WS Controller
Modbus Specification

TABLE OF CONTENTS

1 Overview 2
2 Message Structure 2
3 Modbus/RTU Serial Transmission Mode 4
4 Modbus Addressing 4
5 Modbus Function Codes 5
5.1 Modbus Exception Codes 8
6 Wiring Specifications 10
7 WS Controller Modbus Definitions 11
7.1 User Holding Registers 11
7.2 User Input Registers 21
7.3 User Data Log 37
7.4 Adjustment Change Log 38

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Visit the Modbus-IDA website at www.modbus.org for the latest update to the Modbus protocol.

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1 Overview

Modbus is the protocol standard being used to handle communication for the WS Controller. The PC running the WSPC program uses Modbus to communicate with the WS Controller which controls and monitors the compressor operation. This specification describes the Modbus functions used specifically for the Sullair WS Controller. For details on the use and application of the Modbus protocol access the Modbus website at http://www.modbus.org/specs.php.

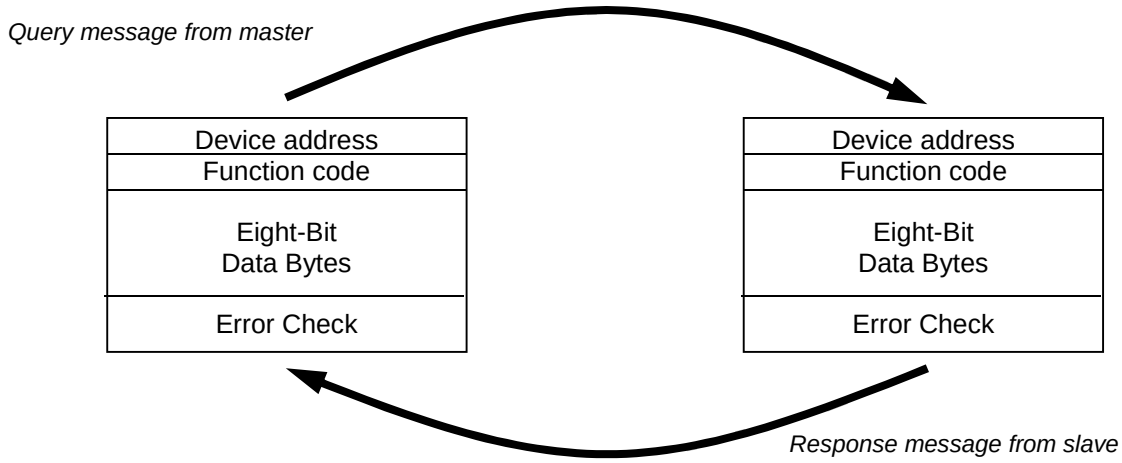
Modbus devices communicate using a client-server technique in which only one device (the client) can initiate transactions (called queries). The other devices (servers) respond by supplying the requested data to the client, or by taking the action requested in the query. A server is any peripheral device (I/O transducer, valve, network drive, or other measuring device) which processes information and sends its output to the client using Modbus. The WS Controllers are server devices, while a typical client device is a host computer running the WSPC application software. Clients can address individual servers, or can initiate a broadcast message to all servers. Servers return a response to all queries addressed to them individually, but do not respond to broadcast queries. The Modbus protocol defines function codes and the encoding scheme for transferring data using RS232/RS485 serial interfaces or via network (Ethernet or TCP/IP) channels. With the RS232 interface, ModBus can be used to send messages between individual devices. With the RS485 interface, transactions can made through a network of devices.

The protocol is a client/server arrangement, meaning a device operating as a client will poll for response from one or more devices operating as a server. The controller, operating as a server is a passive member of the Modbus network simply waiting for the client device to read or write data. In this case, the WSPC User Interface is the active member of the Modbus network, operating as the client. The WSPC initiates data transfers to the WS Controller which functions as the server device.

2 Message Structure

The Modbus communication interface uses a defined message structure to address commands from a client device to the server devices. Modbus enables a client device to communicate with several Modbus nodes at once. Each Modbus message has the same basic structure consisting of the same basic elements in each message. The order in which these elements appear in the message is the same for all messages. A message is always started by a client in the Modbus network and a server, depending on the contents of the message, takes action and responds to it. Each server device is assigned an address which distinguishes it from the other devices in the system. The address is contained in the message header and is used to define which device should respond (or react) to the message. All other nodes on the Modbus network ignore the message if the address field doesn't match their own address. The Modbus message used with the WS Controller includes the Device address, Function code, Starting address, Number of registers, Number of data bytes, Data values, Error check code.

A modbus transaction typically comprises a single query from a client device and a single response from a server device. When a query is broadcast from a client to all servers, no response is transmitted. The following figure illustrates the transactions between a client and a server.



Shown below is a typical modbus message structure. The values of the modbus message are expressed as hexadecimal with certain values paired as shown. The Modbus message elements are defined in the following chart.

Modbus Message: 01 04 00 08 00 01 02 02 30 CRC

Controller Address	Function Code	Starting Address	Number of Registers	Number of Bytes	Data Values	Error Checking

Modbus Message Field Descriptions

Field	Description
Device address	Address of the receiver device (server)
Function code	Code defining the message type (see chart in next section)
Starting Address	Starting address of the register(s) to receive the message
Number of Registers	Number of registers being addressed at the controller. Some modbus messages can address multiple registers.
Number of Bytes	Number of data bytes in the message. A message can include multiple bytes of data information
Data	Data block of information to which the controller responds
Error check	Numeric check value to test for communication errors

3 Modbus/RTU Serial Transmission Mode

Serial Modbus connections recognize two basic transmission modes, ASCII or RTU, remote terminal unit. The transmission mode used with the WS controller is Modbus/RTU. Modbus/ASCII messages are coded in hexadecimal values using only the characters 0...9 and A...F. With Modbus/RTU the data is exchanged in a binary format, where each byte of information is coded in one communication-byte.

A Modbus/RTU message is framed between time gaps of silence on the communication line. Each message must be preceded by a time gap with a minimum length of 3.5 characters. A receiver detecting a gap of at least 1.5 characters will assume that a new message is following and the receive buffer is cleared to prepare to receive the message.

Modbus/RTU Message Elements (typical)

	Modbus/RTU	
Characters	Binary 0...255	
Error check type	CRC Cyclic Redundancy Check	
Frame start	3.5 chars silence	
Frame end	3.5 chars silence	
Gaps in message	1.5 times char length	
Start bit	1	
Data bits	8	
Parity	even/odd	none
Stop bits	1	2

4 Modbus Addressing

The first information in each Modbus message is the address of the receiver. This parameter contains one byte of information. Valid addresses are in the range 0..247. The values 1..247 are assigned to individual Modbus devices in the system. The 0 value is used as a broadcast address to send communication all server devices at once. A server device, when responding, identifies itself by returning the same address as the client in the request. The WS controller allows independent selection of addresses for its RS232 port (generally used only for WSPC) and its RS485 port (suitable for multi-drop networks). When using optional Modbus TCP/IP connections to a controller, the addressing is by the controller's IP address only.

The Modbus message addresses a register with an address value between 0 and 65535. Within a Modbus device, the holding registers (inputs and outputs used to read or set values) are assigned a number between 1 and 65536. This difference causes the register and I/O addresses used in the Modbus messages to be offset from the device address by a value of -1. In other words, if the value of output 18 is to be read, the value 17 must be specified in the Modbus query message. Likewise, when constructing the Modbus message, an offset must be subtracted from the device address to determine the address to be included in the Modbus message structure. Because of these offset address values, care should be taken to avoid common mistakes when designing applications or sending commands using Modbus communication. The following table shows the address ranges for outputs, inputs and holding registers, and the way the address in the Modbus message is calculated given the actual address of the item in the server device.

Device address and Modbus address ranges

Device address	Modbus address calculated	Description
30001...40000*	Device address minus 30001	Input registers
40001...50000*	Device address minus 40001	Holding registers

* Maximum value is device dependent

All data addresses in Modbus messages are referenced to zero. The first occurrence of a data item is addressed as item number zero.

Holding register 40001 is addressed as register 0000 in the data address field of the message. Holding register 40108 is addressed as register 006B hex (107 decimal).

The functions and types of registers referenced with the WS controller are:

Read Holding Register
Read Input Register
Write Single Register
Preset Multiple Registers

Holding and input registers are 16 bit registers. Holding registers are read/write. Input registers are generated by the device and therefore are read only.

5 Modbus Function Codes

The second value in each Modbus message is the function code. This defines the message type and the type of action required by the server. The function code parameter contains one byte of information. Valid function codes are in the range 1..255. Not all Modbus devices recognize all the same function codes. Only the codes used with the WS Controller are discussed in this document.

