

Modbus and BACnet User Manual



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1. INTRODUCTION

The following documentation provides information on how to setup, configure, and operate the Modbus and BACnet communications interfaces with DXL and LHX variable frequency drives.

The Modbus protocol states each device must have the following data categories: Coils, Discrete Inputs, Holding Registers, and Input Registers. These categories hold all accessible Read/Write and Read Only parameters and measurements available through the Modbus interface.

The Phase BACnet protocol mimics the Modbus protocol data categories very closely, except for adding a Device Object at the end of the Device object's object list.

2. DEFINITIONS

2.1 Modbus Definitions

Master: Device that transmits and requests information to and from Slave devices

Slave: Device that receives requests from and responds to a Modbus Master device

Coil: Single bit (on/off) Read/Write value

Discrete Input: Single bit (on/off) Read Only value

Holding Register: Read/Write 16-bit register

Input Register: Read Only 16-bit register

Fault Timestamp Register: Read only 16-bit Register containing a portion of information about the last five faults. The faults are sorted from the most recent to least recent. e.g., Fault 1 registers contain information about the most recent fault.

2.2 BACnet Definitions

COV: Change of Value

Service: Action indicated by a BACnet message

Object: An addressable component of a BACnet device containing a list of properties and implementing certain services

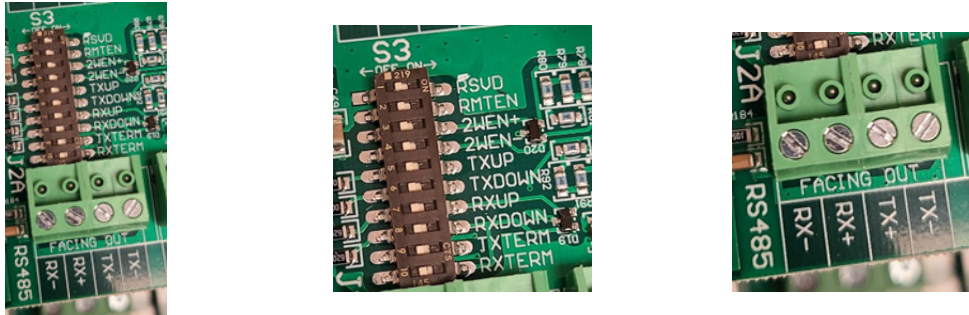
Property: A subcomponent of an object

3. NETWORKING SETUP

3.1 Modbus RTU and BACnet MS/TP Setup

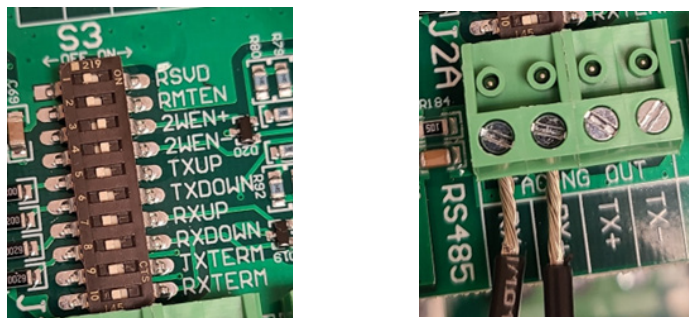
The first picture below shows the serial communication terminal block in the bottom half and the DIP switches mentioned throughout this section in the upper half. No wires are connected to the terminal block and all of the DIP switches are deactivated. The RSVD and RMTEN DIP switches do not affect this setup process.

3.1.1 Wiring Setup



3.1.1.1 Two-Wire

To wire the control board using two-wire communication, turn on the 2WEN+ and 2WEN- DIP switches. The RX+ and TX+ lines become the D1(+) line and the RX- and TX- lines become the D0(-) line. The RX+ and TX+ lines are shorted together in this arrangement, as are the RX- and TX- lines. This must be accounted for when using line termination resistors or biasing the network. The following pictures demonstrate a basic two-wire setup.



If communicating directly to the drive using an RS-485 four-wire adapter, the positive lines RX+ and TX+ should be shorted, and the negative lines RX- and TX- should be shorted together.

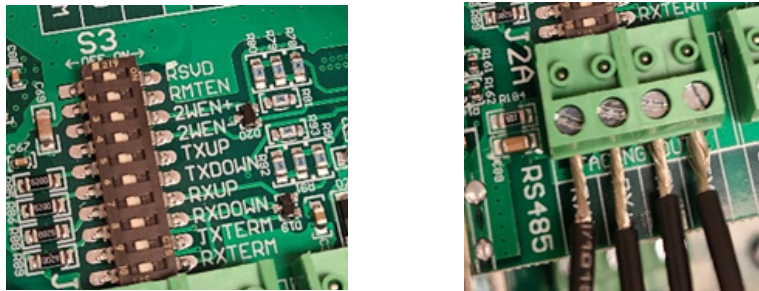
If the PhaseTech Modbus UI is used, the adapter is configurable, and has an Echo Mode feature, the Echo Mode must be turned ON to mimic the echo of a four-wire adapter wired in the two-wire configuration.

