TBV(i)-IA Series Analog/TTL
Operator's Manual

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Please note:

This manual from Net Controls, LLC is the latest version for the revision indicated. The information contained herein is subject to change without notice. It is advised that if this information is used in a critical application, that it be verified with Net Controls.

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Safety Information

This manual utilizes the three icons below to alert the reader to particular areas of importance where special attention should be focused.

 **Note:** *Special uses of the controller and installation pointers are revealed.*

 **CAUTION:** *Heed warning to prevent damage to controller or other equipment.*

WARNING: *Controller hazards that could create serious bodily harm or death.*

Section One: General Information

Introduction

Thank you purchasing a TBV(i)-IA Series Butterfly Valve from Net Controls, LLC! We are glad you chose the TBV(i)-IA-XXX for your application and it is our goal to give you excellent service and support.

Prior to installation, read this manual to insure you are thoroughly familiar with the controller's capabilities and operational characteristics. If you have any problems or questions, please contact Customer Service at (530) 894-3358 or visit our website at **www.n-controls.com.**

TBV(i)-IA Series Butterfly Valves are designed for various automation tasks including downstream pressure control. Typical applications are for vacuum system throttling butterfly valves sized from 1" to 12". The small footprint incorporates all control electronics and associated pressure control software. Two versions are available: "remote" with separate controller and "integrated" with the controller inside the valve case.

A valve open/close switch and local status LEDs are located on the controller front panel. Remote operation and monitoring can be done with the serial RS-232 communication interface. Alternate communications connections are available on select controllers.

Valve Models Covered

This manual is applicable to the following controller models:

- **TBV-IA-XXX** Analog/TTL Integrated Valves
- **TBVi-IA-XXX** Analog/TTL Integrated Valves with Isolation capabilities (flapper o-ring)

Remote controllers are compatible with all Net Controls Throttling Butterfly Valves (both heated and unheated versions). Additionally, all controllers can either be accessed via computer or from an optional touch screen interface. Integrated controllers are packaged on the valve. Remote controllers are separate units that can be located up to 8 feet from the valve. Many cables are available to facilitate installation in a variety of environments.

Manual Organization

This manual is organized to provide instructions on installation, set-up, operation, and troubleshooting. Before proceeding, make sure you are familiar with the caution and warning figures outlined at the beginning of the manual. Pay careful attention to all warning and caution indications found within the following pages.

Section One, *General Information*, outlines the product.

Section Two, *Installation*, details the unpacking of the product and environmental considerations for the application of the product.

Section Three, *Overview*, describes the TBV(i)-IA Series electrical connections and theory of operation.

Section Four, *System Set Up*, explains initialization, normal operation, vacuum gauge configuration, changing set points, position and pressure selection, valve calibration, and changing phase and gain.

Section Five, *Operation*, highlights how the controller is used and the common commands and requests/responses used.

Section Six, *Troubleshooting*, provides a table to solve potential problems.

Appendix A, *Product Specifications*, lists the specifications of the controller.

Appendix B, *Command and Request Reference*, lists the ASCII commands.

Appendix C, *ASCII Request and Response Reference*, lists the RS-232 requests and responses.

Appendix D, *Warranty*, enumerates the Net Controls, LLC warranty for the TBV(i)-IA-XXX Products.

Customer Support

If you encounter any questions or difficulties during the installation, set-up, or use of the valve and/or controller, please contact Net Controls Customer Support.

Contact Phone Number: (530) 894-3358.

Website: www.n-controls.com

If it is found necessary to return the controller to Net Controls, contact Customer Support to obtain additional instructions or a Return Materials Authorization number.

WARNING: *All returned products to NC must be free of all contaminants, including harmful, corrosive, radioactive, or toxic materials.*

Section Two: Installation

Unpacking the TBV(i)-IA-XXX Analog/TTL Valve

- Inspect the shipping container prior to unpacking
- Report any damage to Net Controls, or to the transportation company
- As the product is removed from the box, look for any damage
- If you must return the product, please contact Net Controls Customer Service (see "Customer Support" section of this manual) to obtain a Return Material Authorization (RMA) Number.

Note: *Keep the packing materials until you are sure the controller is satisfactory*

Unpacking Checklist

1. TBV(i)-IA Series Analog/TTL Integrated Valve.

Optional Supplied Cables

1. Interface Cable for connection to HOST computer: DB-9 connector to controller.
2. Gauge Cable for connection to pressure gauge(s): DB-15 connector to controller.
3. Power Cable for 24VDC connection to unit: DB-9 connector to controller.

Preliminary Controller Check

All products are stringently tested and then carefully packed for shipment. However, sometimes shipment can cause damage to occur. Therefore, it is advisable to check the unit prior to installation. We recommend the user:

- Connect the valve to a suitable power source (24VDC +/- 5% @ 100W).
- After the power is applied, the valve will complete a 30 second initialization sequence provided the valve interlock TTL input is held low. The valve will initialize to the open position.
- If the Open and Closed LED's remain on simultaneously, the valve is not initialized.
- Pushing the "OPEN/CLOSE" switch on the controller front panel allows you to further manually exercise the valve.
- Contact Technical Support if the valve does not operate as outlined above.

Safety Conditions

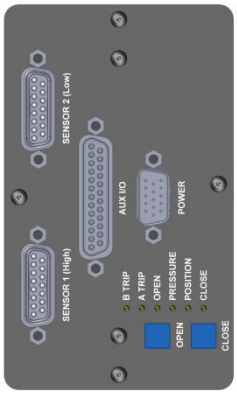
WARNING: *Keep body parts and other items away from valve due to valve plate pinching hazard.*

CAUTION: *Check to make sure the voltage is correct before applying power.*

Product Location and Requirements

It is recommended to mount the controller such that the LEDs on the front panel can be seen by an operator or technician for troubleshooting purposes. Environmental conditions required for proper operation:

- Operating temperature: 65°C ambient temperature for Electronics
- Acceptable ambient humidity: 0 to 95% non-condensing
- Allow at least 3” of access to the top of the integrated controller where LEDs and connectors are located
- Ensure proper mounting direction. Flapper Plate screws are facing away from the pump.



FLOW

Note: ***The Interface Cable (RS-232 Serial Communications) must be an overall braided shielded cable, properly grounded, to meet CE specifications.***

Section Three: Overview

Top Panel Indicators

Figure 3.1 below shows the top panel of the TBV(i)-IA-XXX. **Table 3.1** explains the function of each indicator.

