Valvcon™
Modbus™ protocol communication module

Installation, maintenance and operating instructions

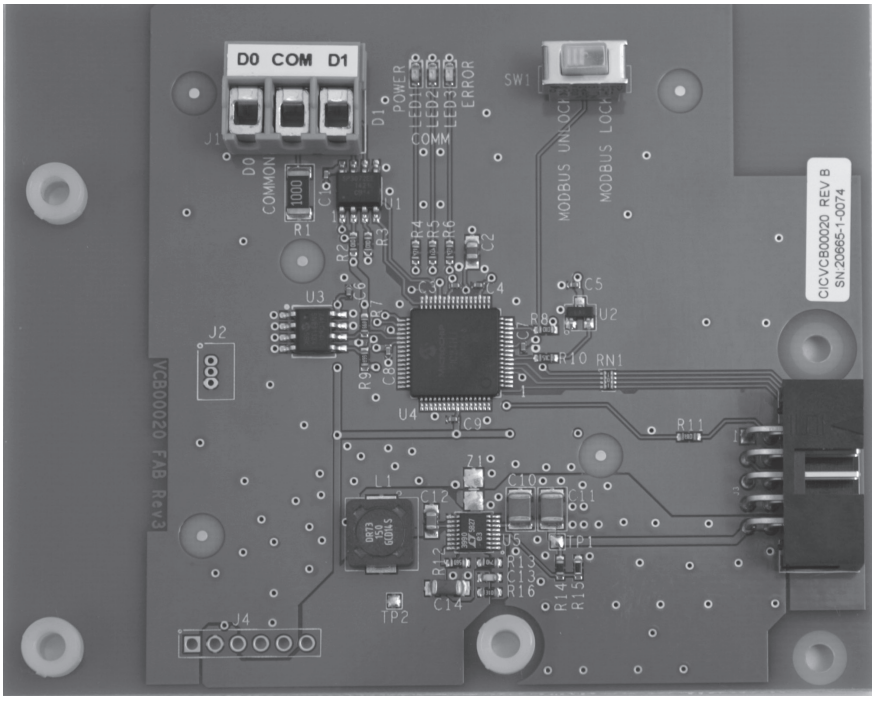


Table of contents

READ THESE INSTRUCTIONS FIRST!

These instructions provide information about safe handling and operation of the valve.

If you require additional assistance, please contact the manufacturer or manufacturer's representative.

SAVE THESE INSTRUCTIONS!

Addresses and phone numbers are printed on the back cover.

1. INTRODUCTION

1.1 PURPOSE

The purpose of this document is to explain how the *Modbus* Host should communicate with the VALVCON™ VCB00020 *Modbus* Communication Module when installed on the VALVCON™ VCB00010. Prior knowledge of the *Modbus* Serial protocol is assumed.

This document is an engineering description of the *Modbus* features of the VALVCON™ VCB00020 *Modbus* Communication Module. Features may change in future versions.

1.2 SAFETY PRECAUTIONS

WARNING

DANGEROUS VOLTAGES ARE PRESENT INSIDE THE ACTUATOR COVER UNLESS THE POWER SUPPLY TO THE ACTUATOR HAS BEEN SHUT OFF ON DISCONNECTED. USE EXTREME CAUTION WHENEVER WORKING ON THE ACTUATOR WITH THE COVER REMOVED.

WARNING

WHENEVER WORKING INSIDE THE ACTUATOR BE SURE TO FOLLOW ALL GUIDELINES, AND HEED ALL WARNINGS IN THIS MANUAL. IF INSTALLING AN OPTION KIT, BE SURE TO READ AND FOLLOW THE SUPPLIED INSTRUCTIONS CAREFULLY AND HEED ANY ADDITIONAL WARNINGS.

1.3 REFERENCES

For background information please see:

Modbus Application Protocol Specification V1.1b by Modbus-IDA, dated December 28, 2006 from
www.*Modbus*-IDA.org

Modbus over Serial Line Specification and Implementation Guide V1.02 by Modbus-IDA, dated December 20, 2006 from
www.*Modbus*-IDA.org

The VALVCON™ *Modbus* Communication Module is intended to be a “conditionally compliant, BASIC class” device.

1.4 OVERVIEW

The VALVCON™ Communication Module is a *Modbus* slave device. It will receive information from the *Modbus* Host. The VALVCON™ Communication Module will only transmit when requested by the *Modbus* Host.

The VALVCON™ Communication Module *Modbus* Slave operations will be supported as specified in “*Modbus* Application Protocol Specification, v1.1b” and “*Modbus* over Serial Line Specification and Implementation Guide V1.02”. Not every possible *Modbus* command issued by the Modbus Host will be supported. For those commands not supported an exception code (1) will be returned to the Modbus Host.

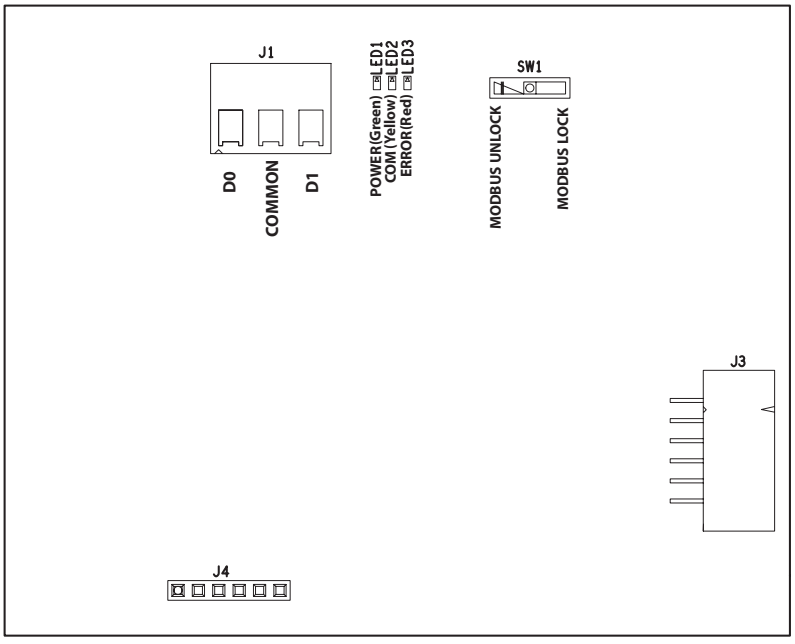


Figure 1 - Connection Diagram

When the VALVCON™ Modbus firmware is active it should respond to all Modbus Host requests within ten milliseconds not including the time to transmit the request and receive the response based on the communication baud rate and size of the two packets. For example, if the baud rate is 9600 and there is a twelve byte request packet followed by a six byte response packet, the complete sequence should take no more than 28 milliseconds based on (12 x 1 msec) + 10 msec + (6 x 1 msec) = 28 msec.

1.5 CIRCUIT BOARD ATTRIBUTES (SEE FIGURE 1)

1. J1, Customer Wiring Terminal Block for Network Wiring
2. J3, VCB00010 Interface Connection
3. LED's, Power, Comm, & Error
4. SW1, Modbus Lock Switch
5. J4 (Factory use only)

2. NETWORK WIRING

The VALVCON™ *Modbus* Communication Module implementation is based on RS485 2W configuration. Network Cabling and installation is the responsibility of the system integrator and should follow the guidelines provided by *Modbus* over Serial Line Specification and Implementation Guide V1.02.

2.1 CABLES

A *Modbus* over Serial Line Cable must be shielded. At one end of each cable its shield must be connected to protective ground. If a connector is used at this end, the shell of the connector is connected to the shield of the cable.

An RS485-*Modbus* must use a balanced pair (for D0-D1) and a third wire (for the Common).

WARNING

CONNECTION OF A CROSSED CABLE IN A 2-WIRE MODBUS SYSTEM MAY CAUSE DAMAGES.

2.2 TWO-WIRE MODBUS DEFINITION

A *Modbus* solution over serial line should implement a "Two-Wire" electrical interface in accordance with EIA/TIA- 485 standard. On such a 2W-bus, at any time one driver only has the right for transmitting. In fact a third conductor must also interconnect all the devices of the bus: the common. (see **Figure 2**)

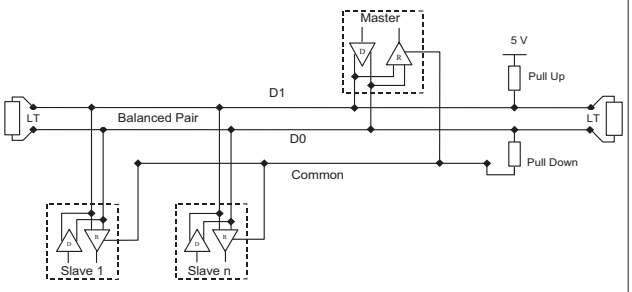


Figure 2 - Typical Schematic

2.3 TERMINAL BLOCK

2.4 GROUND CONNECTION

The VALVCON™ *Modbus* Communication Module circuit ground is connected to RS485 common through a 100 ohm resistor

WARNING

THE USE OF ISOLATED TRANSCEIVERS AT OTHER NODES OR ISOLATED REPEATERS ARE NECESSARY TO AVOID ISSUES WITH UNEXPECTED GROUND CURRENTS..