3.1.1.2 Four-Wire (Modbus RTU Only)

To wire the control board to a four-wire Modbus RTU network, connect the following:

- ▶ •Master's T+ to Slave's R+
- ▶ •Master's T- to Slave's R-
- ▶ •Master's R+ to Slave's T+
- ▶ •Master's R- to Slave's T-
- ▶ •Common grounds must be connected as well
- ▶ •Adapters with the Echo Mode feature must be turned OFF.

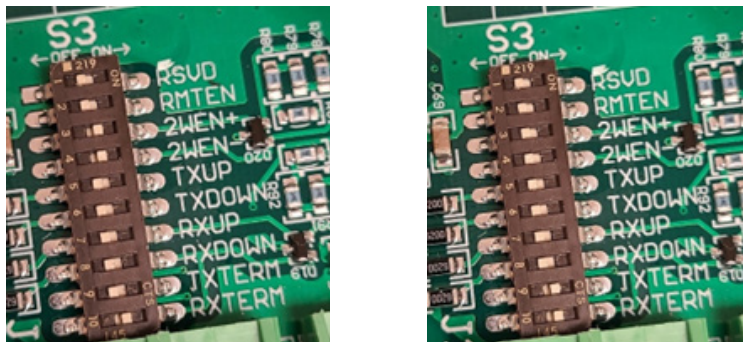
The following pictures demonstrate a basic four-wire setup. No DIP switches need to be enabled for this setup.



3.1.2 Line Termination

A Modbus RTU or BACnet MS/TP network must have one ~120Ohm 1/4W resistor at each end of a balanced line pair. In two-wire communication, 2 termination resistors are used, and in four-wire communication (Modbus RTU Only), a total of four line termination resistors must be used.

If a DXL/LHX drive is at either end of a Modbus RTU or BACnet MS/TP network, termination resistors are provided for the RX and TX line pairs. Turning on the RXTERM or TXTERM DIP switches will provide 136 Ohms of termination resistance for the RX and TX line pairs, respectively. The following pictures show these DIP switch configurations for two-wire and four-wire setups respectively (note the 2WEN+/- positions). If desired, termination resistors may be separately installed in the terminal block on the control board.

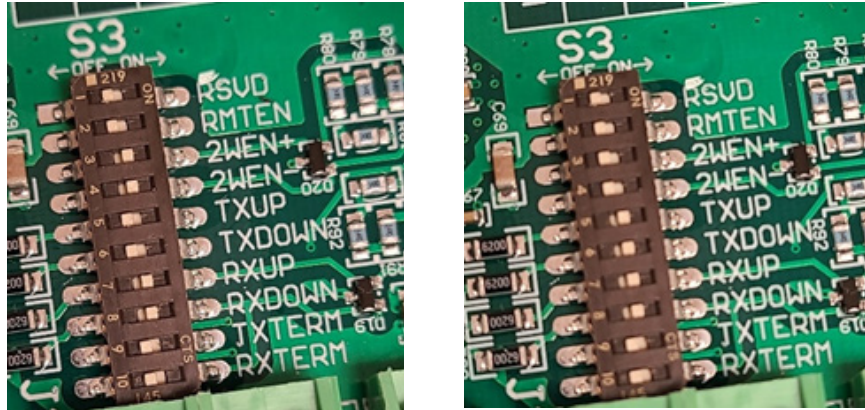


When communicating directly to a DXL/LHX drive using an adapter, it may be useful to provide termination resistors at both ends of the line. Depending on how long the cable is, the baud rate, and the type of shielding used, adding termination resistors may improve the quality of communication between the drive and other devices on the network.

3.1.3 Line Polarization (Biasing)

Providing a bias for DXL/LHX drives is not necessary for operation but can still function if connected to a biased network. Biasing can also be useful if communicating directly with the drive using an adapter.

DXL/LHX drives supply line biasing capability. Turning on the RXUP or TXUP DIP switches will provide a +5V bias on the RX+ and TX+ lines, respectively. Turning on the RXDOWN and TXDOWN DIP switches will provide a ground bias on the RX- and TX- lines, respectively. All built-in biasing resistors are 620 Ohms. The following pictures show these DIP switch configurations for two-wire and four-wire setups respectively (note the 2WEN+/- positions).



Note 1: +5V and ground biasing can also be supplied by the network, and it is recommended that the biasing resistors be close to the Master device in a Modbus RTU network. 450-650 Ohm resistors must be used, and it is required that only one bias resistor be on each data line.

Note 2: To avoid excess loading on a network with bias resistors, the maximum number of devices on a single network without a repeater is reduced from 32 to 28.

