VERDERFLEX®

Peristaltic Cased Tube Pump

Appendix J
Modbus® RTU

Vantage 5000

CE

VERDER
passion for pumps

Vantage 5000

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Appendix J

1.1 Modbus® RTU Introduction

ℹ️ Modbus® is a registered trademark of Schneider Electric, licensed to the Modbus® Organization, Inc.

Note

All Modbus® systems must be installed or certified by a qualified installation engineer. Modbus® control and connectivity must be implemented in accordance with Verder recommendations.

For Modbus® operation, the pump must have an M12 connector on the back of the pump and be a Vantage 5000 M version.

The Modbus® interface within the Vantage 5000 uses galvanic isolated semiconductor technology that facilitates high differential potentials across a network without creating current loops.

The communication is based around a master/slave system where the Vantage 5000 acts as a slave device and uses RS485 electrical connectivity via A/B terminals. The maximum differential voltage should not exceed +/- 12V.

The Modbus® protocol used is Modbus® RTU.

1.2 Modbus® Connection

The Modbus® network is interfaced to the Vantage 5000 via an Amphenol M series A Type 5 WAY Connector positioned on the back of the pump.
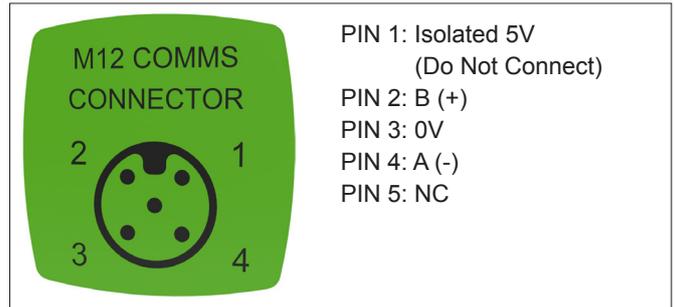

M12 COMMS CONNECTOR

2 1
3 4

PIN 1: Isolated 5V
          (Do Not Connect)
PIN 2: B (+)
PIN 3: 0V
PIN 4: A (-)
PIN 5: NC

Figure 1 M12 Comms Connector Label

To minimise system noise and maintain network integrity it is advised that 'Spur' connections (derivation cables) not use in conjunction with a Vantage 5000 and use a M12 'A' coded Y or T distributor connector link the Vantage 5000 directly to the system network.

The connector should have shield continuity between each of the three connector shields. To allow the cable shield to connect to the protective ground (protective Earth), usually situated at one point on the principal cable.

Alternatively, if shield continuity through the connector is not maintained, at one end of each cable its shield must be connected to protective ground (protective Earth).

The installation should also conform to your local regions' electrical installation requirements.
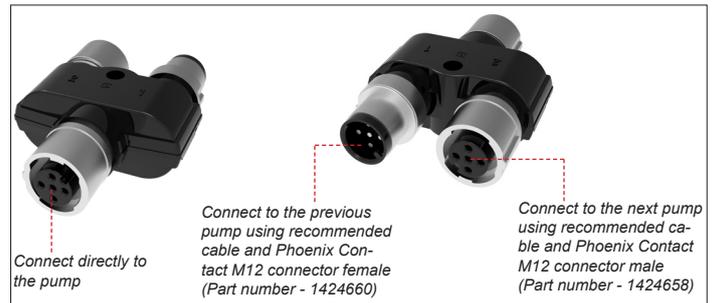

Connect directly to the pump

Connect to the previous pump using recommended cable and Phoenix Contact M12 connector female (Part number - 1424660)

Connect to the next pump using recommended cable and Phoenix Contact M12 connector male (Part number - 1424658)

Figure 2 Y distributor connector A coded

Figure 3 Back of the Pump - Vantage 5000 M

1.2 Modbus® Connection *(continued)*

The network cable should be screened twisted pair with additional core for 0V Common line. The network should be terminated and wired as specified in "Modbus® over Serial Line Specification and Implementation Guide" available on the Modbus.org website, refer to (→ 3.4 Multipoint System requirements and 3.6 Cables).

The wiring diagram (→ *Figure 4 Modbus® system wiring diagram)* is based on the Modbus.org document: "Modbus® over Serial Line Specification and Implementation Guide". Values of resistors may differ slightly from the diagram. For EMC purposes, the protective ground (protective Earth) arrangements of the shield may need to vary from those shown in the diagram below.

Accessories recommendation are: Phoenix Contact M12 connectors (part numbers - 1424658 and 1424660) with easy to wire push-in terminals and Phoenix Contact shielded Y-distributor connector (part number – 1419933).

Please follow the notes below:
1. Line termination (LT) is required on the signal lines. This should be located at each of the 2 ends of the bus.

2. Line polarization is required on the signal lines. One pull up resistor and one pull down resistor for the whole bus. Located at the master. This is used to reduce noise interference which can be interpreted by the receiver as data. Observe correct polarity at the master.

3. Beware of crossing the data signal lines, observe correct polarity. Some manufacturers of Modbus® equipment label the data lines on their devices with "A" and "B", "+" and "-" or Signal and Inverted Signal. These labels can be opposite to other devices in the network. In this implementation B is the Non-Inverting output (+), A is the Inverting output (-).

4. After entering failsafe mode due to a Modbus communications timeout, there may be a delay before communications can be re-established.

5. System 0V Common line, shield and protective grounding (protective Earth) arrangements should be implemented according to the Modbus® document "Modbus® over Serial Line Specification and Implementation Guide".

6. Ensure that each device on the Modbus® network has a unique address. If two devices have the same address abnormal behaviour can occur. In such a case, the Master would not be able to communicate with all slaves on the bus.