2.5 UNIT LOAD

The RS485 receiver used on VALVCON™ *Modbus* Communication Module board presents a 1/8 unit load to the network, theoretically allowing up to the maximum number of addressable devices (247) on the network without needing to use a repeater.

2.6 LINE TERMINATION RESISTORS

The VALVCON™ *Modbus* Communication Module board does not provide a dedicated line terminator resistor. A resistor may be inserted into the terminal block to provide the line termination if the VCB00020 is at the end of the line. A 120 ohm line termination resistor is recommended at each end of the transmission line to improve signal quality and minimize the reflections from the end of the RS485-cable.

2.7 LINE POLARIZATION RESISTORS

Line polarization resistors are not provided on the VALVCON™ *Modbus* Communication Module board. The receivers used on VALVCON™ *Modbus* Communication Module board are "failsafe" receivers and do not require line polarization.

3. PARTS VERIFICATION AND INSTALLATION

3.1 ADC-SERIES PARTS VERIFICATION

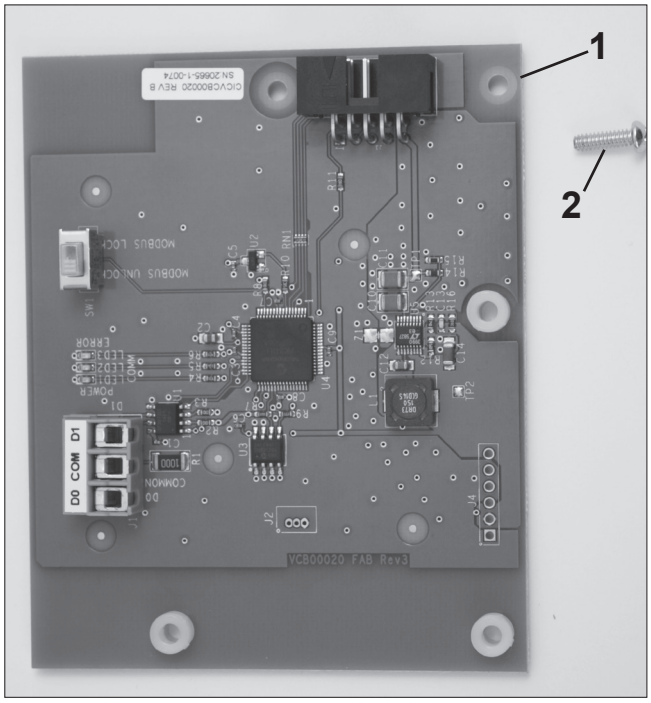


Figure 3 - Communication Module

Table 2 - VCK00001 ADC (150-600 lb-in)			
Item #	Parts #	Description	Quantity
1	VCB00020	*Modbus* Comm Board	1
2	VC001245	#4-40x3/8" Phillips Screw	1

1. Locate the replacement VCK00001 upgrade kit for an ADC (if installing VCK00002 for LADC, refer to LADC section of this manual).
2. Verify parts received to the parts listed in **Table 2** and **Figure 3** above.
3. Inspect all parts and hardware to be certain that it is free of damage that may have occurred in shipping.
4. Collect the tools required, refer to **Table 3**.

Table 3 - Tools Required	
5 mm Hex wrench (ADC-Series)	6 mm Hex wrench LADC-Series)
#1 Phillips screwdriver	Small Flat Blade Screwdriver
1/16 inch Hex wrench	#2 Phillips screwdriver

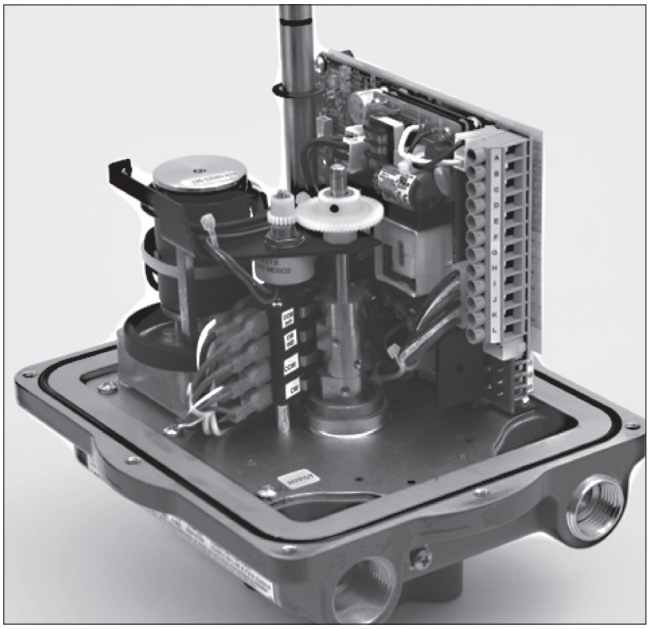


Figure 4 - Cover Removal

Remove the actuator cover, using a 5 mm hex wrench for an ADC. This is what the inside should resemble.

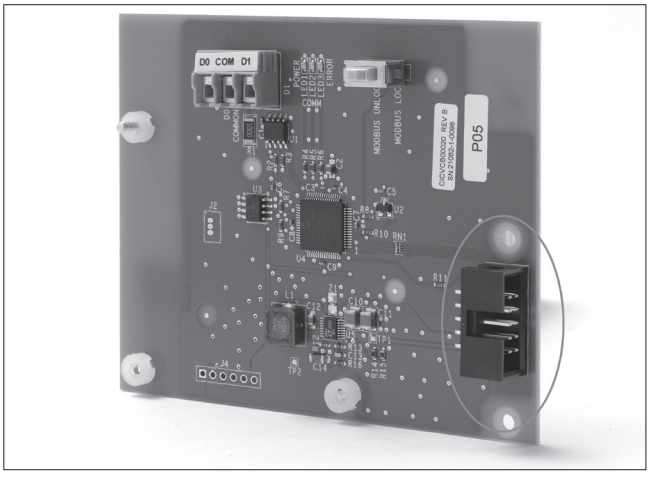


Figure 5 - Communication Module

Locate the VCB00020 *Modbus* Board. Locate the connector. (Shown in **Figure 5**)

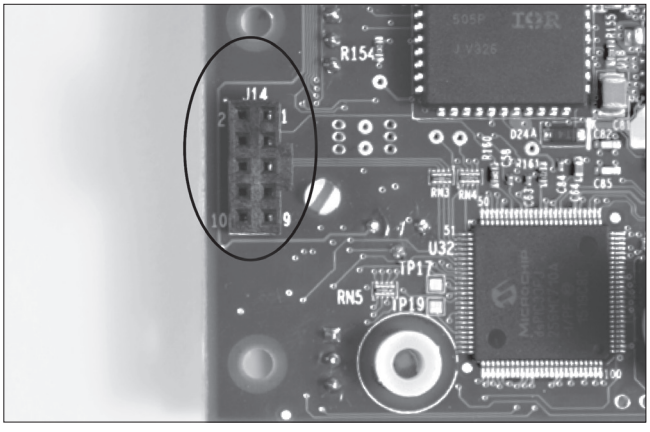


Figure 6 - "J14" Connection

Locate "J14" on the VCB00010 control board.

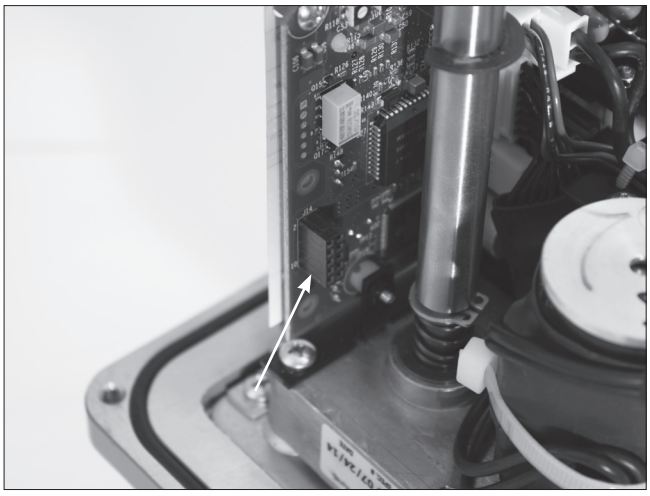


Figure 7 - Connect Boards

Plug the VCB00020 *Modbus* board directly into J14 of the VCB00010 board.