Normally, when the Modbus server (controller) answers a response, it returns the same function code as in the request. This is true except when an error is detected. In this case, the highest bit of the function code is turned on. This allows the client (PC running WSPC program) to easily recognize the difference between a successful response and a failure. The following table lists function codes used with the WS Controller.

Modbus function codes

Code	Description
03	Read holding registers
04	Read input registers
06	Write Single Register
16	Preset multiple registers

5.1 Function 03: Read Holding Registers

Internal values in a Modbus device are stored in holding registers. These registers are two bytes wide and can be used for various purposes. Some registers contain configuration parameters where others are used to return measured values (temperatures etc.) to a host. Registers in a Modbus compatible device start counting at 40001. They are addressed in the Modbus message structure with addresses starting at 0. Modbus function 03 is used to request one or more holding register values from a device. Only one server device can be addressed in a single query. Broadcast queries with function 03 are not supported.

Function 03 query structure

Byte	Value	Description
1	1...247	Server device address
2	3	Function code
3	0...255	Starting address, high byte
4	0...255	Starting address, low byte
5	0...255	Number of registers, high byte
6	0...255	Number of registers, low byte
7(...8)	CRC	Error check value

After receiving a query message with Modbus function 03, the server puts the requested input values in a message structure and sends this message back to the Modbus client. The length of the message depends on the number of input values returned. This causes the length of the output message to vary. The Modbus answer message starts with the controller address and the function code 03. The next byte is the number of data bytes that follow. This value is two times the number of registers returned. The data follow. Because of the size of the holding registers, every register is coded with two bytes in the answering message. The first data byte contains the high byte, and the second the low byte of the register. An error check is appended for the WSPC program to check if a communication error occurred. Each Modbus answering message has the following general structure.

Function 03 answer structure

Byte	Value	Description
1	1...247	Server device address
2	3	Function code
3	0...255	Number of data bytes N
4...N+3	0...255	Bit pattern of input values
N+4(...N+5)	CRC	Error check value

Example:

[01][03][00][02][00][06][64][08]

[01][03][0C][00][01][06][E0][06][40][06][40][06][40][02][58][7F][D6]

5.2 Function 04: Read Input Registers

Modbus function 04 is used to read input registers. Broadcast addressing mode is not supported. You can only query the value of inputs of one device at a time. The address of the first input and the number of inputs to read must be put in the data field of the query message. Inputs on devices start numbering at 30001. This address value is equivalent to address 0 in the Modbus message.

Function 04 query structure

Byte	Value	Description
1	1...247	Server device address
2	4	Function code
3	0...255	Starting address, high byte
4	0...255	Starting address, low byte
5	0...255	Number of inputs, high byte
6	0...255	Number of inputs, low byte
7(...8)	CRC	Error check value

After receiving a query message with Modbus function 04, the server puts the requested input values in a message structure and sends this message back to the Modbus client. The length of the message depends on the number of input values returned. This causes the length of the output message to vary. The Modbus answer message starts with the controller address and the function code 04. The next byte is the number of data bytes that follow. This value is two times the number of registers returned. The data follow. Because of the size of the holding registers, every register is coded with two bytes in the answering message. The first data byte contains the high byte, and the second the low byte of the register. An error check is appended for the WSPC program to check if a communication error occurred. Each Modbus answering message has the following general structure.

Function 04 answer structure

Byte	Value	Description
1	1...247	Server device address
2	4	Function code
3	0...255	Number of data bytes **N**
4...**N**+3	0...255	Bit pattern of input values
N+4(...**N**+5)	CRC	Error check value

Example:

[01][04][00][02][00][06][D1][C8]

[01][04][0C][00][00][00][00][00][4D][00][00][00][03][09][E3][BF][6A]

5.3 Function 6: Write Single Register

Modbus function 6 is used to set values into a single holding register. When broadcast, the function presets the same register reference in all attached servers. The query message from the client specifies the register to be preset. The requested preset value is specified in the request data field.

Function 6 query structure

Byte	Value	Description
1	1...247	Server device address
2	6	Function code
3	0...255	Starting address, high byte
4	0...255	Starting address, low byte
5	0...255	Register data, high byte
6	0...255	Register data, low byte
7(..8)	CRC	Error check value

The reply to this command is simply an echo of the first six bytes of the request. The Modbus response message has the following general structure.

Function 6 response structure

Byte	Value	Description
1	1...247	Server device address
2	6	Function code
3	0...255	Starting address, high byte
4	0...255	Starting address, low byte
5	0...255	Register data, high byte
6	0...255	Register data, low byte
7(...**8**)	CRC	Error check value

Example:

[01][06][00][10][00][02][09][CE]

[01][06][00][10][00][02][09][CE]

5.4 Function 16: Preset Multiple Registers

Modbus function 16 is used to preset values into a sequence of holding registers. When broadcast, the function presets the same register references in all attached servers. The query message from the client specifies the registers to be preset. The requested preset values are specified in the request data field.

Function 16 query structure

Byte	Value	Description
1	1...247	Server device address
2	16	Function code
3	0...255	Starting address, high byte
4	0...255	Starting address, low byte
5	0...255	Number of Registers, high byte
6	0...255	Number of Registers, low byte
7	0...255	Byte count N
8	0...255	Registers data, high byte
9	0...255	Registers data, low byte
...	0...255	Additional High / Low pairs of Register Data
N+8(...N+9)	CRC	Error check value

The reply to this command is simply an echo of the first six bytes of the request. The Modbus response message has the following general structure.

Function 16 response structure

Byte	Value	Description
1	1...247	Server device address
2	16	Function code
3	0...255	Starting address, high byte
4	0...255	Starting address, low byte
5	0...255	Number of registers, high byte
6	0...255	Number of registers, low byte
7(...**8**)	CRC	Error check value

Example:

[01][10][00][03][00][01][02][06][40][A4][33]

[01][10][00][03][00][01][F1][C9]

5.5 Modbus Exception Codes

If the server receives the query without a communication error, but cannot handle it, the server will return an exception response informing the client of the nature of the error. The exception response codes are described in the table below.

Code name	Description
01 Illegal Function	The message function requested is not recognized by the server.
02 Illegal Data Address	The received data address is not an allowable address for the server.
03 Illegal Data Value	The received data value is not an allowable value for the server.
04 Server Device Error	An unrecoverable error occurred while the server was attempting to perform the requested action.
05 Acknowledge	The server has accepted the request and is processing it, but a long duration of time is required to do so. This response is returned to prevent a timeout error from occurring at the client.
06 Server Device Busy	The message was received without error, but the server was already engaged in processing a long duration program command.
07 Negative Acknowledge	The server cannot perform the program function received in the query. This code is returned for an unsuccessful programming request using function code 13 or 14 (codes not supported by WS Controller).
08 Memory Parity Error	The server attempted to read extended memory, but detected a parity error in memory.

In an exception response, the server sets a most-significant bit (MSB) of the function code to 1. The server then returns the exception code in the data field of the response message.

6 Wiring Specifications

The WS Controller is configured to be connected to the computer running the WSPC program using RS-232 or RS-485 serial interfaces. Other connections via modem or Ethernet interfaces are capable when the necessary equipment is installed.

Any WS controller has two independent modbus ports. Connector J13 is RS-485, and may be used for industrial networks and connecting multiple compressors. Connector J14 is RS232, and would normally be used with a local PC or connected to a modem. J14 may also be connected to an external receptacle for remote access. Each port has a red RX indicator which lights when data are received and a green TX indicator which lights when data are sent. These indicators may be used when setting up communications to verify connections have been established.

Some controllers may be equipped with an optional Ethernet port. This may be located on the Control Engine Module, or on the User Interface Module. This supports Modbus TCP/IP. Addressing is by IP address only, set in registers 40102-40109. The default settings allow a simple connection to a Windows PC using a crossover cable. This may easily be configured for a compressor-room LAN. Limit request size to 50 registers or less.

7 WS Controller Modbus Definitions

This section defines the Modbus registers assigned to operations of the WS Controller. All registers are assigned addresses consisting of integer values. Many of these values are converted into user readable terms that appear on the WS Controller interface panel and the WSPC user interface display at the PC. Sequencing related addresses are accessible through the sequencing port. Refer to the Sequencing and Protocol Manual for information on sequencing operation. All of the registers can be accessed using a Modbus communication method. Independent ports are provided for RS232 and RS485 connections. The RS232 communication is configured by default for Modbus/RTU at a speed of 38400 Baud, No Parity, 1 stop bit, and is field-alterable. The RS485 communication is configured by default for Modbus/RTU at a speed of 19200 Baud, Even Parity, 1 stop bit, and is field-alterable.