3.1.4 Line Shielding and Wiring

The Modbus and BACnet standards require shielded twisted-pair cabling, as this aids in mitigating noise interference. In a network, it is not recommended to tie the shielding of the cable to the DXL/LHX drive's COM port, and it should be grounded separately, near the Master device in a Modbus RTU network.

When communicating directly to a DXL/LHX drive using an adapter, it is recommended to tie the shielding to ground via the control board's COM screw terminal, and not to the adapter itself.

3.2 Modbus IP and BACnet IP Setup

3.2.1 Wiring Setup

To wire the control board for these ethernet-based communication protocols, plug one end of a Cat 5 or Cat 6 cable into the Ethernet port on the control board and the other end into a router or ethernet switch.

3.2.2 Minimal Parameter Setup

For these protocols, the Program My IP, Program Gateway, and Program Subnet parameters must all be set up before use. The Program My MAC Parameter is given a unique default value but can also be changed if necessary.

The specific details of this setup will vary depending on network layout and configuration details.

4. MODBUS AND BACNET CONFIGURATIONS

4.1 Modbus RTU Configurations

Modbus ID – Modbus network device address from 1 to 247. The Modbus ID of the DXL/LHX drive must be the only device on that network with that value, otherwise multiple devices will read and respond to the same message.

Modbus Stop Bits – The number of stop bits following a byte, 1 or 2 are supported.

Modbus Parity – Parity Bit enable/configuration. Even, Odd, and None parities are supported.

Modbus Data Rate – Baud Rate of the network. 2400, 4800, 9600, 19200, 38400, and 57600 rates are supported.

Modbus Wiring – Select between two and four-wire communication.

Modbus Fault Select – Select what happens when communication is lost. The drive will either stop outputting and display a warning or generate a fault. The user may also disable this feature.

Modbus Fault Time – The time it takes for the communication loss event to trigger.

When using the PhaseTech Modbus UI program, it is important to match the configurations between the DXL/LHX drive and the UI's configurations under the Options menu.

4.2 Modbus IP Configurations

Modbus ID – Modbus network device address from 1 to 247. Unlike Modbus RTU, this parameter is mostly ignored since the DXL/LHX drive's IP address effectively replaces this functionality.

Modbus Fault Select – Select what happens when communication is lost. The drive will either stop outputting and display a warning or generate a fault. The user may also disable this feature.

Modbus Fault Time – The time it takes for the communication loss event to trigger.

Program My IP – IP address of the DXL/LHX drive. Must be a uniquely assigned static IP on the network.

Program My MAC – MAC address of the DXL/LHX drive. A unique MAC address is provided for every DXL/LHX drive by default, but this address can be changed if necessary.

Program Gateway – Gateway address for the network that the DXL/LHX drive connected to.

Program Subnet – Subnet mask for the network that the DXL/LHX drive is connected to.

4.3 BACnet MS/TP Configurations

BACnet ID – BACnet network device address from 1 to 127. The BACnet ID of the DXL/LHX drive must be the only device on that network with that value, otherwise multiple devices will read and respond to the same message.

BACnet Device Object ID – BACnet Device Object Identifier from 20000 to 20500. The BACnet Device Object ID must be the only device on that network with that value. This ID is used alongside the BACnet ID for a few messages, e.g. Who-Is and I-Am messages.

BACnet Stop Bits – The number of stop bits following a byte, 1 or 2 are supported.

BACnet Parity – Parity Bit enable/configuration. Even, Odd, and None parities are supported.

BACnet Data Rate – Baud Rate of the network. 2400, 4800, 9600, 19200, 38400, and 57600 rates are supported.

BACnet Wiring – Select between two and four-wire communication.

BACnet Fault Select – Select what happens when communication is lost. The drive will either stop outputting and display a warning or generate a fault. The user may also disable this feature.

BACnet Fault Time – The time it takes for the communication loss event to trigger.

4.4 BACnet IP Configurations

BACnet ID – BACnet network device address from 1 to 127. Unlike BACnet MS/TP, this parameter is mostly ignored since the DXL/LHX drive's IP address effectively replaces this functionality.

BACnet Device Object ID – BACnet Device Object Identifier from 20000 to 20500. The BACnet Device Object ID must be the only device on that network with that value. This ID is used for a few messages, e.g. Who-Is and I-Am messages.

BACnet Fault Select – Select what happens when communication is lost. The drive will either stop outputting and display a warning or generate a fault. The user may also disable this feature.

BACnet Fault Time – The time it takes for the communication loss event to trigger.

Program My IP – IP address of the DXL/LHX drive. Must be a uniquely assigned static IP on the network.

Program My MAC – MAC address of the DXL/LHX drive. A unique MAC address is provided for every DXL/LHX drive by default, but this address can be changed if necessary.

Program Gateway – Gateway address for the network that the DXL/LHX drive connected to.

Program Subnet – Subnet mask for the network that the DXL/LHX drive is connected to.