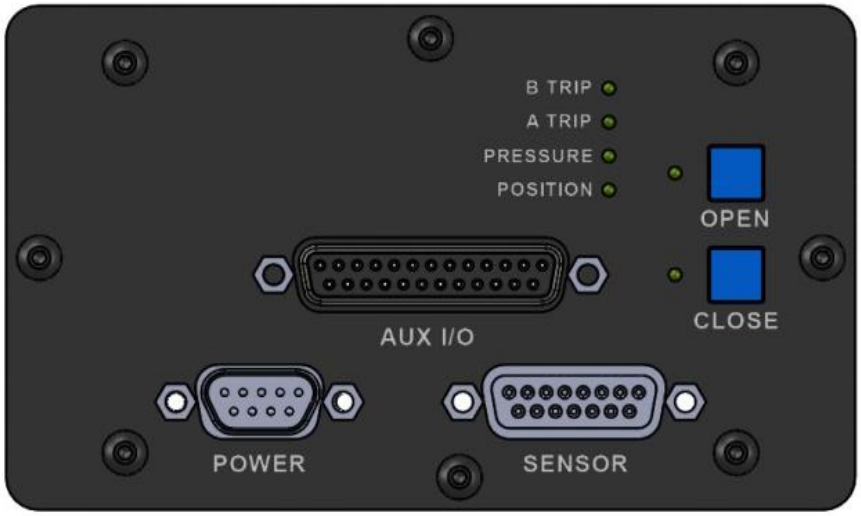


Figure 3.1 – Top Panel Indicators

Table 3.1 Front Panel Indicators

Top Panel Component	Function
Open/Closed Switches	Opens and closes the valve. Pressing both for 5 seconds will initialize the valve.
A/B Trip LEDs	Illuminated when customer configured trip points are active
Open LED	Illuminated when valve is open. When Closed LED is Illuminated, valve is not initialized
Closed LED	Illuminated when valve is fully closed. When Open LED is Illuminated, valve is not initialized
Pressure LED	Illuminated when Analog Setpoint input is set to Pressure mode via TTL input
Position LED	Illuminated when Analog Setpoint input is set to Position mode via TTL input

Gauge/Sensor Input Connection

Figure 3.2 below shows the location of the gauge input connectors. **Tables 3.2** detail the pin-outs required for each connector.

Table 3.2 Sensor DB15 Female

Pin	Description/Function
1	Sensor 2 Input Signal (+)
2	Sensor 1 Input Signal (+)
3	Not Connected
4	Not Connected
5	15V Power Supply Common
6	-15VDC Power Out
7	+15VDC Power Out
8	+15VDC Power Out
9	Sensor 2 Input Signal (-)
10	+24VDC Power Return
11	+24VDC Power Out
12	Sensor 1 Input Signal (-)
13	15V Power Supply Common
14	-15VDC Power Out
15	Chassis Ground

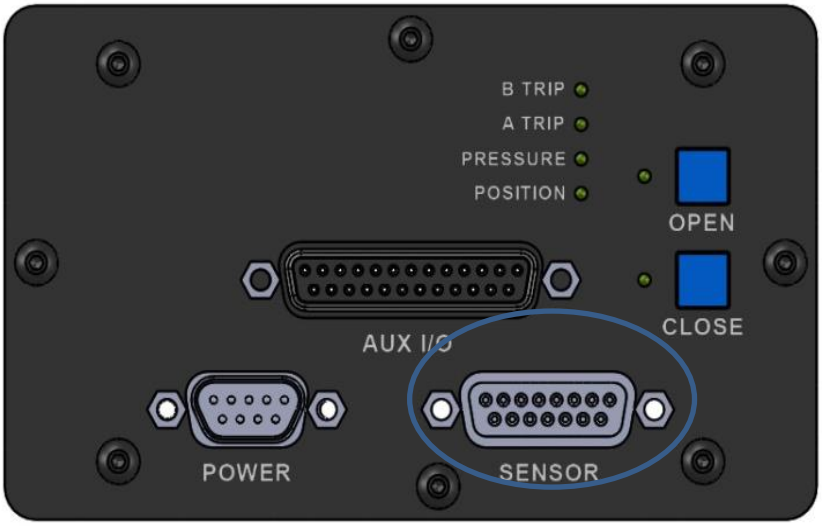


Figure 3.2 – Gauge/Sensor Input Connectors

Auxiliary I/O Connection

Figure 3.3 below shows the location of the Auxiliary I/O connectors. **Table 3.3** details the pin-outs required.

Table 3.3 Aux I/O Connector DB25 Female

Pin	Description/Function
1	RS-232 TXD (transmitted by the HOST to the TBV)
2	RS-232 RXD (transmitted by the TBV to the HOST)
3	Valve Open (Input)
4	Valve Close (Input)
5	Position/Pressure (Input)
6	Not Connected
7	Not Connected
8	Not Connected
9	Analog Setpoint (+)
10	Analog Setpoint (-)
11	Analog Pressure Out (+)
12	Analog Position Out (+)
13	Analog Ground
14	Relay A Normally Open
15	Relay A Normally Closed
16	Relay A Common
17	Relay B Normally Open
18	Relay B Normally Closed
19	Relay B Common
20	Valve Open (Output)
21	Valve Closed (Output)
22	Valve Inhibit (Input)
23	Remote Zero (Input)
24	Digital/TTL Common
25	Chassis Ground

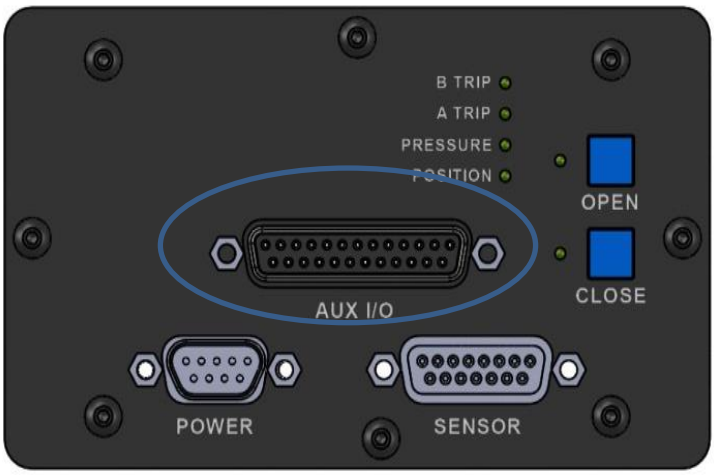


Figure 3.3 Aux I/O Connector

Power Connection

Figure 3.4 below shows the location of the Power Input Connector. **Table 3.4** details the pin-outs.