Please implement your PLC algorithm to avoid timeouts on other devices when one Modbus unit is switched off, refer to (→ *1.3 PLC Algorithm)*
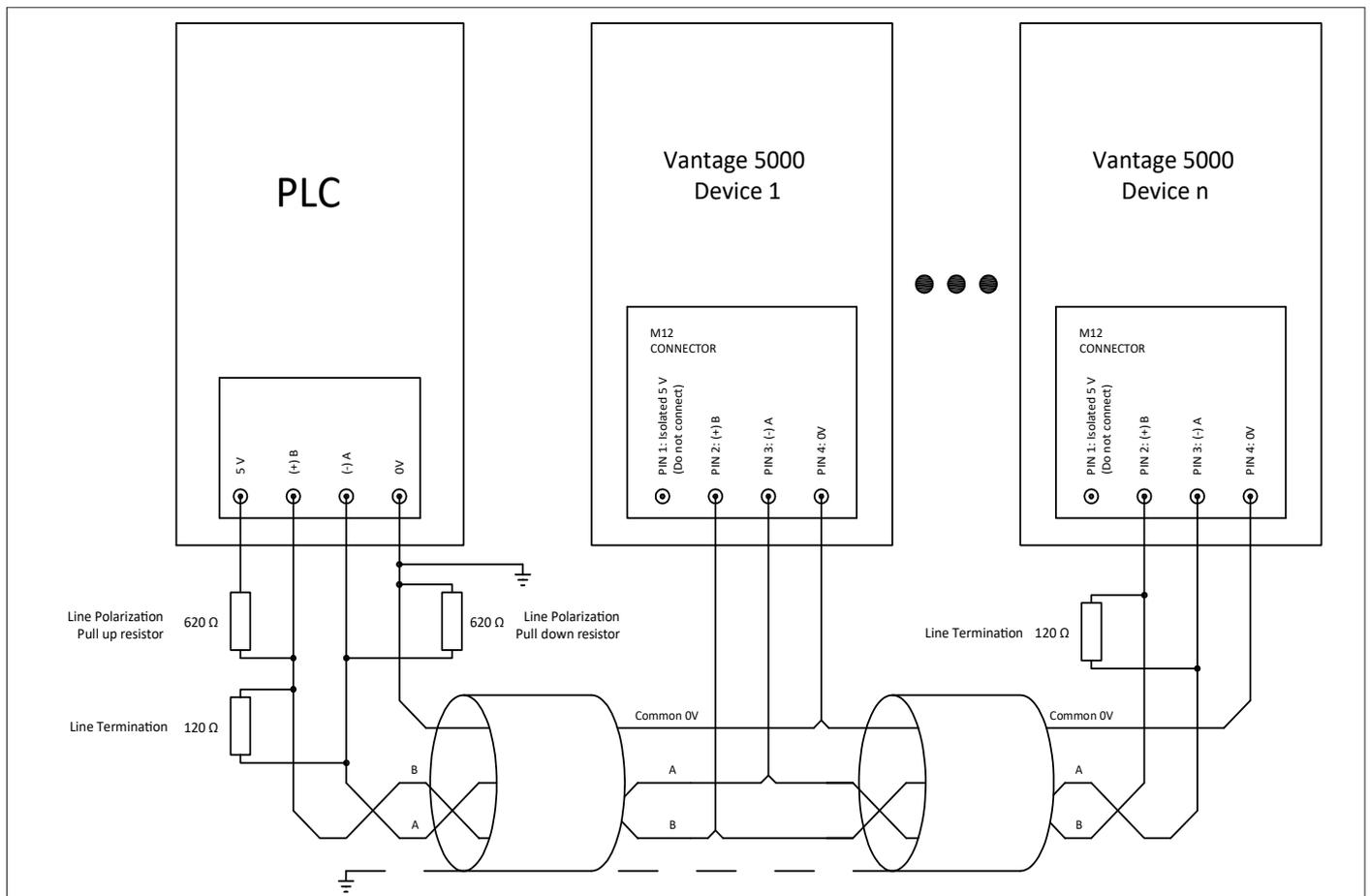For examples of your own Modbus® PLC's programs see your PLC distributors website.

Figure 4 Modbus® system wiring diagram
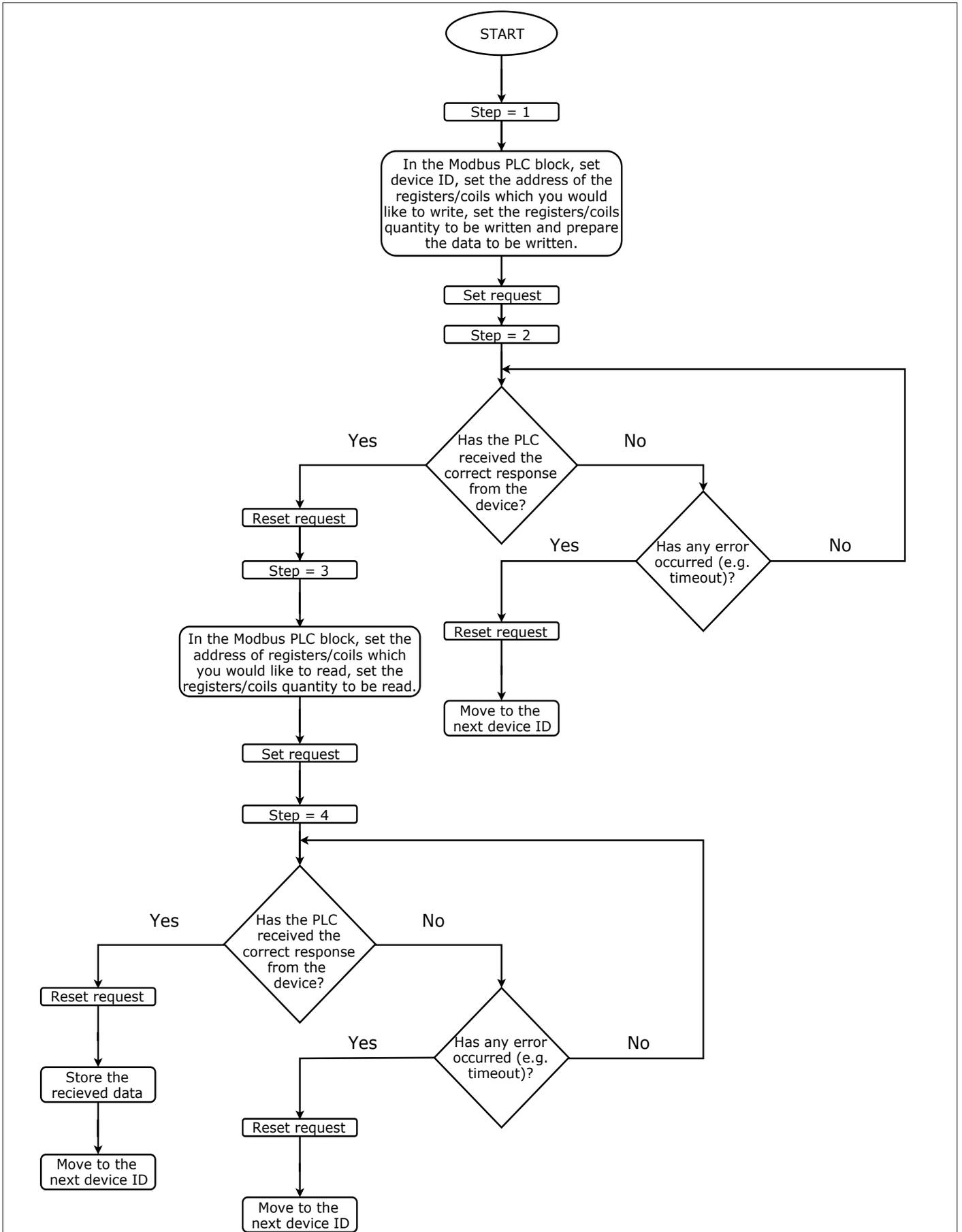
1.3 PLC Algorithm