BACnet IP UDP Port – Port that the DXL/LHX drive will use to communicate via BACnet IP.

5. PHASETECH UI OPERATION

5.1 Start Up

To begin, run the application PhaseTechUI.exe. When ran for the first time, the user will be prompted to select a DXL/LHX drive control.

Once the main page is loaded, use the Modbus Slave Address Select box to type in the Modbus ID of the DXL/LHX drive. Click Set to configure the PhaseTech UI to communicate with the selected device.

Next, use the drop-down menu in the top right labeled "Port Select" to select the COM Port that is being used by the RS-485 adapter. If the COM Port is not found, make sure the adapter is plugged in and connected to the DXL/LHX drive, and ensure that drivers are installed correctly. Either click the Reset button or restart the PhaseTech UI program to reload the COM Port list.

After selecting the correct COM Port, click the Connect button, and automatic communication with the VFD will begin. Parameters will load their current values into the "Current" column.

5.2 Changing Parameters

To write to a Read/Write parameter address, either type in the Register Address in the text box, use the Register Name dropdown menu, or click the row of the parameter to select that parameter. Type in a Value that is in the Min/Max range of that parameter and click the Send button. Allow for a few seconds for the parameter to be updated in the table.

Parameter values must be within the parameter's range, otherwise the drive will ignore the command. The min and max values can be found in the VFD's User Manual.

5.3 Relays

Sending a command to the VFD through Modbus will change the "Program Rly No" parameter to "2 Modbus Control". This will prevent other features from controlling the relay.

6. IMPLEMENTED MODBUS FUNCTION CODES

Message Structure Implementation Details

Every Modbus message must contain a Slave ID, a Function Code, and a two-byte CRC. Two-byte register number and data fields must always be “Big-Endian” where the high byte is transmitted first, followed by the low byte. Every two-byte CRC must be transmitted with the low byte transmitted first, followed by the high byte.

Note 1: Coil registers must not add the Coil register category offset to an address. e.g., to Coil number 1 the address must be 0

Note 2: Discrete Inputs and Extended Diagnostics allow addresses with or without the category offsets. e.g., to access Discrete Input number 10002, the address may be either 1 or 10002.

Note 3: Input and Holding registers require addresses to include the category offsets. e.g., to access Input register number 30005 the address must be 30005.

6.1 Read Coil – Function Code 1

Coil Register Start: 00001

Reads one or more coil values or sends an error message. The maximum number of coils that can be read is 4 per response.

6.2 Read Discrete Inputs – Function Code 2

Discrete Input Start: 10001

Reads one or more discrete input values or sends an error message. The maximum number of discrete inputs that can be read is 8 per response.

6.3 Read Holding Registers – Function Code 3

Holding Register Start: 40001

Reads one or more holding register values or sends an error message. The maximum number of holding registers that can be read is 30 per response.

6.4 Read Input Registers – Function Code 4

Input Register Start: 30001

Reads one or more input register values or sends an error message. The maximum number of input registers that can be read is 30 per response.

6.5 Write Single Coil – Function Code 5

Sets one coil value or sends an error message.

6.6 Write Single Holding Register – Function Code 6

Sets one holding register value or sends an error message.

6.7 Diagnostics – Function Code 8

All Diagnostic messages and responses use the same function code and are differentiated by their sub function codes.

6.7.1 Return Query Data – Sub Function Code 0

Echoes the data received.

6.7.2 Restart Communications – Sub Function Code 1

Echoes the data received and restarts Modbus communications.

Note 1: Event Log is not implemented. Setting Data to 0xFF00 will not affect the Restart Communications command.

Note 2: This is the only command that the drive will act on when in Listen Only Mode. Sending this command will reset communications and Listen Only Mode will be disabled. If the drive is coming out of Listen Only Mode, no response message will be sent.

6.7.3 Force Listen Only Mode – Sub Function Code 4

This command will force the drive into Listen Only Mode. The drive can receive Modbus messages, but it will perform no actions, and give no responses. The only way to set the drive to normal Modbus operation is to send the Diagnostics - Restart Communications command, and no response will be given. Future requests will be acted on and responded to.

6.7.4 Clear Counters – Sub Function Code 10

Echoes the data received and clears all Modbus and SCI counters. The Diagnostics register is not implemented. All counters are reset when the drive powers up.

6.7.5 Return Bus Message Count – Sub Function Code 11

The drive will respond with the total number of Modbus Messages that it has seen.

6.7.6 Return Bus Comm Error Count – Sub Function Code 12

The drive will respond with the total number of CRC errors.

6.7.7 Return Bus Exception Error Count – Sub Function Code 13

The drive will respond with the total number of Illegal Function, Address, and Value errors.

6.7.8 Return Server Message Count – Sub Function Code 14

The drive will respond with the total number of Modbus Messages that have been addressed to that device.