Table 3.4 Power Input Connector DB9 Male

Pin	Description/Function
1	+24VDC Power Input
2	+24VDC Power Input
3	24VDC Power Return
4	24VDC Power Return
5	+15VDC Power Input
6	15VDC Return
7	-15VDC Power Input
8	Not Connected
9	Chassis Ground

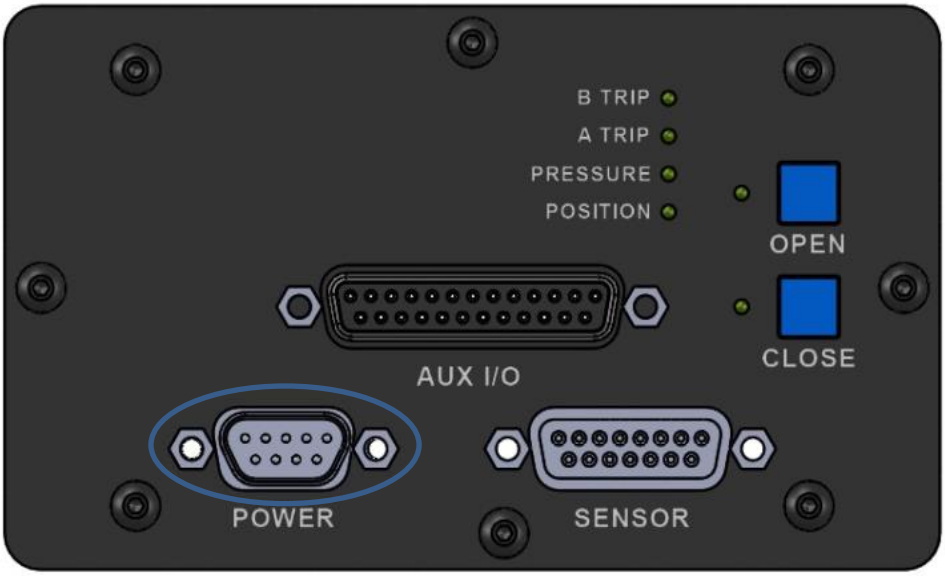


Figure 3.4 – Power Input Connector

Theory of Operation

Figures 3.5 shows a typical TBV-IA-XXX application in which the downstream pressure of a vacuum chamber is controlled with a throttle valve. Typically, a gauge such as a Capacitance Diaphragm Gauge (CDG) is used for pressure measurement. +/-15V is supplied via customer power supply, or via the TBV(i)-IA Series Valve Controller. The output of the gauge (sensor signal) is connected to the TBV-IA-XXX and is used as the Process variable, PV. The Host controller connects via the Aux I/O connector and supplies TTL level signals to Open & Close the valve, select Pressure vs. Position control, and analog Set Point, or SV, signals. The controller will position the valve according to the SV if the Pressure/Position TTL input is held LOW. If the TTL input for Pressure/Position is HIGH, or left unconnected, the controller will maintain pressure in the chamber (SV – PV) at the desired set point value. In addition, the Host controller can read back TTL signals for Open & Closed indications.

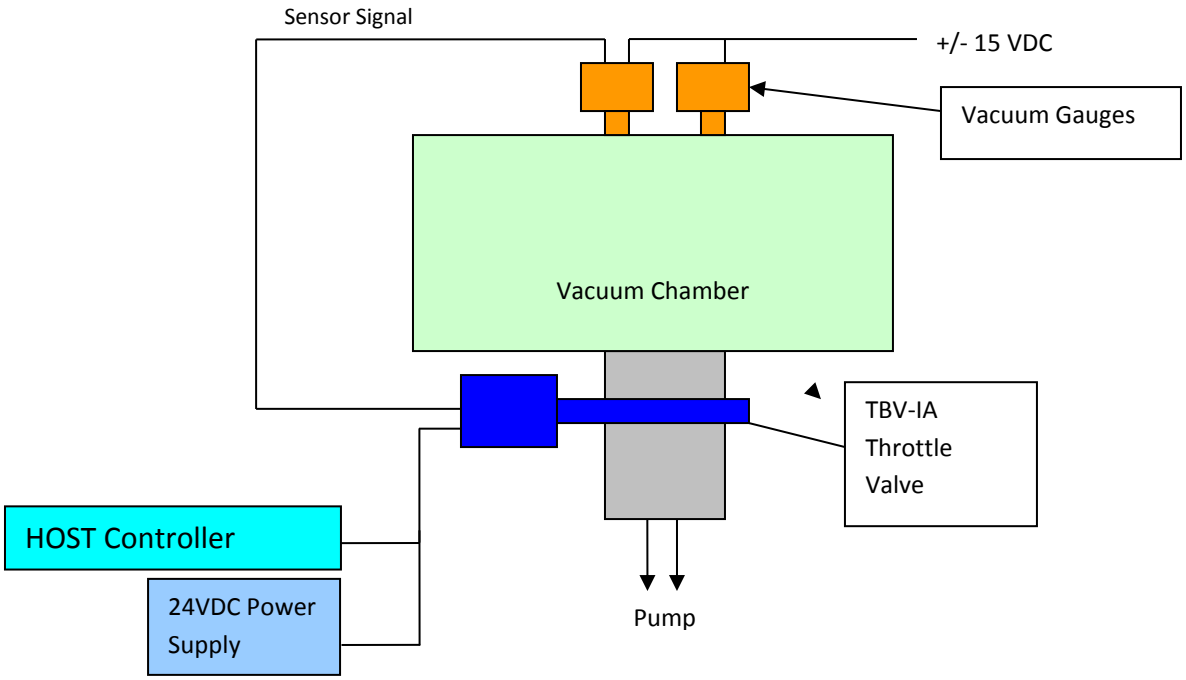


FIGURE 3.5 – Typical Installation and Configuration

Section Four: System Set-Up

WARNING: ***The TBV(i)-IA-Series Valves have moving parts that are accessible when the valve is not installed in a system, creating a risk of personal injury. To avoid injury, keep all objects clear of valve opening.***

Overview

The System Set-Up encompasses how the TBV(i)-IA-XXX operates with the valve and the system as a whole. This section covers the initialization sequence through normal operation, as wells as how to input the commands for pressure and position control, inputting set points, and valve calibration from the HOST to the controller.

Initialization Routine

The initialization routine occurs when the TBV(i)-IA-XXX is first powered up. During this operation the controller finds the fully open and closed points, and allows motor/position calibration steps to run. The OPEN and CLOSED LED's on the top panel are continuously illuminated while the valve is initializing. Upon completion of the initialization, the valve moves to the open position and the OPEN LED will illuminate.

Note: ***The DISABLE INTERLOCK TTL input must be held low for the valve to initialize and move during normal operation. This input, pin 22 on the Aux I/O connector, should be tied to Digital/TTL common (pin 24 on the Aux I/O connector) if the interlock function is not used.***

Normal Operation

Normal operation of the valve follows initialization. One of four (4) modes of operation can be selected:

1. POSITION CONTROL mode
2. PRESSURE CONTROL mode
3. OPEN Mode
4. CLOSED Mode

In POSITION CONTROL mode, the HOST sends a position set point to move the valve to a specific position. Using the serial interface on the Aux I/O connector, this is accomplished using the S1XXX.X command along with the T1X and D1 commands. Using the Analog/TTL interface, this is accomplished by holding the Pressure/Position TTL input LOW and providing an analog voltage proportional to the desired valve position, i.e. 0 VDC = Closed (0°) and 10 VDC = Open (90°).

PRESSURE CONTROL mode regulates system pressure to the selected SV. Using the serial interface on the Aux I/O connector, this is accomplished by sending an S1XXX.X command followed by the T1X and D1 commands. S1XXX.X is stored in memory and need not be entered each time if the SV remains the same. Using the Analog/TTL interface, this is accomplished by holding the Pressure/Position TTL input HIGH and providing an analog voltage proportional to the desired set point (SV).

OPEN mode is activated by sending an "O" command via the serial interface on the Aux I/O connector, or by TTL input. Holding the Open TTL input LOW will cause the controller to exit Pressure/Position control and move to the Open position.