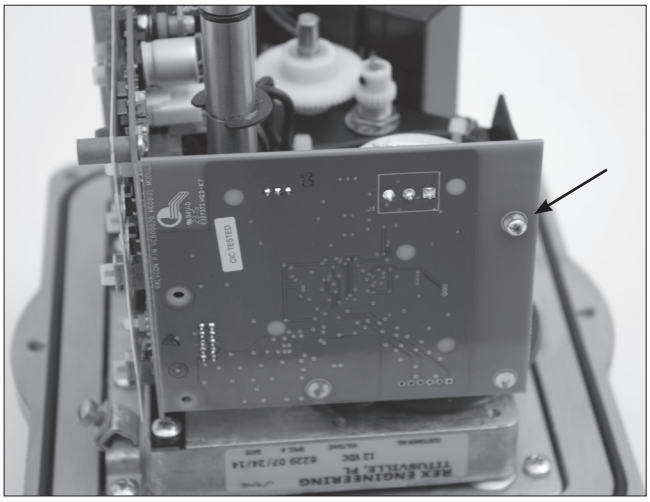


Figure 8 - Secure Board

Install the #4-40 x 3/8”screw(supplied with kit) to securethe board to the bracket as shown. (See **Figure 8**)

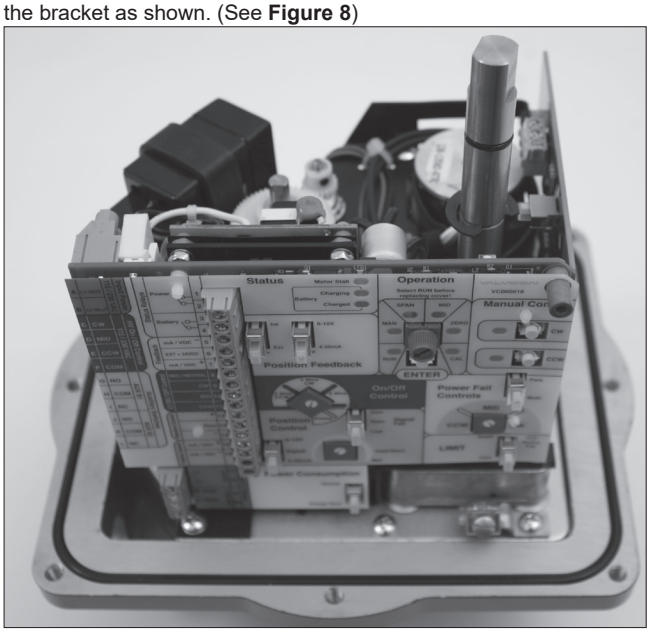
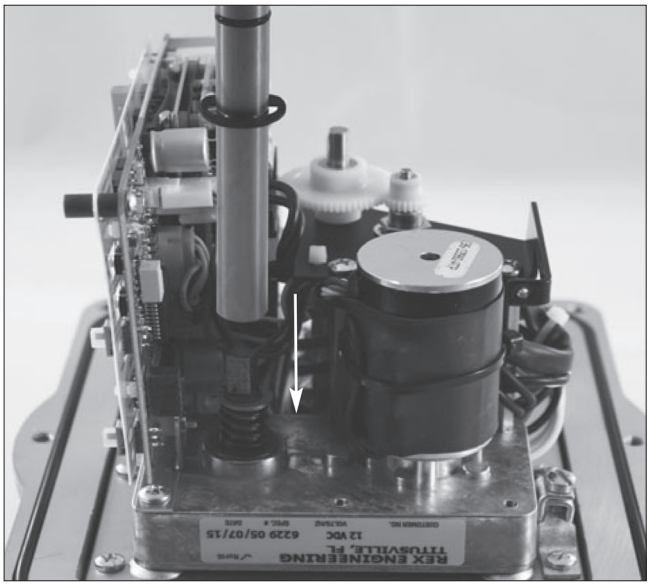


Figure 9 - Board Installed

Refer to sections 1 & 2 of this manual for wiring information. Once the actuator is calibrated and set for the application you need to re-install the cover. Locate and remove the over-ride shaft from the cover, and install it on the square shaft of the motor.



Modbus Communication Module has been removed to better show override shaft installation.

Figure 10

Use the shaft to guide the cover onto the base and secure it with the screws that were previously loosened. Take care to ensure o-ring remains in groove and that it and any wires are not pinched when securing cover.

3.2 LADC-SERIES PARTS VERIFICATION

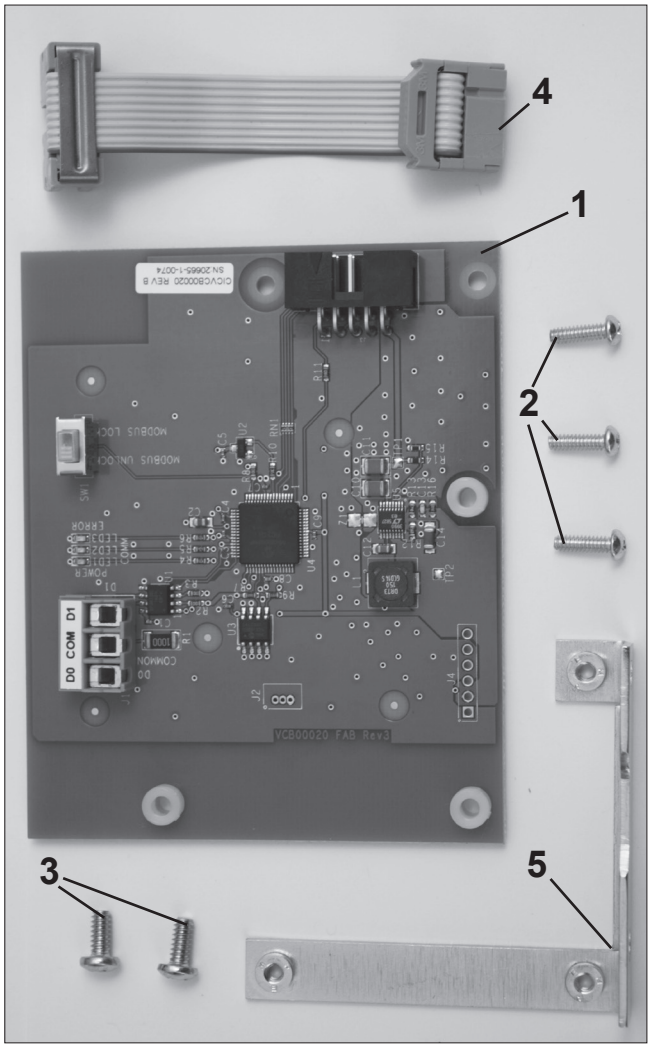


Figure 11 - VCK00002

Table 4 - VCK00002 LADC (1000-3000 lb-in)			
Item #	Parts #	Description	Quantity
1	VCB00020	*Modbus* Comm Board	1
2	VC001245	#4-40x3/8" Phillips Screw	3
3	VC001032	#6-32x3/8", Phillips, Screw	2
4	VCE00001	2" Comm Interconnect Cable	1
5	VCM00005	Comm Board Mounting Bracket	1

LADC INSTALLATION (1000-3000 LB-IN MODELS)

1. Locate the replacement VCK00002 upgrade kit for an LADC (if installing VCK00001 for ADC, refer to ADC section of this manual).
2. Verify parts received to **Table 4** and **Figure 11**.
3. Inspect all parts and hardware to be certain that it is free of damage that may have occurred in shipping.
4. Collect the tools required, refer to the **Table 3**.

