FLOWWORX


# FLOW KING MULTIVARIABLE TRANSMITTER USER MANUAL

796004-01-3

# JT500 TRANSMITTER USER MANUAL

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# 1. INTRODUCTION

## 1.1 What's in the Box?

### *1.1.1 Standard Items*

- Flow King Transmitter (Model JT500) – DP/PT/T or P/T version
    - The Flow King is shipped with dust covers on the flanges and must be removed before use.
- A Flow King "Goodie Bag"
    - Contents will be as follows:
        - 1 USB Cable
        - 1 blue screwdriver
        - 1 Allen wrench
        - 2, 3, 4, 6, 7, and 14 position terminal plate connectors
        - Link to Quick Start Guide

### *1.1.2 Optional Items*

Optional Items may be installed at the factory.

For a complete list of optional items, please refer to the 908004-01-0 JT500 Transmitter Model Specification sheet.

## 2. FLOW KING TRANSMITTER OVERVIEW

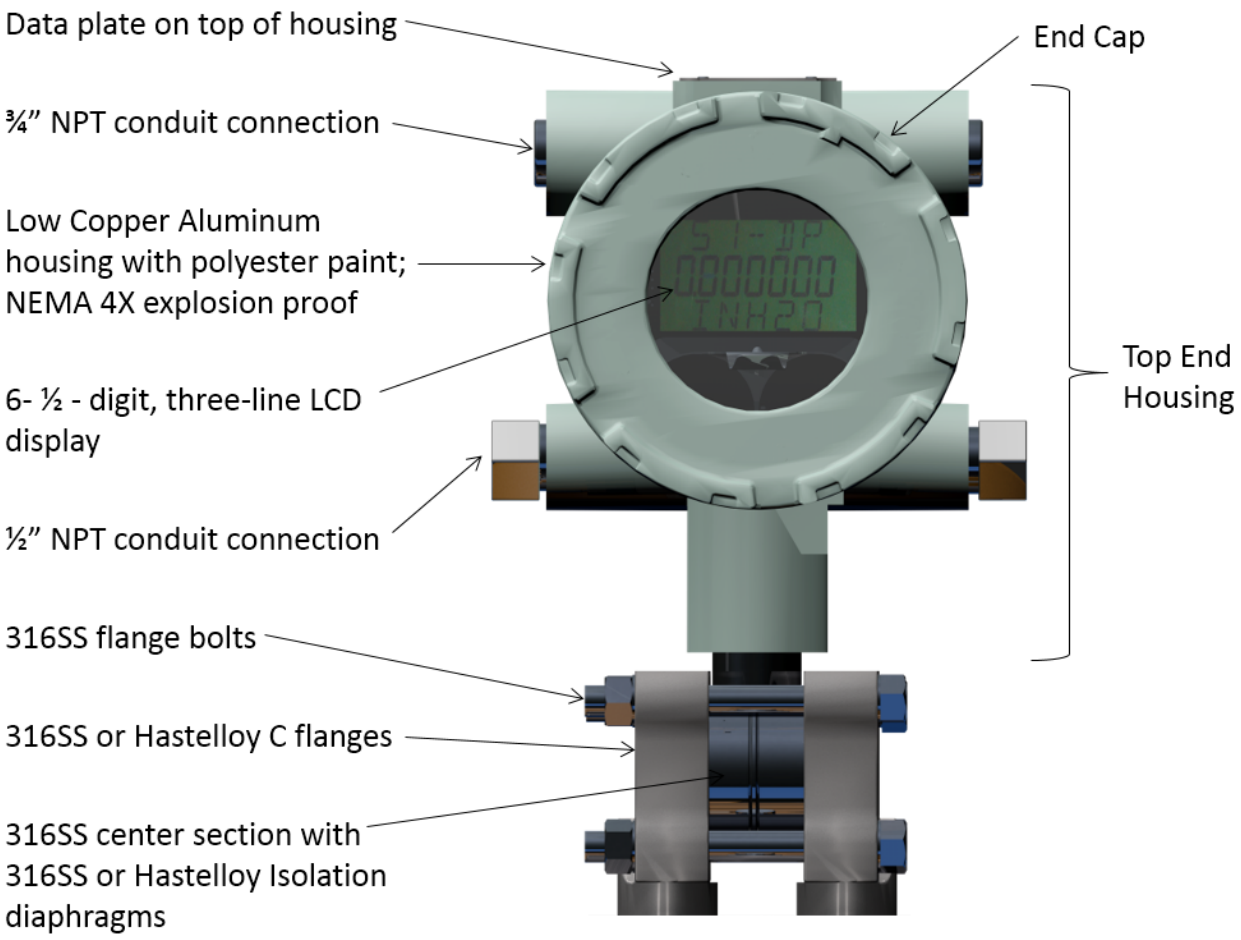



**FIGURE 1**

## 3. UNDERSIDE VIEW FOR FLOW DIRECTION AND PROCESS CONNECTIONS

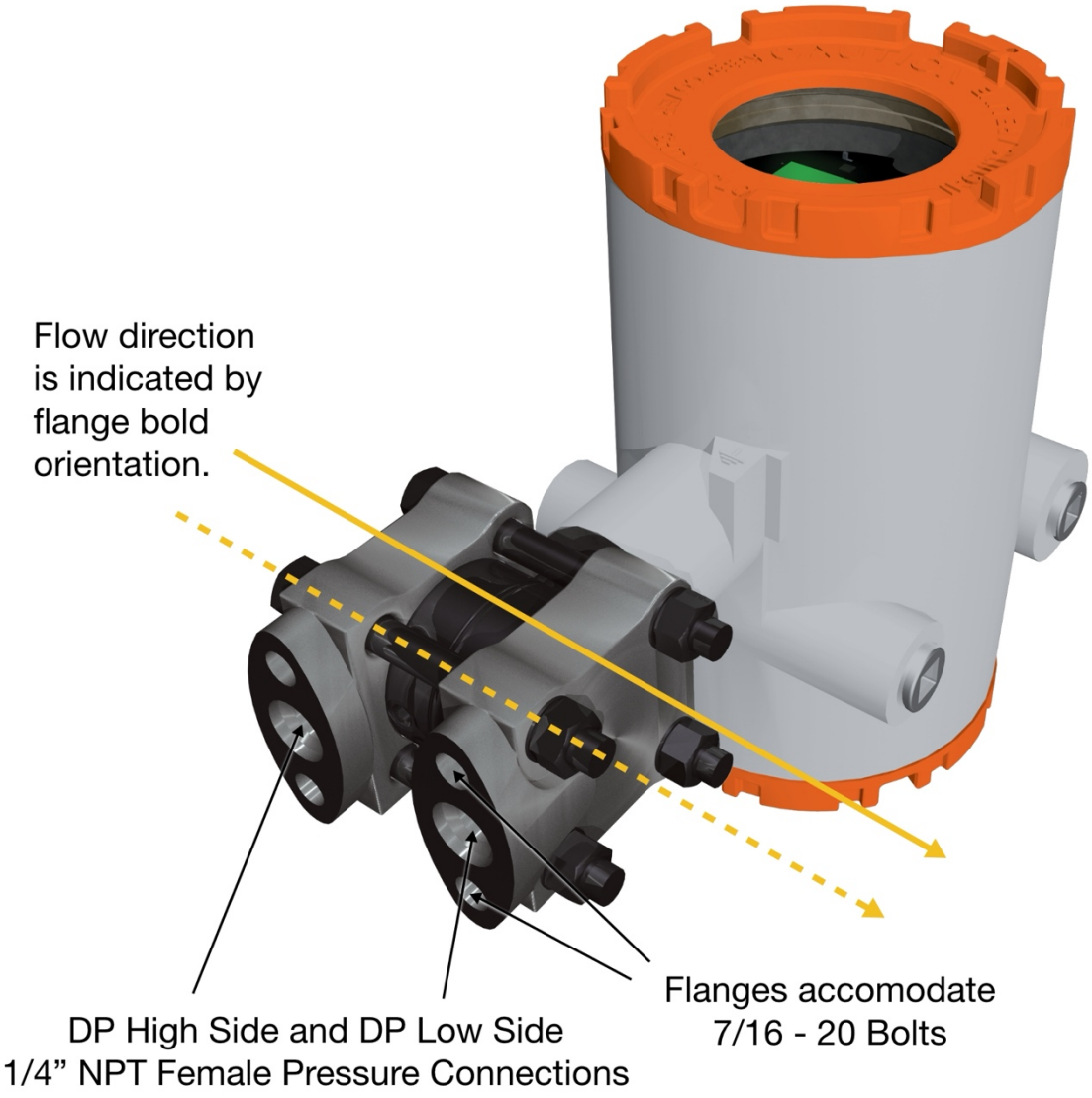



**FIGURE 2**

# 4. SAFETY AND WARNINGS

## 4.1 Hazardous Area Warnings

*Before working in a hazardous area, use a gas detector to make sure that no hazardous gases are present.*

*When wiring in a hazardous area, use explosion-proof practices. Be sure to route permanent wiring to the Flow King transmitter through hard conduit.*

*Before leaving a hazardous area, close end caps tightly to be sure of an explosion-proof seal.*

## 4.2 Mounting and Pressure Fitting Warnings

*The Flow King transmitter must be firmly secured to a pipe, wall or a direct-mounted instrument manifold.*

*Be sure fittings and torque meet maximum pressure rating requirements.*

*Seal all unused conduit connections in housing with appropriate plugs.*

# 5. INSTALLATION AND MOUNTING “HOW TO”

The Flow King Transmitter must be direct-mounted to an instrument manifold or secured to a pipe or wall. Be sure that fittings and torque meet maximum pressure rating requirements.

## 5.1 How to Direct Mount the Flow King Transmitter

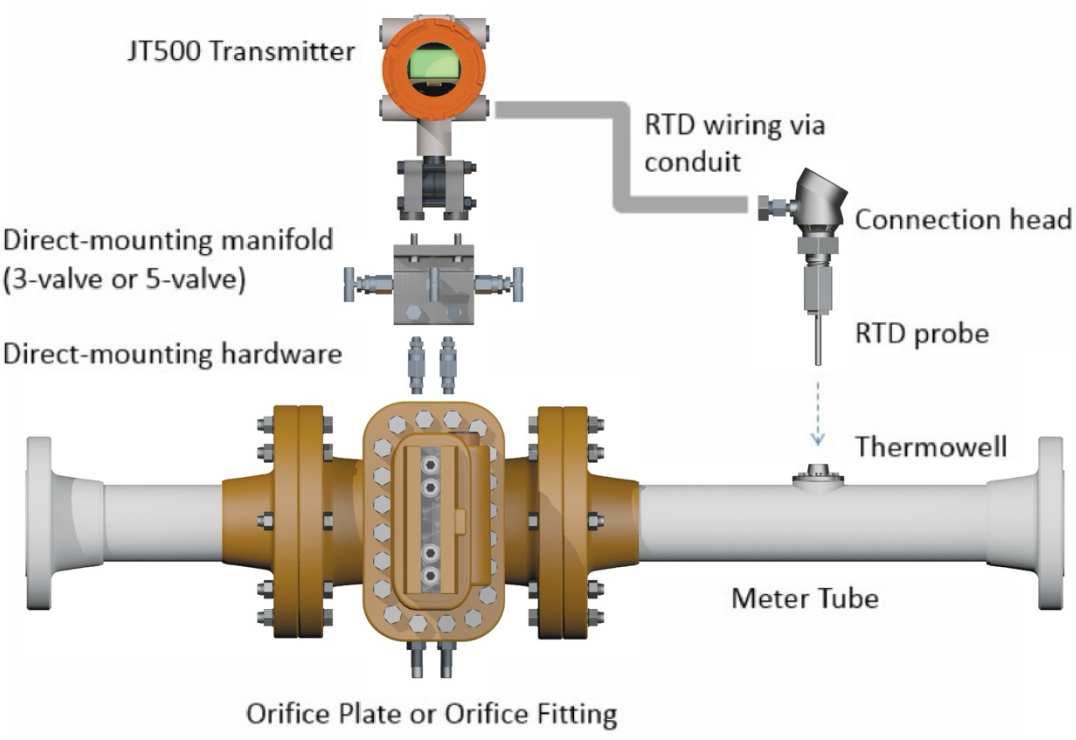



**FIGURE 3**

**Note:** The sensor module has an “H” stamped on the body near the flange that must be mounted on the high-pressure side of the manifold. There is an “L” stamped on the body next to the low side flange. No damage will occur if the sensor is mounted backwards but the DP pressure reading will be reversed. The static pressure measurement is on the high side flange port.

Use short bolts to mount the unit to the manifold. Torque the bolts to 12.5 ft-lbs. Use washers if provided.

## 5.2 How to Pipe Mount the Flow King Transmitter

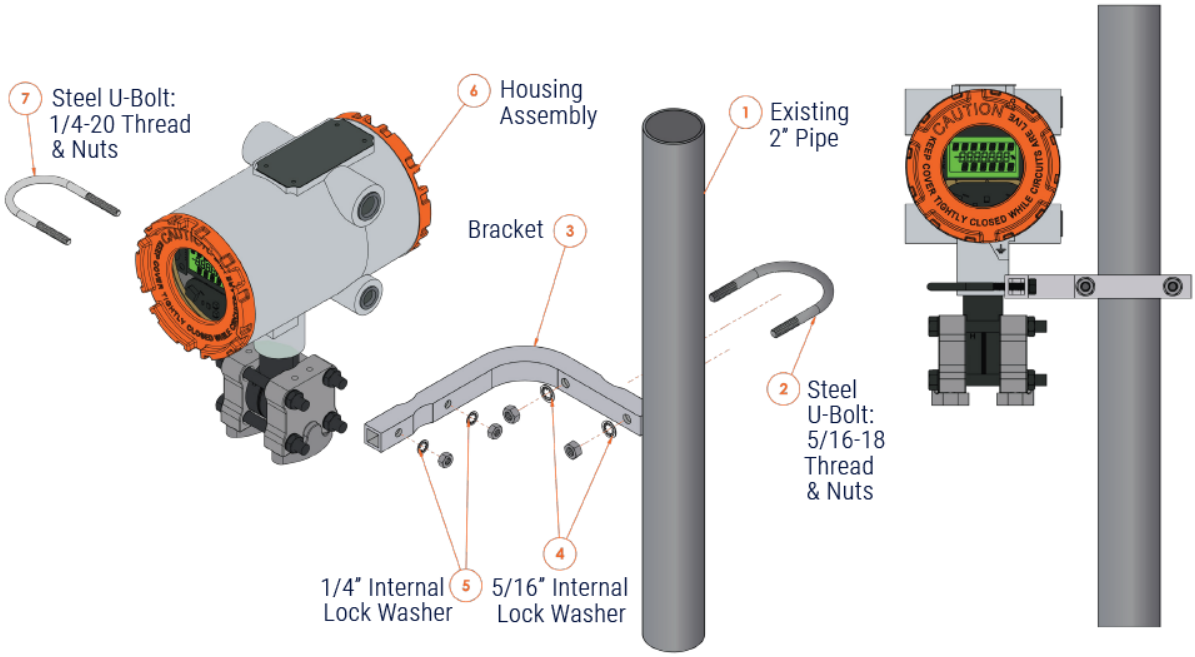



**FIGURE 4**

Be sure to slope gauge lines continuously from the Flow King to the orifice plate to ensure no liquids get trapped in the lines. Trapped liquids will cause measurement errors. Connect conduits to the Flow King after any housing rotation.