6.7.9 Return Server No Response Count – Sub Function Code 15

The drive will respond with the total number of Modbus Messages that it has not responded to.

6.7.10 Return Server NAK Count – Sub Function Code 16

REQUEST:

Slave ID	1 Byte	[Slave ID]
Function Code	1 Byte	0x11
CRC	2 Bytes[Lo:Hi]	[CRCL, CRCH]

RESPONSE:

Slave ID	1 Byte	[Slave ID]
Function Code	1 Byte	0x11
Byte Count	1 Byte	3
Slave ID	1 Byte	Slave ID
Run Status	1 Byte	0x00(off) or 0xFF(on)
System Status	1 Byte	0(ok), positive number = Fault
CRC	2 Bytes[Lo:Hi]	[CRCL, CRCH]

The drive will respond with the total number of Negative Acknowledge exception responses.

6.8 Report Slave ID – Function Code 17

This is a Phase Technologies specific function code that contains information about a VFD's run state.

REQUEST MESSAGE:

Slave ID	1 Byte	[Slave ID]
Function Code	1 Byte	0x41
Starting Address	2 Bytes[H:L]	0 to x
Number of Registers	2 Bytes[H:L]	1 to N*
CRC	2 Bytes[Lo:Hi]	[CRCL, CRCH]

RESPONSE:

Slave ID	1 Byte	[Slave ID]
Function Code	1 Byte	0x41
Data Byte Count	1 Byte	2 x N*
Register Value 0	2 Bytes[H:L]	Value
	
Register Value [N* - 1]	2 Bytes[H:L]	Value
CRC	2 Bytes[Lo:Hi]	[CRCL, CRCH]

ERROR RESPONSE:

Slave ID	1 Byte	[Slave ID]
Function Code	1 Byte	0xC1
Exception Code	1 Byte	02 or 03
CRC	2 Bytes[Lo:Hi]	[CRCL, CRCH]

6.10 Unimplemented Function Codes

Read Exception Status – 7

Get Comm Event Counter – 11

Get Comm Event Log – 12

Write Multiple Coils – 15

Write Multiple Registers – 16

Read File Record – 20

Write File Record – 21

Mask Write Register – 22

Read/Write Multiple Registers – 23

Read FIFO Queue – 24

Encapsulated Interface Transport – 43

CAN open General Request and Response PDU – 43/13

Read Device Identification – 43/14

7. IMPLEMENTED BACNET SERVICES

7.1 Unconfirmed Services

Unconfirmed BACnet services do not require a response.

7.1.1 Who Is/I Am

The Who-Is service asks DXL/LHX drives on the network with a BACnet Device object identifier within a certain range (or all DXL/LHX drives) to respond with an I-Am message. The I-Am message contains a DXL/LHX drive's BACnet Device object identifier and other networking information such as message size restrictions and message segmentation capabilities.

7.1.2 Unconfirmed COV Notification

This message is sent by a DXL/LHX drive when a previously set up COV subscription detects a change in its subscribed object. It contains the updated present value of the subscribed object alongside the remaining lifetime of the COV subscription.

7.2 Confirmed Services

Confirmed BACnet services do require a valid response.

7.2.1 Confirmed COV Notification

This message is sent by a DXL/LHX drive when a previously setup COV subscription detects a change in its subscribed object. It contains the updated present value of the subscribed object alongside the remaining lifetime of the COV subscription.

7.2.2 Subscribe COV

This message is sent to a DXL/LHX drive to subscribe to future COV notifications for a particular object. This message can also indicate both the lifetime of the subscription and whether the COV notifications should be Unconfirmed or Confirmed services. It can also be used to cancel, extend, or modify an existing COV subscription.

In a DXL/LHX drive, COV subscriptions can be created for coils, discrete inputs, and input data registers. COV notifications will contain the present value of the subscribed object.

7.2.3 Read Property

This message is sent to a DXL/LHX drive to read one property of an object.

In a DXL/LHX drive, these are the properties that can be read from each object:

For the Device object, the object name, object identifier, and object list can be read.

- ▶ The object name is the name of the DXL/LHX drive with “- BACnet” appended.
- ▶ The object identifier is the value of the BACnet Device Object ID parameter.
- ▶ The object list contains a list of all the objects available in the DXL/LHX drive. This includes all coils, discrete inputs, input registers, holding registers, and the Device object. The object list must be accessed solely via index due to its length, with the zero-index containing its length.

For coils, discrete inputs, input registers, and holding registers, the object name, object identifier, and present value can be read.

- ▶ The object name is the name of the associated parameter or measurement.
- ▶ The object identifier is the equivalent Modbus address for the parameter or measurement.
- ▶ The present value is the current value of the parameter or measurement.

7.2.4 Read Multi Property

This message is sent to a DXL/LHX drive to read one or more properties of one or more objects.

For the Device object, only the All property can be read, which effectively reads the Device object identifier and object name. Refer to Read Property for descriptions of these properties.