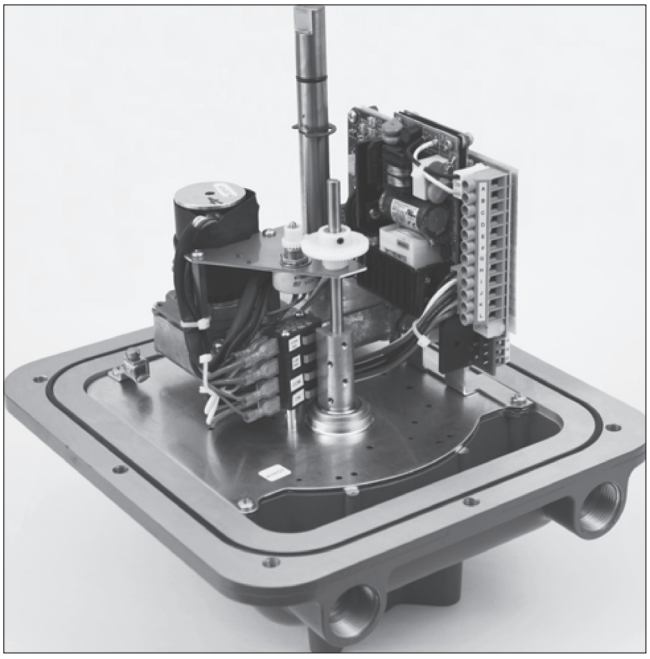


Figure 12 - LADC Internals

Remove the actuator cover, using a 6 mm hex wrench to loosen the cover screws (note that the cover retains the screws; they do not need to be completely removed from the cover). The actuator will resemble **Figure 12** above.

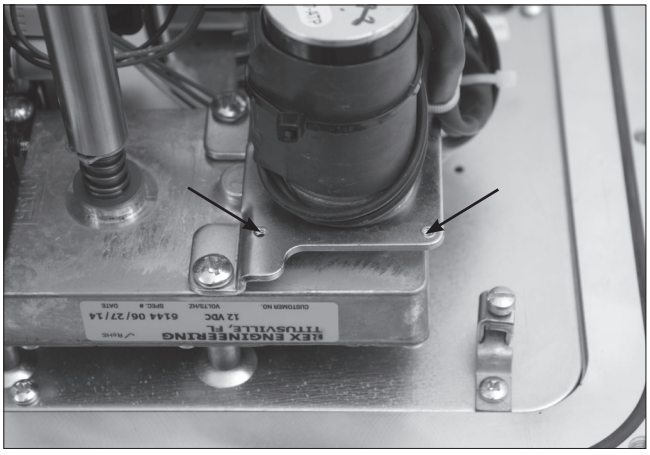


Figure 13 - Screw Locations

Note the screw locations found on the Motor Gearbox. See **Figure 13**.

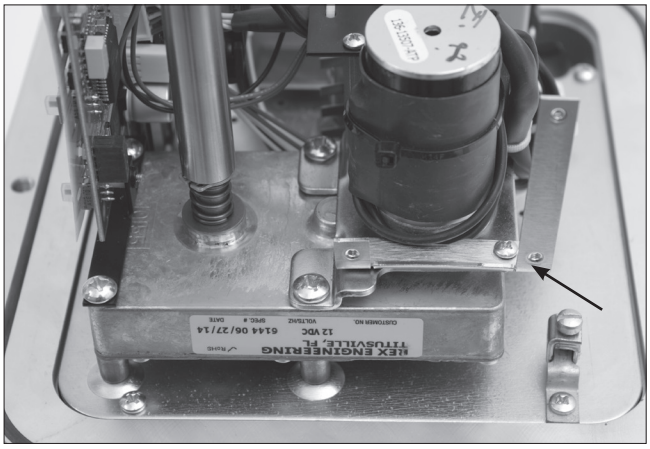


Figure 14 - Bracket Locations

Locate the *Modbus* board bracket (See **Figure 11**) and install to the motor bracket using supplied #6-32 x 3/8" phillips screws (2) as shown. (See **Figure 14**)

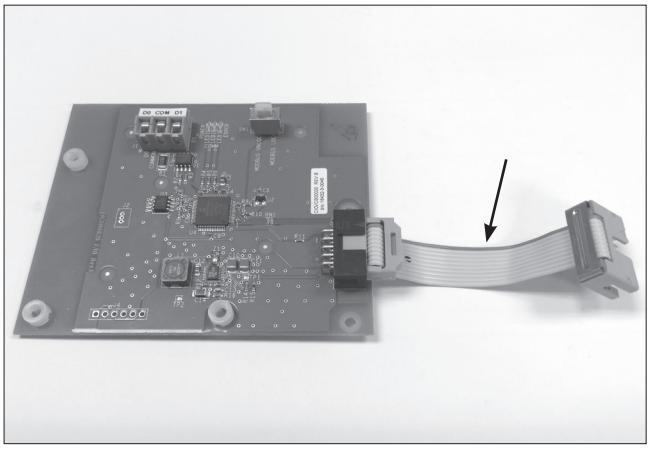


Figure 15 - Cable

Locate the *Modbus* board and cable, and install the cable as shown. (See **Figure 15**) (Note the red stripe on the cable is on top as shown.)

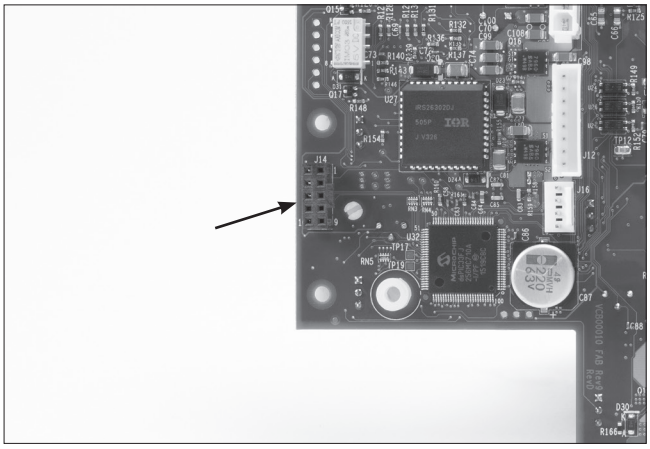


Figure 16 - "J14" Connector

Locate J14 on the VCB00010 control board, and note the locating tab.

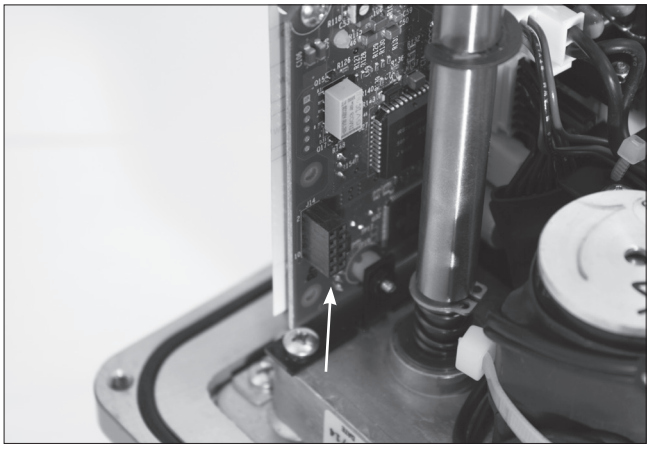


Figure 17 - Cable Connection

Locate the free end of the cable. (VCE00001) (See **Figure 15**)

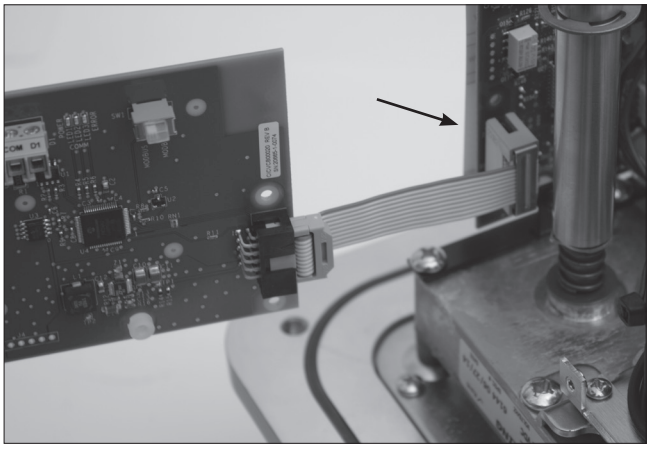


Figure 18 - Control Board Connector

Install the free end of the cable to "J14" of the control board as shown (red stripe up). (See **Figure 18**)