Since the Flow King is attitude sensitive, it is recommended to zero the unit after installation is complete.

## 5.3 How to Rotate the Top End Housing

Once the Flow King transmitter has been installed, prior to the installation of any conduits, the top-end housing can be rotated, horizontally, up to 180° clockwise or counterclockwise.

**CAUTION: The Flow King transmitter could be damaged if the housing is rotated more than 180° from the position that it was set at the factory.**

Rotating the top-end housing serves to provide the most convenient field technician access or LCD viewing angle.

To rotate the top-end housing, use a 0.0781 (5/64) hex wrench to loosen the set screw that locks the top-end housing to the bottom-end transducer assembly.

Rotate the top-end housing horizontally to the desired position and tighten the set screw.

# 6. CONNECTIONS AND WIRING “HOW TO”

## 6.1 Overview

All external wiring connections to the Flow King transmitter are made via the termination panel, which is accessed by unscrewing the back-end cap.

Pluggable terminal blocks on the Flow King transmitter termination panel simplify wiring. Since the screws are located on the sides of the terminal blocks, the terminal blocks should be removed before wiring.

To wire to the terminations, use the provided screwdriver or a 2.5 mm “technician blade” and #16 - 24 AWG wire.

Make connections by inserting the bare wire (up to 1/4”) into the clamp next to the screw and securing the screw. The wire should be inserted fully so that no bare wires are exposed to cause shorts. If using stranded wire, tin the bare end with solder to improve conductivity.

Allow some slack in the wires when making terminal connections. The slack makes the connections more manageable and minimizes mechanical strain on the terminal blocks.

The use of twisted-pair, shielded and insulated cable for I/O signal wiring will minimize signal errors caused by electromagnetic interference (EMI), radio frequency interference (RFI) and transients. **When using shielded cable, all shields should be grounded only at one point in the system. This is necessary to prevent ground current loops that can cause signal errors.**

When wiring is complete, be sure to tightly clamp each terminal block using the hold-down screws at each end. The following picture shows the available interfaces on the termination panel.

Take care in preparing the wires from the Resistance Temperature Detector (RTD). Be sure to insert all strands of wire into the terminal block plug and screw the clamping screws down firmly. Avoid clamping on the wire insulation. To conserve space, not every input has a corresponding “ground” connection. The DI/DO inputs require that the “-” wires share “-“ inputs.

Left-hand Column

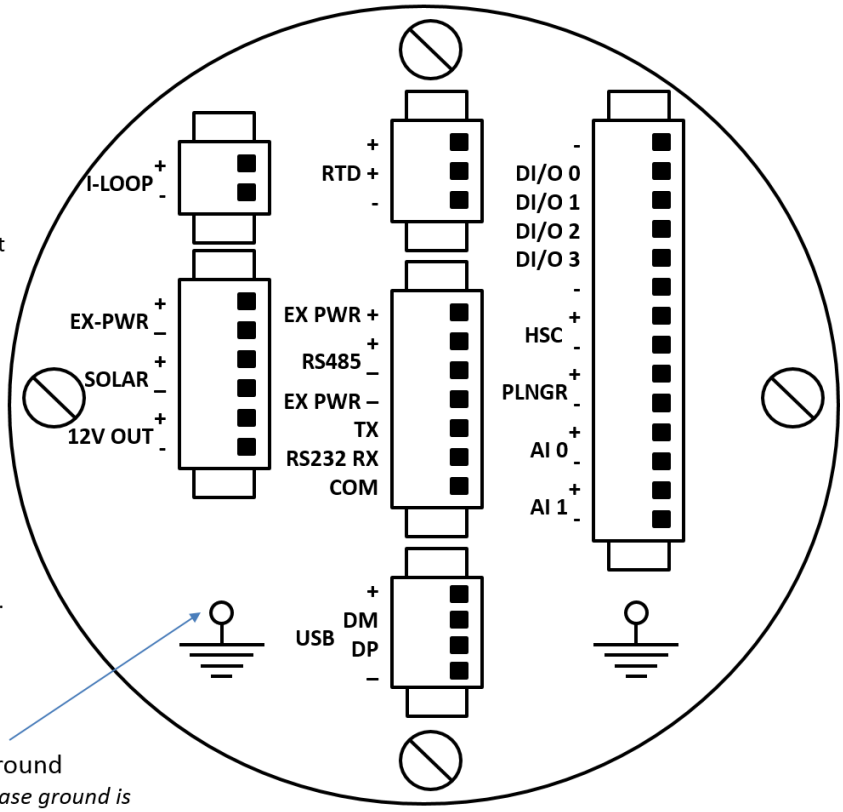
- I-LOOP – Currently not used
- EX-PWR – External dc power input
- SOLAR – Solar panel input – (*FUTURE*)
- 12V OUT – 12 Vdc output input – (*FUTURE*)

Center Column

- RTD – Three-wire 100-ohm RTD input
- EX PWR – External d.c. power input (use either this connector or the one on the left-hand terminal block) 4-30VDC
- RS485 communication port
- RS232 communication port
- USB communication port

Right-hand Column

- DI/O 0 to DI/O 3 – Four digital inputs/outputs
- HSC – High-speed counter input (0-10KHz with switchable 100-Hz filter) – (*FUTURE*)
- PLNGR – High-speed pulse input (e.g. for plunger arrival sensor) – (*FUTURE*)
- AI 0 and AI 1 – Two analog inputs (1-5Vdc)




**NOTE:** *Case ground is isolated from signal ground.*

**FIGURE 5**

## 6.2 How to Connect the USB Cable

The typical application for the USB interface is to connect a PC for configuration via the Flow King Transmitter Graphical User Interface (GUI).

The USB terminal block is located at the bottom, center of the termination panel. FlowWorx provides a customized cable for the USB interface. The cable is “pre-wired” to a compatible, pluggable terminal block. Simply plug-in the terminal block and connect the other end of the USB cable to the PC.

**When using the terminal block USB, always connect the terminal block first, then connect to the PC.**

The Flow King transmitter is a USB-2.0 full-speed device. For the USB port, there is no need to configure parameters such as baud rate or number of data bits. As viewed on the PC Device Manager, the USB port number is “USB Serial Port (COMxx)” where “xx” indicates the port number may change. The Flow King Transmitter GUI communicates on the COMxx port.

While connected to a PC via USB, the Flow King transmitter will draw full power from the PC. Since there is no need for a separate power supply, this simplifies set-up and testing at the bench. If the Flow King transmitter is already connected to a power source, there is no need to disconnect it to use the USB interface, as the Flow King transmitter auto-switches between power sources.

## 6.3 How to Connect to the RS-232 Interface

Typical RS-232 applications include point-to-point interfacing with a PLC or RTU or connecting a PC as an alternative to using the USB interface. FlowWorx recommends the USB interface for connection to a PC. A PC would typically use a “null modem” cable with a DB-9 connector. Recommended maximum cable length is 20 feet.

Please note that on the Flow King transmitter, the RS-232 and RS-485 ports are independent and can, therefore, both be used simultaneously.

The RS-232 “TX,” “RX” and “COM” terminals are located to the lower, center on the termination panel.

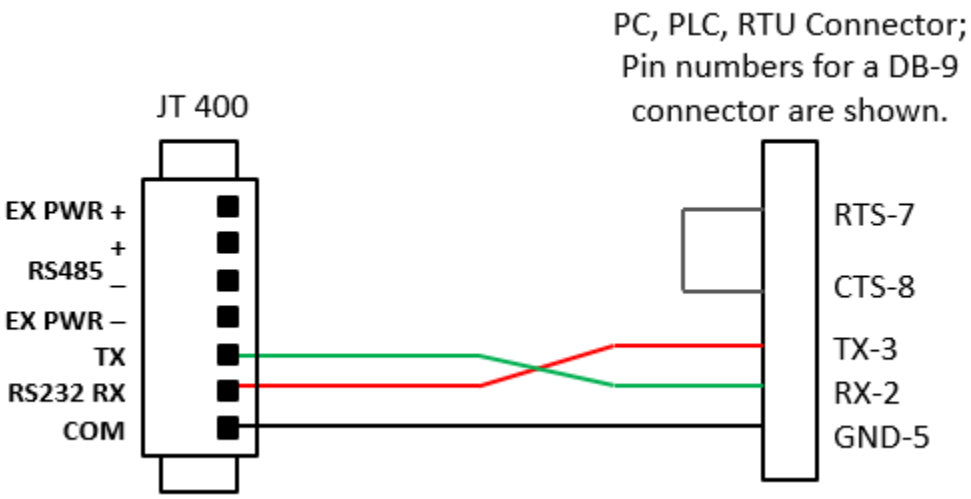



**FIGURE 6**

To configure RS-232 communications parameters, please see **How to Set-up RS-232 and RS-485 Communications**.

## 6.4 How to Connect to the RS-485 Interface

The typical application for the RS-485 interface is a hard-wired, multi-drop network in which the Flow King transmitter connects to a PLC, RTU and/or other transmitters on a network that is up to 4000 feet in wiring length. FlowWorx recommends a 24-gauge paired conductor cable such as Belden 9843.

Please note that, on the Flow King transmitter, the RS-232 and RS-485 ports are independent and can, therefore, both be used simultaneously.

The RS-485 "+," RS-485 "- "and "EX PWR -"terminals are located at the center of the termination panel. External power connections are located on the same terminal block to provide the convenience of connecting to only a single terminal block for most Flow King applications.

Please also note that all terminals labeled "EX PWR +" are tied together internally. Therefore, do not use separate power sources for each.

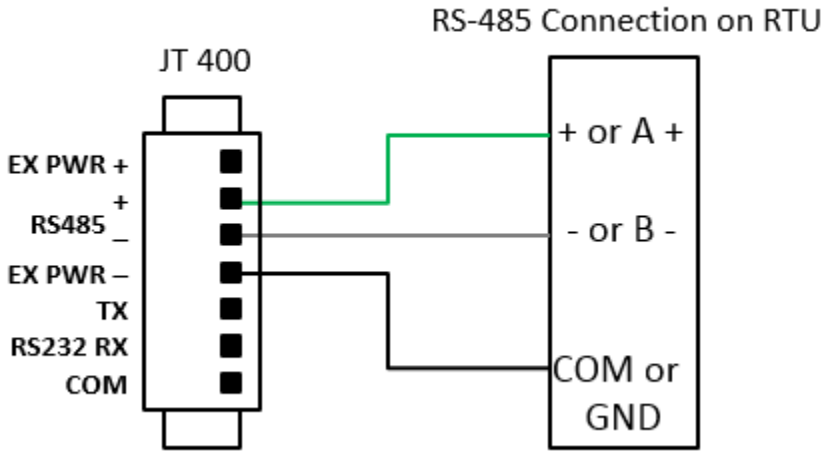



**FIGURE 7**

To configure RS-485 communications parameters, please see **How to Set-up RS-232 and RS-485 Communications**.

## 6.5 How to Connect the RTD Temperature Input

This application is to measure the process temperature using a 3-wire, 100-ohm platinum RTD that is installed within a thermowell in the meter tube.

The Flow King transmitter uses the Callendar-Van Dusen coefficients from the resistance-to-temperature calculation algorithm. The Flow King Transmitter GUI allows the user to customize the RTD by changing coefficients.

The RTD terminals which consist of two “+” and one “- “are located at the top center of the termination panel.

Temperature measurement accuracy is dependent on all three wires being the same length and same gauge.

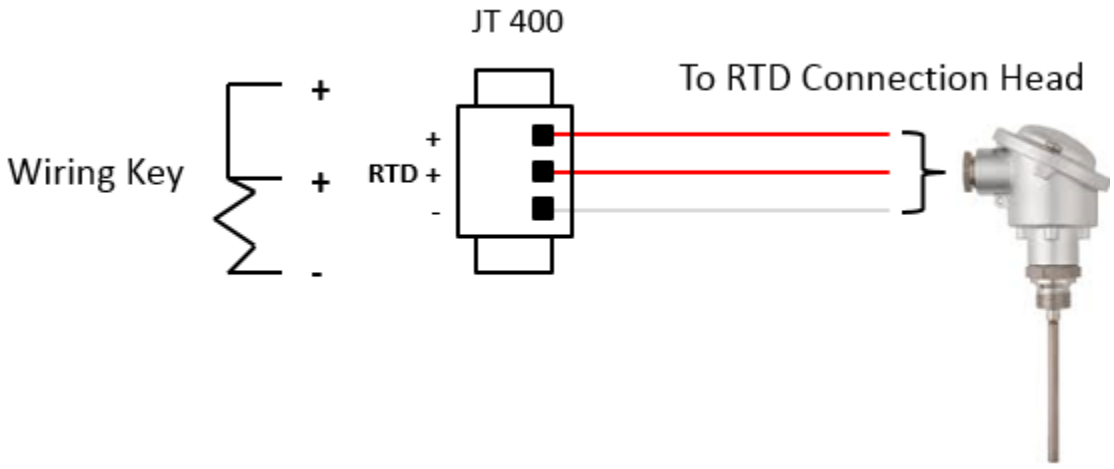



**FIGURE 8**

To calibrate the RTD input and configure associated settings, please see **Temperature Calibration**.

## 6.6 How to Connect the Analog Inputs

The typical application for the analog inputs is monitoring process variables such as well-head casing pressure and tubing pressure via sensors that produce voltage outputs. Analog input circuitry supports inputs from 1-5V devices. **Please note that such transmitters are calibrated externally.**

Each AI signal is channeled through signal conditioning circuitry that provides a 3.6 Hz low pass filter, a Transorb for surge suppression, multiplexer, and an A-to-D Converter.

Analog inputs are protected against over-voltage up to 30 Vdc.

Analog inputs will read accurately up to 10% over range.

The two analog input points are located to the lower right of the termination panel.