The function of each Modbus register used with the WS Controller is described in the following sections. The table lists the name of the register, the Modbus address, default value, and the minimum and maximum limits for each holding register.

The units of measure for pressure registers is a factor of 1/16 psig. When reading or setting a pressure value, divide the value by 16 to display as psig, divide by 232 to display as bar, or divide by 2.32 to display as kPascal.

The Units of measure for temperature registers is 1/16 degree Fahrenheit. When reading a temperature value, divide the value by 16 to display as degrees Fahrenheit. Subtract 512, then divide the value by 28.8 to display as degrees Celsius.

Holding registers are usually read/write access. Values in holding registers are typically settings that control the machine operation. A Modbus command can be communicated to read the registry value or write to the registry at any time. Invalid values will not be accepted. Unused registers are set to 0 by default, but may hold any integer from 0 to 32767. Input Registers are read-only and contain machine and controller operation data.

The WSPC User Interface program provides a command wizard which can aid in sending Modbus communications from the PC to the controller. Refer to the WSPC User Interface Operator's manual for instructions about using the Modbus Command Wizard.

7.1 User Holding Registers

This version of software has holding registers numbered 40001-40180 (register 1-180, communications address 0x0000 – 0x00B3) available for reports or adjustments of the compressor. Many are for internal or diagnostic use, but may be monitored if desired. Registers not shown below are unused, but reserved for future use.

Administrator and Manager Password Registers

LABEL	ADDR	DEF	MIN	MAX
ADMN_PW	40001	0	-32767	32767
MNGR_PW	40002	0	-32767	32767

The ADMN_PW and MNGR_PW password registers are used for machine protection. These registers are normally set to 0.

Modbus address number

LABEL	ADDR	DEF	MIN	MAX
MBPC_ADDX	40003	1	1	247

The MBPC_ADDX register controls the Modbus address number for the RS232 port only. Do not change this register unless absolutely necessary. Any change should be carefully noted, particularly what the value was changed from and changed to. An improper setting of this register can disable communication between the PC and controller. The controller power must be cycled once for the change to take effect. By setting controllers to different numbers, multiple controllers may be connected to an appropriate network, and can be addressed individually via the WSPC interface. This is a duplicate of register 40047, for compatibility purposes.

Unload Pressure

LABEL	ADDR	DEF	MIN	MAX
UNLOAD	40004	1760	640	*

The UNLOAD register controls the Unload pressure of the controller. If the operating pressure goes higher than the set value, the compressor will unload. The units of measure are 1/16 psig. *The maximum setting is limited to acceptable levels for modulation or load/unload operation.

Load Pressure

LABEL	ADDR	DEF	MIN	MAX
LOAD	40005	1600	480	*

The LOAD register controls the load pressure of the controller. If the operating pressure falls below this setting, the compressor motor will start, and the compressor will load and start delivering air to the system. The units of measure are 1/16 psig. *The maximum setting is 16 (1 psi) below the UNLOAD setting.

VFD Setpoint Pressure

LABEL	ADDR	DEF	MIN	MAX
SETPOINT	40006	1600	480	*

The SETPOINT register controls the control pressure for variable speed drive packages. The drive will adjust compressor delivery to equal the demand at this pressure, within its rated range of air delivery. The units of measure are 1/16 psig. *The maximum is model-dependent.

Unload Time Setting

LABEL	ADDR	DEF	MIN	MAX
UNLOAD_TIME	40008	600	0	1800

The UNLOAD_TIME sets the time the compressor motor will run idle after unloading. If the compressor is in Automatic mode, the motor will stop after running idle for the time in this register. The units of measure are seconds.

Drain Interval

LABEL	ADDR	DEF	MIN	MAX
DRAIN_INTERVAL	40009	300	0	3600

The DRAIN_INTERVAL register controls the off time INTERVAL the drain solenoid valve. If the register is set to zero, the drain operation is disabled. The units of measure are seconds.

Drain Time

LABEL	ADDR	DEF	MIN	MAX
DRAIN_TIME	40010	5	0	60

The DRAIN_TIME register controls the ON time of the drain solenoid valve. If the register is set to zero, the drain operation is disabled. The units of measure are seconds.

Restart Time

LABEL	ADDR	DEF	MIN	MAX
RESTART_TIME	40011	0	0	120

The RESTART_TIME register controls the controller behavior after a power interruption. If set to zero, the controller will proceed to the OFF mode, and must be manually started at the keypad. If a number is entered, the controller will pause for this delay interval, and then return to the operating mode that was in effect prior to the power interruption. Regardless of the restart setting, the controller will return to a faulted condition if a fault was in effect prior to the interruption. The units of measure are seconds.

Wye Delta Time

LABEL	ADDR	DEF	MIN	MAX
WYE_DELTA_TIME	40012	5	0	30

On packages with reduced-current starters, the WYE_DELTA_TIME register sets the duration of the start connection of the motor. Packages with other controls may have this setting reduced to zero, or set for an initial loading delay. The units of measure are seconds.

Modulation

LABEL	ADDR	DEF	MIN	MAX
MODULATE	40013	1	0	1

The MODULATE register sets the modulation parameter. Set this register to 1 to allow modulation, set it to 0 to disable modulation for load-unload control. The settings control the solenoid valve that enables and disables compressor modulation. Disabling modulation may reduce the unload pressure setting to prevent motor overload; always check these settings after changing this register. When this setting is changed, new upper limits are automatically imposed on the unload setting.

VFD Clear History Registers

LABEL	ADDR	DEF	MIN	MAX
CLEAR_RECENT	40014	0	0	1

The CLEAR_RECENT register clears the “recent” history registers of variable speed drive packages.

VFD Kilowatt-Hour

LABEL	ADDR	DEF	MIN	MAX
VFD_KWHCOST	40015	70	1	999

The VFD_KWHCOST register sets the cost per KWH to be used in savings calculations for variable speed drive packages.

Modbus Remote

LABEL	ADDR	DEF	MIN	MAX
MODBUS_REMOTE	40016	0	0	1

The MODBUS_REMOTE register is normally not used, but may be field-configured as a control input by an administrator. If this is done, the administrator will provide information on the function.

Language

LABEL	ADDR	DEF	MIN	MAX
LANGUAGE_WS	40017	1	1	5

The LANGUAGE register controls the language displayed at the WS Controller user interface.

Enter: 0= Chinese, 1= English, 2= French, 3= Spanish, 4= German, 5= Portuguese, 6=Russian

Pressure Units

LABEL	ADDR	DEF	MIN	MAX
UNITS_PRESS	40018	0	0	2

The UNITS_PRESS register controls the pressure units displayed by the machine's user interface.

Enter: 0= psig, 1= bar, 2= kPa

Temperature Units

LABEL	ADDR	DEF	MIN	MAX
TEMP_UNITS	40019	0	0	1

The TEMP_UNITS register controls the temperature units displayed by the machine's user interface.

Enter: 0= degrees F, 1=degrees C

Compressor Operation Mode

LABEL	ADDR	DEF	MIN	MAX
MODE_SET	40020	1	1	2

The MODE_SET register controls the compressor operating mode.

Enter: 1=Manual, 2=Automatic.

Sequence Mode

LABEL	ADDR	DEF	MIN	MAX
SEQ_MODE	40021	0	0	4

The SEQ_MODE register sets the sequencing mode of the compressor operating in a sequence. Refer to the Sequencing manual for details.

0= DISABLED, 1= REMOTE, 2= SERVER, 3= HOURS, 4= COMNUM

Sequence Timer

LABEL	ADDR	DEF	MIN	MAX
SEQ_MIN_HI	40022	0	0	184
SEQ_MIN_LO	40023	0	0	32767

The SEQ_MIN_HI and SEQ_MIN_LO registers set the sequence timer, and control of the machine rotations while sequencing by hours. The units of measure for the LO register is minutes, HI is 32767 minutes.

Sequence Com Number

LABEL	ADDR	DEF	MIN	MAX
SEQ_COM	40024	1	1	16

The SEQ_COM register sets the sequence COM number of the compressor in a sequence. Refer to the Sequencing and Protocol manual for details.

Sequence Number of Machines

LABEL	ADDR	DEF	MIN	MAX
SEQ_MACHINES	40025	1	1	16

The SEQ_MACHINES register sets the total number of machines operating in a sequence. Refer to the Sequencing and Protocol manual for details.