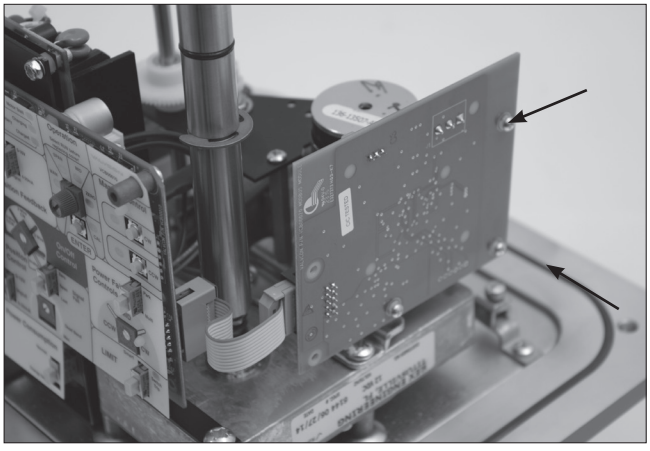


Figure 19 - Install Communication Module

Rotate the board to the right and install the three #4-40 x 3/8" Phillips screws (supplied with kit) to secure it to the bracket. (See **Figure 19**)

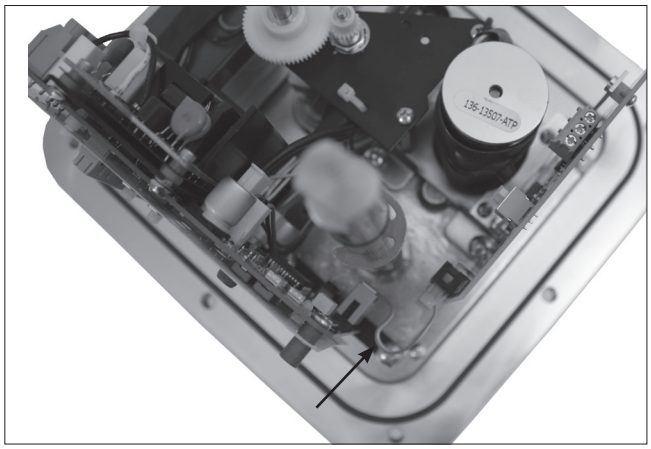


Figure 20 - Installed Cable (as viewed from above)

Make sure the cable looks like **Figure 20** to avoid issues.

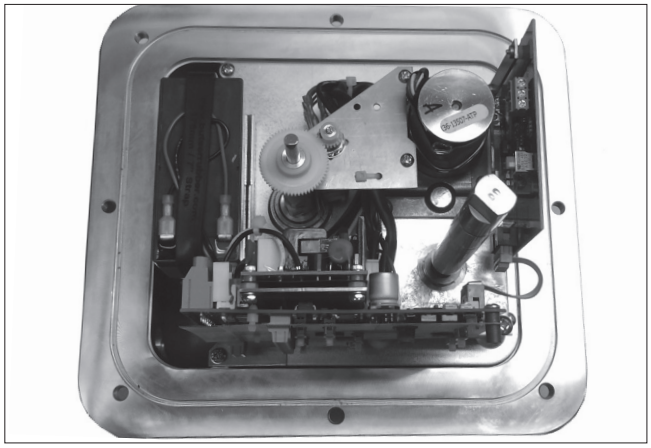


Figure 21 - Board Installed

Refer to sections 1 & 2 of this manual for wiring information. Once the actuator is calibrated and set for the application you need to re-install the cover. Locate andremove the over-ride shaft from the cover, and install it onthe square shaft of the motor.

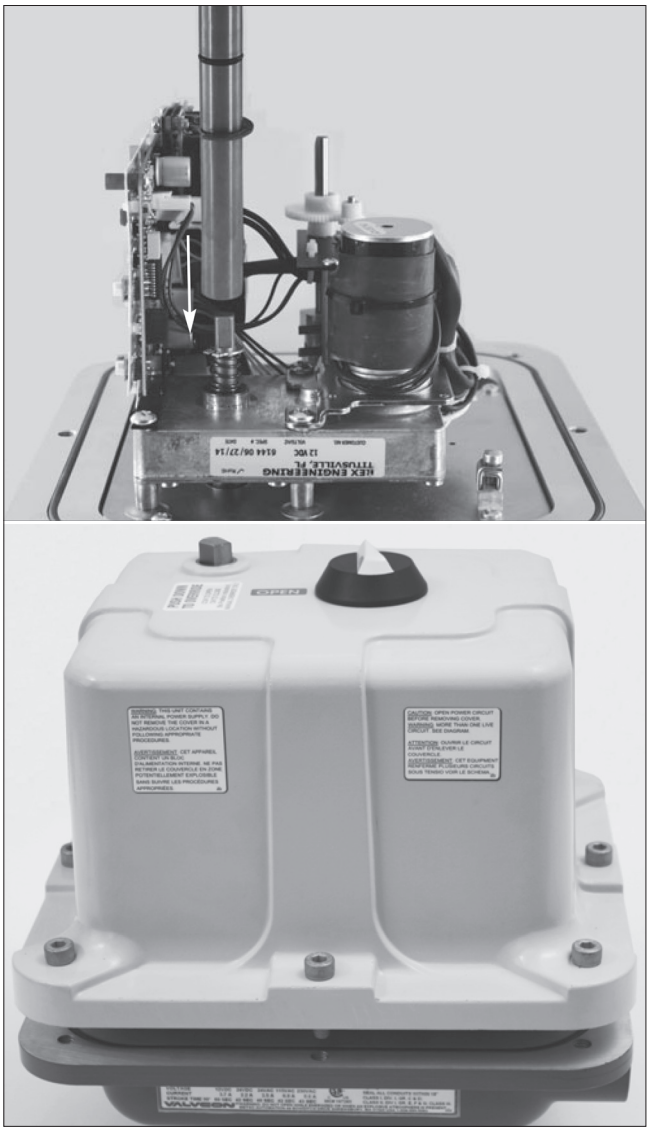


Figure 22 - Install Cover

Use the shaft to guide the cover onto the base and secure it with the screws that were previously loosened. Take care to ensure o-ring remains in groove and that it and any wires are not pinched when securing cover.

4. *MODBUS* IMPLEMENTATION

4.1 GENERAL SETUP INFORMATION

Table 5	
Address	**Default is 1, can be changed via direct connection to a Modbus Host**
Transmission Mode	RTU
Electrical Interface	RS485, multidrop, half-duplex (2-wire)
Parity	Default is Even
Data Rate	Default is Autobaud (9600 or 19200)

Table 6	
LED Name/Use	**Color**
Power On	Green
Communication Active	Yellow
Communication Error or Device Error	Red

FUNCTION CODES

All *Modbus* function codes specified in "*Modbus* Application Protocol Specification, v1.1b" are listed in table 7. Only function codes 8 and 43 have subcodes. Supported functions are indicated in table 7.

The VALVCON™ *Modbus* firmware treats Read Holding Registers and Read Input Registers the same. The VALVCON™ *Modbus* firmware will return the following for the Read Device Identification function code to the right of the equal sign:

Table 7

Code	Subcode	Description
3		Read Holding Registers
4		Read Input Registers
6		Write Single Registers
8	00	Diagnostic, Return Query Data (aka Echo)
8	10	Diagnostics, Clear Counters and Diagnostic Register
8	11	Diagnostic, Return Bus Message Count
8	12	Diagnostic, Return Bus Communication Error Count
8	13	Diagnostic, Return Bus Exception Error Count
8	14	Diagnostic, Return Slave Message Count
8	15	Diagnostic, Return Slave No Response Count
8	16	Diagnostic, Return Slave NAK Count
8	17	Diagnostic, Return Slave Busy Count
8	18	Diagnostic, Return Bus Character Overrun Count
8	20	Diagnostic, Clear Overrun Counter and Flag
23		Read/Write Multiple Registers
43	14	Read Device Identification

VendorName =Neles

ProductCode =VCB00020

MajorMinorRev =674

VendorUrl =www.neles.com

ProductName =*Modbus* Communication Module

ModelName =VCB00020

EXCEPTION CODES

Supported Exception Codes are listed in table 8.

Table 8

Code	Exception
1	Illegal Function (function code not supported)
2	Illegal Data Address
3	Illegal Data Value
4	Slave Device Failure (could not execute function code)
6	Slave Device Busy

4.2 MODBUS REGISTERS

REGISTER SIZE

All VALVCON™ *Modbus* registers are 16-bit. Any data that will not fit in 16-bits is placed in adjoining 16-bit registers. The VALVCON™ *Modbus* firmware will accept a single request from the *Modbus* Host to read multiple registers. **NOTE:** The total number of registers in one request cannot exceed sixteen.

For 32-bit data fields that span two 16-bit registers, the *Modbus* Host should read the two 16-bit registers with one request to ensure the entire received 32-bit data field is valid.

The *Modbus* Host can write more than one VALVCON™ 16-bit register at a time. For 32-bit data fields that span two 16-bit registers, the *Modbus* Host must write the two 16-bit registers with one request. The number of registers to write in one request cannot exceed sixteen. **NOTE:** Any attempt to write a register that is not defined or a register that is defined as read-only will generate a *Modbus* exception. In the case of a multiple register write command that includes a non-writeable register, none of the registers will be written.