CLOSED mode is activated by sending a "C" command via the serial interface on the Aux I/O connector, or by TTL input. Holding the Closed TTL input LOW will cause the controller to exit Pressure/Position control and move to the Closed position.

Tuning

The TBV(i)-IA-XXX contains a highly optimized adaptive control algorithm that has been designed to work over a wide range of flow and pressure combinations. However, some vacuum system designs may affect the pressure control time constants and, as a result, pressure control performance may at times be affected. If satisfactory pressure control cannot be achieved with the installed algorithm, please contact Net Controls Customer Support.

Set up of the operating parameters of the controller is accomplished only through the sending of serial commands via the Aux I/O connector. When the valve is installed in an Analog/TTL only application, a break-out cable may be needed to bring out serial communications to a test computer. Net Controls can provide software for tuning (See **Figure 4.1**) if needed.

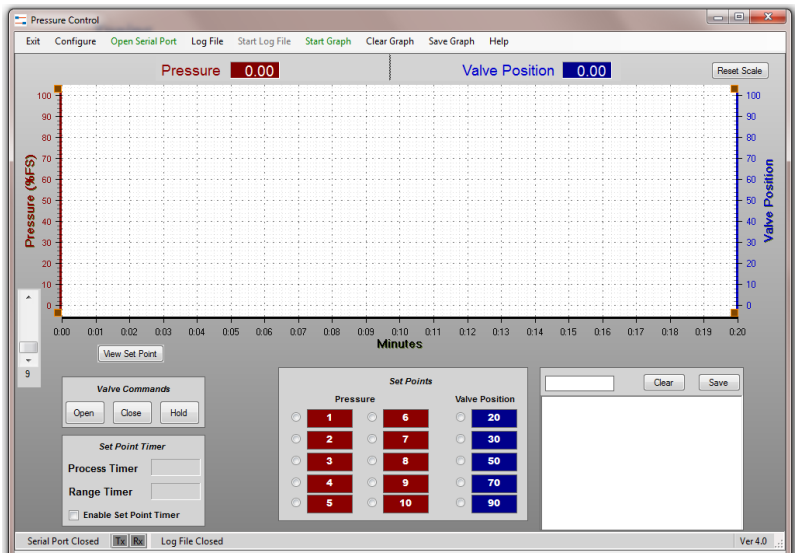


Figure 4.1 Software for System Tuning

This software allows users to tune and view results in real time, as well as to save data files for later review.

Changing PID Gain

Gain may be changed from the default factory setting using the M1xxxx command, where xxxx is the integer gain value from 10 to 10,000. However, this change is not normally required for most applications due to the adaptive algorithm employed by the TBV(i)-IA Series controllers. To maintain backwards compatibility use command SG1xxxx.

Changing PID Phase

"Lead" or Phase may be changed from the default factory setting using the X1xxxx command, where *xxxx* is an integer value from 1 to 10,000 representing milliseconds. However, this change is not normally required for most applications due to the adaptive algorithm employed by the TBV(i)-IA Series controllers. To maintain backwards compatibility use command SP1xxxx.

Vacuum Gauge/Sensor

The TBV(i)-IA Series controllers are equipped to acquire an analog pressure signal from one or two vacuum gauges via the Senor 1 (High) and Sensor 2 (Low) connectors located on the top panel. ±15 VDC is available to power the gauges from this port.

Note: ***If the power requirement of the two gauges exceeds the controller's rated power output, then a separate power source must be furnished by the user.***

Configuring Pressure Gauge Parameters

The Valve is factory configured to use Torr as the pressure unit, 10 Torr as the sensor full range for Sensor 1 (High) and 0 Torr (not connected) for Sensor 2 (Low), and 0 to 10 Volts for the sensor input signal. When only one gauge is used, the pressure signal must be connected to the Sensor 1 (High) DB15 connector. Using two gauges requires the following:

1. The full scale range of the two gauges must be at least one but no more than four decades (factors of ten) apart.
2. Only one gauge is active at a time.

Steps to Programming Sensor Inputs

1. Program the full scale range of the High Sensor:

N1xx, where xx is the value found in Table 4.1 indicating the full scale range of Sensor 1. For example, enter N500 if Sensor 1 is a 500 Torr gauge.

2. Program the full scale range of Sensor 2 with the command:

N2xx, where xx is the value found in Table 4.1 indicating the full scale range of Sensor 2. The full scale range of Sensor 1 must always be greater than that of Sensor 2.

Note: ***It is unnecessary to program the gauge full scale range when only one gauge is used.***

Table 4.1 – Sensor Range Values

Sensor 1&2 Full Scale (Torr)	Value of xx
0.1	0.1
0.2	0.2
0.5	0.5
1	1
2	2
5	5
10	10 (Sensor 1 default)
50	50
100	100
500	500
1000	1000
0	Not connected (Sensor 2 default)

Adding Set Points Via Serial Commands

Follow the steps below to change the set points. The set point must be programmed *before* using the set point to control either pressure or position. Five programmable set points are user selectable by issuing the following command:

Snxx.xx where xx.xx is a number from 0.00 to 100.00, for the gauge full scale percentage and n is a number 1, 2, 3, 4, or 5 representing programmable set points. One or no decimal places may also be used, i.e. x.x. or x. For instance *S125* would make set point number 1, 25% of full scale of the pressure gauge.

The set points can now be used to control either pressure or position.

Activating Dual Pressure Gauges

When two pressure gauges are connected to the 98 Controller, one of three operating modes can be used:

1. First gauge primary (this is the power-on default): Controller only recognizes and reports Sensor 1. The serial command is L1.
2. Second gauge primary: Controller only recognizes and reports CDG2. The serial command is L2.
3. Dual range: Controller auto-switches and scales the High and Low sensor inputs. The serial command for this mode is L0 (zero).

 **NOTE:** ***All set point commands are with respect to the high range gauge (Sensor 1).***

Digital I/O Connections

Digital inputs and outputs of the TBV(i)-IA Series Valves are designed to interface with TTL and CMOS logic. Also, switches and relays can be used on the inputs as they are active LOW signals referenced to pin 24 of the Aux I/O connector, see **Figure 4.2**.