Sequence Low Pressure Setting

LABEL	ADDR	DEF	MIN	MAX
SEQ_LOWPRESS	40026	1440	480	3968

The SEQ_LOWPRESS register is the sequence low pressure setting. Refer to the Sequencing and Protocol manual for details. The units of measure are 1/16 psig.

Sequence Recover Time

LABEL	ADDR	DEF	MIN	MAX
SEQ_RECOVERTIME	40027	5	2	60

The SEQ_RECOVERTIME register controls the sequence recover time. Refer to the Sequencing and Protocol manual for details. The units of measure are seconds.

Sequence Rotate Time

LABEL	ADDR	DEF	MIN	MAX
SEQ_ROTATEMINS	40028	0	0	32767

The SEQ_ROTATEMINS register controls the sequence rotate time. Refer to the Sequencing and Protocol manual for details. The units of measure are minutes.

eConnect ID

LABEL	ADDR	DEF	MIN	MAX
SEQ_ECONNECTID	40029	0	0	15

The SEQ_ECONNECTID register sets the eConnect ID number for the compressor. Refer to the Sequencing and Protocol Manual and the eConnect Manual for further details.

Date and Time

LABEL	ADDR	DEF	MIN	MAX
CLOCK_SEC	40030	0	0	59
CLOCK_MIN	40031	0	0	59
CLOCK_HOUR	40032	0	0	23
CLOCK_MDAY	40033	1	1	31
CLOCK_MONTH	40034	4	1	12
CLOCK_YEAR	40035	2005	1980	2055
CLOCK_WDAY	40036	6	0	7

These registers are used by the real-time clock in the controller to obtain date and time values. The WS Controller uses these registers to log the times of event occurrences such as faults and warnings. The first six registers are adjustable for seconds through year. WDAY is a read-only register indicating the day of the week.

Countdown Timers

LABEL	ADDR	DEF	MIN	MAX
MBTIMER1	40037	0	0	32767
MBTIMER2	40038	0	0	32767
MBTIMER3	40039	0	0	32767

The MBTIMER1…3 registers are normally not used, but may be field-configured as a control input by an administrator. If this is done, the administrator should provide information on the function. These registers automatically count down to zero at the rate of 10 counts per second. These are the preferred method for employing remote control via Modbus, as they will automatically clear if communications are lost.

Language

LABEL	ADDR	DEF	MIN	MAX
LANGUAGE_REM	40040	0	0	32767

The LANGUAGE register controls the language displayed at a remote user interface.

Maintenance and Warning Reset

LABEL	ADDR	DEF	MIN	MAX
MAINT_RESET	40041	0	0	32767
WARN_RESET	40042	0	0	32767
WARNC_RESET	40043	0	0	32767
WARND_RESET	40044	0	0	32767

The _RESET registers are used to clear maintenance or warnings at the controller. To clear all maintenance and warning indications write the maximum value, 32767, to the register. To clear individual service messages, add the values shown in the matrix below to the minimum value of the register. These registers will self-clear to zero after the reset is completed.

Value	Maintenance	Warning B	Warning C	Warning D
1	Fluid filter	Fluid filter	Dryer Fault	Temp 4 high
2	Separator	Separator	Dryer Overload Fault	Temp 4 low
4	Air filter	Air filter	Dryer High Temp Fault	Temp 5 high
8	Oil analysis	Temp 1 high	Dryer Low Temp Fault	Temp 5 low
16	Oil change	Temp 1 low	Dryer High Temp Warning	Temp 6 high
32	Maintenance	Temp 2 high	Dryer Low Temp Warning	Temp 6 low
64		Temp 2 low	Not Commissioned	Temp 7 high
128		Temp 3 high	Brownout	Temp 7 low
256		Temp 3 low	Dryer high Moisture	Temp 8 high
512		Power int	Expansion Comm Error	Temp 8 low
1024		Seq comm.		Temp 9 high
2048		User		Temp 9 low
4096		Battery		Temp 0 high
8192		Dryer		Temp 0 low
16384		VFD Overtemp		DP2 High
32168		Ethernet		High Interstage Press

Modbus port settings

LABEL	ADDR	DEF	MIN	MAX
MBPC_ADD	40047	1	1	247
MBPC_BAUD	40048	384	12	576
MBPC_PAR	40049	0	0	3
USER_PW	40050	0	0	32737
MBPE_ADD	40051	1	1	247
MBPE_BAUD	40052	192	12	576
MBPE_PAR	40053	1	0	3

These registers hold independent settings for the RS485 and RS232 Modbus ports. Any change should be carefully noted, particularly what the value was changed from and changed to. An improper setting of this register can disable communication between the PC and controller. The controller power must be cycled once for the change to take effect. By setting controllers to different numbers, multiple controllers may be connected to an appropriate network, and can be addressed individually via the WSPC interface.

MBPC_ADD register controls the Modbus address number for RS232.

MBPC_BAUD register holds the baudrate/100 for RS232. 1200, 2400, 4800, 9600, 19200, 38400, 57600 are supported.

MBPC_PAR register holds the parity for RS232. 0=none, 1=even, 2=odd, 3=2stop

USER_PW register holds a number for password protection by remote interfaces

MBPE_ADD register controls the Modbus address number for RS485.

MBPE_BAUD register holds the baudrate/100 for RS485. 1200, 2400, 4800, 9600, 19200, 38400, 57600 are supported.

MBPE_PAR register holds the parity for RS485. 0=none, 1=even, 2=odd, 3=2stop

When used with an Expansion Module, port E must be set to Add=1, BAUD=576, PAR=0

IP port settings - Controller

LABEL	ADDR	DEF	MIN	MAX
IP_FLAGS	40101	0	0	32767

LABEL	ADDR	DEF
IP_1 - IP_4	40102-40105	192.168.1.3
NM_1 - NM_4	40106-40109	255.255.0.0
NS_1 - NS_4	40110-40113	192.168.1.1
GW_1 - GW_4	40114-40117	192.168.1.1
PORT_MB	40119	502
PORT_X	40120	80

These registers hold the settings for the IP port only, when so equipped. The IP address will be used for all Ethernet services. Refer to books or on-line literature for setting up a local network, or contact the network administrator before connecting to an existing network. Any change should be carefully noted, particularly what the value was changed from and changed to. An improper setting of this register can disable communication between the PC and controller. The controller power must be cycled once for the change to take effect. By setting controllers to different numbers, multiple controllers may be connected to an appropriate network.

When IP_FLAGS is set to "1", the address will be for a local-link crossover cable to a Windows PC, at address169.254.250.249, netmask 255.255.0.0. The default setting of "0" will set the IP to the address in the following user-adjustable registers.

IP registers determine the IP address of the controller.

NM registers determine the netmask settings for the local area network.

NS registers determine the nameserver address for the network.

GW registers determine the gateway server address.

PORT_MB determines the port for Modbus service. Normally 502, it may be altered for port addressing.

PORT_X determines the port for other Ethernet service. Normally 80, it may be altered for port addressing.

Refresh delay for web pages

LABEL	ADDR	DEF	MIN	MAX
REFRESH	40118	10	2	600

This register applies to controllers with web servers only. Set this for the desired page update rate of the current operating data, in seconds.

User-selectable log data source

LABEL	ADDR	DEF	MIN	MAX
LOG_23_SOURCE	40124	30085	0	49999
LOG_24_SOURCE	40125	30088	0	49999

These select two columns of data to be included in data logging. Enter the Modbus address of the data to be recorded. The default settings select CFM and KW, and as described in the input registers below. This is applicable to software versions 02250189-301 or later.

IP port settings - User Interface

LABEL	ADDR	DEF	MIN	MAX
UI_IP_FLAGS	40131	0	0	32767

LABEL	ADDR	DEF
UI_IP_1 - IP_4	40132-40135	192.168.1.2
UI_NM_1 - NM_4	40136-40139	255.255.0.0
UI_NS_1 - NS_4	40140-40143	192.168.1.1
UI_GW_1 - GW_4	40144-40147	192.168.1.1
UI_PORT_MB	40149	502
UI_PORT_X	40150	80

These registers hold the settings for the IP port only, when so equipped. The IP address will be used for all Ethernet services. Refer to books or on-line literature for setting up a local network, or contact the network administrator before connecting to an existing network. Any change should be carefully noted, particularly what the value was changed from and changed to. An improper setting of this register can disable communication between the PC and controller. The controller power must be cycled once for the change to take effect. By setting controllers to different numbers, multiple controllers may be connected to an appropriate network.

When IP_FLAGS is set to "1", the address will be for a local-link crossover cable to a Windows PC, at address169.254.250.249, netmask 255.255.0.0. The default setting of "0" will set the IP to the address in the following user-adjustable registers.