Figure 5 PLC Algorithm

1.4 Selecting Modbus® Protocol

Follow the steps below to make sure that Modbus® is selected:

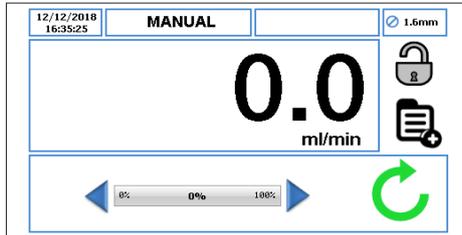▶ Touch the icon 🔓 to unlock the screen and select the main menu 📋 .

Figure 6   Unlock the Screen and Select the Main Menu

▶ To access the Job File Menu, touch the icon 📂 .

Figure 7   Select the Job File Menu

▶ Scroll through the available Job File and highlight the target Job File.

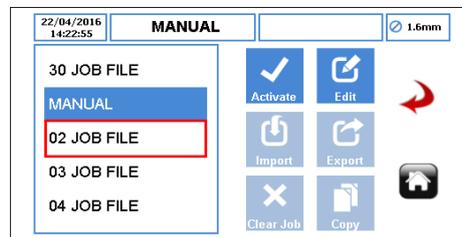▶ To edit the Job File highlighted in red, touch the icon Edit .

Figure 8   Edit the Highlighted Job File

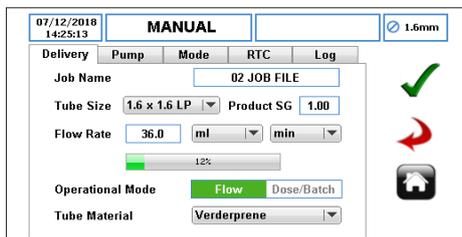▶ Make sure the Flow Mode is selected as shown in the *Figure 9.*

Figure 9 Select the Flow Mode

Note

Modbus® function will be available if flow mode is selected in delivery menu. To perform Dose/Batch functions in the Vantage 5000, the user should implement an algorithm which consist of timed Start/Stop commands in a loop.

Verder does not warrant the use of the Dose/Batch Mode in the job file when in Modbus® mode.

▶ Select ✔ to accept all changes within the Highlighted Job File and the user will be returned to the Job File menu as shown in *Figure 10*. Changes made on this screen are not saved until this icon is pressed. In Modbus mode, Job Files must be set locally on the pump. Important job parameters can be read over Modbus from the read-only input registers.
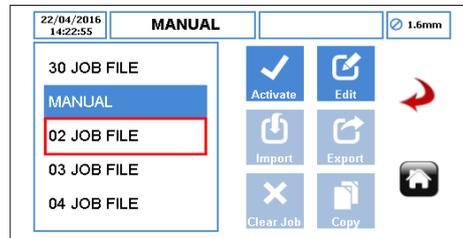

Figure 10   Job File Menu

▶ To activate the Highlighted Job File and any changes made, touch the icon ✔ . If the pump is running, the activate icon will be 'greyed out'. Once a Job File has been activated, the user will be prompted as per *Figure 11*.
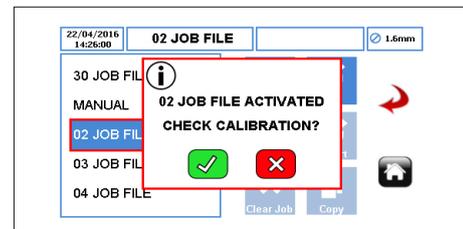

Figure 11   Job File Activated

Note

Calibration of the Vantage 5000 cannot be performed when Modbus® has been enabled. Make sure the pump is in HMI mode for 'Speed' and 'Start/Stop' control when performing a pump calibration.

▶ Return to the Job File Menu and select the remote control menu 🖥 .

Figure 12 Select the Job File Menu

▶ To access the Modbus® function, select Fieldbus from the dropped-down list. For more information about this screen, please see *(→ 1.4.1 Fieldbus).*
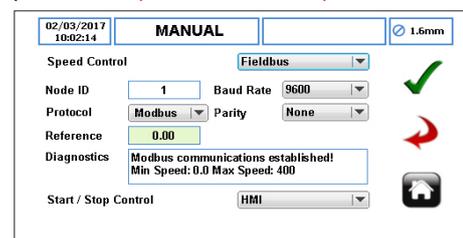