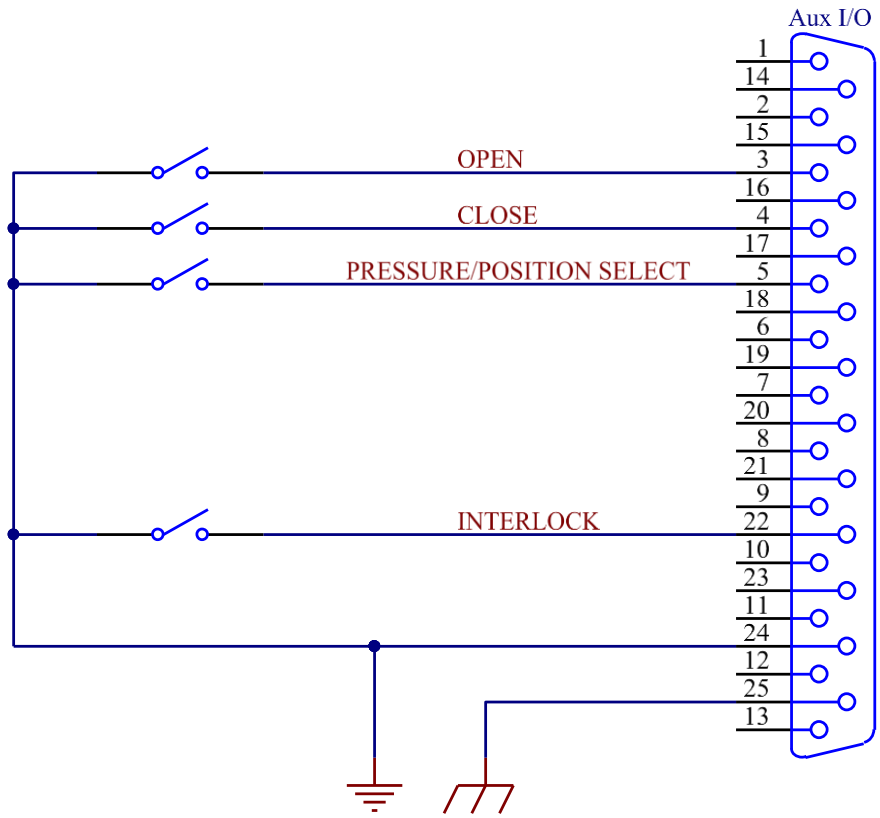


Figure 4.2 Digital I/O Interface Connections

NOTE: ***All TTL inputs are 5V logic level CMOS (TTL Compatible).***

Analog I/O Connections

The analog set point input, on pin 9(+) and 10(-), are fully differential inputs with a range of 0-10V (default), +/-10V, 0-5V, and +/-5V. Because the Valve is designed for downstream pressure control applications, 0-10V is standard. Please contact the factory if another input range is desired.

NOTE: ***Pin 10 (-) should be connected to Analog Ground at the Driving Source, not at the controller. However, if necessary, the analog ground of the controller (Pin 13) can be used.***

Analog outputs, Pin 11 and Pin 12, provide pressure and position outputs with a range of 0-10V. Both outputs are referenced to analog ground, or Pin 13, on the Aux I/O connector. See **Figure 4.3**.

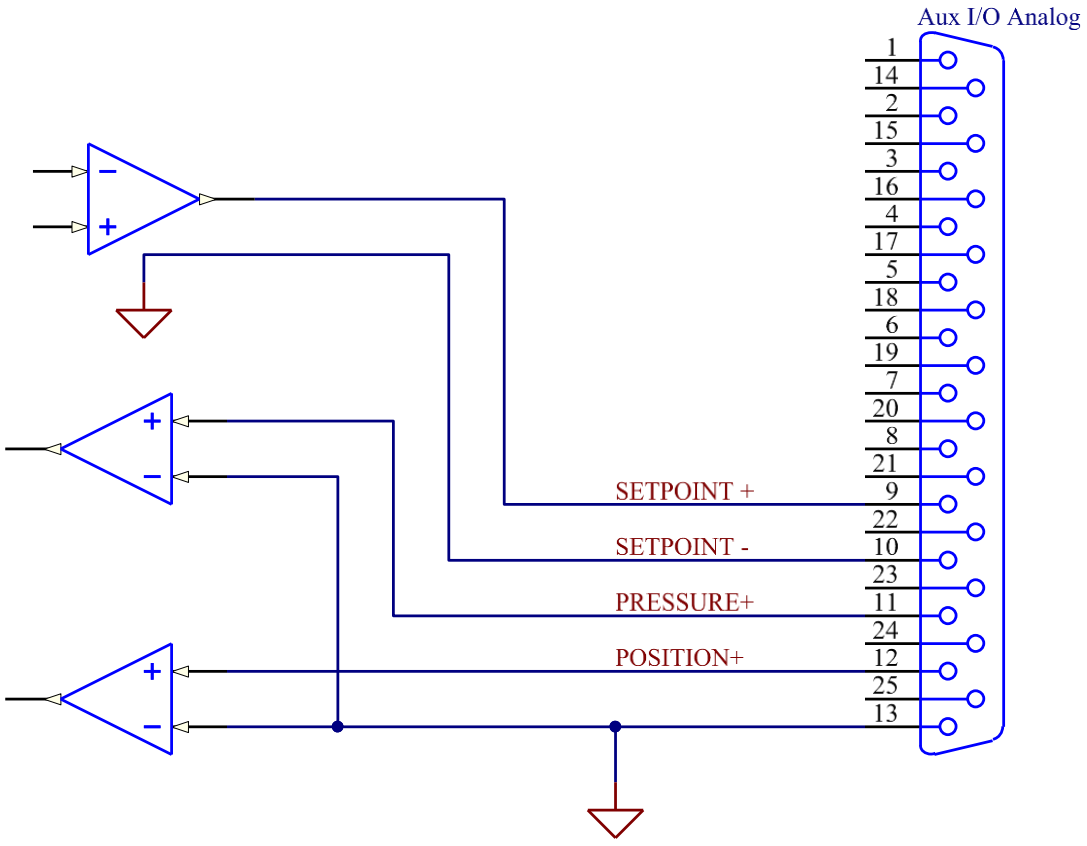


Figure 4.3 Analog I/O Connections

Section Five: Operation

WARNING: ***The TBV(i)-IA-Series Valves have moving parts that are accessible when the valve is not installed in a system, creating a risk of personal injury. To avoid injury, keep all objects clear of valve opening.***

The TBV(i)-IA Series Valves can be controlled via the Analog/TTL interface as well as the Serial communications interface. It should be noted that the analog and TTL functions have priority unless otherwise specified.

Serial Interface Operation

Messages sent to the controller are either commands that instruct the controller to change an operating parameter, or *requests* that prompt the controller to report status information. Responses sent by the controller reply to a *request* message issued by the HOST RS-232 communication system.

Every serial input command sent by the HOST should have an end-of-line delimiter, carriage return ASCII 0x0D [hex], or the line feed character ASCII 0x0A [hex], or the carriage return and line feed characters (CRLF) in that order. The TBV(i)-IA-XXX response end-of-line delimiter is the carriage return (CR) only.

Commands and requests/responses are listed in **Appendices B and C.**

Note: ***Hardware handshaking connections are not available.***

Note: ***The* default *factory RS-232 communications parameter settings are 9600 Baud, 1 stop bit and no parity.***

ASCII Command and Request/Response Examples

Commonly used command and request/response examples are detailed below. Oftentimes reading or verifying of commands is done immediately after inputting commands. The TBV(i)-IA-XXX serial command protocol is not case sensitive. The **Bold typed** letter/number combinations that follow represent the commands and requests/responses.

Reading the Set point

The set point is communicated from the serial port to the HOST by inputting:

R1<CRLF>

The controller responds with **S1+xx.xx,** where **xx.xx** is the set point value.