IP registers determine the IP address of the controller.

NM registers determine the netmask settings for the local area network.

NS registers determine the nameserver address for the network.

GW registers determine the gateway server address.

PORT_MB determines the port for Modbus service. Normally 502, it may be altered for port addressing.

PORT_X determines the port for other Ethernet service. Normally 80, it may be altered for port addressing.

Refresh delay for web pages

LABEL	ADDR	DEF	MIN	MAX
UI_REFRESH	40148	10	2	600

This register applies to controllers with web servers only. Set this for the desired page update rate of the current operating data, in seconds.

7.2 User Input Registers

This version of software has input registers numbered 30001-30760 (register 1-760, communications address 0x0000 – 0x02F7) available for reports of general information about the compressor. Many are for internal or diagnostic use, but may be monitored if desired. Registers not shown below are unused, but reserved for future use.

User Interface Request

LABEL	ADDR
UIREQ	30001

The UIREQ register holds keypress data from the machine's user interface for internal use.

User Interface Voltage

LABEL	ADDR
UIVOLT	30002

The UIVOLT register holds the control voltage measured in the User Interface. The units of measure is 10 millivolts.

User Interface Flags

LABEL	ADDR
UIFLAGS	30003

The UIFLAGS register bits indicate certain general setups:

Bit 0: The package is set up for remote unloading through MBTIMER1.

Bit 1: The package has a variable speed drive.

Bit 2: The package has an integrated dryer

Bit 3: The package has a spiral valve delivery estimator

Bit 4: The package has a "DP2" sensor

Bit 5: The package has a "DP3" sensor

Bit 6: The package has a "large" WS control engine module

Bit 7: The package has a Sullube dryer

Bit 8: The package has a Yaskawa VFD

Bit 9: The package has an Expansion Module

Digital Output Relays

LABEL	ADDR
DIG_OUT	30004

The DIG_OUT register bits indicate which of the output relays are in the "on" state. Bits 0-6 indicate Dout1-7 in the current version of small controllers. Bits 0-8 indicate K0 – K8 on large controllers. Bits 9-15 indicate Expansion Module output relays.

Supervisor Sequence State

LABEL	ADDR
SUPERSEQ_STATE	30005

The SUPERSEQ_STATE register contains the value of the ASCII character for Supervisor sequence states. Refer to the Sequencing and Protocol Manual for details.

Compressor Operating Mode

LABEL	ADDR
MODE	30006

The MODE register contains codes that identify the actual compressor operating mode in effect. Values 0-2 indicate normal operating modes that are controlled by the start/stop keypad at the WS Controller panel and the selected operating mode in the holding register MODE_SET. Values 256 or larger indicate a fault. The compressor operating mode and fault mode codes are listed below.

	Mode	Description
0	STOPPED	manually stopped operating mode
1	CONSTANT	run in constant mode
2	AUTOMATIC	run in automatic mode
256	LO_AN0	analog input below minimum
257	LO_AN1	analog input below minimum
258	LO_AN2	analog input below minimum
259	LO_AN3	analog input below minimum
260	LO_AN4	analog input below minimum
261	LO_AN5	analog input below minimum
262	LO_AN6	analog input below minimum
263	LO_AN7	analog input below minimum
264	LO_AN8	analog input below minimum
265	LO_AN9	analog input below minimum
266	LO_AN10	analog input below minimum
267	HI_AN0	analog input above maximum
268	HI_AN1	analog input above maximum
269	HI_AN2	analog input above maximum
270	HI_AN3	analog input above maximum
271	HI_AN4	analog input above maximum
272	HI_AN5	analog input above maximum
273	HI_AN6	analog input above maximum
274	HI_AN7	analog input above maximum
275	HI_AN8	analog input above maximum
276	HI_AN9	analog input above maximum
277	HI_AN10	analog input above maximum
278	ILSTATE	invalid operating state
279	MOTOR1OL	motor 1 alarm or overload
280	MOTOR2OL	motor 2 alarm or overload
281	ESTOP	emergency stop button
282	WATERP	water pressure switch running
283	UICOMM	user interface communication
284	MVCOMM	main vacon communication
285	FVCOMM	fan vacon communication
286	LOWOILP	low oil pressure running
287	UNUSED287	unused
288	HIGHSUMPP	high sump pressure
289	LOWSUMP	low sump pressure running
290	TEMP1HIGH	high temp 1
291	TEMP1LOW	low temp 1 running
292	TEMP2HIGH	high temp 2
293	TEMP2LOW	low temp 2 running
294	TEMP3HIGH	high temp 3
295	TEMP3LOW	low temp 3 running
296	POWERINT	power interruption
297	WATCHDOG	ce watchdog timer
298	LOWPKGP	system pressure is low after 10 minutes
299	OPTFAULT	admin assignable fault input
300	OPTRUNFAULT	admin assignable run fault input
301	UIVOLTLOW	ui voltage monitor
302	UIVOLTHIGH	ui voltage monitor
303	STARTERAUX	start aux contact

(continued on the next page)

304	HIGHPWET	high pressure fault
305	HIGHPDRY	high pressure fault
306	HIGHPPKG	high pressure fault
307	HIGHPNET	high pressure fault
308	HIGHPHI	high pressure fault
309	HIGHPLO	high pressure fault
310	PHASE	phase relay
311	DRYER	dryer protection
312	DRYEROL	dryer overload
313-378	VFD	Vacon VFD faults 0-65 (refer to drive manual)
379	MEMORY	Controller memory fault
380	CEVOLTLOW	Low voltage to controller
381	CEVOLTHIGH	High voltage to controller
382	DRYER_HIT	High temperature in integrated dryer
383	DRYER_LOT	Low temperature in integrated dryer
384	MVINIT	VFD Initialization error
385	SPIRAL_HIP	High pressure on Spiral Valve actuator
386	F_A_HIGHPINT	High interstage pressure
387	F_A_TEMP4HIGH	high temp 4
388	F_A_TEMP4LOW	low temp 4 running
389	F_A_TEMP5HIGH	high temp 5
390	F_A_TEMP5LOW	low temp 5 running
391	F_A_TEMP6HIGH	high temp 6
392	F_A_TEMP6LOW	low temp 6 running
393	F_A_TEMP7HIGH	high temp 7
394	F_A_TEMP7LOW	low temp 7 running
395	F_A_TEMP8HIGH	high temp 8
396	F_A_TEMP8LOW	low temp 8 running
397	F_A_TEMP9HIGH	high temp 9
398	F_A_TEMP9LOW	low temp 9 running
399	F_A_TEMP0HIGH	high temp 0
400	F_A_TEMP0LOW	low temp 0 running
401	F_D_PUMPOL	Oil pump overload relay
402	F_D_PUMPAUX	Oil pump starter or contact
403	F_C_PORTC_COMM	Port C communication fault
404	F_C_PORTE_COMM	Port E communication fault
405	F_C_PETHR_COMM	Ethernet communication fault
406	F_D_HIGHVOLT	No high voltage at remote starter
407	F_A_UNLOAD	High pressure above unload setting
408	F_A_DP3	Low DP3 while running
409-569	VFD	Yaskawa VFD faults (refer to drive manual)
570	F_D_BROWNOUT	Brownout fault
571	UNUSED287	unused
572	F_Y_NORUN	yaskawa drive not responding to run command
573	F_A_SULDRY_RH	high humidity fault
574	F_D_MOTOR1OT	Main motor over temperature
575	F_D_MOTOR1OT	Fan motor over temperature

Compressor Operating State

LABEL	ADDR
STATE	30007

The STATE register contains codes that identify the operating state of the compressor. These indicate the machines response to the operating mode and the current conditions. Note that some state only apply to special compressor packages.

1 POWERUP
2 FAULTED
3 READY
4 ENABLED
5 AUTOENABLED
6 WAITING FOR BLOWDOWN
7 PRESTART
8 START
9 PAUSE
10 UNLOADED
11 LOADING
12 FULLLOAD
13 MODULATING
14 STOPPING
15 REMOTE UNLOAD
16 REMOTE STOPPING
17 FAULTING
18 UNLOADING
19 REMOTE UNLOADING
20 PRECOOL THE DRYER
21 FLUSH WATER
22 FILL WATER
23 JOG WATER PUMP
24 POST-RUN FLUID PUMP
25 PRE-RUN FLUID PUMP
26 POST-RUN FLUID PUMP - REMOTE
27 POST-RUN FLUID PUMP – AUTOMATIC
28 BROWNOUT

Analog Inputs

LABEL	ADDR	Content	Units
AN0	30008	Temperature T1	1/16 degree F
AN1	30009	Temperature T2	1/16 degree F
AN2	30010	Temperature T3	1/16 degree F
AN3	30011	Pressure P1	1/16 psi
AN4	30012	Pressure P2	1/16 psi
AN5	30013	Pressure P3	1/16 psi
AN6*	30014	Pressure P4	1/16 psi
AN7*	30015	Pressure P5	1/16 psi
AN8*	30016	Temperature T4	1/16 degree F
AN9*	30017	Temperature T5	1/16 degree F
AN10	30018	Control Supply Volts	10mv

The AN0…AN10 registers show the current conditions at the analog inputs. The content and units shown are for the most common compressor versions. Refer to the package wiring diagram and documentation for special packages. *AN6-AN9 apply to large controllers only.