Power to the sensors could be provided by an external power supply or by the optional 12 Vdc output that is available on the Flow King transmitter termination panel. **NOTE: External power connections should be made last, after all other wiring has been connected.**

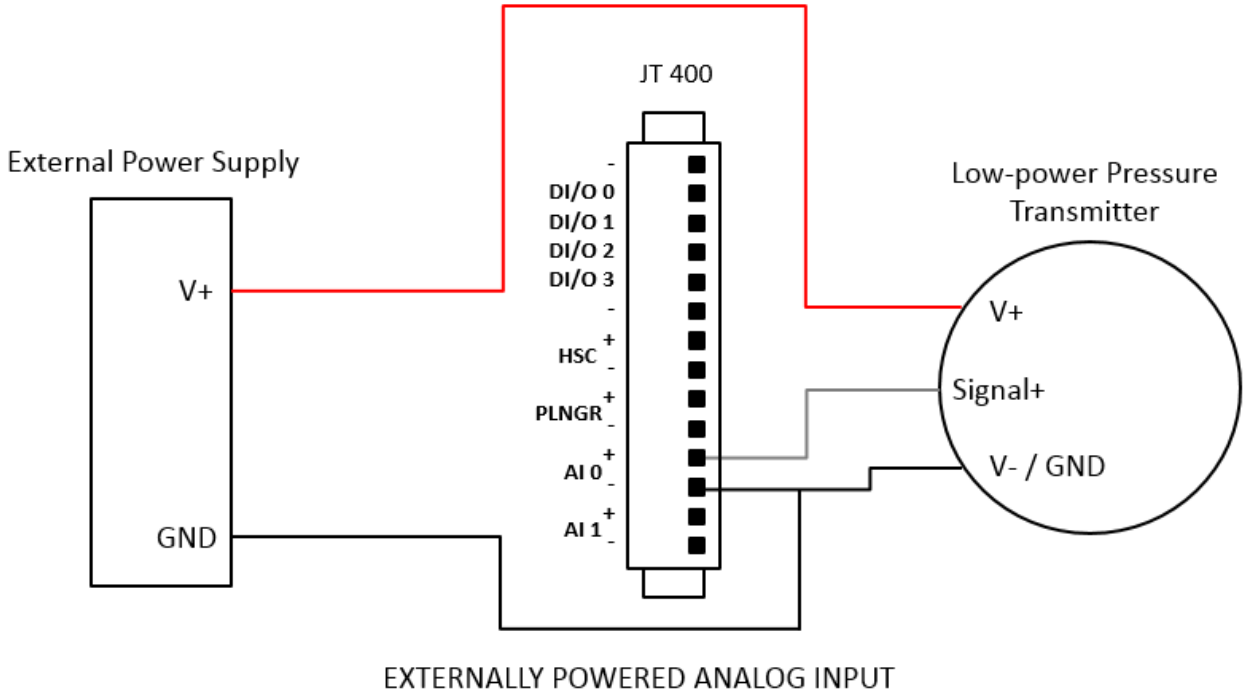
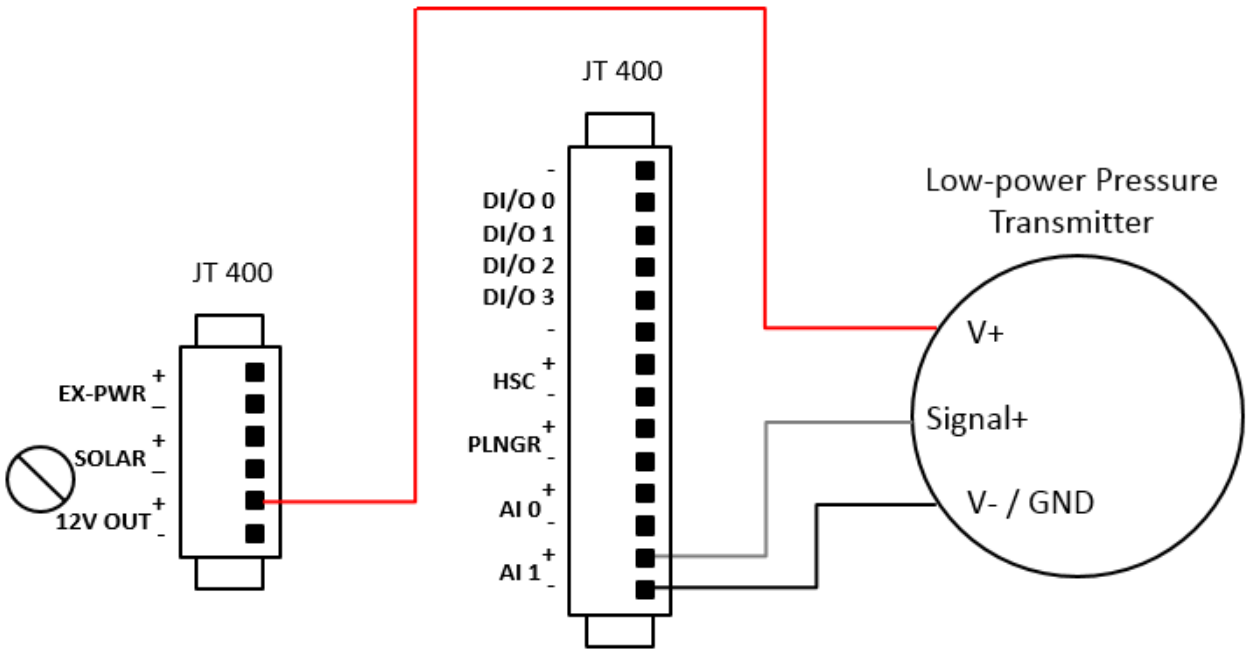



**FIGURE 9**




INTERNALLY POWERED ANALOG INPUT

**FIGURE 10**

## 6.7 How to Connect the Digital Inputs/Outputs

The typical application for digital inputs is monitoring the “on/off” status of equipment such as compressors and pumps or valve limit switches.

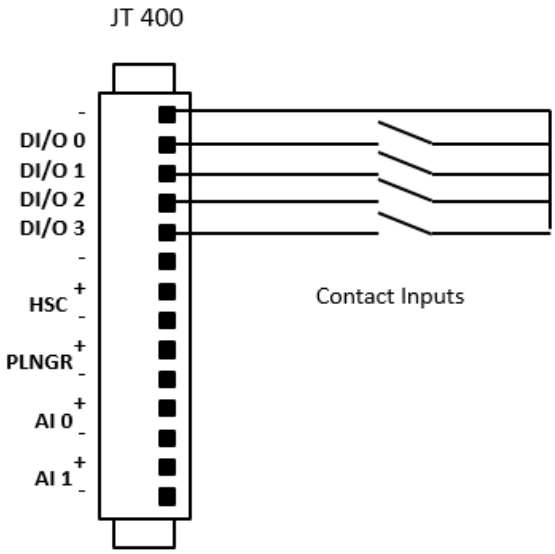
Typical applications for digital outputs include operation of compressors, pumps, valve actuators and other equipment that is controlled by an on/off signal.

DIO circuitry provides internally sourced DI operation for Dry Contacts pulled internally to 3.3 Vdc when the field input is open. Each DI is protected with a surge suppressor. DO circuitry utilizes open-drain MOSFETs and surge suppressors. The DOs sink current to digital ground. DOs will sink up to 500 mA.

The four digital input/output points are located to the upper right of the termination panel. Terminals labeled, “DIO 0” through “DIO 3” are the positive terminals. For convenient ground connections, two, “-“terminals are located immediately above and below those four.

Each point can be wired as an input or output. DI/DO operation is controlled via a Modbus command and may be configured using the GUI. To set-up the digital input/outputs, please see **I/O OPERATIONS**.

Voltage, commonly called the “wetting” voltage for a dry contact or input device, is fed from the “DIO x” terminal. The other side must be connected to one of the “-“terminals, which are immediately above and below the DIO terminals.




DIGITAL INPUT CONNECTIONS

**FIGURE 11**

## 6.8 How to Connect External DC Power

Power to operate the Flow King transmitter can be provided by a PLC, RTU or external power supply. The Flow King transmitter presents a very light load of less than 1 mA at 4 Vdc. The voltage input range is 4.0 to 30.0 Vdc.

The Flow King transmitter auto-switches among multiple power sources including USB or external.

On the Flow King termination panel, there are two sets of EX-PWR + and – terminals, in the center and left, center of the termination panel. These are connected internally. Do not connect two different sources to these connections! The pair that is used is left to the installer's discretion. Since the TB in the center provides connections for RS-232 and RS-485 communications, it allows more convenient wiring.

**NOTE: External power connections should be made last, after all other wiring has been connected.**

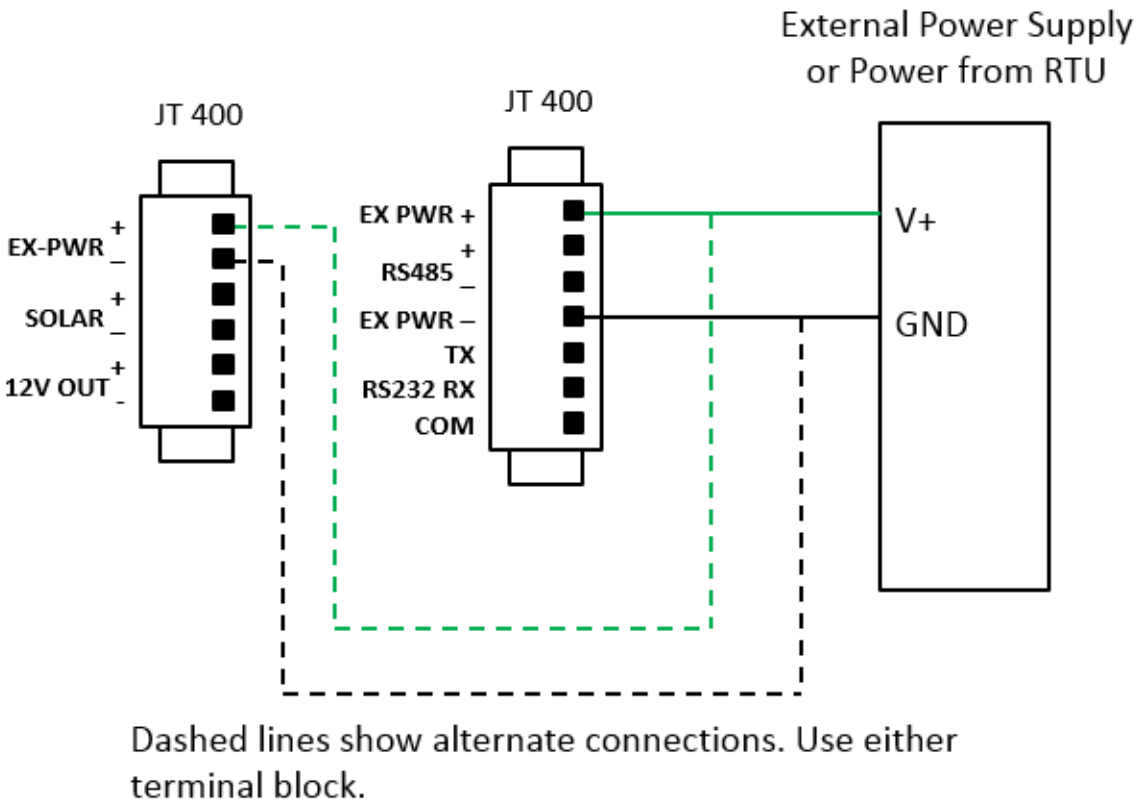



**FIGURE 12**

# 7. HOW TO USE THE LIQUID CRYSTAL DISPLAY

The three-line LCD displays the name of the parameter or variable on the top line, the value on the second line and the units on the third line.

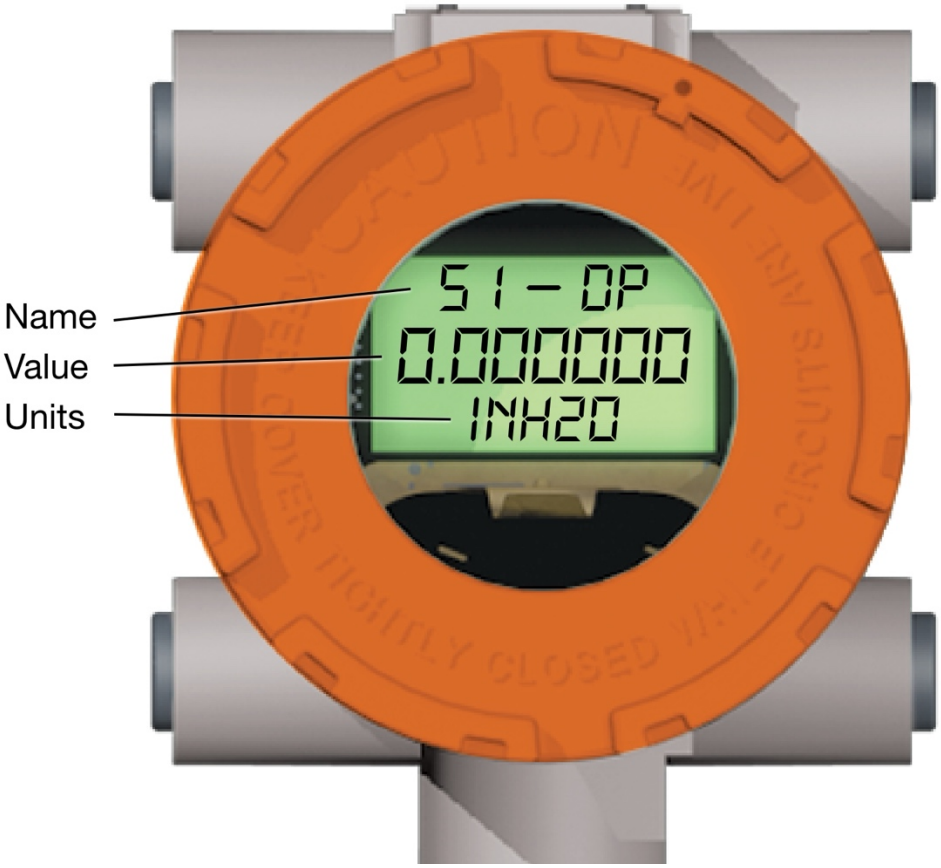



**FIGURE 13**

Whenever power is applied to the Flow King transmitter, the display continually cycles through the following:

- Flow King Transmitter Address
- RS-485 Baud Rate
- RS-232 Baud Rate
- Primary Variable (DP or Gauge Pressure) Value
- Static Pressure Value
- Estimated Temperature (sensor temperature measured internal to the Flow King transmitter)
- Process Temperature Value from RTD
- Firmware revision
- Additionally, up to nine other customer defined LCD screens can be displayed.

# 8. HOW TO SET-UP AND OPERATE THE FLOW KING TRANSMITTER VIA THE FLOW KING TRANSMITTER GRAPHICAL USER INTERFACE (GUI)

## 8.1 Software Installation

To install the Flow King Transmitter GUI, insert the included CD or USB Flash Drive in the PC or download the latest version from the Flowworx web site and follow the instructions to run the installation and set-up process.

## 8.2 Default Flow King Factory Settings

Each Flow King ships from the factory with the following settings:

- Address: 1
- RS-485 and RS-232 baud rate: 9600
- RTS Delay: 50 ms
    - This value is the approximate oscilloscope measured RTS delay.
    - The integer in the Modbus register 130 would be “50”.
    - The equivalent BSAP RTS delay would be 50 ms.
    - NOTE: Depending on the application this RTS delay may not be ideal.
- DP Units: “inH2Oat68F”
- SP Units: “PSI”
- PT Units: “DegreesF”
- Flow King User Description: “Flow King”
- BSAP Group Number: 1

## 8.3 Flow King Transmitter GUI Start-up

To start the Flow King Transmitter GUI, click on the Flow King GUI icon.

The Main Monitor as shown, below, will appear on the PC screen.