Verifying the Control Mode

To verify the set point for either pressure control or position control, enter the command:

R26<CRLF>

The controller responds with **T1x,** where **x** is **0** for position control or **1** for pressure control (default).

Reading the Valve Position

The command below reports the valve position as a % of full open:

R6<CRLF>

The controller repsonds with **Vxx.xx,** where **xx.xx** is a number from 0.00 to 100% of valve position.

Reading System Pressure

The pressure (Sensor 1, Sensor 2, or both) can be reported using the following command:

R5<CRLF>

The controller responds with **P+xx.xx,** where **+** signifies the polarity of the value and **xx.xx** is a percentage of full scale between 0.00 and 100.00%.

If two pressure sensors are used, the controller will report the pressure as a percentage of the high range gauge. For example, if the system has a 1000 Torr gauge attached to Sensor 1 and a 10 Torr gauge attached to Sensor 2 with the actual system pressure reported as 0.1 Torr, the response to the R5 command will be P+0.010.

Note: ***The format for the R5 command response changes when the pressure falls below 10% to P+x.xxx.***

Reading the Pressure Gauge Set-Up

The controller calculates the ratio of the two pressure sensor full scale settings. The two sensors have a maximum set ratio limit of 1000:1.

To verify the sensor full scale settings, a report may be elicited by using the following commands:

For Sensor 1: **RN1<CRLF>**

The controller will respond with **N1xx.xx,** where **xx.xx** is the full scale range of Sensor 1.

For Sensor 2: **RN2<CRLF>**

The controller will respond with **N2xx.xx,** where xx.xx is the full scale range of Sensor 2.

Selecting Valve Position Control or Pressure Control

Set point input values are the same for position or pressure control. To program the TBV-IA Series to the desired type of control, position or pressure, input the commands below. The factory default setting is pressure control.

T10<CRLF> Places the valve in position control mode

T10<CRLF> Places the valve in pressure control mode

Controlling Valve Position

Valve position can be controlled a variety of ways in addition to using set points. Table 5.1 lists the various commands associated Position Control.

Table 5.1 Valve Position Commands

Serial Command	Action
O<CRLF>	Valve opens
C<CRLF>	Valve closes
H<CRLF>	Valve stops at current position
Vxx.xx<CRLF>	Valve moves from 0.00 to 100.00% as determined by xx.xx
T10<CRLF>	Sets the set point type to “position control”*

* Next, follow the information outlined in the *Changing Set Points 1 Through 5* and *Controlling System Pressure* sections located on page 20 of this manual.

Controlling System Pressure

System pressure can only be controlled via set points. Set points are activated using the Dx commands, where x is the set point defined using Snxx.xx.

Using System Set Points

Set points must first be defined by using the Snxx.xx command as outlined Section Four.

D1<CRLF> Activates Set Point 1 in either Pressure or Position Control mode

NOTE: ***The set point can be changed at any time and will be active immediately if in pressure control mode.***

Analog/TTL Operation

All digital inputs are active LOW (see **Table 5.2**) and should be pulled to <0.8V for proper operation. HIGH is > 2.5V. All inputs are read at 40 millisecond intervals. Thus, to activate a digital function, the input must be held low for this minimum duration. All digital outputs are active HIGH (see **Table 5.3**) and are capable of souring up to 20mA at 5VDC.

Analog and digital functions take precedence over the serial communications. For example, if the valve close input is brought LOW, the valve will immediately close and remain closed as long as the digital input is LOW. When the valve close input is brought HIGH, the valve will respond to serial commands for position.

Table 5.2 Digital Input Functions

Aux I/O Pin	State	Function
3	LOW HIGH	Open the Valve None
4	LOW HIGH	Close the Valve None
5	LOW HIGH	Position Control Mode Pressure Control Mode
22	LOW HIGH	Disable Interlock Interlock is active
23	LOW HIGH	Remote Zero Command None

Table 5.3 Digital Output Functions

Aux I/O Pin	State	Function
20	LOW HIGH	Valve **NOT** Open Valve is **OPEN**
21	LOW HIGH	Valve **NOT** Closed Valve is **CLOSED**

Section Six: Troubleshooting

In general, the TBV(i)-IA Series valves require no maintenance if properly installed and operated. If a problem does occur with the valve, please refer to the basic troubleshooting instructions below or contact Net Controls Customer Support to obtain additional instructions or a Return Materials Authorization (RMA) number.

WARNING: ***All returns to Net Controls must be free of harmful, corrosive, radioactive, or toxic materials.***

TABLE 6.1 – Possible Failure Modes and Recommended Actions

SYMPTOM	POSSIBLE CAUSES	RECOMMENDED ACTION
The controller does not appear to turn on. No LEDs are illuminated.	The controller is not receiving power	Check external power supply, cabling and pin assignments. Try to restart the controller by power cycling.
The controller is on (one or more LEDs illuminated) but it will not respond to commands or buttons	The initialization safety lock function is active. OPEN and CLOSED LED's are on	Check that Pin 22 is connected to Pin 24 on the Aux I/O connector, or that the system is proving a LOW TTL level signal on Pin 22 with respect to digital ground.
	The RS-232 serial connections are not properly made	Check cabling and pin assignments. Make sure hardware handshaking is **NOT** active.
	Communications settings	Make sure HOST is set for 9600,8,N,1. Handshaking should be disabled.
Pressure control performance is unsatisfactory	The controller is not receiving the gauge pressure signal, or the signal is contains noise	Check the gauge cabling and signal stability. Also, check for electrical noise or system vibrations.
	The valve is in position control mode	Ensure Pin 5 on the Aux I/O connector is HIGH with respect to digital ground (>2.5VDC)
Valve fails to move, or both Open and Closed LED's illuminate periodically during operation	Valve plate is being obstructed by contamination	Remove the valve from service and clean. Ensure the plate is free to move throughout the bore before re-installing.
	Valve throttle plate is exposed to excess heat	Contact Net Controls for a reduced diameter plate for your application.