Figure 13 Modbus® Settings

1.4.1 Modbus® Parameter Definition

This section refers to digital communication protocol selections and defining the digital paramenters
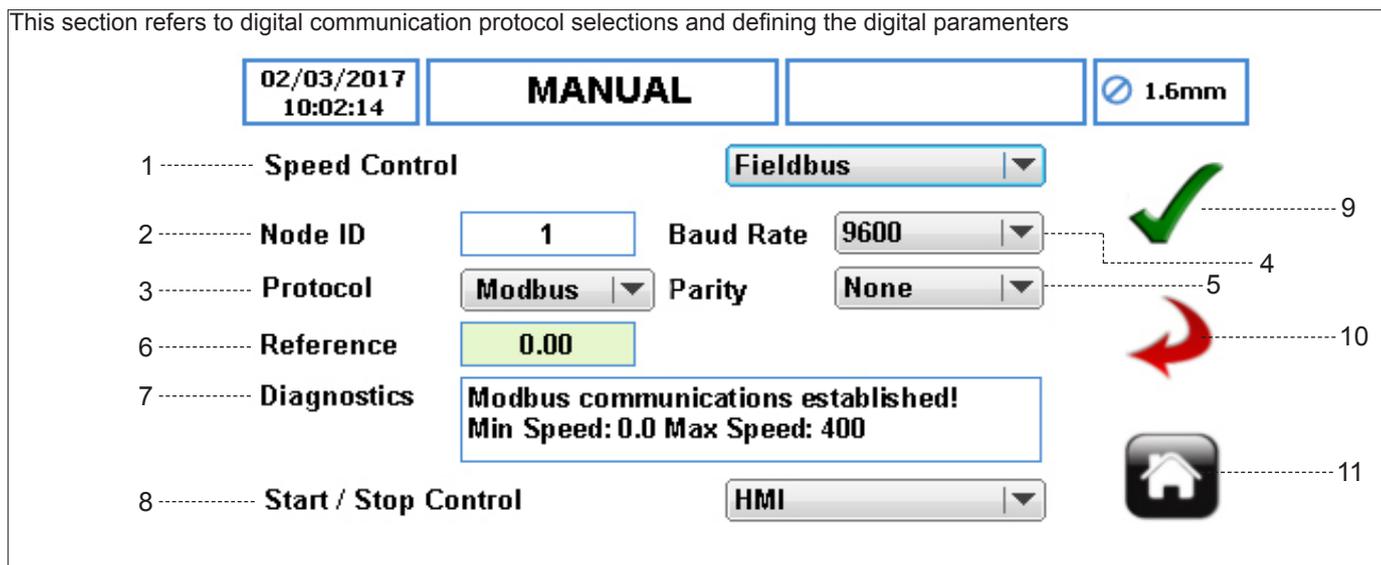

Figure 14 Fieldbus

1. SPEED CONTROL – select Fieldbus for Digital Communication Protocols.

Note

When the FIELDBUS option is selected then the value loaded into the 'Speed Set Point' register overrides all other speed setting sources.

2. NODE ID – although the node id values can be set between 0 and 255. It is recommended to use values between 1 to 247.

3. PROTOCOL – set the speed control mode from a drop-down list:
   a. Modbus®
   b. Profibus
   c. ASCII

4. BAUD RATE – sets the baud rate from a drop-down list. The default is set to 9600.

a.	110	f.	4800	l.	115200
b.	150	h.	9600	m.	230400
c.	300	i.	19200	n.	460800
d.	1200	j.	38400	o.	921600
e.	2400	k.	57600		

Note

Usually baud rate of between 1200 and 115200 are used on Modbus® systems. The most commonly used are 9600 and 19200 Baud. Lower Baud rates are used on larger networks.

5. PARITY – sets the parity from a drop-down list. The default is set to None.
   a. None
   b. Even
   c. Odd

6. REFERENCE – indicates the value of the 'speed set point' register.

7. DIAGNOSTICS – informs the user of the status of the Modbus® communications. If a valid, complete, Modbus® packet has been sent within a 40 second time window then the display will show 'Modbus® detected' in addition to the 'Min' and 'Max' speeds set in the pump, otherwise the display will show 'Modbus® Undetected'.

8. START/STOP CONTROL
   a. FIELDBUS – enables the start/stop functionality via the 'Motor Run' control bit of the 'Control' register. If a valid Modbus® message is not detected in 40 seconds, then the pump will stop running. Loss of Profibus is detected in milliseconds due to the protocol standards.
   b. FIELDBUS+D-SUB – allows the user to incorporate an external emergency STOP button, which will override the Fieldbus control of the 'Motor Run' command.

Note

The STOP button on the front of the pump will override all other control signals.

9. ACCEPT – accepts all changes within the Job File. Changes made on this screen are not saved until this icon is pressed.

10. GO BACK/CANCEL – cancels any changes and return to the Job File Menu. If the user has made changes, there will be a prompt asking the user if the changes should be saved.

11. HOME – returns the user to the Home Screen. If the user has made changes, there will be a prompt asking if the changes should be saved.

1.5 Examples of Modbus® Frames

Each Modbus® RTU frame consist of 8 bytes of data. Each byte of data is two hexadecimal characters, which are contained in the data field of the message. If studying the transmitted electrical signal on the Modbus® line with an oscilloscope the user should understand that the start, parity and stop bit will be added to each data byte.

Example of a Modbus® request to read 2 input registers 255 (Pump Model) to 256 (Job Tube Size) - registers 30256 to 30257 from device ID 2.
On a *Modbus®* scanner you would see: 02 04 00 FF 00 02 41 C8. The CRC will change depending on data transmitted.

Field Name	Header	Slave Address	Function	Starting Address		Quantity of Registers		Error check		Trailer
				Hi Byte	Lo Byte	Hi Byte	Lo Byte	Lo Byte	Hi Byte	
HEX	None	02	04	00	FF	00	02	41	C8	None

Table 1   Modbus® Request to Read 2 Inpuit Registers (Example)

The response to that request will be: 02 04 04 13 88 00 01 8D EA

Field Name	Header	Slave Address	Function	Byte Count	Data Hi	Data Lo	Data Hi	Data Lo	Error check		Trailer
									Lo Byte	Hi Byte	
HEX	None	02	04	04	13	88	00	01	8D	EA	None

Table 2   Modbus® Response for the 2 Input Registers (Example)

Which means – register 255 (Pump Model) value of device ID 2 is 1388 (HEX) = 5000 (DEC) and register 256 value of device ID 2 is 1 (HEX) = 1 (DEC) which means that tube size of that device is 1.6x1.6 LP.

Example of Modbus® request to write 2 holding registers, 511 (Control Word) to 512 (Speed Set Point) – registers 40512 to 40513 to device ID 2. In this case pump speed will be changed to 400 RPM and it will be started.

On a Modbus® scanner you would see: 02 10 01 FF 00 02 04 00 01 0F A0 EA 37

Field Name	Header	Slave Address	Function	Starting Address		Quantity of Registers		Byte Count	Data Hi	Data Lo	Data Hi	Data Lo	Error check		Trailer
				Hi Byte	Lo Byte	Hi Byte	Lo Byte						Lo Byte	Hi Byte	
HEX	None	02	10	01	FF	00	02	04	00	01	0F	A0	EA	37	None

Table 3   Modbus® Request to Write 2 Holding Registers (Example)

The response will be: 02 10 01 FF 00 02 70 37

Field Name	Header	Slave Address	Function	Starting Address		Quantity of Registers		Error check		Trailer
				Hi Byte	Lo Byte	Hi Byte	Lo Byte	Lo Byte	Hi Byte	
HEX	None	02	10	01	FF	00	02	70	37	None

Table 4   Modbus® Response for the 2 Holding Registers (Example)

Which means that the two register values were written to the device.