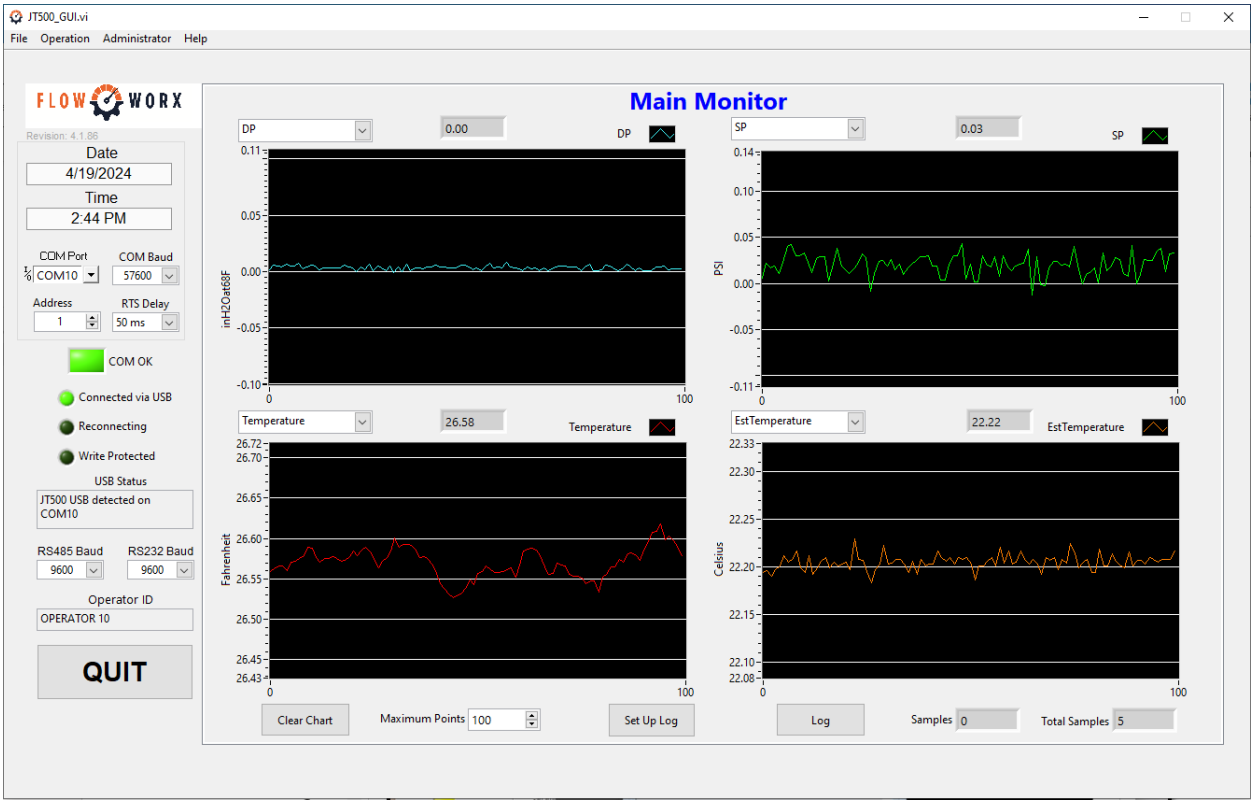



**FIGURE 14**

Before proceeding to configuration of the live displays and trend graphs within the Main Monitor, the user should confirm and, if necessary, configure the settings in the left-hand column of the display. Please see the next page for those functions.

## 8.4 PC Displays and Operations Overview

The Flow King Transmitter GUI display layout is shown, below:

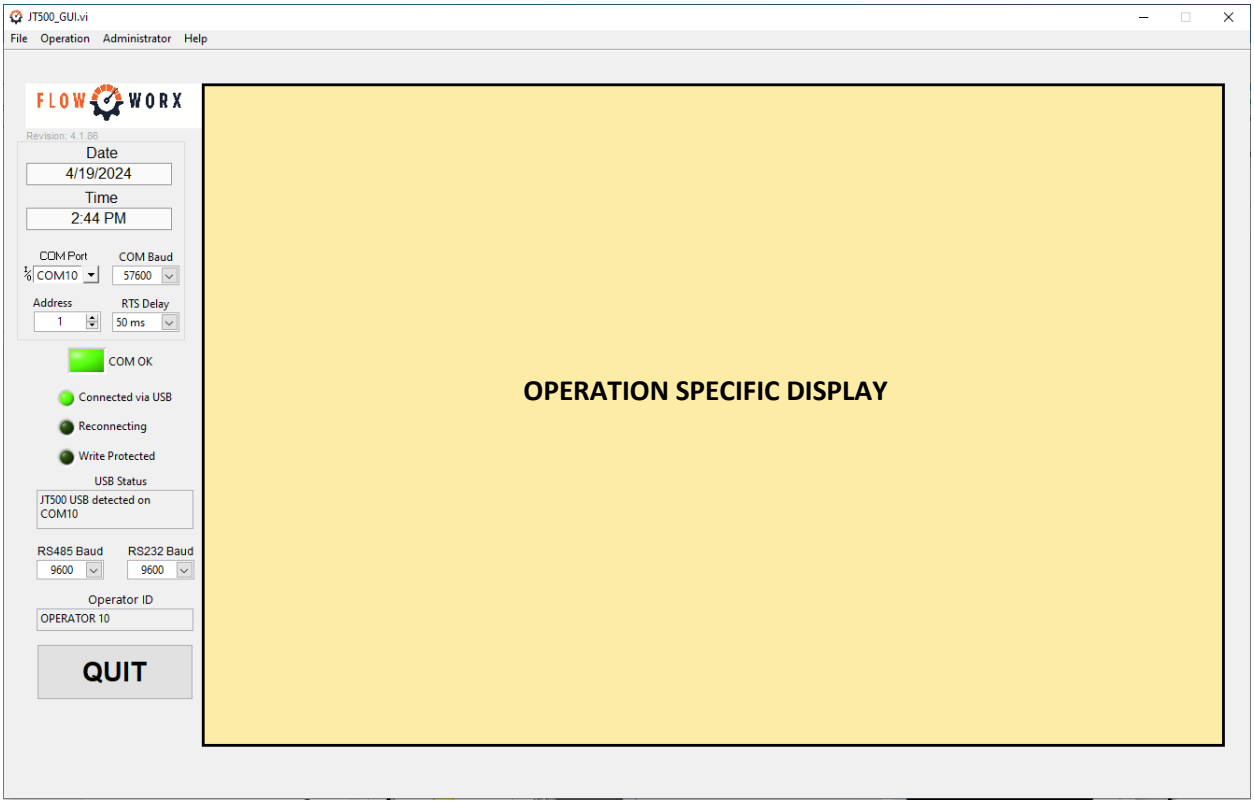



**FIGURE 15**

## 8.5 Screen Sections which are Common to All Operations

Regardless of the operation in process, the following screen sections are always available:

The top line shows the Flow King Transmitter GUI version number. The Toolbar line provides access to the common functions including File, Operation, Administrator, and Help. Drop-down functions are shown in the chart, below:

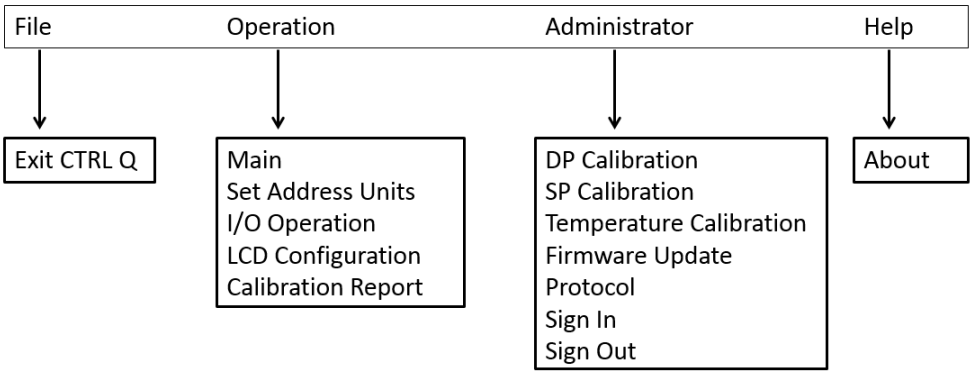


**FIGURE 16**

Note: If the user is not signed-in to the Administrator level, the calibration labels under "Administrator" will be disabled. Before calibrating, the user must sign-in. Please see **How to Sign-in**.

Along the left-hand column, common fields and functions include the following:

- Date and time from the PC
- PC communication port and baud rate selections
- Flow King transmitter address selection
- Flow King transmitter RTS Delay selection
- "Com Baud rate" button, which initiates an auto-baud dialog box for the RS-232 and RS-485 ports.
- PC-to-Flow King communication status; bright green and yellow (as shown) means that communication is working properly, whereas dark green means that the PC is not communicating with the Flow King transmitter.
- Field for Operator ID – this information appears on the As-found/as-left log.
    - This field is set to default to "Operator 12". To change this from the default simply click in this text location and delete "Operator 12" and retype up to a 12-character operator ID. It is important to note that this information is saved on the computer and not the Flow King. It is important to note as well that this field will retain the Operator ID until either it is changed or there is a change to the GUI.
- "QUIT" button exits the Flow King Transmitter GUI.

# 9. HOW TO CONFIGURE PC COMMUNICATIONS PORT AND BAUD RATE

PC communications port and baud rate are normally the first settings the user checks and, if necessary, configures.

Communication between the PC and the Flow King transmitter could be via RS-232, RS-485, or USB. These communications paths are independent of each other. For USB, the communication speed is fixed at 57600. For RS-232 and RS-485, it is configurable to baud rates of 1200, 1800, 2400, 4800, 7200, 9600, 14400, 19200, 28800, 38400, 56000, and 57600. The default is 9600 baud. Flow King device address ranges from 1 to 239 with a default of 1.

In the left-hand column, click on the down arrow that is adjacent to the Com Port and Com Baud fields to display the choices that are available, then click on the appropriate choice.

Normally, the USB interface is used to connect the PC to the Flow King transmitter, in which case the baud rate setting must be set to 57600. However, if the PC is connected to the Flow King transmitter via RS-232 or RS-485, the user should check the RS-232 or RS-485 baud rate that appears in the sequence on the Flow King transmitter LCD and set the Com Baud on the GUI to the same value.

# 10. HOW TO SELECT THE TRANSMITTER ADDRESS

In the left-hand column, click on the up or down arrow that is adjacent to the Flow King Address to increment or decrement to the desired figure. The address can also be changed by highlighting the old value and typing in the new one. To communicate with this new address the user can either use the “Enter” key or click out of the input box.

# 11. HOW TO SET-UP RS-232 AND RS-485 COMMUNICATIONS

RS-232 and RS-485 communications are set up using the drop-down menu.

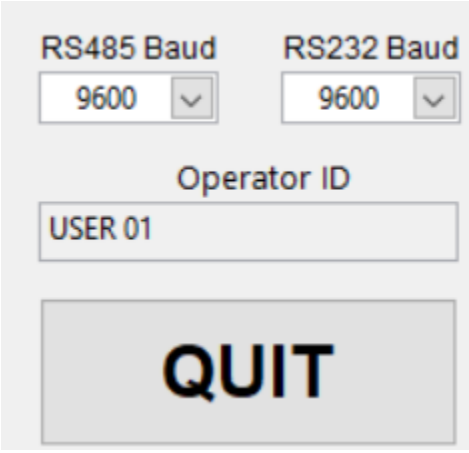
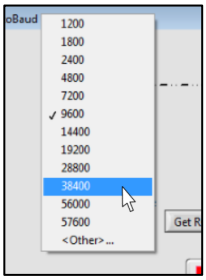



**FIGURE 17**

Note that the transmitter address, RS-232 baud rate and RS-485 baud rate appear on the LCD display sequence.

To change the baud rate for either the RS-485 or RS-232 port, the user must click either within the white space or the up or down keys to scroll through the available baud rates. Please note that if the user clicks in the white space the following will show:




Click on the “Complete” button when finished. The dialog box will disappear, and the PC will automatically change to the new baud rate to maintain communications with the Flow King.

It is important to note that all Flow King’s that are on the same RS-485 line should all have the same RTS Delay. To change the RTS Delay of a given Flow King all that is required is that the dropdown menu titled “RTS Delay” in the left-hand column be used to select a new delay.

## 12. SET ADDRESS & UNITS OPERATIONS

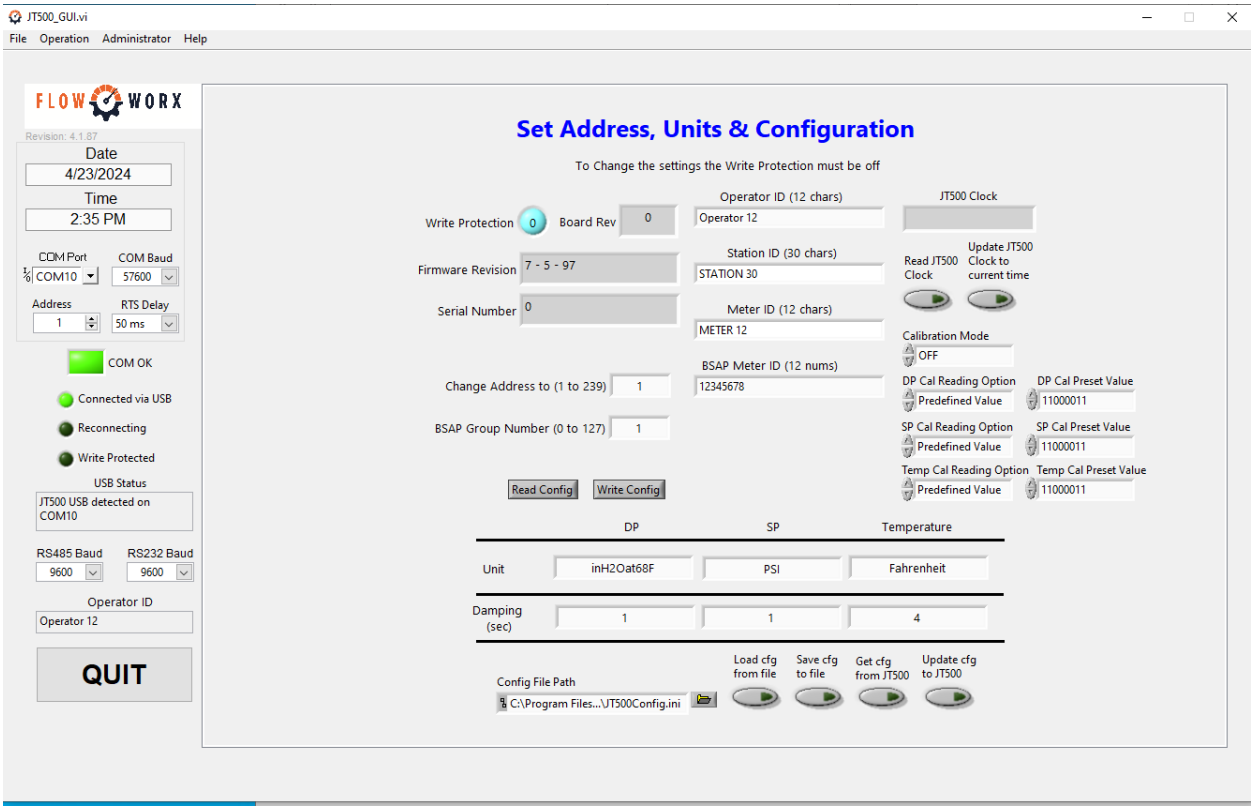


FIGURE 18

# 13. HOW TO TURN WRITE PROTECTION ON AND OFF

To change settings, write protection must be off.

The Flow King transmitter includes a hardware Write Protect switch that is located immediately above the LCD. It is accessible by removing the front cover. On the switch:

Right (“OFF”) position = Write Protection is off.