Appendix A: Product Specifications

Table A.1 –General/Electrical Specifications

Feature	Specification
Rated Input Voltage	24VDC +/- 10%
Rated Input Protection	28VDC max, reverse input protection with automatically resettable PTC fuse
Power (9 pin D-sub Male)	24VDC @ 3.0A Peak 24VDC @ 1.25A Nominal: 30W* *without CDG option
Rated Output Power (for gauge excitation)	Option: ± 15VDC @ 600 mA
Protection Class	1
Degree of Protection (IP)	X0
Laser Class	1 (LED's)
Certification/EU Directives	CE Standard for Process Equipment EMC Directive 2004/108/EC Low Voltage Directive 2006/95/EC
Harmonized Standards	EN61000-6-2:2005 EN61000-6-3:2007 EN61010-1:2001
Operating Temperature	0 - 65°C for electronics Valve: up to 150°C (optional)
Allowable Ambient Humidity	0 to 95% non-condensing
Analog Inputs	0-10VDC, protected to +/-16VDC, Fully Differential
Analog Outputs	0-10VDC for Pressure and Position Out
Digital Inputs	TVS protected 5V CMOS logic, TTL compatible
Digital Outputs	TVS/current limited 5VDC sourcing outputs TTL compatible 20mA drive capable

Table A.2 –RS-232 Serial I/O specifications

Feature	Specification
Connector	25 pin Female D-sub
Settings	9600, 8, N, 1
Max Cable Length	50 ft.
Response Time	10 msec guaranteed by RTOS

Table A.3 – Series 98 universal valve controller Performance specifications

Feature	Specification
Valve Speed (open to closed)	90 to 350msec depending on valve size
Control Range	0.5% to 100% of sensor range
Accuracy	0.25% of reading
Repeatability	+/-0.1% of full scale analog input range

Table A.4 –Product Reliability

Feature	Specification
Electronics MTBF	>10,000 hours
Valve/o-ring lifetime	>2 million cycles

Dimensions:

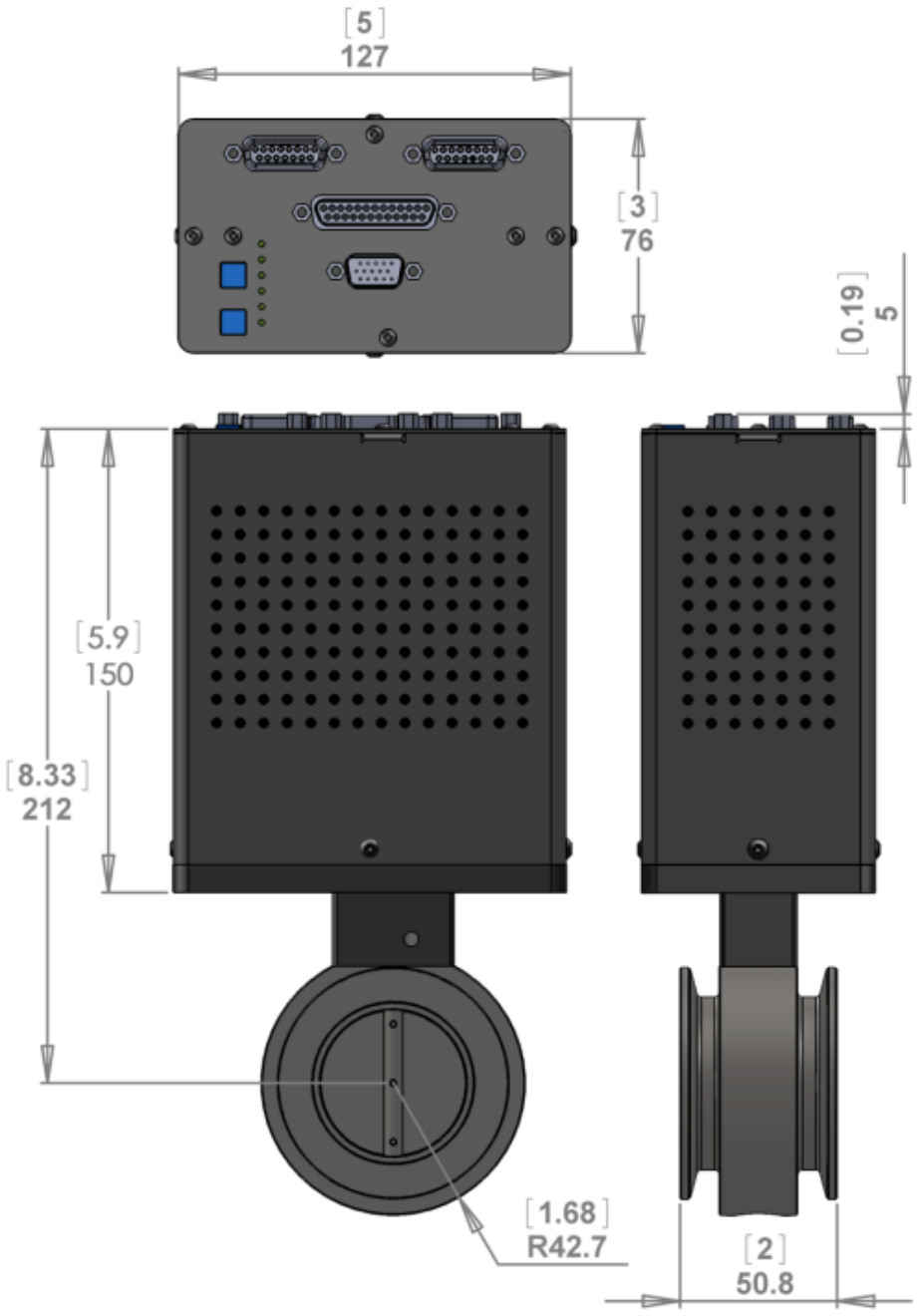


Figure A.1 NW50 Dimensions

APPENDIX B: ASCII COMMAND REFERENCE

TABLE B.1 – ASCII SERIAL COMMANDS

COMMAND	DESCRIPTION	NOTES
SP	Sets phase for active set-point	
SG	Sets gain for active set-point	
C	Close the valve	Same function as pressing the CLOSE switch
O	Open the valve	Same function as pressing the OPEN switch
H	Hold the valve in the current position	Stops active pressure control, if device is in that mode
Snxx.xx	Used to program a value for n=1-5, where n identifies the programmable set point and xx.xx is any number between 0.00 and 100.00, representing the % of gauge full scale	S125, for example, programs the value of the first set point at 25%. When using a 1 Torr gauge, this corresponds to 250 mTorr.
Vxx.xx	Go to valve position	xx.xx is 0 to 100% of full open
L0	Auto select CDG1 or CDG2 for best resolution	Default two gauge configuration
L1	Control to and report CDG1 values only	Selects Gauge 1 for maintenance function.
L2	Control to and report CDG2 values only	Selects Gauge 2 for maintenance function.
N1xx	Sets the full scale range of CDG1	Values for xx can be found in Table 4.1
N2xx	Sets the full scale range of CDG2	Values for xx can be found in Table 4.1
D1	Select set point 1	
D2	Select set point 2	
D3	Select set point 3	
D4	Select set point 4	
D5	Select set point 5	
G *value*	Sensor voltage range *value* 0 = 1 Volt 1 = 5 Volts 2 = 10 Volts	
P1 *value*	Set low threshold for process limit 1 *value* is % of F.S.	Requires installed options
P2 *value*	Set high threshold for process limit 1 *value* is % of F.S.	Requires installed options
P3 *value*	Set low threshold for process limit 2 *value* is % of F.S.	Requires installed options
P4 *value*	Set high threshold for process limit 2 *value* is % of F.S.	Requires installed options
J *value*	Calibrate the valve, where *value* is: C = Remove Inhibit 1 = Initialize to open 2 = Initialize to close	
T1 *value*	Set point 1 type where *value* is: 0 = position 1 = pressure	
T2 *value*	Set point 2 type where *value* is: 0 = position 1 = pressure	