For coils, discrete inputs, input registers, and holding registers, either the All property can be read, or the present value property can be read. The All property effectively reads the parameter or measurement's object identifier, present value, and object name. Refer to Read Property for descriptions of these properties.

7.2.5 Write Property

This message is sent to a DXL/LHX drive to set one property of an object.

For coils and holding registers, the present value can be set. Refer to Read Property for a description of this property.

8. CONTROLLING VFD FUNCTIONALITY

Below is a description of some parameters used to control the basic output functionality of a DXL/LHX drive that are not directly accessible in its UI.

Modbus/BACnet Control Mode – Changes the Hand/Off/Auto (HOA) setting of the VFD. Set this parameter to 0 for Off, 1 for Manual, or 2 for Auto. Any other values are ignored.

Modbus/BACnet Run Stop Control – Controls the Run/Stop command in Manual Mode. Set this parameter to 0 for Stop, or 1 for Manual Run. VFD must be in Manual Mode. Any other values are ignored. This will cause the VFD to ramp to Max Frequency and will ignore Modbus/BACnet Manual Frequency control.

Modbus/BACnet System Reset – Will perform a system reset if the drive is in a faulted state. Set this parameter to 1 to reset the VFD from a faulted state. Any other values are ignored.

Modbus/BACnet Manual Frequency – Controls the output frequency of the VFD. The drive must be in Manual mode, or this command will be ignored. Setting this value between Min Frequency and Max Frequency (inclusive) will set Modbus/BACnet Run Stop Control to 1 and start the VFD. Setting this value lower than Min Frequency or higher than Max Frequency will set Modbus/BACnet Run Stop Control to 0 and stop the VFD. This will override control from Modbus/BACnet Run Stop Control and will ramp to the set frequency. Frequency has a multiplier of 10 (e.g., sending 456 will set the drive frequency to 45.6 Hz)

9. COMPLETE MODBUS PARAMETER LIST

Coil		
Address	Parameter	Read Only
1	Relay 1	RW
2	Relay 2	RW
3	Relay 3	RW
4	Relay 4	RW

Discrete		
Address	Parameter	Read Only
10001	Run Status	RO
10002	Aux 1 Setting	RO
10003	Aux 2 Setting	RO
10004	Aux 3 Setting	RO
10005	Aux 4 Setting	RO
10006	Fan On	RO
10007	Fan Speed	RO
10008	Precharge Engaged	RO

Input – Data		
Address	Parameter	Read Only
30001	HOA Setting	RO
30002	System Status	RO
30003	Frequency	RO
30004	Iu Output	RO
30005	Iv Output	RO
30006	Iw Output	RO
30007	Output HP	RO
30008	Output KW	RO
30009	Output KVA	RO
30010	Output PF	RO
30011	Current Balance	RO
30012	Bus Voltage	RO
30013	V12 Input	RO
30014	V23 Input	RO
30015	V31 Input	RO
30016	I1 Input	RO
30017	I2 Input	RO
30018	I3 Input	RO
30019	NTC Temp 1	RO
30020	NTC Temp 2	RO
30021	NTC Temp 3	RO
30022	NTC Temp 4	RO
30023	NTC Temp 5	RO
30024	NTC Temp 6	RO
30025	10VDC Analog Input	RO
30026	I1 4-20ma Analog Input	RO
30027	I2 4-20ma Analog Input	RO
30028	RTC Year	RO
30029	RTC Month	RO
30030	RTC Date	RO
30031	RTC Hour	RO

30032	RTC Minute	RO
30033	RTC Second	RO
30034	Measured PSI	RO
30035	Measured GPM	RO
30036	Measured FT	RO
30037	Target Hz	RO
30038	Target PSI	RO
30039	Target GPM	RO
30040	Target FT	RO
30041	Reserved	RO
30042	Reserved	RO
30043	Reserved	RO
30044	Reserved	RO
30045	Reserved	RO
30046	Connection Strength	RO

Input – Fault Time Stamps		
Address	Parameter	Read Only
30501	Fault 1 ID	RO
30502	Fault 1 Year	RO
30503	Fault 1 Month	RO
30504	Fault 1 Date	RO
30505	Fault 1 Hour	RO
30506	Fault 1 Minute	RO
30507	Fault 1 Second	RO
30508	Fault 2 ID	RO
30509	Fault 2 Year	RO
30510	Fault 2 Month	RO
30511	Fault 2 Date	RO
30512	Fault 2 Hour	RO
30513	Fault 2 Minute	RO
30514	Fault 2 Second	RO
30515	Fault 3 ID	RO
30516	Fault 3 Year	RO
30517	Fault 3 Month	RO
30518	Fault 3 Date	RO
30519	Fault 3 Hour	RO
30520	Fault 3 Minute	RO
30521	Fault 3 Second	RO
30522	Fault 4 ID	RO
30523	Fault 4 Year	RO
30524	Fault 4 Month	RO
30525	Fault 4 Date	RO
30526	Fault 4 Hour	RO
30527	Fault 4 Minute	RO
30528	Fault 4 Second	RO
30529	Fault 5 ID	RO
30530	Fault 5 Year	RO
30531	Fault 5 Month	RO