REGISTER VALUES

All 16-bit and 32-bit fields are unsigned unless explicitly stated to be "signed". Signed fields are two's-complements. All 16-bit and 32-bit fields are stored as "little-endian" (least significant byte first). Bit 0 is least significant bit of a 16-bit or 32-bit field.

REGISTER ASSIGNMENTS

The register assignments are divided into different functional groups. Per the *Modbus* spec, the maximum register address is 0x270F or 9999.

Writeable registers are limited to single parameters in order to reduce the chance of mistakenly setting the wrong parameter.

Read-only register assignments have been chosen to, on the one hand provide data in a succinct form to reduce the number of *Modbus* queries and network transmission time needed, while on the other hand provide easily understood data with simple queries.

Data that is naturally limited to only a very few choices, such as switch settings, is bit packed and multiple settings are grouped within a register.

Data that may range over a wider range of values, such as voltage, current and temperature readings have individually readable registers. Registers may be read using the "read multiple register" command to significantly reduce transaction time.

Consult your Controller Manual for specific behavior. Registers are addressed starting at zero, therefore controller registers 1-16 are addressed as 0-15.

5. READ/WRITE MODBUS REGISTER ASSIGNMENTS

5.1 SCRATCHPAD

Test out being able to read and write to the actuator without changing setting or parameter values by using the scratchpad registers 0 & 1.

Registers 0 & 1 can be found on page 12 (Complete Register List)

5.2 MODBUS PARAMETERS

ADDRESSING

Every VALVCON™ *Modbus* Communication Module board will be manufactured with the same *Modbus* device address (which is 1). The device address should be changed before adding a second slave device to the *Modbus* network. It is recommended that all VALVCON™ Communication Module slave addresses be changed and NOT to use address 1 in an actual *Modbus* network. The device address can be changed to another value by the *Modbus* Host writing to the VALVCON™ Communication Module *Modbus* Device Address Register. The Addressing Registers are 20-25.

WARNING

ENSURE AT THE TIME OF THE DEVICE ADDRESSING THAT THERE ARE NOT TWO DEVICES WITH THE SAME ADDRESS. IN SUCH A CASE AN ABNORMAL BEHAVIOR OF THE WHOLE SERIAL BUS CAN OCCUR. THE MASTER WOULD BE UNABLE TO COMMUNICATE WITH THE SLAVES ON THE NETWORK.

AUTOBAUD SUPPORT

Autobaud for *Modbus* RTU packets will be supported for two baud rates: 9600 and 19200. The VALVCON™ *Modbus* firmware will track framing errors to determine whether to switch to the other baud rate. The basic algorithm is to switch to a different baud rate after about 10 to 20 sequential framing errors have been detected. The *Modbus* Host device must not also vary its baud rate, rather it should repeatedly send a message at the desired rate until the VALVCON™ Actuator locks onto the proper rate.

MODBUS PARITY

If choosing “No Parity” the controller needs to have 2 stop bits to account for the missing Parity Bit. If choosing “Even Parity” or “Odd Parity” the controller only needs to have 1 stop bit.

MODBUS ACTIVITY TIME OUT

This register allows a user to fine tune Low Power operation vs. having to repeat *Modbus* commands because the actuator is sleeping. It is measured in Seconds before it allows Low Power Sleep mode. Whether or not the VCB00020 module enters sleep mode is determined by the activity of the VCB00010 board.

MODBUS LOCK SWITCH

To prevent the *Modbus* Parameters (Device Address, Baud Rate, and Parity) from being accidently changed, the *Modbus* Lock Switch, can be set to “Lock” to prevent any future update. The state of the *Modbus* Lock Switch can be viewed in the Configuration Settings Register 61 and *Modbus* LOCK Switch Register 120.

6. READ ONLY MODBUS REGISTER ASSIGNMENTS

6.1 MANUFACTURING INFO

The Manufacturing Info Registers are 30-35 and 140-145 where installed Firmware Revision and Circuit Board Serial Numbers are stored for both the VCB00010 Control Board and the VCB00020 *Modbus* Board.

6.2 STATUS

The user may choose to read Value of Motor Current and System Status Bits as a 32 bit read to get simultaneous measurements. The System Status Registers are 40-49 and 130-133 and the information in Register 41 is also mirrored in the registers 90-101.

6.3 CALIBRATION

Calibration is only performed manually. The results of the calibration may be read from registers 50-56.

6.4 USER CONFIGURATION INFO

User Configurations are set by front panel controls on the VCB00010 Circuit Board. The value of these settings may be read from the following registers. These values change only when a user adjusts front panel controls. The User Configuration registers are 61-63 and the information in Register 61 is also mirrored in the registers 110-120.

7. COMPLETE REGISTER LIST

Tag	Register	R/W	Size	Description
0	Scratchpad 0	R/W	16 bit	Testing Only. Any value can be written and read back here. Initialized to 0 at power ON.
1	Scratchpad 1	R/W	16 bit	Testing Only. Any value can be written and read back here. Initialized to 0 at power ON. Register 0 and 1 can be used together to write and read back a 32 bit value.
8	Modbus Heart Beat Value	R/W	16 bit	Heart beat value in seconds set to indicate how often to expect communication to determine when to drive to fail position 0 – Heart Beat disabled (default) Non-zero value – Failure to receive message within this period results in drive to fail position as indicated by register 9 * Note : Heartbeat maybe ignored when enabled if the Activity Timeout(Register 23) is enabled and less than the Heartbeat value Register value is restored after power cycle
9	Modbus Heart Beat Timeout Drive Position	R/W	16 bit	1=Stop, 2=Drive to lower limit: = CW in CAM mode = ZERO in Smart Mode 3=Drive to upper limit: = CCW in CAM mode = SPAN in Smart Mode 4=Drive to MID position, Register value is restored after power cycle
10	*Modbus* Motor Command	R/W	16 bit	Default is 0. 0= Modbus Control Off (respond to wired signals) 1= Stop 2= Drive to CW Limit in CAM Mode or Drive to Zero in Smart Mode 3= Drive to CCW Limit in CAM Mode or Drive to Span in Smart Mode 4= Drive to MID Position 5= Drive to Target (value in Register 11) If power is cycled while this register is NON Zero the register will be initialized to 1 upon return of power. (Modbus will still have control but the motor will be stopped). The register must be rewritten after a power cycle to resume Modbus control. If the VCB00020 Board is removed while this register is a non-zero value then the board may not respond to On/Off or Analog Control signals until a VCB00020 board is reattached and relinquishes control. In Smart Mode Zero and Span may be CW or CCW depending on calibration.
11	*Modbus* Motor Drive Target	R/W	16 bit	Position to move motor to for *Modbus* Motor Command 5. Position Range 0 to 1000. 0= Calibrated Zero Position 1000= Calibrated Span Position
12	*Modbus* Motor Heater Override	R/W	16 bit	Default is 3. This is only valid and acted upon if *Modbus* Motor Command is active. 0=Heater Low Power Mode (turns heater Off to save power) 1=Heater Humid (maintains high temperature to drive out moisture) 2=Heater Cold (maintains a temperature above freezing) 3=Modbus Heater Override OFF (responds to heater pot) If power is cycled while this register is non-zero, the register will be initialized to 3 upon return of power.