Left (“WP”) position = Write Protection is on.

The Flow King Transmitter GUI will display the status of the switch on the “Set Address and Units” page. To allow the Flow King transmitter to be configured by the Flow King transmitter GUI, a Modbus master RTU, or a BSAP controller, the write protect switch must be in the “OFF” position. The Flow King ships in the default (off) position.

Access the Set Address & Units Display by clicking Operation on the toolbar and, in the drop-down window, clicking on Set Address & Units.

# 14. HOW TO CHECK THE FLOW KING TRANSMITTER FIRMWARE REVISION

Access the Set Address & Units Display by clicking Operation on the toolbar and, in the drop-down window, clicking on Set Address & Units.

The field next to “Firmware Revision” will show the revision for the Flow King transmitter.

Please note that this information is also available on the LCD display sequence.

# 15. HOW TO CHECK THE FLOW KING TRANSMITTER SERIAL NUMBER

Access the Set Address & Units Display by clicking Operation on the toolbar and, in the drop-down window, clicking Set Address & Units.

The field next to “Serial Number” will show the serial number of the Flow King transmitter.

## 16. HOW TO DEFINE THE OPERATOR ID

Access the Set Address & Units Display by clicking Operation on the toolbar and, in the drop-down window, clicking on Set Address & Units.

Click within the field under Operator ID (12 Chars) and type a description. To set that description, click on the “Write Config” button.

## 17. HOW TO CHANGE THE FLOW KING ADDRESS

Access the Set Address & Units Display by clicking Operation on the toolbar and, in the drop-down window, clicking on Set Address & Units.

Click in the “Change Address To” box and highlight the current value. Type in the desired address (1 – 239) and press the Write Config button The address will change to the selected value to allow for continued communication.

## 18. HOW TO SET UNITS FOR DP, SP AND TEMPERATURE

Access the Set Address & Units Display by clicking Operation on the toolbar and, in the drop-down window, clicking on Set Address & Units.

Click within the appropriate field on the “Unit” line to see a list of units that are available. To change units, click on the desired units in the list then click on the “Write Config” button.

## 19. HOW TO SET DAMPING FOR DP, SP AND TEMPERATURE

Access the Set Address & Units Display by clicking Operation on the toolbar and, in the drop-down window, clicking on Set Address & Units.

Click within the appropriate field on the “Damping (sec)” line, highlight the existing number and enter a number, which is the damping time constant in seconds, and click on the “Write Config” button. Note that it takes five time constants for a step change on the input to settle.

It is important to note that the GUI has built in limit checking. Meaning that the GUI will only accept a number from 1 to 20 for damping. The firmware of the Flow King also has built in limit checking for the 32-bit registers 7420, 7423, and 7426 and the equivalent 16-bit registers 440-441, 446-447, and 452-453. This firmware limit checking will only allow a number between 1 and 30 to be written to these registers.

# 20. MAIN MONITOR OPERATIONS


FIGURE 19

## 20.1 How to View Live Readings and Select the Variable on a Chart

Access the Main Monitor Display by clicking Operation on the toolbar and, in the drop-down window, clicking on Main.

Also, note that the Main Monitor appears upon start-up of the Flow King Transmitter GUI.

The Main Monitor provides live readings and live strip chart graphs of the DP, SP, temperature (from RTD) and sensor temperature ("estimated temperature"). The charts begin tracing when the display starts up. The horizontal axes default to 100 samples while the vertical axes auto-scale based on the latest readings.

While the DP, SP, temperature and estimated temperature graphs default to the locations shown in the accompanying screen capture, the user can rearrange them. For example, to

display the SP in the upper left graph, click on the down arrow that is next to the variable selection field (which, at the moment, shows “DP”) and click on “SP” in the drop-down list.

## 20.2 How to Configure Chart Options

Clicking on the chart options field for any of the four graphs brings up a drop-down list that provides numerous alternatives to the appearance of the graph. Colors, plot styles, line widths, x-scale and y-scale can all be modified.

To clear and re-start each of the graphs, click on the Clear Chart button, which is below the graph on the lower left of the Main Monitor display.

To change the number of points that are plotted horizontally, click on the up or down arrow adjacent to “Maximum Points” to increment or decrement the number, which defaults to 100.

# 21. HOW TO EXPORT GRAPH DATA

Right-clicking on the chart options field also brings up options to export the plot data to the clipboard or to an Excel file.

# 22. HOW TO LOG GRAPH DATA

Live data from multiple Flow King transmitters can be logged to a file on the PC.

To access the configuration display for logging graph data, click on the Set Up Log button.

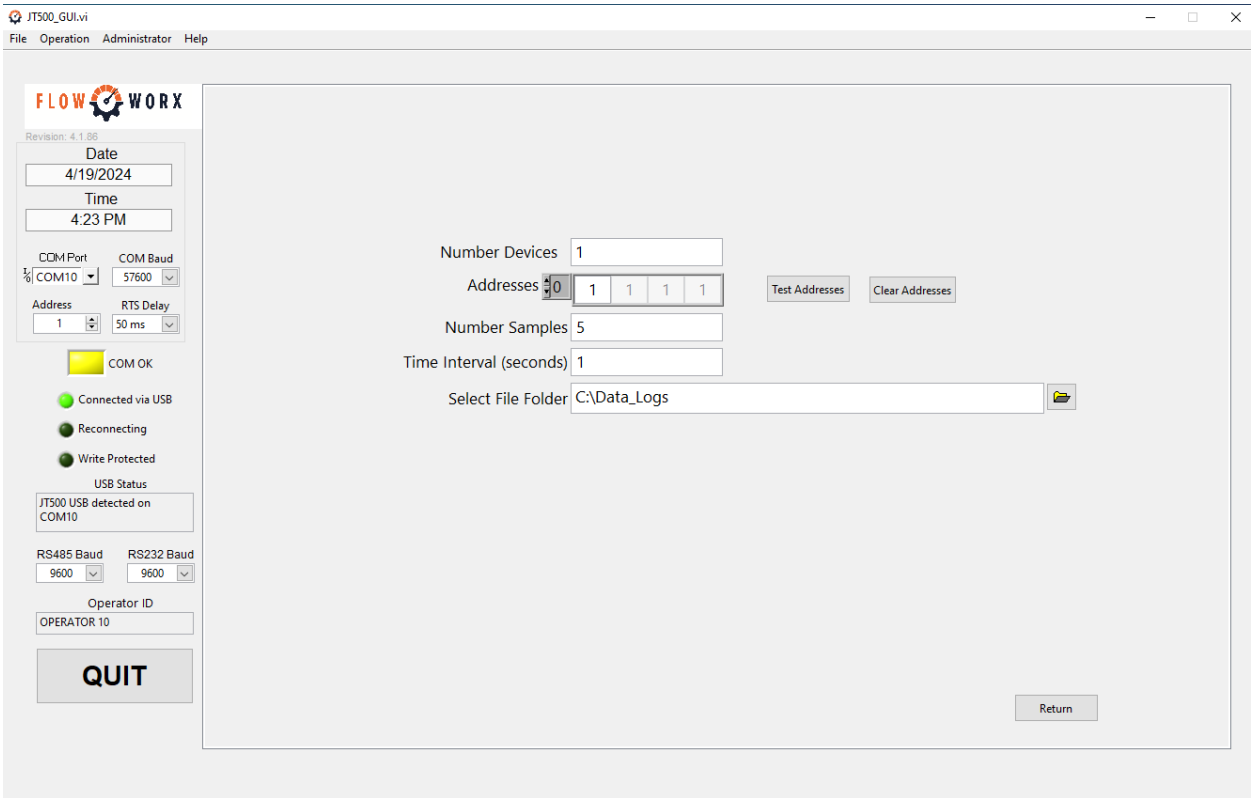



**FIGURE 20**

On the Setup Log display, use the following fields to configure the log:

The “Number Devices” field will auto increment or decrement the number of Flow King transmitters from which the data will be logged depending on the “Addresses” field beneath it.

The “Addresses” field is an array of user defined addresses. Using the up or down arrow to increment and/or decrement the index of the array can allow the user to add up to 239 Flow King transmitter address.

In the “Number Samples” field, enter the number of samples to log.

In the “Time Interval” field, enter the sample interval in seconds.

In the “Select/Create File Folder” field, browse for or enter a destination folder name. Please note that the result should be in the following format of this example: “C:\Data_Logs”. The resulting log file(s) name(s) will be “addr” + the address number in CSV format. In the case of the figure provided above the file created would be “addr3.csv” and it would be found in the folder “C:\Data_Logs”.

Click on the “Test Address” button. This will validate communications to each Flow King transmitter. This operation is also performed automatically when the user returns to the Main Monitor.

Click on the Return button to return to the Main Monitor.

To start the log, click on the Log button on the Main Monitor. The “Samples” field will increment.

Note: Once logging begins, please don’t exit from the Main Monitor as it would cause logging to automatically cease.

To stop logging, click again on the Log button. The “Samples” field will stop incrementing.

# 23. I/O OPERATIONS

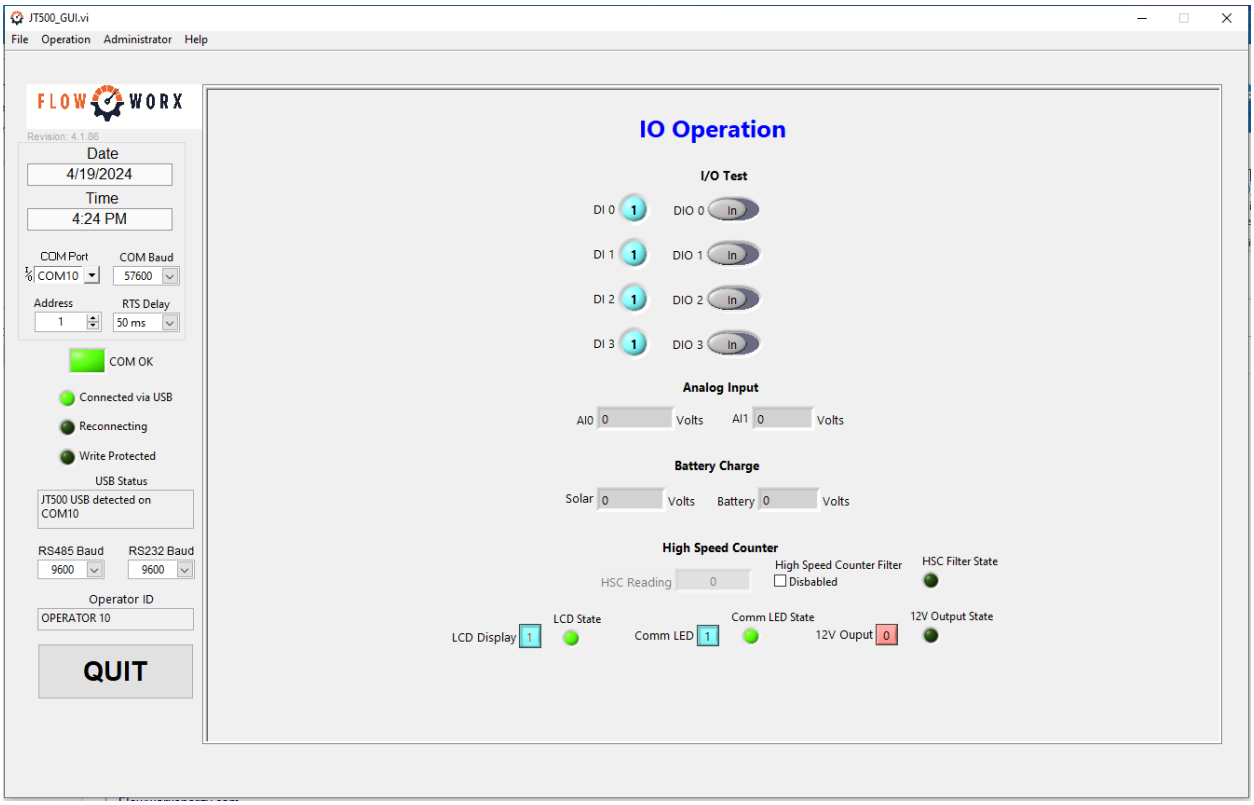



**FIGURE 21**

## 23.1 How to View I/O Point Status

Access the I/O Operation Display by clicking Operation on the toolbar and, in the drop-down window, clicking on I/O Operation.

DI and DO status is shown in the top, four fields.

“1” on a light blue background = on.

“0” on a magenta background = off.

Below the DI/DO points, values of the two analog inputs are shown in units of volts.

## 23.2 How to Select Digital Input and Digital Output operation on a Per-point Basis

Access the I/O Operation Display by clicking Operation on the toolbar and, in the drop-down window, clicking on I/O Operation.

Each point can be toggled between input and output operation by clicking on the oval-shaped field. The label will alternate between “DI” and “DO” to indicate whether the point is, respectively, an input or output.

# 24. LCD CONFIGURATION

The LCD cycles through seven different sets of information as the factory default. The data, name and units appear on the left column of figure 34. The display may be modified by what content may be displayed and for how long. Note that one additional item (Board temperature) may be added. In addition, up to nine Modbus user-defined sets may be added. Since the user-defined data is contained in Modbus registers, a wired Flow King can have its display updated remotely through an RTU.

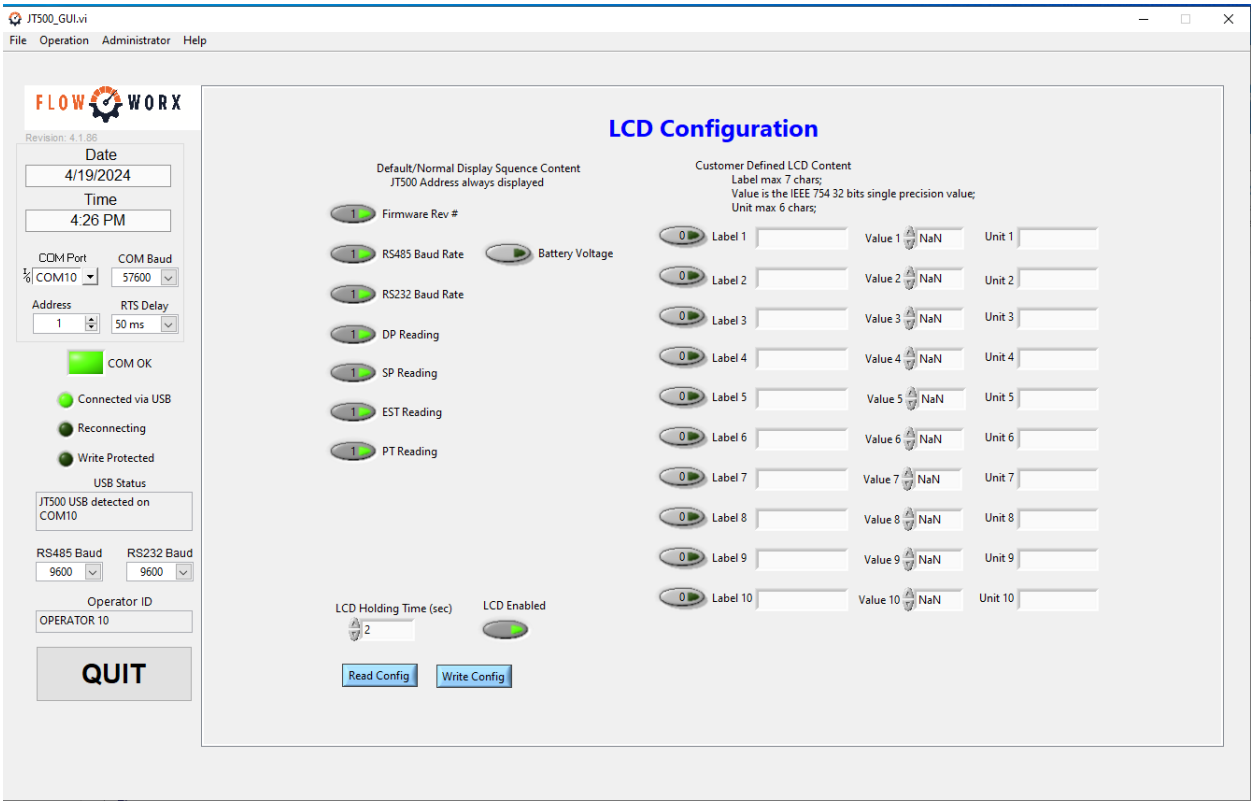



**FIGURE 22**

# 25. CALIBRATION AND SIGN-IN OPERATIONS

To calibrate the DP, SP or temperature inputs, the user must sign-in to the Administrator level.