Note:
The Register Address of the Input Registers, e.g. 0x00FF (255) Pump Model is represented by the Modbus® Register Address 30256.The Register Address of the Holding Registers, e.g. 0x01FF (511) Control Word is represented by the Modbus® Register Address 40512. Whether your PLC accepts the Register Address shown in the tables in this document or the Modbus® Register Address is PLC dependent. To test the address used is correct, the installer can first access the "Pump Model" register. For more details, see the frame examples.

1.6 Understanding Modbus® Message

1.6.1 Understanding a Received Message

ℹ️ Modbus® can only send word length (16 bit wide) messages. In some cases, data is split into two words, such as Flow Rate which uses register 269 and 270. To understand the value, you have to first merge the two words into one double word and then convert it from Hexadecimal to Decimal value.

Example for 32-bit integer values:
Reg 269 = 0xAB98, reg 270 = 0x0002
After merging = 0x0002AB98
After conversion = 175000, which means that the flow rate is 175 units

ℹ️ In some cases, it is not only split into two words, but you must also convert the value using IEE-754, if it is 32-bit floating point.

Example for 32-bit floating-point values:
Displacement per revolution
Reg 267 = 0x3333
Reg 268 = 0x3F33
After merging = 0x3F333333
After conversion (IEEE-754) = 0.7 units/revolution

ℹ️ For the registers Input States, Output States, Status Word, Control Word Applied, if we want to understand the state of each bit the following method is used.

Example conversion to binary:
Reg 259 Status word = 0x0105
After conversion to binary = 0000 0001 0000 0101 binary

Bit Number	Function	Value
0	Motor Running	1
1	Global Error Flag	0
2	FieldBus Enable	1
3	Door Open Error	0
4	Calibration Out of Range	0
5	Fieldbus Stopped	0
6	Over Temperature Error	0
7	Motor Stalled	0
8	Modbus® Initialised	1
9	Tube Burst	0
10	Low Set Point Out of Range	0
11	High Set Point Out of Range	0
12	Fluid Level Alert	0
13	Profibus Chip Detected	0
14	Profibus Chip Error	0
15	Direction	0

Table 5   Conversion to Binary (Example)

1.6.2 Understanding Writes to Holding Registers

ℹ️ To set a calibration factor:

1. The pump has to be stopped
2. Set bit 4 of Control Word (register 511) or 711 Coil to 0
3. Update registers 513 and 514. It will be updated in Applied Calibration Factor after point 4.
4. Change bit 4 of Control Word (register 511) to 1 or set 771 Coil to 1.

ℹ️ To set a Minimum/Maximum speed:

1. The pump has to be stopped
2. Set bit 3 of Control Word (register 511) or 710 Coil to 0
3. Update registers 515 and 516. It will be updated instantly.
4. Change bit 3 of Control Word (register 511) to 1 or set 770 Coil to 1. Keep it set to 1 to apply minimum and maximum speed.

ℹ️ To set Failsafe Setup Word/Speed make sure the pump is stopped.

1.7 Failsafe Operation

A valid Modbus® frame must be sent at least once every 30 seconds for the pump to maintain a defined operational state. If no valid Modbus® frame is detected for 30 seconds, then after a further 10 seconds the pump will revert to a set of default conditions defined by the settings in the 'Failsafe Setup Word' and the 'Failsafe Speed'.
If failsafe is triggered, a stop then start signal will be required to re-start the pump.

These registers can be read from:
- Read Only, Current Status, 'Input Register', (→ 1.8.1 Input Registers)
- Read/Write, Pending Status, 'Holding Register', (→ 1.8.2 Holding Registers)

1.7.1 Failsafe Setup Word

Type: Holding Register
Address: 0x205 (decimal 517)

Modbus® Function Code: 0x06 (decimal 6), Write single
Modbus® Function Code: 0x10 (decimal 16), Write multiple

Bit Number	Function	State Description	
0	Failsafe Pump Speed	Bit State	Action
		0	Pump off
		1	Pump continues at the last demanded speed
1	Failsafe Speed Source	Bit State	Action
		0	Use settings defined in bit number 0 above
		1	Pump continues at the speed defined in 'Failsafe Speed' as shown in the 'Holding Registers' and 'Input Registers'
2-15	Not Used		

Table 6   Failsafe Operation

1.8 Modbus® Data/Address Field Information

The Modbus® communication protocol allows for the reading or writing of single or multiple registers and the reading or writing of single bit registers known as 'Coil' registers, depending on the code specified in the code field of a Modbus® message.

1.8.1 Input Registers *(continued)*

Input registers reflect the actual active state of the pump.

Type: Input Registers
Modbus® Function Code: 0x04 (decimal 4), Read

Note

The register address is read-only data. Each address holds data that is word length (16 bits wide).

Register Address Hex (decimal)	Field Description	Example Value	Explanation of Field
0x00FF (255)	Pump Model	5000	The 16-bit integer value of the model number of the pump.
0x0100 (256)	Job Tube Size	4	The 16-bit integer value is derived from the following table: <table><tr><td>Tube Size</td><td>Value</td></tr><tr><td>1.6 x 1.6 LP</td><td>1</td></tr><tr><td>3.2 x 1.6 LP</td><td>2</td></tr><tr><td>4.0 x 1.6 LP</td><td>3</td></tr><tr><td>4.8 x 1.6 LP</td><td>4</td></tr><tr><td>6.4 x 1.6 LP</td><td>5</td></tr><tr><td>8.0 x 1.6 LP</td><td>6</td></tr><tr><td>3.2 x 2.4 LP</td><td>7</td></tr><tr><td>4.8 x 2.4 LP</td><td>8</td></tr><tr><td>6.4 x 2.4 LP</td><td>9</td></tr><tr><td>8.0 x 2.4 LP</td><td>10</td></tr><tr><td>9.6 x 2.4 LP</td><td>11</td></tr><tr><td>3.2 x 2.4 MP</td><td>12</td></tr><tr><td>3.2 x 3.2 HP</td><td>13</td></tr></table>
0x0101 (257)	Software Version Number (Low Word)	194	The 32-bit integer value representing the Version number 1.7.4.
0x0102 (258)	Software Version Number (High Word)	0	
0x0103 (259)	Status Word		See (→ 1.8.4 System Status Word Register)
0x0104 (260)	Pump Speed	105	The 16-bit integer value that represents the value of the 'Applied Speed' when the pump is running. When the pump is not running this value returns to zero. The example represents the speed in tenths of RPM therefore 10.5 RPM.
0x0105 (261)	Pump Run Time (Low Word)	0x7E86	The 32-bit integer representing the total pump running time in seconds. For example, 0x00017E86 (97926 in decimal) equates to 1 day, 3 hours, 12 minutes and 6 seconds.
0x0106 (262)	Pump Run Time (High Word)	0x0001	