Tag	Register	R/W	Size	Description
20	*Modbus*	R/W	16 bit	Default is 1. 0 cannot be set. Reserved for Modbus Broadcast. Address range 1 to 247. This parameter may be changed only if the Modbus Lock switch is not set to “Lock.”
21	*Modbus* Baud Rate	R/W	16 bit	Default is 1. 0= Autobaud 1= 9600 2= 19200 This parameter may be changed only if the Modbus Lock switch is not set to “Lock.”
22	*Modbus* Parity	R/W	16 bit	Default is 0. 0= Auto Parity 1= No Parity 2= Even Parity 3= Odd Parity Note: only Even Parity is required for a Basic Device. This parameter may be changed only if the Modbus Lock switch is not set to “Lock.”
23	*Modbus* Activity Timeout	R/W	16 bit	Default is 60. Timeout 0= never enter low power mode Time Out range is 1 to 65535 seconds.
24	*Modbus* Active Baud Rate	R	16 bit	1=9600 2=19200 This is the actual Baud Rate being used. Use if Register 21 is in Autobaud mode.
25	*Modbus* Active Parity	R	16 bit	1=No Parity 2=Even 3=Odd Parity This is the actual Parity being used. Use if Register 22 is in Auto Parity mode.
30	Motor Firmware Version	R	16 bit	VCB00010 Firmware Version Number
31	*Modbus* Firmware Version	R	16 bit	VCB00020 Firmware Version Number
32	VCB00010 Factory Serial Number	R	16 bit	VCB00010 Factory Serial Number bits 31-16
33	VCB00010 Factory Serial Number	R	32 bit	VCB00010 Factory Serial Number bits 15-0

Tag	Register	R/W	Size	Description
34	VCB00020 Factory Seria Number	R/W	32 bit	VCB00020 Factory Serial Number bits 31-16”
35	VCB00020 Factory Seria Number	R/W		CB00020 Factory Seri Number bits 15-0”
40	Value of Motor Current	R/W	16 bit	Amps in 0.01 A increments
41	System Status Bits	R/W	16 bit	Bit 0 – Motor Running (0= Stopped, 1= Active) Bit 1 – Motor Direction (0= CW, 1= CCW) Bit 2 – Reserved Bit Bit 3 – Awake Status (0= Sleep, 1= Awake) Bit 4 – Power Source (0= External Power, 1= Internal Battery) Bit 5 – Stall Status (0= Not Stalled, 1= Stalled) Bit 6 – Fault/Error Status (0=No Fault, 1= Active Fault) Bit 7 – CW Limit Switch (0= Not Tripped, 1= Tripped) Bit 8 – CCW Limit Switch (0= Not Tripped, 1= Tripped) Bit 9 – Reserved Bit Bit 10 – Reserved Bit Bit 11 – Reserved Bit Bit 12 – Heater Power (0= Not Active, 1= Active) Bit 13 – Battery Charging Circuit (0= Not Charging, 1= Charging Circuit Active) Bit 14 – Battery Status (0= Please Check, 1= OK) Bit 15 – External Power Status (0= Please Check, 1= OK)
44	External Power Voltage DC Value	R	16 bit	Voltage in 100 mV units (123 12.3V) External sources are Diode OR’d to this measurement node. The highest external voltage will drive this node.
45	Internal Battery Voltage	R	16 bit	Voltage in 100 mV units. Measured with the Charger tuned off.
46	Internal Temperature	R	+/- 15 bit	Temperature in Degree C (signed, negative values are 2’s compliment)
47	Motor Drive Target	R	16 bit	Target that motor is driving toward from Register 11 or ired inputs. Range 0 to 1000. 0= Calibrated Zero Position 1000= Calibrated Span osition
48	Actual Position	R	+/- 15 bit	Actual Position of Actuator. Could be outside calibrated range (signed)

Tag	Register	R/W	Size	Description
49	Motor Pot Position	R/W	+/- 15 bit	Actual Position of Actuator read in (0-1023) ADC units
50	Span Position	R/W		Calibrated Span Position (0-1023) ADC units
51	Zero Position	R/W	16 bit	Calibrated Zero Position (0-1023) ADC units
52	Span Position	R/W	16 bit	Span Input A/D Signal (0-1023) ADC units
53	Zero Position	R	16 bit	Span Input A/D Signal (0-1023) ADC units
54	Mid Position	R	16 bit	Calibrated Mid Position (0-1023) ADC units
55	External Pot Zero Value	R	16 bit	External Pot Zero value (0-1023) ADC units
56	External Pot Span Value	R	16 bit	External Pot Span value (0-1023) ADC units
61	Configuration Settings	R	16 bit	Bit 0 – Power Consumption (0= Normal, 1= Allow Sleep) Bit 1 – Power Fail (0= Multicycle, 1= Park) Bit 2 – Signal Fail (0= Hold Last Position, 1= Go To End Position) *If 1 see Bit 14 for M in or Max Bit 3 – Limit (0= Cams, 1= Use Calibrated Limits) Bit 4,5 – Control Mode (00= External Analog Control, 01= 2 Wire CW Control, 10= 2 Wire CCW Control, 11= 3 Wire Control) Bit 6 – Potentiometer Control (0=No Pot Detected, 1= Pot Detected and Used) *Only Valid if Control Mode is in External Analog Control Bit 7,8 – Power Fail (00= Power Fail CCW, 01= Power Fail MID, 10= Power Fail CW, 11= Invalid) Bit 9,10 – Heater Mode (00= Heater Off or Low Power, 01= Cold Mode, 10= Invalid, 11= Humid Mode) Bit 11,12 – Battery Type (00= Sealed Lead Acid, 01= NiMH, 10= Li Ion, 11= No Battery) Bit 13 – Run Mode (0= Run Mode, 1= Zero, Span, Mid, or Cal Mode) Bit 14 – Signal Fail End Position (0= Min, 1= Max) *Only used if Bit 2 is a 1 Bit 15 – Modbus Lock Switch (0=Unlocked, 1= Locked)
62	Current Limit Value	R	16 bit	Amps in 0.1 A increments This is an internal drive limit value that is independent of the gearing. It is NOT a percent of the rated torque. The value is set by the torque limit potentiometer which is normally a factory setting according to the mechanical configuration of the actuator.

Tag	Register	R/W	Size	Description
63	Deadband	R	16 bit	Analog Control Deadband Value Deadband in 0.1% increments of total control range. Range 0 to 20 (0 to 2%)
90	Motor Status	R		0=Stopped 1=Active
91	Motor Direction	R	16 bit	0=CW 1=CCW
92	Awake Status	R	16 bit	0=Sleep 1=Awake
93	Power Source	R	16 bit	0=External Power 1=Internal Battery
94	Stall Status	R	16 bit	0= Not Stalled 1= Stalled
95	Fault/Error Status	R	16 bit	0= No Fault 1= Active Fault
96	CW Limit Switch Status	R	16 bit	0= Not Active 1= Limit Switch Activated
97	CCW Limit Switch Status	R	16 bit	0= Not Active 1= Limit Switch Activated
98	Heater Power	R	16 bit	0= Not Active 1= Active
99	Battery Charging Circuit	R	16 bit	0=Not Active 1= Active 1= Active
100	Battery Status	R	16 bit	0=Please Check 1=OK A Zero indicates when one of the tests in the Battery Status Pass/Fail Values (Register 157) is a zero. This will clear after the next load test or a combined battery replacement and power cycle.
101	External Power Source Status	R	16 bit	0=Please Check 1=OK A Zero indicates when the External Power Voltage DC Value (Register 44) drops below 10.5 even for just a few microseconds. This will clear when the External Power Voltage DC Value raises above 10.8.
110	Power Consumption	R	16 bit	0= Normal 1= Allow Sleep
111	Power Fail	R	16 bit	0= Multicycle 1= Park
112	Signal Fail	R	16 bit	0= Hold Last Position 1= Go to Min 2= Go to Max
113	Limit	R	16 bit	0= Use Limit Switch Limits 1= Use Calibrated Limits
114	Control Mode	R	16 bit	0= External Analog Control 1= 2 Wire CW Control 2= 2 Wire CCW Control 3= 3 Wire Control
115	Potentiometer Control	R	16 bit	0= No Pot Detected 1= Pot Detected and Used

Tag	Register	R/W	Size	Description
156	Initiate Load	R/W	16 bit	When you initiate a load test that the 12 hour rest period does not occur before the load test and could affect the results of the tests.
157	Batter y Status Press/ Fail Values	R		Bit 0 – Open Circuit Voltage Test (0= Fail, 1= Pass) Bit 1 – Resistance Test (0= Fail, 1= Pass) Bit 2 – Fade Test (0= Fail, 1= Pass) Bit 3 – Run Time Voltage Test (0= Fail, 1= Pass) Bit 4 – Early Discharge Test (0= Fail, 1= Pass) Bit 5 – Recharge Time Test (0= Fail, 1= Pass) Bit 6 – M inimum Voltage Test (0= Fail, 1= Pass)
158	Load Tests Total	R	16 bit	Number of Load Tests (max 65535) This value will clear after a power cycle.
159	Temp of Last Load Test	R	16 bit	Temperature of last load test in Degree C (signed, negative values are 2's compliment)
160	Load Test Torque Setting	R	16 bit	1= Large Actuator 2= Small Actuator
161	Last Load Test Time Stamp	R	16 bit	Last Load Test Time Stamp bits 31-16 (read 161 & 162 together for time stamp in seconds incrementing only when power is on for lifetime of VCB00010 board)
162	Last Load Test Time Stamp	R	16 bit	Last Load Test Time Stamp bits 15-0
163	Current Time Stamp	R	32 bit	Current Time Stamp bits 31-16 (read 163 & 164 together for time stamp in seconds incrementing only when power is on for lifetime of VCB00010 board)
164	Current Time Stamp	R	32 bit	Current Time Stamp bits 15-0

