x03	0x06, 0x10	(0.0 to 1.0) PSIA
AP Sensor Tare Counts	float	R/W	7096	0x03	0x06, 0x10	(- 4.3E+38 to 4.3E+38)
AP Sensor Tare Offset	float	R/W	7097	0x03	0x06, 0x10	(- 4.3E+38 to 4.3E+38)
AP Tare Temp. Counts	float	R/W	7098	0x03	0x06, 0x10	(- 4.3E+38 to 4.3E+38)
Normal Units Temperature [˚F]	float	R/W	7099	0x03	0x06, 0x10	(14.0-100) ˚F
Normal Units Pressure PSIA	float	R/W	7100	0x03	0x06, 0x10	(0.1-60.0) PSIA
PID KpM Activation	float	(c) R/W	7101	0x03	0x06, 0x10	(0.0 – 1.0) Normalized

Table 4.4 (continue)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min – max value)
				Read	Write	
LCD Flow Reading Dead Band	float	R/W	7102		0x06, 0x10	(0.0 – 0.01) Normalized
Valve PID Proportional Term	float	(c) R/W	7103	0x03	0x06, 0x10	(0.0-2.5)
Valve PID Integral Term	float	(c) R/W	7104	0x03	0x06, 0x10	(0.0-2.5)
Valve PID Derivative Term	float	(c) R/W	7105	0x03	0x06, 0x10	(0.0-2.5)
Solenoid Valve PID bias	float	(c) R/W	7106	0x03	0x06, 0x10	(0.0-1.0)
PID Proportional Maltiplier	float	(c) R/W	7107	0x03	0x06, 0x10	(0.0 – 10.0)
Auto Tune Kp high limit	float	(c) R/W	7108	0x03	0x06, 0x10	(0.0 – 5.0)
Auto Tune Ki high limit	float	(c) R/W	7109	0x03	0x06, 0x10	(0.0 – 5.0)
Auto Tune Kd high limit	float	(c) R/W	7110	0x03	0x06, 0x10	(0.0 – 5.0)
Valve PID Kp2PFS Coeff.	float	(c) R/W	7111	0x03	0x06, 0x10	(0.0 – 5.0)
DP NLES A Parameter	float	R/W	7112	0x03	0x06, 0x10	(0.0 – 1.0)
Factory Reserved Registers	float	R	7113 to 7188	0x03	N/A	N/A

Table 4.4 (continue)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min – max value)
				Read	Write	
Flow Tare Counts	float	R/W	7189	0x03	0x06, 0x10	(- 4.3E+38 to 4.3E+38)
Factory Reserved	float	R/W	7190	0x03	0x06, 0x10	(- 4.3E+38 to 4.3E+38)
Factory Reserved	float	R/W	7191	0x03	0x06, 0x10	(- 4.3E+38 to 4.3E+38)
STD Units Temperature [˚F]	float	R/W	7192	0x03	0x06, 0x10	(14.0-100) ˚F
STD Units Pressure (PSIA)	float	R/W	7193	0x03	0x06, 0x10	(0.1-60.0) PSIA
PID Oscillations Criteria	float	R/W	7194	0x03	0x06, 0x10	(0.0 – 0.3) Normalized
PSP PFS[0]	float	R/W	7195	0x03	0x06, 0x10	(0.0 – 1.0)
PSP PFS[1]	float	R/W	7196	0x03	0x06, 0x10	(0.0 – 1.0)
PSP PFS[2]	float	R/W	7197	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[3]	float	R/W	7198	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[4]	float	R/W	7199	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[5]	float	R/W	7200	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[6]	float	R/W	7201	0x04	0x06, 0x10	(0.0 – 1.0)