30532	Fault 5 Date	RO
30533	Fault 5 Hour	RO
30534	Fault 5 Minute	RO
30535	Fault 5 Second	RO

Holding -> Operation Parameters		
Address	Parameter	Read Only
40001	Min Frequency	RW
40002	Max Frequency	RW
40003	Start Up Ramp Time	RW
40004	Accel Curve Select	RW
40005	Accel Minimum Time	RW
40006	Accel Middle Time	RW
40007	Accel Middle Freq	RW
40008	Shutdown Ramp Time	RW
40009	Decel Curve Select	RW
40010	Decel Minimum Time	RW
40011	Decel Middle Time	RW
40012	Decel Middle Freq	RW
40013	Overcurrent Limit	RW
40014	Under Current	RW
40015	Coast To Stop	RW
40016	Ground Fault Sensitivity	RW
40017	Submersible Pump	RW
40018	Reverse Rotation	RW
40019	Output Voltage	RW
40020	Switching Frequency	RW
40021	Overload Derate Enable	RW
40022	Overcurrent Derate Enable	RW
40023	Overtemp Derate Enable	RW
40024	V/F Selection	RW
40025	V/F Min Frequency	RW
40026	V/F Mid Frequency	RW
40027	V/F Min Voltage	RW
40028	V/F Mid Voltage	RW
40029	PWM Over Modulation	RW

40030	Skip Freq 1 Setpoint	RW
40031	Skip Freq 1 Bandwidth	RW
40032	Skip Freq 2 Setpoint	RW
40033	Skip Freq 2 Bandwidth	RW
40034	Skip Freq 3 Setpoint	RW
40035	Skip Freq 3 Bandwidth	RW
40036	Motor RPM	RW
40037	Current Unbalance	RW
40038	DC Bus Ripple Compensation	RW

Holding -> Auto Restart Parameters		
Address	Parameter	Read Only
40501	Enable Restarts	RW
40502	Under Current Delay	RW
40503	Restart Delay	RW
40504	Startup Delay	RW
40505	Short Cycle Delay	RW
40506	Under Current Restart Delay	RW
40507	Number of Auto Restarts	RW
40508	Startups per Cycle	RW
40509	Max Cycle Time	RW
40510	Sensor Connection Fault Delay	RW

Holding -> Interface Parameters		
Address	Parameter	Read Only
41001	System Config	RW
41002	Menu Complexity	RW
41003	Disable Manual Mode	RW
41004	Program Relay No 1	RW
41005	Program Relay No 2	RW
41006	Program Relay No 3	RW
41007	Program Relay No 4	RW
41008	Aux 1 Select	RW
41009	Aux 2 Select	RW
41010	Aux 3 Select	RW
41011	Aux 4 Select	RW
41012	LCD Contrast	RW
41013	Reserved	RW
41014	Enable 1Ph Input	RW
41015	Analog Setpoint Control	RW
41016	Analog Select I1	RW
41017	Analog Select I2	RW
41018	Analog Select VIN	RW
41019	Analog Input Reverse I1	RW
41020	Analog Input Reverse I2	RW
41021	Analog Input Reverse VIN	RW
41022	Speed Pot Scale Select	RW
41023	Disable Active Front End	RW
41024	Troubleshooting	RW
41025	Oiler On-Delay Timer	RW
41026	Aux 3 Speed Ref	RW
41027	Aux 4 Speed Ref	RW
41028	Aux 3+4 Speed Ref	RW
41029	RTC Calibration	RW
41030	Customer Comm Protocol	RW
41031	Modbus ID	RW
41032	BACnet Device Object ID	RW

41033	Modbus Stop Bits	RW
41034	Modbus Parity	RW
41035	Modbus Baud Rate	RW
41036	Modbus Wiring	RW
41037	Modbus Fault Select	RW
41038	Modbus Fault Time	RW
41039	Modbus HOA Control Mode	RW
41040	Modbus Run Stop	RW
41041	Modbus Manual Frequency	RW
41042	Modbus DAC Voltage	RW
41043	Modbus DAC Current	RW
41044	Modbus System Reset	RW
41045	Reserved	RW
41046	IOUT Select	RW
41047	VOUT Select	RW
41048	IOUT Source	RW
41049	VOUT Source	RW
41050	IOUT Reverse	RW
41051	VOUT Reverse	RW
41052	Analog Output Max Output Amps	RW