## 25.1 How to Sign-in

Access the Sign-in dialog box by clicking Administrator on the toolbar and, in the drop-down window, clicking on Sign In.

In the “Password” field enter the default password (the factory password is “*password*”) or the password that has been assigned by the system administrator, then click the ENTER button.

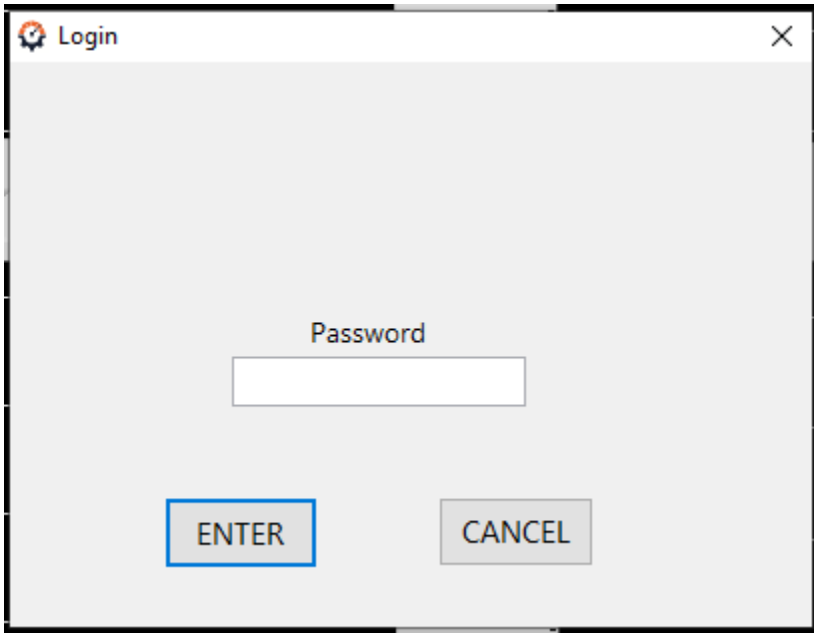



**FIGURE 23**

If a valid password is entered, the dialog box will disappear.

# 26. DP CALIBRATION OPERATIONS

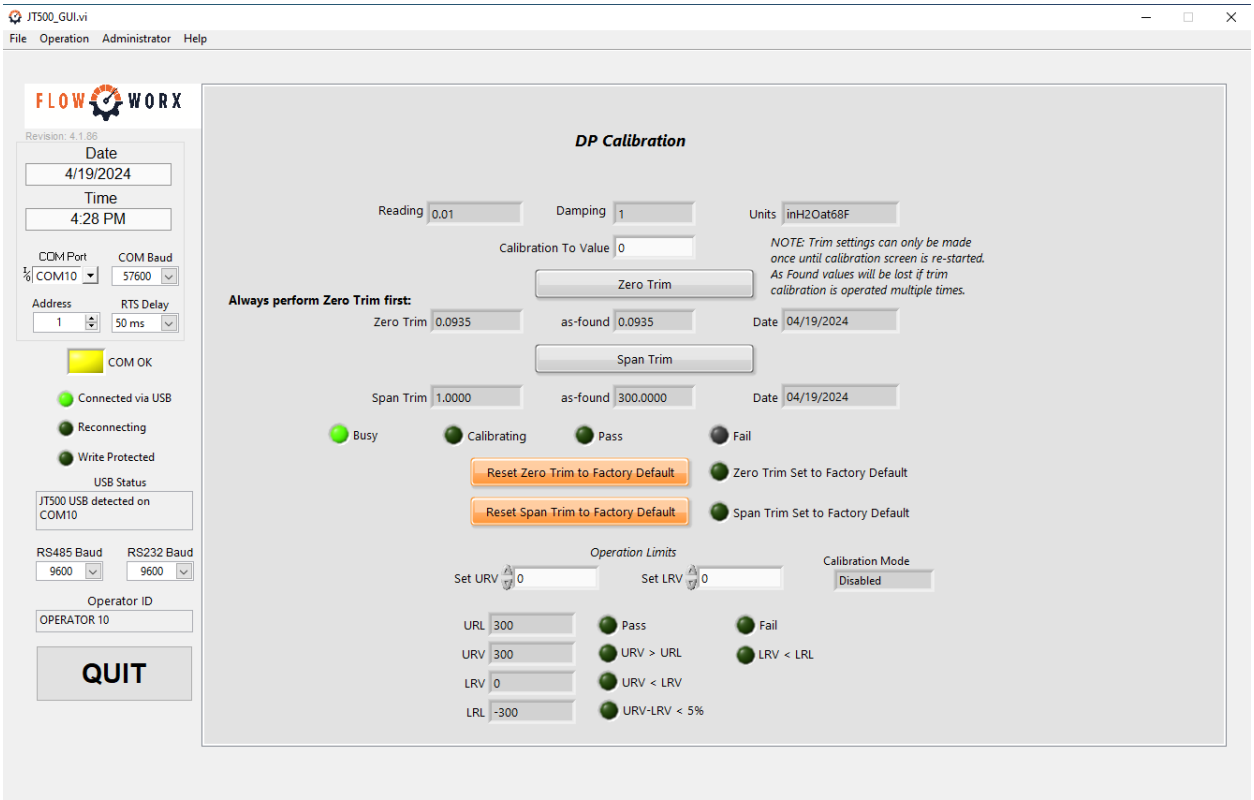



**FIGURE 24**

## 26.1 How to Check the Status of DP Calibration

Access the DP Calibration Display by clicking Administrator on the toolbar and, in the drop-down window, clicking on DP Calibration.

The following information is available on the DP Calibration display:

- DP live reading, damping and units
- Zero trim value, as-found zero trim and the date when the zero was last trimmed
- Span trim value, as-found span trim and the date when the span was last trimmed
- Status lights indicating calibration process status including pass, fail, and Zero and Span trim set to factory default.
- Status lights indicating the status of changing the upper-range value and lower-range value including pass, fail, upper-range value is greater than the upper-range limit, lower-range value is less than the lower-range limit, upper-range value is less than the lower-range limit, and too little a difference (5%) between the upper-range value and lower-range value

## 26.2 How to Calibrate the DP Input

Access the DP Calibration Display by clicking Administrator on the toolbar and, in the drop-down window, clicking on DP Calibration.

To reset zero and span trims to the factory defaults— (done at the user's discretion)—click on the Reset Trims to Factory Defaults button. The "Set to Factory Default" status light will indicate successful completion of the operation. It is important to note that this operation does not provide the user any way to cancel or undo this operation.

To calibrate the DP zero, apply zero differential pressure to the Flow King transmitter process connections, then enter the corresponding value (typically, 0) in the "Calibration To Value" field and click on the Zero Trim button. Check the status lights below the span trim values to view the status of the zero trim operation.

To calibrate the DP span or to calibrate to a point in the DP range, apply a known differential pressure to the Flow King transmitter process connections, then enter the corresponding value in the "Calibration To Value" field and click on the Span Trim button. Check the status lights below the span trim values to view the status of the span trim operation.

To set the upper-range value, enter a value in the "Set URV" field or use the adjacent up or down arrows to increment or decrement the value. Check the status lights to the lower right to view the status of the operation.

To set the lower-range value, enter a value in the "Set LRV" field or use the adjacent up or down arrows to increment or decrement the value. Check the status lights below the field to view the status of the operation.

Exceeding the URV / LRV limits will trigger an event to be logged in the archive during the period it occurred.

It is important to let the pressure value stabilize prior to clicking the trim button. Pressure calibration should be done with damping set to "1". Verify that there are no leaks in the pressurization system.

# 27. STATIC PRESSURE (SP) CALIBRATION OPERATIONS

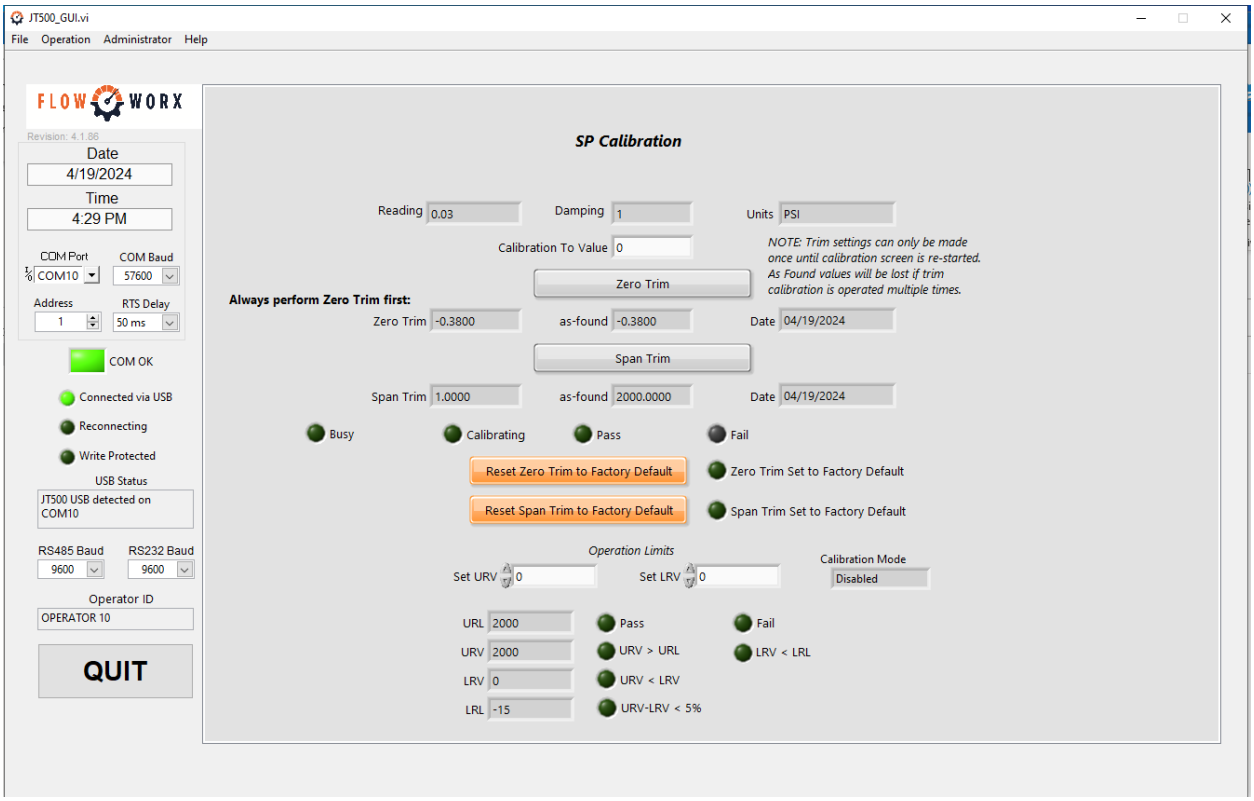



**FIGURE 25**

## 27.1 How to Check the Status of SP Calibration

Access the SP Calibration Display by clicking Administrator on the toolbar and, in the drop-down window, clicking on SP Calibration.

The following information is available on the SP Calibration display:

- SP live reading, damping and units
- Zero trim current value, as-found zero trim and the date when the zero was last trimmed
- Span trim current value, as-found span trim and the date when the span was last trimmed
- Status lights indicating calibration process status including pass, fail, and Zero and Span trim set to factory default.
- Status lights indicating the status of changing the upper-range value and lower-range value including pass, fail, upper-range value is greater than the upper-range limit, lower-range value is less than the lower-range limit, upper-range value is less than the lower-

range limit, and too little a difference (5%) between the upper-range value and lower-range value

## 27.2 How to Calibrate the SP Input

Access the SP Calibration Display by clicking Administrator on the toolbar and, in the drop-down window, clicking on SP Calibration.

To reset zero and span trims to the factory defaults— (done at the user's discretion)—click on the Reset Trims to Factory Defaults button. The "Set to Factory Default" status light will indicate successful completion of the operation. It is important to note that this operation does not provide the user anyway to cancel or undo this operation.

To calibrate the SP zero, apply zero static pressure to both Flow King transmitter process connections, then enter the corresponding value (typically, 0) in the "Calibration To Value" field and click on the Zero Trim button. Check the status lights below the span trim values to view the status of the zero trim operation.

To calibrate the SP span or to calibrate to a point in the SP range, apply a known static pressure to both Flow King transmitter process connections, then enter the corresponding value in the "Calibration To Value" field and click on the Span Trim button. Check the status lights below the span trim values to view the status of the span trim operation.

To set the upper-range value, enter a value in the "Set URV" field or use the adjacent, up or down arrows to increment or decrement the value. Check the status lights to the lower, right to view the status of the operation.

To set the lower-range value, enter a value in the "Set LRV" field or use the adjacent, up or down arrows to increment or decrement the value. Check the status lights below the field to view the status of the operation.

Exceeding the URV / LRV limits will trigger an event to be logged in the archive during the period it occurred.

To calibrate the residual static effect on DP zero at the SP calibration pressure, return to the DP calibration display and enter a target value and click the trim button. Always verify that there are no leaks in the system and that the applied pressure remains stable during the calibration process. Calibration works best with damping set to "1".

Note: The Flow King uses sensors made of single-crystal silicon. Silicon is for all practical purposes a perfectly elastic material. Its properties never change, so once a Flow King is made in

the factory, it should never require a calibration for sensitivity (Span) or linearity. Only the occasional zero calibration is necessary.

Field devices that apply pressure using a pump with a closed system are convenient but are subject to instability due to adiabatic effects from within and without the system. They are most useful as a calibration check rather than a calibration reference.