Table 7   Input Registers

1.8.1 Input Registers *(continued)*

Register Address Hex (decimal)	Field Description	Example Value	Explanation of Field
0x0107 (263)	Job Run Time (Low Word)	0x5638	The 32-bit integer representing the total job running time in seconds. For example 0x00025638 (153144 in decimal) equates to 1 day, 18 hours, 32 minutes and 24 seconds.
0x0108 (264)	Job Run Time (High Word)	0x0002	
0x0109 (265)	Tacho Counter (Low Word)	0x3278	The 32-bit integer representing the number of rotations of the rotor to the nearest whole number. For example, 0x00013278 equates to 78456 rotations.
0x010A (266)	Tacho Counter (High Word)	0x0001	
0x010B (267)	Displacements per Revolution (Low Word)	0xE6D7	The 32-bit floating point number based on the flow rate and the pump speed. For example, 0x416D-E6D7 equates to 14.868857 units/rev.
0x010C (268)	Displacement per Revolution (High Word)	0x416D	
0x010D (269)	Flow Rate (Low Word)	0x61DB	The 32-bit integer representing the flow rate x 1000. For example, 0x000261DB (156123 in decimal)equates to 156.123 units as selected (e.g. ml/min).
0x010E (270)	Flow Rate (High Word)	0x0002	
0x010F (271)	Job Mode	0	The 16-bit integer value derived from the following table:
0x0110 (272)	Flow Rate Units	2	The 16-bit integer value derived:
0x0111 (273)	Calibration Date (Low Word)	0x0B39	The 32-bit integer value representing Unix time format i.e. the total number of seconds from Thursday, 1 January 1970. For example, 0x581B0B39 (14781673553) equates to Thu, 03 Nov 2016 10:02:33 GMT.
0x0112 (274)	Calibration Date (High Word)	0x581B	
0x0113(275)	Applied Calibration Factor (Low Word)	0xDD2F	The 32-bit floating point number representing the active calibration factor. For example, 0x4064DD2F equates to 3.576.
0x0114(276)	Applied Calibration Factor (High Word)	0x4064	

Within the Job Mode row (0x010F):

Job mode	Value
Flow	0
Dose	1
Batch	2

Within the Flow Rate Units row (0x0110):

Unit of Measure (UoM)	Value
ml/sec	1
ml/min	2
Grams/sec	3
Grams/min	4
l/hour	5
Pounds/hour	6
USG/hour	7

Table 7   Input Registers (continued)

1.8.1 Input Registers *(continued)*

Register Address Hex (decimal)	Field Description	Example Value	Explanation of Field
0x0115 (277)	Job Counter	45	The 16-bit integer representing the number of doses that a pump has delivered. This number is reset to zero when the 'Reset Job Counter' bit is set in the control word.
0x0116 (278)	Input States		See (→ 1.8.5 Input/Output Status Word Register)
0x0117 (279)	Output States		See (→ 1.8.5 Input/Output Status Word Register)
0x0118 (280) [1]	Control Word Applied		See (→ 1.8.3 Control Word Register)
0x0119 (281) [1]	Speed Applied	405	The 16-bit integer value representing the speed to be applied in tenths of RPM. The example represents 40.5 RPM.
0x011A (282) [1]	Minimum Speed Applied	54	The 16-bit integer value representing the minimum speed setting in tenths of RPM. The example represents 5.4 RPM.
0x011B (283) [1]	Maximum Speed Applied	2567	The 16-bit integer value representing the maximum speed setting in tenths of RPM. The example represents 256.7 RPM.
0x011C (284) [1]	Failsafe Setup Word Applied	2	The example value indicates that if Modbus[®] fails then use the failsafe speed. (→ 1.7 Failsafe Operation)
0x011D (285) [1]	Failsafe Speed Applied	135	The example value indicates the speed in tenths of RPM i.e. 13.5 RPM. (→ 1.7 Failsafe Operation)
0x011E (286)	General Purpose Output 1	2	The 16 bit integer value derived: Output Type / Value table below

For register 0x011E (286), General Purpose Output 1:

Output Type	Value
Disabled	0
Tube Burst	1
General Alarm	2
Direction	3
Start/Stop Status	4
Auto/Manual Status	5
Analogue Status	6

The example value indicates that the General Purpose Output 1 is allocated to the General Alarm.

Table 7   Input Registers (continued)

[1] *These registers refer to the actual active settings and values of the pump, whereas their reflected registers, as seen in (→ 1.8.2 Holding Registers), are associated with pending values which will be updated when the pump is stopped. This differentiation is important for system programmers to understand since certain registers should not be dynamically updated whilst the pump is running.*

1.8.1 Input Registers

Register Address Hex (decimal)	Field Description	Example Value	Explanation of Field
0x011F (287)	General Purpose Output 2	5	The 16-bit integer value derived: | Output Type	Value
---	---
Disabled	0
Tube Burst	1
General Alarm	2
Direction	3
Start/Stop Status	4
Auto/Manual Status	5
Analogue Status	6	 The example value indicates that the General Purpose Output 2 is allocated to the Auto/Manual Status.
0x0120 (288)	General Purpose Output 3	0	The 16 bit integer value derived: | Output Type	Value
---	---
Disabled	0
Tube Burst	1
General Alarm	2
Direction	3
Start/Stop Status	4
Auto/Manual Status	5
Analogue Status	6	 The example value indicates that the General Purpose Output 3 is disabled.
0x0121 (289)	General Purpose Output 4	1	The 16-bit integer value derived: | Output Type	Value
---	---
Disabled	0
Tube Burst	1
General Alarm	2
Direction	3
Start/Stop Status	4
Auto/Manual Status	5
Analogue Status	6	 The example value indicates that the General Purpose Output 4 is allocated to the Tube Burst.