Table 4.4 (continue)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	**Parameter Type**	**Access**	**PDU Address**	**Modbus Function**		**Remark, (parameter min – max value)**
				Read	**Write**	
PSP PFS[7]	float	R/W	7202	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[8]	float	R/W	7203	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[9]	float	R/W	7204	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[10]	float	R/W	7205	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[11]	float	R/W	7206	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[12]	float	R/W	7207	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[13]	float	R/W	7208	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[14]	float	R/W	7209	0x04	0x06, 0x10	(0.0 – 1.0)
PSP PFS[15]	float	R/W	7210	0x04	0x06, 0x10	(0.0 – 1.0)
Single precision 32-bit IEEE-754 floating-point RAM Diagnostic parameters (each floating-point parameters represented by 1 registers: one register holds 32 bit of data [31-0])						
DP Temp. Counts Aver.	float	R	7500	0x04	N/A	-65535.0 to 65535.0 (counts)
AP Temp. Counts Aver.	float	R	7501	0x04	N/A	-65535.0 to 65535.0 (counts)
Reference Voltage Counts	float	R	7502	0x04	N/A	-65535.0 to 65535.0 (counts)
Temp. Sensor Average	float	R	7503	0x04	N/A	-65535.0 to 65535.0 (counts)
DP ADC Counts Aver.	float	R	7504	0x04	N/A	-8388607 to 8388607 (counts)

Table 4.4 (continue)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	**Parameter Type**	**Access**	**PDU Address**	**Modbus Function**		**Remark, (parameter min – max value)**
				Read	**Write**	
Single precision 32-bit IEEE-754 floating-point RAM Diagnostic parameters (each floating-point parameters represented by 1 registers: one register holds 32 bit of data [31-0])						
AP ADC Counts Average	float	R	7505	0x04	N/A	-8388607 to 8388607 (counts)
DP Sensor Temp. [˚C]	float	R	7506	0x04	N/A	(-10.0 to 80.0) ˚C
DP Sensor Temp. [˚C]	float	R	7507	0x04	N/A	(-10.0 to 80.0) ˚C
2.5Vdc Reference voltage	float	R	7508	0x04	N/A	(0.0 – 3.3) Vdc
CPU die Temperature	float	R	7509	0x04	N/A	(0.0 – 125.0) ˚C
Gas Temp. Sensor Counts	float	R	7510	0x04	N/A	-65535.0 to 65535.0 (counts)
Gas Temp. ˚K	float	R	7511	0x04	N/A	(270.0 - 365.0) ˚K.
DP Sensor Pressure [PSID]	float	R	7512	0x04	N/A	-3.0 to 3.0 (PSID)
AP Sensor Pressure [PSIA]	float	R	7513	0x04	N/A	0.0 to 120.0 (PSIA)
Analog Input PFS	float	R (c)	7514	0x04	N/A	0.0 to 110.0 (%FS)
Solenoid Current PFS	float	R (c)	7515	0x04	N/A	0.0 - 1.0 (normalized)

Table 4.4 (continue)

Modbus Registers ("Daniel's Extension" mapping: one register holds 32 bit of data [31-0])						
Parameter Name	Parameter Type	Access	PDU Address	Modbus Function		Remark, (parameter min – max value)
				Read	Write	
Single precision 32-bit IEEE-754 fl oating-point Process Information (PI) parameters (each floating-point parameters represented by 1 registers: one register holds 32 bit of data [31-0])						
Mass Flow RateReading in current MEU	float	R	7600	0x04	N/A	(- 4.3E+38 to 4.3E+38)
Vol. Flow RateReading in current VEU	float	R	7601	0x04	N/A	(- 4.3E+38 to 4.3E+38)
Totalizer#1 Reading	float	R	7602	0x04	N/A	(0.0 to 4.3E+38)
Totalizer#2 Reading	float	R	7603	0x04	N/A	(0.0 to 4.3E+38)
Gas Temp. [˚C]	float	R	7604	0x04	N/A	(- 10.0 to 85.0 ˚C)
Gas Absolute Pressure [PSIA]	float	R	7605	0x04	N/A	(0.0 to 120 PSIA)
Mass Flow Average in MEU	float	R	7606	0x04	N/A	(- 4.3E+38 to 4.3E+38)

NOTE: Details and functional description for parameters can be found in the corresponding digital instrument Operation Manual. These documents can be found at:

http://www.aalborg.com/index.php/main_page/download_listings/categ/12

NOTE: Your mass flow Digital instrument was calibrated at the factory for the specified gas and full scale flow range (see device's front label). There is no need to adjust the EEPROM calibration related parameters unless linearity adjustment is needed, flow range has to be changed, or new additional calibration is required. Any alteration of the EEPROM calibration related parameters will VOID calibration warranty supplied with instrument.