T3 *value*	Set point 3 type where *value* is: 0 = position 1 = pressure	
T4 *value*	Set point 4 type where *value* is: 0 = position 1 = pressure	
T5 *value*	Set point 5 type where *value* is: 0 = position 1 = pressure	
B *value*	Valve position output range where *value* is: 0 = 5 Volts 1 = 10 Volts	Requires installed options
X1 *value*	Set phase of set point 1, where *value* = 0 to 1000	
X2 *value*	Set phase of set point 2, where *value* = 0 to 1000	
X3 *value*	Set phase of set point 3, where *value* = 0 to 1000	
X4 *value*	Set phase of set point 4, where *value* = 0 to 1000	
X5 *value*	Set phase of set point 5, where *value* = 0 to 1000	
M1 *value*	Set gain of set point 1, where *value* = 0 to 1000	
M2 *value*	Set gain of set point 2, where *value* = 0 to 1000	
M3 *value*	Set gain of set point 3, where *value* = 0 to 1000	
M4 *value*	Set gain of set point 4, where *value* = 0 to 1000	
M5 *value*	Set gain of set point 5, where *value* = 0 to 1000	

APPENDIX C: Serial Request and Responses

TABLE C.1 – ASCII SERIAL REQUESTS AND RESPONSES

Request	Description	Response
R5	Requests the current pressure	P+xx.xx, where xx.xx is a number from 0.00 to 100.00
R6	Requests the current valve position	V +xx.xx, where xx.xx is a number from 0.00 to 100.00
R38	Requests the software version	98 – [version#] [version date]
GSN	Get the serial number of the device	Serial nb xxxxxx
R1	Set point 1 value	S1 *value* Where value is % of F.S.
R2	Set point 2 value	S2 *value* Where value is % of F.S.
R3	Set point 3 value	S3 *value* Where value is % of F.S.
R4	Set point 4 value	S4 *value* Where value is % of F.S.
R10	Set point 5 value	S5 *value* Where *value* is % of F.S.
R11	Low threshold Process limit #1	P1 *value* Where *value* is %FS
R12	High threshold Process limit #1	P2 *value* Where *value* is %FS
R13	Low threshold Process limit #2	P3 *value* Where *value* is %FS
R14	High threshold Process limit #2	P4 *value* Where *value* is %FS
R26	Set point 1 type (either pressure or position)	T1 *type*, where *type* equals: 0 = position 1 = pressure
R27	Set point 2 type (either pressure or position)	T2 *type*, where *type* equals: 0 = position 1 = pressure
R28	Set point 3 type (either pressure or position)	T3 *type*, where *type* equals: 0 = position 1 = pressure
R29	Set point 4 type (either pressure or position)	T4 *type*, where *type* equals: 0 = position 1 = pressure
R30	Set point 5 type (either pressure or position)	T5 *type*, where *type* equals: 0 = position 1 = pressure

RN1	Sensor range of gauge 1	E *value*, where *value* equals: 0 = 0.1 10 = 1000 1 = 0.2 11 = 5000 2 = 0.5 12 = 10000 3 = 1 13 = 1.33 4 = 2 14 = 2.66 5 = 5 15 = 13.33 6 = 10 16 = 133.3 7 = 50 17 = 1333 8 = 100 18 = 6666 9 = 500 19 = 13332
RN2	Sensor range of gauge 2	E *value*, where *value* equals: 0 = 0.1 10 = 1000 1 = 0.2 11 = 5000 2 = 0.5 12 = 10000 3 = 1 13 = 1.33 4 = 2 14 = 2.66 5 = 5 15 = 13.33 6 = 10 16 = 133.3 7 = 50 17 = 1333 8 = 100 18 = 6666 9 = 500 19 = 13332
R35	Sensor full scale voltage range	Sensor FS voltage: *value* 0 = 1 Volt 1 = 5 Volts 2 = 10 Volts
R37	System status	M*abc* For the *value of a*: 0 = Local 1 = Remote For the *value of b:* 0 = not learning 1 = learning system 2 = learning valve For the *value of c:* 0 = open 1 = close 2 = stop 3 = set point 1 4 = set point 2 5 = set point 3 6 = set point 4 7 = set point 5 8 = Analog set point
R41	Phase 1 value	X1 *value* Where *value* is Phase/Lead
R42	Phase 2 value	X2 *value* Where *value* is Phase/Lead

R43	Phase 3 value	X3 *value* Where *value* is Phase/Lead
R44	Phase 4 value	X4 *value* Where *value* is Phase/Lead
R45	Phase 5 value	X5 *value* Where *value* is Phase/Lead
R46	Gain 1 value	M1 *value* Where *value* is gain
R47	Gain 2 value	M2 *value* Where *value* is gain
R48	Gain 3 value	M3 *value* Where *value* is gain
R49	Gain 4 value	M4 *value* Where *value* is gain
R50	Gain 5 value	M5 *value* Where *value* is gain
RP	Reports Phase on active set-point	Phase: *value* Where *value* is Phase of active set point
RG	Reports Gain on active set-point	Gain: *value* Where *value* is Gain of active set point

APPENDIX D: WARRANTY

Net Controls, LLC Warranty

Each product sold by Net Controls, LLC (NET CONTROLS) is warranted to be free from the manufacturing defects that adversely affect the normal functioning thereof during the twelve (12) month period immediately following delivery thereof by NET CONTROLS (or in the case of products or components of any product purchased by NET CONTROLS from another for any lesser period of time that such manufacturer warrants said product or component to NET CONTROLS), provided that the same is properly operated under conditions of normal use and that regular, periodic maintenance and service is performed or replacements made, in accordance with the instructions provided by NET CONTROLS. The foregoing warranty shall not apply to any product or component that has been repaired or altered by anyone other than an authorized NET CONTROLS representative or that has been subject to improper installation or abuse, misuse, negligence or accident. NET CONTROLS shall not be liable for any damage, loss, or expense, whether consequential, special, incidental, direct or otherwise, caused by, arising out of or connected with the manufacture, delivery (including any delay in or failure to deliver), packaging, storage or use of any product sold or delivered by NET CONTROLS. In the event that THE NET CONTROLS' product shall fail to conform to the foregoing warranty or to the description thereof contained herein, the purchaser thereof, as its exclusive remedy, shall upon prompt notice to NET CONTROLS of any such defect or failure and upon the return of the product, part or component in question to NET CONTROLS at it's factory, with transportation charges prepaid, and upon NET CONTROLS's inspection confirming the existence of any defect inconsistent with said warranty of any such failure, be entitled to have such defect or failure cured at the NET CONTROLS factory and at no charge therefore, by replacement or repair of said product, as NET CONTROLS may elect. NET CONTROLS MAKES NO WARRANTY OR REPRESENTATION OF ANY KIND, EXPRESS OR IMPLIED, (INCLUDING NO WARRANTY OR MERCHANTABILITY), EXCEPT FOR THE FOREGOING WARRANTY AND THE WARRANTY THAT EACH PRODUCT SHALL CONFORM TO THE DESCRIPTION THEREOF CONTAINED HEREIN, and no warranty shall be implied by law.