# 28. TEMPERATURE (RTD) CALIBRATION OPERATIONS

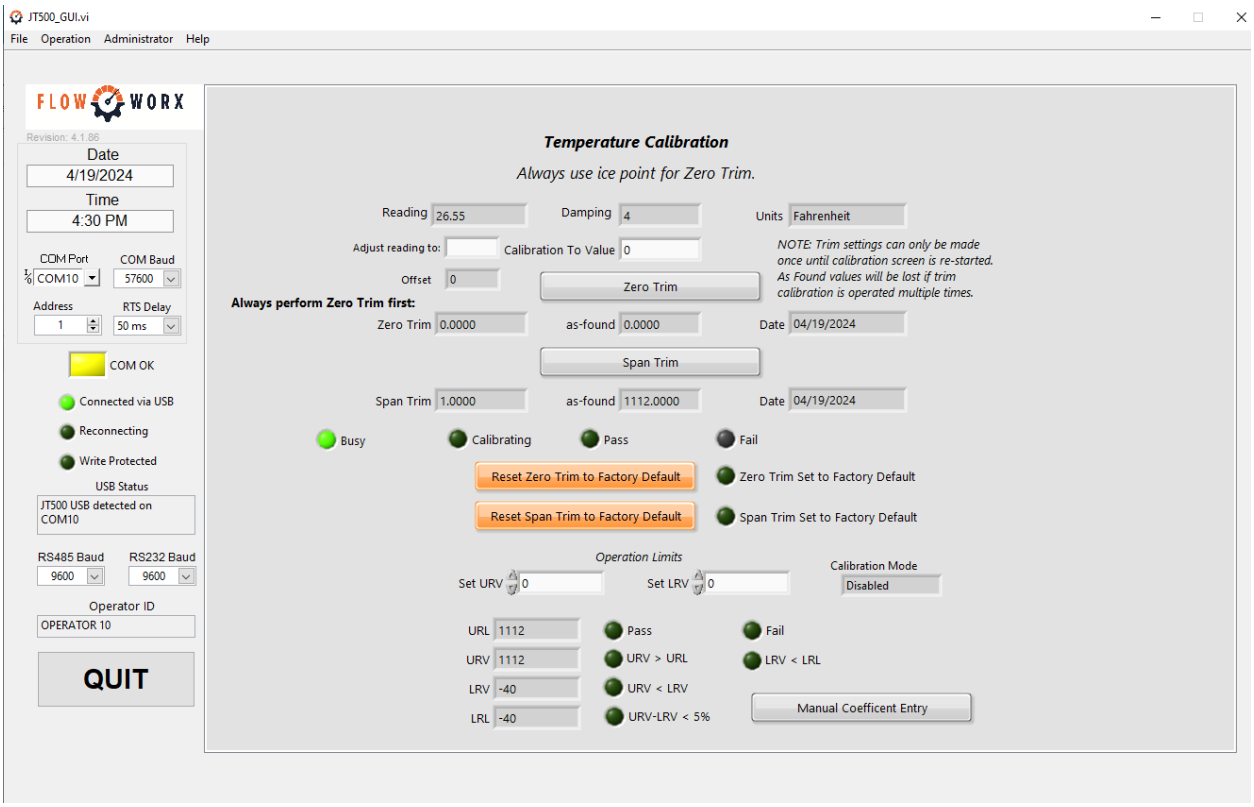



**FIGURE 26**

The preferred way to calibrate the RTD is to enter the value of R0 (if known) for the RTD that is connected to the Flow King. The Flow King will perform the rest of the correction internally.

The Flow King also allows for a two-point (zero and span) resistance calibration should the user prefer.

## 28.1 How to Check the Status of Temperature Calibration

Access the Temperature Calibration Display by clicking Administrator on the toolbar and, in the drop-down window, clicking on Temperature Calibration.

The following information is available on the Temperature Calibration display:

- Temperature live reading, damping and engineering units
- Zero trim current value, as-found zero trim and the date when the zero was last trimmed

- Span trim current value, as-found span trim and the date when the span was last trimmed
- Status lights indicating calibration process status including pass, fail, and too much of a difference (3%) between the target value and the current reading
- Status lights indicating the status of changing the upper-range value and lower-range value including pass, fail, upper-range value is greater than the upper-range limit, lower-range value is less than the lower-range limit, upper-range value is less than the lower-range limit, and too little a difference (5%) between the upper-range value and lower-range value

## 28.2 How to Calibrate the Temperature Input

Access the Temperature Calibration Display by clicking Administrator on the toolbar and, in the drop-down window, clicking on Temperature Calibration.

To reset zero and span trims to the factory defaults— (done at the user's discretion)—click on the Reset Trims to Factory Defaults button. The "Set to Factory Default" status light will indicate successful completion of the operation. It is important to note that this operation does not provide the user any way to cancel or undo this operation.

To calibrate the temperature zero, apply a known resistance that corresponds to the ice point of water (0°C or 32°F) to the Flow King transmitter RTD terminations, then enter the corresponding value (0 or 32) in the "Calibration To Value" field and click on the Zero Trim button. Check the status lights below the span trim values to view the status of the zero trim operation.

To calibrate the temperature span or to calibrate to a point in the temperature range, apply a known resistance to the Flow King RTD terminations, then enter the corresponding temperature value in the "Calibration To Value" field and click on the Span Trim button. Check the status lights below the span trim values to view the status of the span trim operation.

To set the upper-range value, enter a value in the "Set URV" field or use the adjacent, up or down arrows to increment or decrement the value. Check the status lights to the lower, right to view the status of the operation.

To set the lower-range value, enter a value in the "Set LRV" field or use the adjacent, up or down arrows to increment or decrement the value. Check the status lights below the field to view the status of the operation.

Exceeding the URV / LRV limits will trigger an event to be logged in the archive during the period it occurred.

Note: Platinum RTDs are sensing devices where the “zero” and “Span” are interrelated. The change in resistance with temperature is in “ohms per ohm”. This means that the greater the resistance you start with (at the ice point), the greater the change in resistance will be. This is what the Callendar-Van Dusen equation and coefficients account for this. It is only necessary to calibrate the ice point by one of the three following methods:

1. either entering a known value for R0 (see the section **How to Manually Modify the RTD Coefficients**), or
2. By connecting a resistor that has the known value of R0 and click on the zero trim
3. Or by using an ice bath with a RTD and click on the zero trim with either 0°C or 32°F as the target value depending on the units used.

The Flow King measures resistance and converts the value to temperature. It does so with a ±0.1°C accuracy. A Class A RTD falls within ±0.15°C at the ice point and a Class B RTD falls within ±0.3°C accuracy. Without any calibration, you can expect a RMS error of about 0.18°C with a Class A device without any calibration at all. A useful field calibration could easily be done by simply inserting a precision 100-ohm resistor (±0.01%) into the RTD terminal block and clicking on set zero if necessary.

## 28.3 How to Manually Modify the RTD Coefficients

Access the “Manual Coefficient Entry” menu by clicking the button at the bottom the “Temperature Calibration” screen in Figure 36. This produces the following menu:

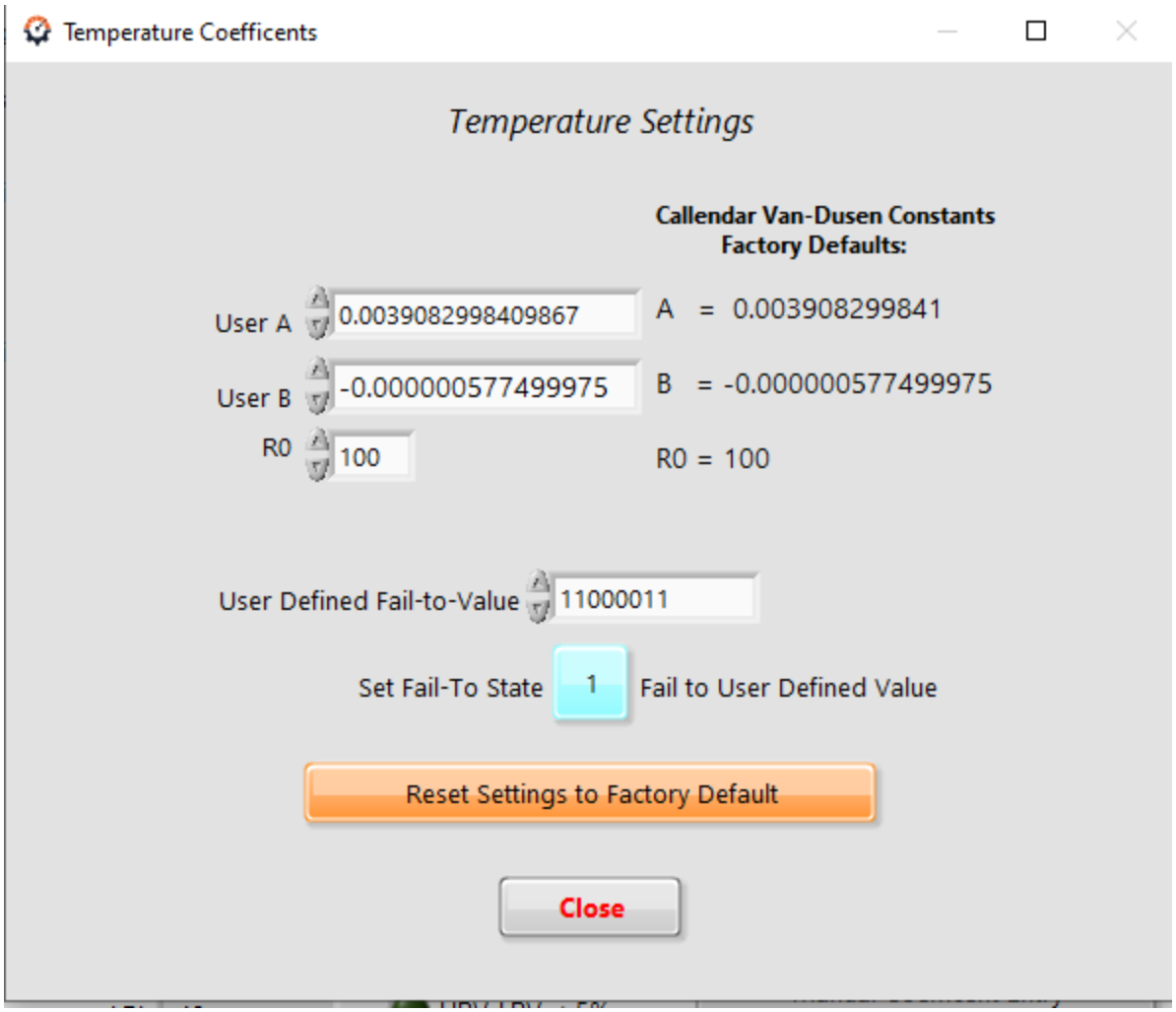



**FIGURE 27**

From this window the default coefficients shown can be modified as the user requires. Please note that if at any time the default coefficients need to be restored the button “Reset Settings to Factory Default” will do so. The standard used to define the default coefficients is IEC-751.

## 29. HOW TO UPDATE THE FIRMWARE

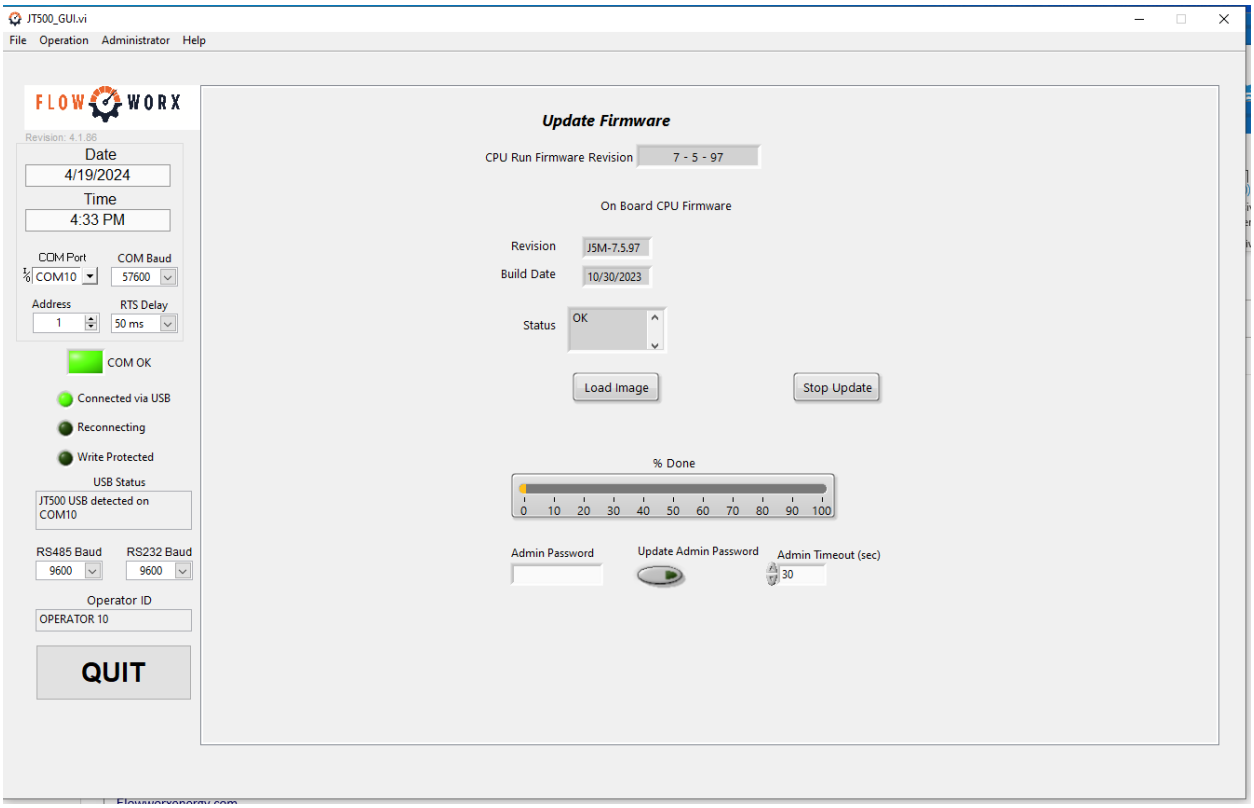



**FIGURE 28**

Occasionally Firmware updates become available. These updates may be made to address certain application issues, improve efficiency or add features. Firmware updates are currently made available from the FlowWorx engineering team. For each update, a set of release notes will be provided to describe what the update covers. The release notes will also indicate if the update is urgent or routine. Please read the release notes prior to updating the firmware. FlowWorx always provides free firmware updates.

The firmware may be updated through any port, but we recommend using the USB port for the quickest updates. If using the other ports, change the baud rate to 57600 prior to updating the firmware.

You must be signed in as administrator to update the firmware. Also, write protection must be “off”. Drop down the “Administrator” tab and select “Firmware Update”. The display will appear as seen in figure 40 above. You need to know the path to the firmware image file. Download the image file (.TXT format) from the Flowworx website to a convenient location on your computer. The link to either log in or register (if you have not already) is as follows:

http://flowworxenergy.com/publications/ (scroll to the bottom)

**NOTE: Upon logging in through this link the user will have access to latest version of the firmware along with access to the latest manual and GUI.**

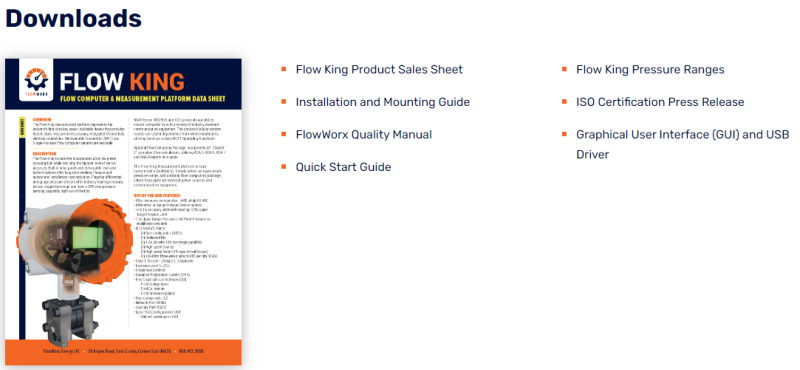



**FIGURE 29**

All Flow King settings will be unaffected by a firmware update unless otherwise noted in each set of release notes.