Table 7   Input Registers

1.8.2 Holding Registers *(continued)*

Data loaded into the holding registers does not immediately become active if the pump is performing some active function. The data read from these registers will reflect what has been written, not what the actual active registers are holding as read from the input registers (→ 1.8.1 Input Registers).

Type: Holding Registers
Modbus® Function Code: 0x03 (decimal 3), Read
Modbus® Function Code: 0x06 (decimal 6), Write single
Modbus® Function Code: 0x10 (decimal 16), Write multiple

Note

Each address holds data that is word length (16 bits wide).

Note

The Vantage 5000 pump operating under Modbus® is dependent on the incoming data message transmitted from the remote source.
The Vantage 5000 includes Modbus® data integrity checks which should identify such incoming data faults however, it is still possible that invalid data could result in incorrect operation or even require a pump reset. Accordingly, system developers are recommended to include checks to ensure the validity of the data format, the value and the range in their supervisory and communication software.

Register Address Hex (decimal)	Field Description	Example Value	Explanation of Field
0x01FF (511) [1]	Control Word	3	The example represents a requirement for the pump to run and in an anticlockwise direction. (→ 1.8.3 Control Word Register).
0x0200 (512)	Speed Set Point	237	The 16-bit integer value representing the required speed in tenths of RPM. The example shows a set point of 23.7 RPM.
0x0201 (513) [2]	Calibration Factor (Low Word)	0x337D	The 32-bit floating point value which represents the calibration factor. The example shows a calibration factor of 0x3EB3337D equates to 0.3500022.
0x0202 (514) [2]	Calibration Factor (High Word)	0x3EB3	
0x0203 (515) [3]	Minimum Speed	115	The 16-bit integer representing the minimum speed in tenths of RPM therefore the minimum speed is set to 11.5 RPM. This will only be actioned if the Fieldbus min/max speed is enabled (→ 1.8.3 Control Word Register).
0x0204 (516) [3]	Maximum Speed	2475	The 16-bit integer representing the maximum speed in tenths of RPM therefore the maximum speed is set to 247.5 RPM. This will only be actioned if the Fieldbus min/max speed is enabled (→ 1.8.3 Control Word Register).
0x0205 (517) [4]	Failsafe Setup Word	2	The example defines that if Modbus® fails then use the failsafe speed. (→ 1.7 Failsafe Operation)
0x0206 (518) [4]	Failsafe Speed	135	The example shows the failsafe speed in tenths of RPM i.e.13.5 RPM. (→ 1.7 Failsafe Operation)

Table 8   Holding Registers (continued)

[1] *The Control Word is a volatile register. It does not hold its value when the pump is powered down.*
[2] *The Calibration Factor will not be updated until the 'Fieldbus Calibration Factor Load' flag in the 'Control Word' is set to 1 and the pump is stopped, at which point this value will be set in the 'Applied Calibration Factor' register.*
[3] *Minimum and Maximum speed registers must be updated whilst the pump is stopped. These values will then be readable in Minimum Speed Applied and Maximum Speed Applied registers. The 'Fieldbus Min/Max Enable' flag must be enabled via the 'Control Word' register.*
[4] *The Failsafe Setup Word and Failsafe Speed will not be updated whilst the pump is running. These values will be readable in 'Failsafe Setup Word Applied' and 'Failsafe Speed Applied'.*

1.8.2   Holding Registers *(continued)*

Register Address Hex (decimal)	Field Description	Example Value	Explanation of Field
0x0207 (519)	General Purpose Output 1	2	The 16-bit integer value derived: | Output Type	Value
---	---
Disabled	0
Tube Burst	1
General Alarm	2
Direction	3
Start/Stop Status	4
Auto/Manual Status	5
Analogue Status	6	 The example value indicates that the General Purpose Output 1 is allocated to the General Alarm.
0x0208 (520)	General Purpose Output 2	5	The 16-bit integer value derived: | Output Type	Value
---	---
Disabled	0
Tube Burst	1
General Alarm	2
Direction	3
Start/Stop Status	4
Auto/Manual Status	5
Analogue Status	6	 The example value indicates that the General Purpose Output 2 is allocated to the Auto/Manual Status.
0x0209 (521)	General Purpose Output 3	0	The 16-bit integer value derived: | Output Type	Value
---	---
Disabled	0
Tube Burst	1
General Alarm	2
Direction	3
Start/Stop Status	4
Auto/Manual Status	5
Analogue Status	6	 The example value indicates that the General Purpose Output 3 is disabled.

Table 8   Holding Registers (continued)

1.8.2 Holding Registers

Register Address Hex (decimal)	Field Description	Example Value	Explanation of Field
0x020A (522)	General Purpose Output 4	1	The 16-bit integer value derived: <table><tr><td>Output Type</td><td>Value</td></tr><tr><td>Disabled</td><td>0</td></tr><tr><td>Tube Burst</td><td>1</td></tr><tr><td>General Alarm</td><td>2</td></tr><tr><td>Direction</td><td>3</td></tr><tr><td>Start/Stop Status</td><td>4</td></tr><tr><td>Auto/Manual Status</td><td>5</td></tr><tr><td>Analogue Status</td><td>6</td></tr></table> The example value indicates that the General Purpose Output 4 is allocated to the Tube Burst.

Table 8   Holding Registers

1.8.3   Control Word Register

The following bit functions will not take place if the pump is running at the time the command is sent, although the pump will remember that a flag has been triggered and the pump will update the relevant registers or actions as soon as the pump has stopped. This register is volatile i.e. it loses its value when the power is removed and will default to the value 0 on power up.

Type: Coil Registers (Volatile)
Modbus® Function Code: 0x01(decimal 1), Read
Modbus® Function Code: 0x05 (decimal 5), Write single
Modbus® Function Code: 0x0F (decimal 15), Write multiple

Note

This is a series of bit wide registers.

Register Address Hex (decimal)	Function	Status Function
0x02FF(767)	Motor Run	0 = Motor not Running 1 = Motor Running
0x0300(768)	Direction	0 = Clockwise 1 = Anticlockwise
0x0301(769)	Tacho Reset	0 = Tacho Counter Unaffected 1 = Reset Tacho Counter
0x0302(770)	Fieldbus Min/Max Enable	0 = Min/Max Disabled 1 = Min/Max Enabled
0x0303(771)	Fieldbus Calibration Factor Load	0 = Do not Load Calibration 1 = Load Calibration Factor

Table 9   Control Word Definition

1.8.4 System Status Word Register

This is a read-only register and reflects the operational status of the Vantage 5000.