Digital Inputs

LABEL	ADDR
DIG_IN_LO	30019
DIG_IN_HI	30020

The DIG_IN_LO…HI registers identify the present values of digital inputs. In the current version of small controllers, bits 0-8 indicate terminal Din 1-9, bit 15 indicates emergency stop. In the current version of large controllers, bits 0-11 indicate terminal Din 1-12, bit 15 indicates emergency stop. The HI register normally 0, or indicates Expansion Module inputs so equipped.

VFD Drive Control

LABEL	ADDR	Vacon ADDR	Yask ADDR
VFD_CONTROL_WORD	30021	42001	1
VFD_GENLCONT_WORD	30022	42002	10
VFD_SPEED_REF	30023	42003	2
USER_VFD_PRESS	30024	42004	8

These values are written to the VFD drive to control its operation. The third and fourth columns indicate the VFD register addresses. Refer to the VSD drive manual and VFD drive communications manual for further description.

VFD Measurements

LABEL	ADDR	Vacon ADDR	Yask ADDR	Units
VFD_ALARM	30025	--	7F	*
VFD_Y_POUT	30026	--	27	0.1 KW
VFD_STATUS_WORD	30027	32101	20	*
VFD_GENLSTAT_WORD	30028	32102	21	*
VFD_ACTUAL_PCT	30029	32103	23	0.01 %
VFD_ACTUAL_FREQ	30030	32104	24	0.01 Hz
VFD_ACTUAL_SPEED	30031	32105	--	1 rpm
VFD_MOTOR_CURRENT	30032	32106	26	0.1 A
VFD_UNIT_TEMP	30033	32107	68	1/16 degree F
VFD_MOTOR_TEMP	30034	32108	7D8	0.1 %
VFD_ACTIVE_FAULT	30035	32109	7F	*
VFD_DCLINK_VOLTAGE	30036	32110	31	1 V
VFD_MOTOR_TORQUE	30037	32111	--	0.1 %
VFD_UNIT_TEMP_FILTER	30038	32107	68	1/16 degree F
USER_VFD_ILIMITING	30039			0.01 Hz

These registers contain data that are read from the VFD drive to monitor its operation. The third and fourth columns indicate the VFD register source. *Refer to the VSD drive manual and VFD drive communications manual for further description.

Separator pressure drop

LABEL	ADDR
SEP_DELTA	30040

This register holds the separator pressure drop, in units of 1/16 psi.

Dryer pre-cooling count down

LABEL	ADDR
DRYER_COOL	30060

This register shows the amount of time remaining for dryer precooling on machines with an integrated refrigerated dryer, in units of 1/10 second.

Controller Software Version

LABEL	ADDR
SW_PNCE_HIGH	30061
SW_PNCE_LOW	30062
SW_PNCE_DATE	30063

This holds the data to complete the controller software part number. The actual part number is “02250”[HI]”-“[LO] (e.g. 02250167-651)

The date is a sixteen bit integer in the form YYYY YYYM MMMD DDDD.

Compressor Run Data

LABEL	ADDR
MIN_CONT_HI	30065
MIN_CONT_LO	30066
MIN_ENABLED_HI	30067
MIN_ENABLED_LO	30068
MIN_RUN_HI	30069
MIN_RUN_LO	30070
MIN_LOADED_HI	30071
MIN_LOADED_LO	30072
MIN_FULLLOAD_HI	30073
MIN_FULLLOAD_LO	30074
COUNT_STARTS_HI	30075
COUNT_STARTS_LO	30076
COUNT_LOAD_HI	30077
COUNT_LOAD_LO	30078

These registers provide data related to the compressor run status. The first five register pairs hold 30-bit values of minutes for control on, operation enabled, motor running, compressor loaded, and compressor fully loaded. The last two pairs count the number of starts and the number of load cycles of the compressor. To calculate the desired number, multiply the HI register by 32768 then add the LO register value.

Warning and Service Indications

LABEL	ADDR
WARNA	30079
WARNB	30080
WARNC	30081
WARND	30679

The WARN registers hold bits which indicate warnings or recommended service. These are cleared by sending commands to MAINT_RESET or WARN_RESET (see section 7.1 above).

Bit	Warn A-Maintenance	Warning B	Warning C	Warning D
0	Fluid filter	Fluid filter	Dryer Fault	Temp 4 high
1	Separator	Separator	Dryer Overload Fault	Temp 4 low
2	Air filter	Air filter	Dryer High Temp Fault	Temp 5 high
3	Oil analysis	Temp 1 high	Dryer Low Temp Fault	Temp 5 low
4	Oil change	Temp 1 low	Dryer High Temp Warning	Temp 6 high
5	Maintenance	Temp 2 high	Dryer Low Temp Warning	Temp 6 low
6		Temp 2 low	Not Commissioned	Temp 7 high
7		Temp 3 high	Brownout	Temp 7 low
8		Temp 3 low	Dryer high Moisture	Temp 8 high
9		Power int	Expansion Comm Error	Temp 8 low
10		Seq comm.		Temp 9 high
11		User		Temp 9 low
12		Battery		Temp 0 high
13		Dryer		Temp 0 low
14		VFD Overtemp		DP2 High
15		Ethernet		High Interstage Press

User Interface Software

LABEL	ADDR
SW_UIPN_HI	30082
SW_UIPN_LO	30083

This holds the data to complete the user interface software part number. The actual part number is “02250”[HI]”-“[LO] (e.g. 02250167-652)

Commission identification

LABEL	ADDR
COMMISID	30084

This shows zero for controllers which have not yet been commissioned. Other numbers are for Sullair reference tables.

Compressor performance

LABEL	ADDR
CFM	30085
CFMPCT	30086
CFMMAX	30087

These registers show estimated compressor CFM, the percent of package ratings, and the nominal package ratings. Estimated delivery is shown as 70% for conventional machines while modulating. Delivery is calculated throughout the range for variable-speed packages.

VSD compressor performance

LABEL	ADDR
VFD_KW	30088
VFD_KWPCT	30089
VFD_KWMAX	30091

These registers show estimated compressor power, the percent of package ratings, and the nominal package ratings for variable-speed packages only.

Records of recent VSD operation

LABEL	ADDR
VFD_L_MINS_HI	30092
VFD_L_SAV_VD_LO	30157

The block of registers detailed below shows the recent activity of a variable speed drive compressor. Throughout the block, totals are (_HI * 32768 + _LO). The period of time is in the first register pair. Average delivery and power for the period follows in the next four registers. This is followed by an estimated total number of thousands of cubic feet, and the total energy use for the period in KWH. The three register pairs that follow, are estimated KWH for the same quantity of air using CAGI curves for load/unload, inlet modulation, and variable geometry controls. The twenty register pairs that follow indicated the number of minutes run at 0% capacity, 5% capacity, etc. and may be used to generate histograms of recent operation. Finally, costs are calculated for the KWH energy for the VSD control and the other control schemes described above.

Records of lifetime VSD operation

LABEL	ADDR
VFD_L_MINS_HI	30162
VFD_L_SAV_VD_LO	30227

This range is organized just like the last block, but holds lifetime data for the compressor. Refer to the details below.