Holding -> Constant Pressure Parameters		
Address	Parameter	Read Only
41501	Control Method	RW
41502	Analog Setpoint 1 (PSI)	RW
41503	Analog Setpoint 2 (PSI)	RW
41504	Analog Setpoint 3 (PSI)	RW
41505	Analog Setpoint 4 (PSI)	RW
41506	Analog Setpoint 1 (GPM)	RW
41507	Analog Setpoint 2 (GPM)	RW
41508	Analog Setpoint 3 (GPM)	RW
41509	Analog Setpoint 4 (GPM)	RW
41510	Analog Setpoint 1 (FT)	RW
41511	Analog Setpoint 2 (FT)	RW
41512	Analog Setpoint 3 (FT)	RW
41513	Analog Setpoint 4 (FT)	RW
41514	Sleep Frequency	RW
41515	Force Sleep Threshold (PSI)	RW
41516	Wake Up Threshold (PSI)	RW
41517	Force Sleep Threshold (GPM)	RW
41518	Wake Up Threshold (GPM)	RW
41519	Force Sleep Threshold (FT)	RW
41520	Wake Up Threshold (FT)	RW
41521	Boost Amount (PSI)	RW
41522	Boost Amount (GPM)	RW
41523	Boost Amount (FT)	RW
41524	Pre-charge Frequency	RW
41525	Pre-charge Time	RW
41526	Pre-charge PSI	RW
41527	Broken Pipe Threshold (PSI)	RW
41528	Broken Pipe Threshold (GPM)	RW
41529	Broken Pipe Threshold (FT)	RW
41530	Broken Pipe Time	RW
41531	Boost Time	RW
41532	Max Analog Sensor Range (PSI)	RW

41533	Max Analog Sensor Range (GPM)	RW
41534	Max Analog Sensor Range (FT)	RW
41535	Analog Measure Offset (PSI)	RW
41536	Analog Measure Offset (GPM)	RW
41537	Analog Measure Offset (FT)	RW
41538	Analog Setpoint Offset (PSI)	RW
41539	Analog Setpoint Offset (GPM)	RW
41540	Analog Setpoint Offset (FT)	RW
41541	Frequency Setpoint Offset	RW
41542	GPM Multiplier	RW
41543	FT Multiplier	RW
41544	Suction Pressure Time	RW
41545	Suction Pressure Fault Level	RW
41546	T Off	RW
41547	T1 On	RW
41548	T2 On	RW
41549	Auto Sleep Bandwidth	RW
41550	Auto Sleep Detection Time	RW
41551	Auto Sleep Curve	RW

Holding -> Lead Lag Parameters		
Address	Parameter	Read Only
42001	Number Lag Pumps	RW
42002	Stage Pump Delay	RW
42003	Destage Pump Delay	RW
42004	Stage Time	RW
42005	Destage Time	RW
42006	Destage Min Frequency	RW
42007	Stage Frequency Reduction 1	RW
42008	Stage Frequency Reduction 2	RW
42009	Stage Frequency Reduction 3	RW
42010	Stage Frequency Reduction 4	RW
42011	Destage Frequency Boost 1	RW
42012	Destage Frequency Boost 2	RW
42013	Destage Frequency Boost 3	RW
42014	Destage Frequency Boost 4	RW
42015	Stage Analog Lag (PSI)	RW
42016	Stage Analog Lag (GPM)	RW
42017	Stage Analog Lag (FT)	RW

Holding -> Multiplex Parameters		
Address	Parameter	Read Only
42501	Number Multiplex Systems	RW
42502	Multiplex Cycle Time	RW
42503	Multiplex Stage Delay	RW
42504	Multiplex Destage Frequency	RW
42505	Multiplex Stage Analog Lag (PSI)	RW
42506	Multiplex Stage Analog Lag (GPM)	RW
42507	Multiplex Stage Analog Lag (FT)	RW
42508	Multiplex Destage Delay	RW

Holding -> PID Control Parameters		
Address	Parameter	Read Only
43001	Acceleration Time	RW
43002	Deceleration Time	RW
43003	Integral Gain	RW
43004	Proportional Gain	RW
43005	Derivative Gain	RW
43006	Derivative Delay Time	RW
43007	Dynamic Gain Enable	RW
43008	PID Update Rate	RW
43009	PID Measurement Filter Rate	RW

Holding -> Torque Control Parameters		
Address	Parameter	Read Only
43501	Enable Torque Control	RW
43502	Motor Rated HP	RW
43503	Motor Rated Voltage	RW
43504	Motor Rated Current	RW
43505	Motor Rated RPM	RW
43506	Speed Proportional Gain	RW
43507	Speed Integral Gain	RW
43508	Torque Proportional Gain	RW
43509	Torque Integral Gain	RW
43510	Flux Proportional Gain	RW
43511	Flux Integral Gain	RW
43512	Torque Limit	RW
43513	Flux Reference	RW
43514	Disable Regen	RW

10. References

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- ▶ http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf
- ▶ ANSI/ASHRAE BACnet Standard 135-2020