NOTE: Most of the digital signal conditioning parameters were set on the factory individually for each instrument to keep best response time and temperature compensation performance. Do not change these parameters unless instructed by factory technical support representative!

5 TROUBLESHOOTING

5.1 Visual Diagnostic using instrument Status LED

The instrument's Status LED indicator may be used for the purpose of troubleshooting Modbus communication interface. In order to do so the instrument's Status LED has to be assigned to "Modbus Diagnostic". It can be accomplished ether via local key-pad / Display interface or via RS232 Communication port using supplied "Digital Instrument Configuration Software". For exact instructions see corresponding digital instrument Operation Manual.

When Status LED is assigned to “Modbus Diagnostic” the Status LED will blink “Green” during frame reception and “Red” during frame transmission. In normal operation the instrument reply within 100-200ms therefore green and red light will be activate almost simultaneously and will appear for human eye as Amber. If there is no LED activity or only Green LED is blinking during frame reception it may indicate that slave device cannot detect communication or master is using wrong slave address.

5.2 Via test/configuration RS232 port using “Instrument Configuration Utility” software

Connect your Aalborg Modbus slave instrument to a PC RS232 COM-port using the supplied communication cable. Start “Instrument Configuration Utility” software (supplied on CD with the instrument). Navigate to **Properties / Device Setting** menu selection and select **“Modbus Interface”** folder from the three-view panel on the left of the screen. The screen similar to Figure 3.1 will appear. Click **“Refresh”** button in the **“MB State Machine Diagnostic”** group box. The following Modbus diagnostic parameters are provided:

1. Bus messages count.
2. CRC Frame Communication Error count.
3. Slave message count.
4. Bus characters overrun count.

Table 5.1 provides list of the possible problem based on combination of the diagnostic parameters.

Diagnostic parameters				Possible cause of the problem
1	2	3	4	
0	0	0	0	No communication detected by slave instrument, check RS485 network cables and D0 and D1 signals.
>0	0	0	0	Slave detected valid Modbus messages for other addresses, make sure master uses correct slave address.
0	>0	0	0	Slave detected invalid messages, make sure Master device set to the same baud rate, parity and stop bit settings.
>0	>0	>0	0	Slave detected both valid and invalid messages, make sure RS485 bus termination and polarization are used correctly and the maximum number of devices is not exceeded number specified in the Master device driver specification. Check the total length of the cables. Try to reduce baud rate.
0	>0	0	>0	Slave received frame with corrupted data. There is problem with communication settings. Make sure RS485 bus termination and polarization are used correctly. Try to reduce baud rate.
>0	0	>0	0	Normal operation. No problem detected by slave device.

5.3 Suggested troubleshooting sequence

If there is problem with Modbus communications please perform following steps:

1. Check all Modbus settings at your master device. Master and slave devices settings must be the same, check baud rate, stop bit and parity setting. Make sure Master supports Modbus RTU mode.
2. Check slave device address, baud rate, stop bit and parity setting.
3. Check cabling and bus termination of your Modbus system. Make sure there is no crossover cables used on some segments of the bus.
4. Check power supply of the slave instrument. Make sure the status LED on the slave instrument is “Green” (normal operation).
5. Perform hardware (power up) or software reset of the slave instrument. Reset bus muster device.
6. If problem still remains try to disconnect one by one all slave devices on the RS485 bus until problem disappear.
7. Check diagnostic parameters provided in the **Table 5.1.**