Type: Input Register
Address: 0x0103 (decimal 259)

Modbus® Function Code: 0x04 (decimal 4), Read
Word length (16 bits wide)

Bit Number	Function	Status Function
0	Motor Running	0 = Motor Not Running 1 = Motor Running
1	Global Error Flag	0 = No Global Errors 1 = Global Error Detected
2	Fieldbus Enable	0 = Fieldbus Disabled 1 = Fieldbus Enabled
3	Door Open Error	0 = Door Closed 1 = Door Opened
4	Calibration Out of Range	0 = IN range 1 = OUT of Range
5	Fieldbus Stopped	0 = The host has to issue a motor stop command in order to restart the pump. 1 = Default. The host can issue a motor run command.
6	Over Temperature Error	0 = Temperature Normal 1 = Over Temperature Detected
7	Motor Stalled	0 = Motor Running Normally 1 = Motor Stalled
8	Modbus® Initialised	0 = Not Initialised 1 = Initialised
9	Tube Burst	0 = Tube Burst Not Detected 1 = Tube Burst Detected
10	Low Set Point Out of Range	0 = Minimum Speed In Range relative to the minimum speed set point 1 = Minimum Speed Out of Range relative to the minimum speed set point
11	High Set Point Out of Range	0 = Maximum Speed In Range relative to the maximum speed set point 1 = Maximum Speed Out of Range relative to the maximum speed set point
12	Fluid Level Alert	0 = 'Product Destination Full' and 'Product Source Empty' not active 1 = 'Product Destination Full' and/or 'Product Source Empty' active
13	Profibus Chip Detected	0 = Profibus Not Detected 1 = Profibus Detected
14	Profibus Chip Error	0 = No Profibus Chip Error 1 = Profibus Chip Error
15	Direction	0 = Clockwise 1 = Anticlockwise

Table 10   System Status Word Definition

1.8.5   Input/Output Status Word Register

The input and output status words address 0x0114 (decimal 276) and 0x0115 (decimal 277) respectively are read-only and represent the state of some of the input/output pins of the 25 WAY Remote I/O Connector as shown in the figure below.
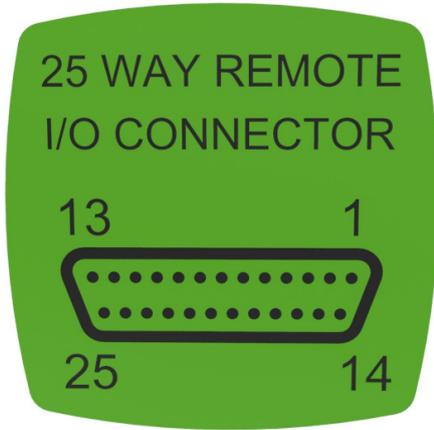
PIN	Input/Output	Description	PIN	Input/Output	Description
1	Input [1	Manual/Auto	14	Input [1	Start
2	Input [1	Stop	15	Input [1	Product Source Empty
3	Input [1	Product Destination Full	16	Input [1	Direction
4	Input	Slave Steps Input	17	Input [1	Bund Detection
5	Output [1	General Purpose Output 1	18	Output	Master Steps
6	Output [1	General Purpose Output 2	19		NC (Not Connected)
7	Output [1	General Purpose Output 3	20	Output	0-10V
8	Output [1	General Purpose Output 4	21	Output	4-20mA
9	Input	4-20mA	22	Input	0-10V
10	Input	Remote I/O +24V	23	Output	+24V Pump Supply
11	Output	+10V Analogue Supply	24		NC (Not Connected)
12	Output	0V Analogue Supply	25	Output	0V Pump Supply
13	Input	Remote I/O 0V			

Figure 15   25 WAY Remote I/O Connector - Diagram & Description of PINs

[1   *I/O with status designation*

For an input to be activated it must be connected to the local or remote 0V depending on how the I/O has been powered. If an input pin is connected to 0V then the pin is considered to be active and will therefore show as a logic 1 in its corresponding status bit. An output that is not active is defined by a logic 0 in the status word, and a logic 1 when it has been activated.

1.8.5.1   Input Status Word Register

Type: Input Register
Address: 0x0116 (decimal 278)

Modbus® Function Code: 0x04 (decimal 4), Read
Word length 16 bits wide

Bit Number	Function	Status function
0	Manual/Auto	0 = Manual Operation 1 = Remote Control Operation
1	Stop	0 = Stop Input Not Active 1 = Stop Input Active
2	Start	0 = Start Input Not Active 1 = Start Input Active
3	Product Destination Full	0 = Product Destination Not Full 1 = Product Destination Full
4	Product Source Empty	0 = Product Source Not Empty 1 = Product Source Empty
5	Bund Detection Input	0 = No Bund Detection 1 = Bund Detected
6	Direction Input	0 = Clockwise Direction 1 = Counter Clockwise Direction
7 to 15	Not Used	Default Value = 0

Table 11   Input Status Word Register

1.8.5.2 Output Status Word Register

Type: Input Register
Address: 0x0117 (decimal 279)

Modbus® Function Code: 0x04 (decimal 4), Read
Word length 16 bits wide

Bit Number	Function	Status function
0	Output 1 Designation [2]	0 = Designation Not Active 1 = Designation Active
1	Output 2 Designation [2]	0 = Designation Not Active 1 = Designation Active
2	Output 3 Designation [2]	0 = Designation Not Active 1 = Designation Active
3	Output 4 Designation [2]	0 = Designation Not Active 1 = Designation Active
4 to 15	Not Used	Default Value = 0

Table 12   Output Status Word Register

[2]   *Refer to the user manual (→   Appendix E, Section 2.2 Vantage 5000 selectable output control functionality and setup).*

1.9 Cable Recommendation

1. 3 Core, 24 AWG, screened twisted pair with additional core for 0V Common Line. The pair is used for contacts A (Pin 4) and B (Pin 2) and the third core used for 0V Common Line.

2. 4 Core, 24 AWG, twin screened twisted pair. One pair used for contacts A (Pin 4) and B (Pin 2) and the other used for 0V Common Line (pin 3). Do not connect the 4th wire to the pump 5V line. Connecting multiple pumps 5V line together may cause damage to the pumps. Do not leave any wires floating.
    Wiring installations should follow the document "Modbus over Serial Line Specification and Implementation Guide" available on the Modbus.org website.