Tag	Register	R/W	Size	Description
116	Power Fail	R	16 bit	0= Power Fail CCW 1= Power Fail MID 2= Power Fail CW 3= Invalid
117	Heater Mode	R		0= Heater Off (Low Power) 1= Heater Low Temp 2= Invalid 3= Heater Humid
118	Battery Type	R	16 bit	0= Sealed Lead Acid 1= NiMH 2= Li Ion 3= No Battery
119	Run Mode	R	16 bit	0= Run Mode 1= Zero, Span, Mid, or Cal Modes
120	Modbus LOCK Switch	R	16 bit	0= Unlocked 1= Locked
130	At Zero Position	R	16 bit	1= At Zero Position
131	At Target Position	R	16 bit	1= At Target Position
132	At Mid Position	R	16 bit	1= At Mid Position
133	At Span Position	R	16 bit	1= At Span Position
140	VCB00010 Factory Serial Number	R	16 bit	VCB00010 Factory Serial Number Part 1
141		R	16 bit	VCB00010 Factory Serial Number Part 2
142		R	16 bit	VCB00010 Factory Serial Number Part 3
143	VCB00020 Factory Serial Number	R	16 bit	VCB00020 Factory Serial Number Part 1
144		R	16 bit	VCB00020 Factory Serial Number Part 2
145		R	16 bit	VCB00020 Factory Serial Number Part 3
150	Load Test A Value	R	16 bit	Voltage in 100 mV units.
151	Load Test B Value	R	16 bit	Voltage in 100 mV units.
152	Load Test C Value	R	16 bit	Voltage in 100 mV units.
153	Load Test D Value	R	16 bit	Voltage in 100 mV units.
154	Battery Charged Status	R	16 bit	0= Not Fully Charged or Charging 1= Fully Charged
155	Battery Test Failures Total	R	16 bit	# of individual test failures since power on, max of 255 This value will clear after a power cycle.
156	Initiate Load Test	R/W	16 bit	Default is 0 to Auto test weekly. Write 1 to initiate a Load Test immediately. If you initiate a load test then the actuator will auto test weekly afterwards.

8. BATTERY STATE OF HEALTH

8.1 BATTERY STATUS RELAY

The Relay on the VCB00010 board between terminals 3 and 4 is reflected directly in the *Modbus* Register 100 and is the Battery Status Relay that will display the evaluation of our State of Health load tests. If this register shows a “1” then the battery has passed the tests so far and can be assumed to be reliable as long as the application is stable. If power is cycled then we will assume the battery is good until it fails one of the tests. A “0” in this register will flag the user to either look into the variables and tests further or replace the battery.

8.2 INITIAL POWER ON TEST

After a power cycle, when a battery is installed or has been called upon to run the actuator, the battery will be checked to verify that it is above 6 VDC and can accept a charge. This will take approximately 2 minutes and will give a good indication as to whether the battery can be brought back to a usable threshold or not. If it fails this test it will be flagged as “Not OK” on Register 100 and the Battery Status Relay. Battery replacement is necessary.

For the Initial Charge Test Register (157, Bit 6) will go to “0” if upon initial power on with a battery installed that the Battery Voltage is less than the Allowable Charge Voltage.

8.3 RECHARGE TEST

The battery will then be charged until it reaches the recharge threshold. We allow the battery to take up to 3 days to reach the threshold value before we flag it as “Not OK.”

For the Recharge Time Test Register (157, Bit 5) will go to “0” if after 3 days of initial charging the Battery Voltage is less than the Recharge Voltage. Battery Replacement is necessary.

8.4 EARLY DISCHARGE TEST

After the recharge threshold has been met, the charging circuit is shut off in order to allow the battery to settle and stabilize for a period of 12 hours. If the voltage drops too much during this period then the battery is flagged as “Not OK.”

The Early Discharge Test Register (157, Bit 4) will go to “0” if the Battery Voltage drops too much after the charging circuit has been turned off for 12 hours.

8.5 LOAD TEST

Next the actuator will try to run a proper load test. The test takes approximately 3 seconds. **NOTE:** The test will not run if the motor is being called on to move. If a motor movement delays the load test it will keep on trying until it finds a window of inactivity long enough to run.

The Load Test first measures the Open Circuit Voltage and stores that as Load Test A into Register 150.

The Open Circuit Voltage Test Register (157, Bit 0) will go to “0” if the value stored in Register 150 drops below the allowable Battery Voltage.

Next a fixed resistive load is applied using the motor and the after 250 mS the voltage is measured and stored as Load Test B into Register 151. Test A value minus the “Test B” value is a good indication of the internal resistance of the battery and its power delivery capability.

The Resistance Test Register (157, Bit 1) will go to “0” if the value of Register 150 - Register 151 is greater than the acceptable voltage difference.

After the load is applied for 2.5 seconds another measurement is taken of the battery voltage and stored as Load Test C into Register 152. Test A value minus the “Test C” measurement is a good indication of the battery voltage “fade” due to gradual loss of capacity over time.

The Fade Test Register (157, Bit)2 will go to “0” if the value of Register 150 - Register 152 is greater than the acceptable voltage difference.

After the 2.5 second load test we wait 250 ms and measure the battery voltage and store the measured value as Load Test D into Register 153. Test A value minus ”Load Test D” is a good indication of the battery ability to recover, however it is not incorporated into the acceptance criteria of the Battery State of Health.

Another continuous test that is run is to verify that the battery voltage is higher than the battery shutdown voltage. This means that the battery would not have the capacity during a power cycle.

The Run Time Voltage Test Register (157, Bit 3) will go to “0” if the Battery Voltage is less than the Shutdown Voltage.

7 days After a load test has been performed then (604800 seconds of uninterrupted power), the actuator will rest the charging circuit for 12hrs and then perform a load test. The time between tests is potentially 7.5 days (648000 seconds of uninterrupted power).

NOTE: In extreme temperatures, some battery tests are more likely to fail due to physical limitations of testing and may not accurately depict the Battery State of Health. In these situations, it is up to the user to determine if the behavior of the battery and its environmental conditions are acceptable or if the actuator requires service. The Battery State of Health is a conservative estimate for this reason.

9. LOW POWER OPERATION

The VALVCON™ *Modbus* Communication Module will enter a low power state when the VALVCON™ *Modbus* firmware detects no activity on the *Modbus* network after some period of time and sleep mode is allowed by the Motor control processor.

When the *Modbus* Host transmits another packet the VALVCON™ *Modbus* firmware will resume operation from its low power state but lose the first byte of the packet. The first byte of the *Modbus* RTU packet is the *Modbus* device ID. If the packet was intended for the VALVCON™ *Modbus* Communication Module the *Modbus* Host will have to retransmit the packet for the VALVCON™ *Modbus* firmware to successfully receive the packet. The *Modbus* Host must retransmit the packet before the VALVCON™ *Modbus* time out period expires. Otherwise the VALVCON™ *Modbus* firmware will reenter low power state again and miss the first byte of the next packet.

The *Modbus* Host can set the time out period in seconds by writing to the *Modbus* Activity Time Out Register. If the register has a zero value (default) then the VALVCON™ *Modbus* firmware will always stay active to receive every packet received by the *Modbus* Host and never enter low power state.

If the *Modbus* network is very active then the *Modbus* Activity Time Out Register should be set to zero as the *Modbus* Communication Module may never enter the low power state anyway. If the *Modbus* Host rarely polls any *Modbus* slave device then set the *Modbus* Activity Time Out Register to a non-zero value, such as 30 seconds.

10. TROUBLESHOOTING

10.1 SETTING SYSTEM TO DEFAULT CONFIGURATION

To set registers 20 (Device Address), 21 (Baud Rate), 22 (Parity), 23 (Activity Timeout), and 10 (Motor Command) to default perform the following steps:

1. First set the *Modbus* Lock Switch on the VCB00020 *Modbus* Module to the Unlocked Position.
2. Next set the Mode Selector Pot on the VCB00010 Board to Manual Mode.
3. Next Press and hold the Enter button for 5 seconds total.
4. If the reset occurs the LED’s on the VCB00020 will turn off briefly and cycle back on in order (Green, Yellow, Red, Yellow, then Green). Otherwise repeat steps 1-3.
5. If reset is unsuccessful, check connection of VCB00020 communication module to VCB00010 Universal control board; note if LADC verify that cable is properly connected to both boards.
6. Repeat steps 1-3 if still no reset consult local representative or Neles.

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