Detail of VSD operation blocks

LABEL	Recent ADDR	Lifetime ADDR	DESCRIPTION
VFD_MINS_HI	30092	30162	Sample period minutes
VFD_MINS_LO	30093	30163	Sample period minutes
VFD_CFM	30094	30164	average cfm
VFD_CFMPCT	30095	30165	average cfm%
VFD_KW	30096	30166	average kw
VFD_KWPCT	30097	30167	average kw%
VFD_KCF_HI	30098	30168	total thousands cubic feet
VFD_KCF_LO	30099	30169	total thousands cubic feet
VFD_KWH_HI	30100	30170	total kw hours
VFD_KWH_LO	30101	30171	total kw hours
VFD_KWH_LU_HI	30102	30172	total kwh est load/unload
VFD_KWH_LU_LO	30103	30173	total kwh est load/unload
VFD_KWH_IM_HI	30104	30174	total kwh est inlet mod
VFD_KWH_IM_LO	30105	30175	total kwh est inlet mod
VFD_KWH_VD_HI	30106	30176	total kwh est variable displacement
VFD_KWH_VD_LO	30107	30177	total kwh est variable displacement
VFD_PCT_00_HI	30108	30178	minutes 0%
VFD_PCT_00_LO	30109	30179	minutes 0%
VFD_PCT_05_HI	30110	30180	minutes 5%
VFD_PCT_05_LO	30111	30181	minutes 5%
VFD_PCT_ _HI	30112-30145	30182-30215	minutes Hi/Lo in 5% increments
VFD_PCT_95_HI	30146	30216	minutes 95%
VFD_PCT_95_LO	30147	30217	minutes 95%
VFD_PCT_100_HI	30148	30218	minutes 100%
VFD_PCT_100_LO	30149	30219	minutes 100%
VFD_COST_HI	30150	30220	total cost
VFD_COST_LO	30151	30221	total cost
VFD_SAV_LU_HI	30152	30222	total cost for load/unload
VFD_SAV_LU_LO	30153	30223	total cost for load/unload
VFD_SAV_IM_HI	30154	30224	total cost for inlet mod
VFD_SAV_IM_LO	30155	30225	total cost for inlet mod
VFD_SAV_VD_HI	30156	30226	total cost for variable displacement
VFD_SAV_VD_LO	30157	30227	total cost for variable displacement

Fault Indications and Time Logs

LABEL	ADDR
FAULT_CODEnn	30235-30250
FAULT_HOURSnn_HI	30251-30266
FAULT_HOURSnn_LO	30267-30282

These registers hold fault logs for the last 16 faults occurring in the compressor system. The codes are the same as the MODE codes above. To calculate minutes, multiply the HI reading times 32768 and add the LO reading. Take the previous product and divide by 60 to determine hours. Also see addresses 30647-30678 for fault date and times values.

Fault Sensor Logs

LABEL	ADDR
FAULT_A0_000 (T1)	30283
FAULT_A0_005 (T1)	30284
FAULT_A0_010 (T1)	30285
FAULT_A0_015 (T1)	30286
FAULT_A0_020 (T1)	30287
FAULT_A0_025 (T1)	30288
FAULT_A0_030 (T1)	30289
FAULT_A0_035 (T1)	30290
FAULT_A0_040 (T1)	30291
FAULT_A0_045 (T1)	30292
FAULT_A0_050 (T1)	30293
FAULT_A0_055 (T1)	30294
FAULT_A0_060 (T1)	30295
FAULT_A0_120 (T1)	30296
FAULT_A0_180 (T1)	30297
FAULT_A0_240 (T1)	30298
FAULT_A0_300 (T1)	30299
FAULT_A0_360 (T1)	30300
FAULT_A0_420 (T1)	30301
FAULT_A0_480 (T1)	30302
FAULT_A0_540 (T1)	30303
FAULT_A0_600 (T1)	30304
FAULT_A1_nnn (T2)	30305-30326
FAULT_A2_nnn (T3)	30327-30348
FAULT_A3_nnn (P1)	30349-30370
FAULT_A4_nnn (P2)	30371-30392
FAULT_A5_nnn (P3)	30393-30414
FAULT_A6_nnn (P4)	30415-30436
FAULT_A7_nnn (P5)	30437-30458
FAULT_A8_nnn (T4)	30459-30480
FAULT_A9_nnn (T5)	30481-30502
FAULT_A10_nnn	30503-30524

The FAULT_A0_000 … FAULT_A10_ registers hold sensor logs prior to the most recent fault. The detail for temperature (A0) is detailed above. For each sensor, the record shows the values at approximately 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 120, 180, 240, 300, 360, 420, 480, 540, and 600 seconds prior to the fault. The six arrays A0 through A5 contain data for all available sensors of the WS controller. Pressures units are expressed as 1/16 psig. Temperature units are expressed as 1/16 degrees F. The A10 array shows values of the power supply voltage at the same times intervals, in units of 10 milliVolts.

Controller manufacturing dates

LABEL	ADDR
SW_UIPN_DATE	30525
COMMISS_DATE	30528
BOARD_UI_MFG_DATE	30529
BOARD_CE_MFG_DATE	30530

These record manufacturing dates for controller components. This is applicable to software versions 02250189-301 or later. These four registers indicate the user interface software date, the date of the controller commissioning, and the dates that the circuit boards were manufactured for the user interface and controller.

The date of each is a sixteen bit integer in the form YYYY YYYM MMMD DDDD.

Timestamp

LABEL	ADDR
SAVETIME_HI	30531
SAVETIME_LO	30532

The SAVETIME_HI and SAVETIME_LO registers hold the timestamp of the last update of the non-volatile memory. This is a 32 bit representation of each time.

The format of the HI and LO fault times are: 00MM MMDD DDDh hhhh 00mm mmmm 00ss ssss

where M=months, D=days, h=hours, m=minutes, and s=seconds.

Communication Fault Log

LABEL	ADDR
UI_CFAULTS_LIM	30526
UI_CFAULTSU	30533
UI_CFAULTST	30534

The UI_CFAULTSU and UI_CFAULTST registers keep a running count of internal communication faults. The U register holds recent faults, the T register holds the cumulative total. A fault will occur if UI_CFAULTSU exceeds the limit in UI_FAULTS_LIM.

VFD Communication Fault Log

LABEL	ADDR
VFD_FAULTS_LIM	30527
VFD_IFAULTSU	30535
VFD_IFAULTST	30536
VFD_CFAULTSU	30537
VFD_CFAULTST	30538

The VFD_CFAULTSU and VFD_CFAULTST registers keep a running count of VFD communication faults. The U register holds recent faults, the T register holds the cumulative total. A fault will occur if VFD_CFAULTSU exceeds the limit in VFD_FAULTS_LIM. Initialization faults are recorded separately during power-up processes.

Supervisor Communication Fault Log

LABEL	ADDR
SEQ_CFAULTSU	30539
SEQ_CFAULTST	30540

The SEQ_CFAULTSU and SEQ_CFAULTST registers keep a running count of Supervisor bus communication faults. The U register holds recent faults, the T register holds the cumulative total.

Sequencing Operation Data

LABEL	ADDR
SEQ_MODE	30541-30557
SEQ_STATUS	30558-30574
SEQ_HOURS	30575-30591
SEQ_CAPACITY	30592-30608
SEQ_PRESS	30609-30625
SEQ_NEXT2START	30626
SEQ_NEXT2LOAD	30627
SEQ_NEXT2UNLOAD	30628
SEQ_SYSTEMPRES	30629

These registers hold the values for the sequence system display. The first four arrays are as described in the Supervisor Sequencing and Protocol manual. Pressures in the array are in 1/16 psig units of measure.

Maintenance Indicators

LABEL	ADDR	
MAINT00	30631	Oil filter
MAINT01	30632	Separator
MAINT02	30633	Air filter
MAINT03	30634	Oil analysis
MAINT04	30635	Oil change
MAINT05	30636	Maintenance

The MAINT00…MAINT05 registers hold the time remaining until the next scheduled maintenance. The units of measure are hours.

Fault Logs

LABEL	ADDR
FAULT_TIMEnn_HI	30647-30662
FAULT_TIMEnn_LO	30663-30678

The FAULT_TIMEnn_HI…TIMEnn_LO registers hold fault logs for the last 16 faults occurring in the compressor system. Also see addresses 30235-30282 for fault codes and run times. This is a 32 bit representation of each time.

The format of the HI and LO fault times are: 00MM MMDD DDDh hhhh 00mm mmmm 00ss ssss

where M=months, D=days, h=hours, m=minutes, and s=seconds.

Controller warnings

LABEL	ADDR
WARND	30679

Refer to the information and table at 30079.

Delta Pressure Monitors

LABEL	ADDR
USER_DP3	30684
USER_DP2	30685

These register holds the pressure differences, in units of 1/16 psi. These are typically applied to oil pressure monitoring.

Expansion Module communications

LABEL	ADDR
USER_EXP_COMMFAULTSU	30686
USER_EXP_COMMFAULTST	30687

These register holds the number of recent and total communication errors with the expansion module.

Expansion Analog Inputs

LABEL	ADDR	Content	Units
AN0	30688	Temperature T1	1/16 degree F
AN1	30689	Temperature T2	1/16 degree F
AN2	30690	Temperature T3	1/16 degree F
AN3	30691	Pressure P1	1/16 psi
AN4	30692	Pressure P2	1/16 psi
AN5	30693	Pressure P3	1/16 psi
AN6*	30694	Pressure P4	1/16 psi
AN7*	30695	Pressure P5	1/16 psi
AN8*	30696	Temperature T4	1/16 degree F
AN9*	30697	Temperature T5	1/16 degree F
AN10	30698	Control Supply Volts	10mv

The AN0…AN10 registers show the current conditions at the expansion module analog inputs. The content and units shown are for the most common compressor versions. Refer to the package wiring diagram and documentation for special packages. *AN6-AN9 apply to large controllers only.

Control Module Serial Numbers

LABEL	ADDR
BOARD_SNCE_	30711-720
BOARD_SNUI_	30721-730

This holds ASCII text data for the controller modules' serial number, 10 characters each. This is applicable to software versions 02250189-301 or later, and boards manufactured 2010 or later.

Controller Hardware Part Numbers

LABEL	ADDR
BOARD_PNCE_HIGH	30741
BOARD_PNCE_LOW	30742
BOARD_PNUI_HIGH	30743
BOARD_PNUI_LOW	30744

This holds the data to complete the modules' hardware part number. Two registers each are provided for the controller and for the user interface. The actual part number is “02250”[HI]”-“[LO] (e.g. 02250167-651) This is applicable to software versions 02250189-301 or later, and boards manufactured 2010 or later.

7.3 User Data Log

This version of software has holding registers numbered 36001-39000 (register 6001-9000, communications address 0x1770 – 0x2327) available for reports of the compressor's recent operation. These data are recorded only in controllers with software versions 02250189-301 or later.

User Data Log

LABEL	Rec 0	Rec 1	Rec 2	Rec 3	Rec 4	...	Rec 120	Reference
LOG_TIME_HI	36001	36026	36051	36076	36101	...	38976	*
LOG_TIME_LO	36002	36027	36052	36077	36102	...	38977	*
LOG_MIN_RUN_HI	36003	36028	36053	36078	36103	...	38978	30069
LOG_MIN_RUN_LO	36004	36029	36054	36079	36104	...	38979	30070
LOG_MODE	36005	36030	36055	36080	36105	...	38980	30006
LOG_STATE	36006	36031	36056	36081	36106	...	38981	30007
LOG_DIG_IN_LO	36007	36032	36057	36082	36107	...	38982	30019
LOG_DIG_OUT	36008	36033	36058	36083	36108	...	38983	30004
LOG_AN0	36009	36034	36059	36084	36109	...	38984	30008
LOG_AN1	36010	36035	36060	36085	36110	...	38985	30009
LOG_AN2	36011	36036	36061	36086	36111	...	38986	30010
LOG_AN3	36012	36037	36062	36087	36112	...	38987	30011
LOG_AN4	36013	36038	36063	36088	36113	...	38988	30012
LOG_AN5	36014	36039	36064	36089	36114	...	38989	30013
LOG_AN6	36015	36040	36065	36090	36115	...	38990	30014
LOG_AN7	36016	36041	36066	36091	36116	...	38991	30015
LOG_AN8	36017	36042	36067	36092	36117	...	38992	30016
LOG_AN9	36018	36043	36068	36093	36118	...	38993	30017
LOG_AN10	36019	36044	36069	36094	36119	...	38994	30018
LOG_VFD_ACTUAL_FREQ	36020	36045	36070	36095	36120	...	38995	30030
LOG_VFD_MOTOR_CURRENT	36021	36046	36071	36096	36121	...	38996	30032
LOG_VFD_UNIT_TEMP	36022	36047	36072	36097	36122	...	38997	30033
LOG_VFD_MOTOR_TEMP	36023	36048	36073	36098	36123	...	38998	30034
LOG_USELECT23	36024	36049	36074	36099	36124	...	38999	(40124)
LOG_USELECT24	36025	36050	36075	36100	36125	...	39000	(40125)

This table contains 120 records. Each record consists of 25 data registers, as noted above. These include records at 5 second intervals before the previous fault, records of 1 minute intervals before the previous fault, and records of recent significant changes in data.

*The format of the HI and LO log times are: 00MM MMDD DDDh hhhh 00mm mmmm 00ss ssss

Formats of the next 21 data registers are as described in the reference registers. The final two are user-selectable in the holding registers. Data format will be as described for the selected data.

7.4 Adjustments record of change Log

This version of software has holding registers numbered 39001-39300 (register 9001-9300, communications address 0x2328 – 0x2454) available for reports of the compressor's recent operation. These data are recorded only in controllers with software versions 02250189-301 or later.

Record of adjustments changes

LABEL	Rec 0	Rec 1	Rec 2	Rec 3	Rec 4	...	Rec 30
ROC_TIME_HI	39001	39011	39021	39031	39041	...	39291
ROC_TIME_LO	39002	39012	39022	39032	39042	...	39292
ROC_MIN_RUN_HI	39003	39013	39023	39033	39043	...	39293
ROC_MIN_RUN_LO	39004	39014	39024	39034	39044	...	39294
ROC_REG_ID	39005	39015	39025	39035	39045	...	39295
ROC_OLD_VALUE	39006	39016	39026	39036	39046	...	39296
ROC_NEW_VALUE	39007	39017	39027	39037	39047	...	39297
	39008	39018	39028	39038	39048	...	39298
	39009	39019	39029	39039	39049	...	39299
	39010	39020	39030	39040	39050	...	39300

This table contains 30 records. Each record consists of 10 data registers, as noted above. These show when recent changes were made to the controller's holding registers.

The format of the HI and LO log times are: 00MM MMDD DDDh hhhh 00mm mmmm 00ss ssss

Run time is in minutes, equal to the HI time times 32768 plus LO.

REG ID is the Modbus register identification number for the holding register shown in section 7.1

The old value was in effect prior to the change.

The new value became effective after the change.

Revisions:

December 4, 2006: Original release for controller software 02250167-651 and later.

April 24, 2007: Revised to cover additional data available on 02250169-179 and later:
Added 30024, 30039 to show additional VFD information (unused on prior versions)
Added warning codes for VFD overtemp in 40042 and 30080 (used on prior versions)

December 12, 2007: Revised for controller software 02250174-082 and later.
Added function code 6 - Write single register
Revised list for UIFLAGS-30003, MODE-30006, STATE-30007
Added new DRYER_COOL-30060, WARNC- 30081, WARNC_RESET-40043

January 4, 2010: Document corrections:
Section 5.3: documentary correction function ID from 16 to 6.
Section 6:documentary correction RS232 connector identification from J12 to J14.
Section 7.1: added new holding registers for new software to be released in 2010:
IP Port settings, Refresh delay, and User-selectable log data source.
Section 7.2: added new faults to Compressor Operating Mode.
Revised function of CFMMAX, revised description of registers 30085-30091.
Added new input registers for new software to be released in 2010:
Control module manufacturing dates, serial numbers, and hardware part numbers.
Section 7.3: Added description of log data in new software to be released in 2010.
Section 7.4 Added description of the adjustment record of change.

March 28, 2010
Section 4, 6, added notes regarding option Ethernet ports
Section 7.1, added Warn D reset, LANGUAGE, USER_MBPC_ADD, USER_MBPC_BAUD, USER_MBPC_PAR, USER_PW, IP_FLAG to IP settings and note. Added LANGUAGE_REM.
Section 7.2 - Added WARN_D, fault codes 386-407, operating states 21-26.
Added large-board rows and revised the description of analog inputs to indicate special construction.

June 1, 2011
Section 7.1 - revised 40042-5, added 40119, 40120, 40131-40150
Section 7.2 - revised 30003, 30006, 30007, 30080-2, added 30684, 30685
Section 7.3 - corrected "Reference" register identifications

January 10, 2012

Section 7 – revised RS232 default, command wizard descriptions.

Section 7.1 – revised number of register space from 130 to 180. Revised registers 40003, 40042, 40043, 40044, 40047-40053.

Section 7.2 – revised 30004, 30006, 30007, 30014-30017, 30019, 30021-30039, 30080, 30081, 30679, 30082, 30083, 30415-30502, 30526, 30527, 30528, 30529, 30530, 30536, 30637

April 10, 2013

Section 7.1 – revised 40017

Section 7.2 – revised 30003, 30006, 30025, 30026, 30033, 30081

October 22, 2015

Section 6 - Added limit to number of registers.

Section 7.1 - revised 40043, 40051 - 40053,

Section 7.2 - revised 30003, 30004, 30006, 30020, 30081, added 30686-30698