The unit is powered over the USB. If using the USB to update the firmware no other power sources may be connected or the unit won't power cycle when required.

To load the firmware, click Load Image button. Browse for the image file on your computer and select "save." A spiraling dot will appear on the page. Do not leave the page until the spiral stops. If you wish to stop the update, click on the "Stop Update" button and everything will go back to where you started. Follow the prompts to complete the installation including the required power cycling. Due to limitations presented by WINDOWS, the Flow King may require a third power cycle to reconnect it to the PC. When complete, the Status field "Done" and the corresponding revision and build date fields will update to the current revision.

# 30. HOW TO CHANGE THE FLOW KING PROTOCOL

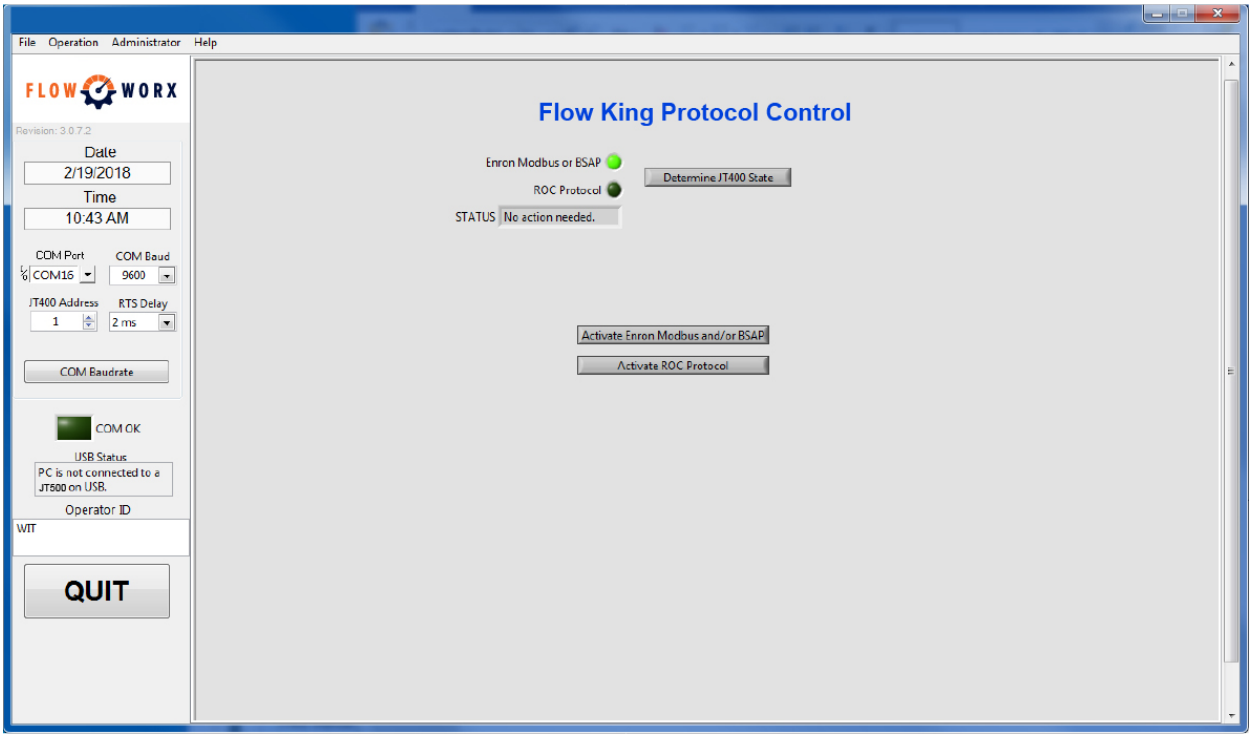



**FIGURE 30**

You must be signed-in as administrator to change the Flow King Protocol. Also, write protection must be "off". Drop down the "Administrator" tab and select "Protocol". The display will appear as seen in figure 43 above. It is important to note that this protocol control should only be performed over RS-485 or RS-232.

The GUI will display the current protocol state:

If "Enron Modbus or BSAP" GUI LED is bright green that is the current protocol.

If "ROC Protocol" GUI LED is bright green that is the current protocol.

The GUI will display the current status of this protocol operation as well:

If the STATUS indicator states: "No action needed" then the GUI can continue to be used.

If the STATUS indicator states: "Please QUIT the GUI" then the Flow King is in ROC Protocol and the GUI cannot be used outside of changing the protocol back to Enron Modbus or BSAP.

If the STATUS indicator states: "Communication Issue" then COM Port selected may be incorrect. If the COM Port is correct, then check the baud rate. If the COM Port and baud rate

are correct then check the Flow King Address and left-click “Determine Flow King State” button to prompt the GUI to try again to communicate with the Flow King.

# 31. HOW TO GENERATE THE AS-FOUND/AS-LEFT REPORT

Once calibrations of the DP, SP and temperature have been completed, the as-found/as-left report is generated by clicking Operation on the toolbar then clicking on Calibration Report in the drop-down list.

This report will be opened in a temporary unsaved Microsoft Excel file that is created by the Flow King GUI.

The file produced would contain the calibration information for that transmitter. For example:

**JT500 Calibration Report**

Time: 4:42 PM
Date: 4/19/2024
Test operator: OPERATOR 10

Firmware Revision : 7 - 5 - 97  Device Serial Number :0

| Parameter | DP | SP | TEMP |
|---|---|---|---|
| Units | inH2Oat68F | PSI | Fahrenheit |
| Damping | 1 | 1 | 4 |
| Zero Trim | 0.093468 | -0.380039 | 0 |
| As Found Zero | 0.093468 | -0.380039 | 0 |
| As Left Zero | 0 | 0 | 0 |
| Zero Cal Date | 04/19/2024 | 04/19/2024 | 04/19/2024 |
| Span Trim | 1 | 1 | 1 |
| As Found Spar | 300 | 2000 | 1112 |
| As Left Span | 300 | 2000 | 1112 |
| Span Cal Date | 04/19/2024 | 04/19/2024 | 04/19/2024 |
| CVD | 0.003908 | -0.000001 | 100 |

**FIGURE 31**

# 32. HOW TO SIGN-OUT

Click “Administrator” on the toolbar and, in the drop-down window, click on Sign Out. Note that this completes the operation; no dialog box appears.

# 33. HOW TO EXIT THE FLOW KING TRANSMITTER GUI

There are four ways to exit the Flow King Transmitter GUI application on the PC:

- Click CTRL+Q.
- Click on the QUIT button in the left-hand column.
- On the toolbar, click File then click Exit.
- Click the close icon (“X”) on the top line of the PC display.

In each case, a dialog box confirming that the user wishes to exit will appear. Click “YES” to exit.

In addition, a dialog box will appear and ask if the user requires an as-found / as-left report if the user has made any changes to the Flow King that is being setup by the GUI. Otherwise, the GUI will exit.

# 34. SERVICE

Servicing should only be performed by a qualified technician who possesses the skills to safely use the equipment necessary.

*Warning*

*No attempt should be made to service a Flow King while it is powered and operating in a hazardous location. Either the area should be made safe or the transmitter should be powered down and removed to a non-hazardous site.*

# 35. TROUBLESHOOTING

| SYMPTOM | POSSIBLE CAUSE |
|---|---|
| No Communications, Display Blank | Verify that input power is reaching the unit, check for reverse polarity.<br>Verify that connector plugs are pushed in all the way and that wires are on the correct terminals.<br>Verify that terminal plug screws are tight and biting on the wire and not the insulation.<br>Check for condensate in conduit lines.<br>If lightning is suspected to have occurred, cycle the power. |
| No communications, Display working | Verify that the address polled is the one on the display.<br>If Multi-drop (RS-485), verify that no other transmitter has the same address.<br>Verify integrity of the daisy chain connections.<br>Verify that the drop is not in a closed loop.<br>Verify that the distance is not too far for the baud rate used.<br>Increase the RTS delay.<br>If lightning is suspected to have occurred, cycle the power.<br>If using USB, verify that the cable was plugged into the Flow King first. If not, cycle the power and try again. |
| Erratic or drifting readings on pressure. | Verify that the shutoff valves are completely open.<br>Verify that any bypass valve is completely closed.<br>Check for leaks in DP lines.<br>Check for gas in liquid lines or liquid in gas lines.<br>Verify that no pulsation exists in the lines.<br>Check for sediment in the lines. |
| RTD reads open | Check for open or short circuits on RTD wires.<br>Verify integrity of terminal plug connections. |
| RTD reading erratic | Verify integrity of connections.<br>Verify that none of the RTD wires are grounded.<br>Verify that the RTD shield is grounded on one end only. |
| RTD Reading in error | Plug-in “dummy” RTD (resistor) for comparison.<br>Check calibration using the user interface. |

| | |
|---|---|
| | |

If it has been determined that the transmitter may have a fault, do not attempt to service it yourself as you may void the factory warranty. Seek guidance from the distributer who provided the product. Defective products may be returned to the distributor for evaluation or repair. Transmitters returned within the warranty period will be repaired or replaced per the warranty agreement. Do not return product without completing return authorization documentation to track its progress.

# APPENDIX

## A1. List of Separate Documents

- Quick Start Installation Guide (English and Spanish language versions)
- Explanation of Flow King USB – First Time Usage Expectations (***Future***)
- Product Specification Sheet
    - Dimensioned Diagram
- Approval Documents and Certifications (***Available upon request***)

## A2. Flow King Floating Point Format Example

**JT500 IEEE 754 32 bit Floating Point Explanation**

Example Floating Point Value: *100.25*

Converted Hex Value: *0x42C88000*

| Byte A | | | | Byte B | | | | Byte C | | | | Byte D | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SEEE | | | | EEEE | | | | EMMM | | | | MMMM | | | |
| 4 | | | | 2 | | | | C | | | | 8 | | | |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |

| Byte C | | | | Byte D | | | |
|---|---|---|---|---|---|---|---|
| MMMM | | | | MMMM | | | |
| 8 | | | | 0 | | | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

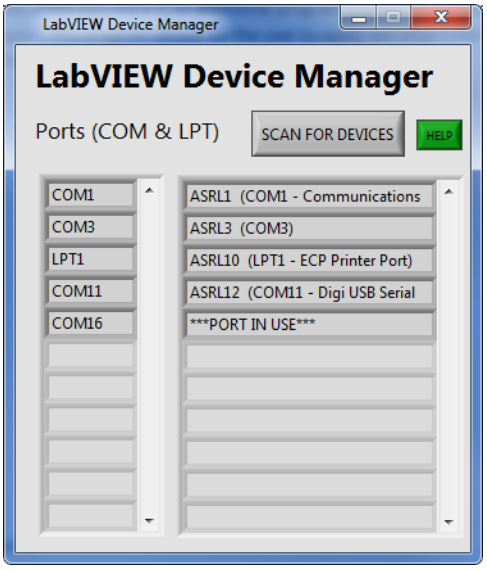
| Byte D | | | | | | | |
|---|---|---|---|---|---|---|---|
| MMMM | | | | MMMM | | | |
| 0 | | | | 0 | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Where:**

"S" is the sign of the floating point number, "E" is the exponent, and "M" is the mantissa.

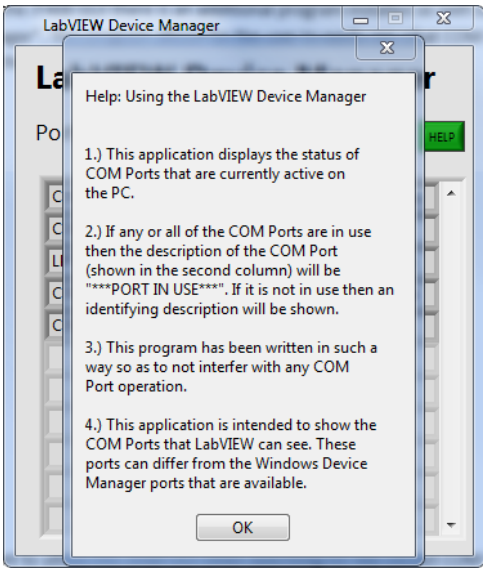
## A.3 LabVIEW Device Manager

In installing the Flow King GUI there is an additional program installed called “LabVIEW Device Manager”. This program allows for the user to easily see what COM Ports will be available to the Flow King GUI.



It is important to utilize this small GUI when searching for the correct COM Port. Due to limitations presented by Windows, there are rare cases where Windows Device Manager will see an active COM Port but the Flow King GUI and the LabVIEW Device Manager will not. This issue can be remedied by disconnecting and reconnecting the attached COM device (in this case the Flow King).

This small GUI also provides the following helpful tips to the user:




## A4. How to Calibrate the DP Input using a Modbus RTU Master

This procedure applies to the DP process variable. The zero and span trim math is performed in the Flow King. The only requirement of the host is that it must write the "calibrate to" value to the appropriate register. The zero calibration and span calibration registers should not be written to simultaneously. The following example applies to the DP process variable.

Apply zero differential pressure to the Flow King (the default would be 0 inH2Oat68F) and wait for the reading to stabilize.

Write the appropriate IEEE 754 32-bit floating value to register 7418. In this case write a zero to that register.

In the case of the equivalent 16 bit registers the value would be written to registers 436 and 437. The format would be that byte A and B are written to register 436 high byte first. C and D are written to 437 with byte C first (since that is the high byte).

Apply the span differential pressure to the Flow King (the factory calibration is for 300 inH2Oat68F) and wait for the live reading to stabilize.

Write the appropriate IEEE 754 32-bit floating value to register 7419. In this case write 300 to that register.

In the case of the equivalent 16 bit registers the value would be written to 438 and 439. The format would be that byte A and B are written to register 438 high byte first. C and D are written to 439 with byte C first (since that is the high byte).

It is important to note that the firmware has built in limit checking to prevent the register values from being corrupted. It is also important to note that the firmware performs limit checking between the live reading and the “calibrate to” value. This checking helps to determine if a calibration can take place.

## A.5 How to Calibrate the SP Input using a Modbus RTU Master

This procedure applies to the SP process variable. The zero and span trim math is performed in the Flow King. The only requirement of the host is that it must write the "calibrate to" value to the appropriate register. The zero calibration and span calibration registers should not be written to simultaneously. The following example applies to the SP process variable.

Apply zero static pressure to the Flow King (the default would be 0 PSI) and wait for the reading to stabilize.

Write the appropriate IEEE 754 32-bit floating value to register 7421. In this case write a zero to that register.

In the case of the equivalent 16 bit registers the value would be written to registers 442 and 443. The format would be that byte A and B are written to register 442 high byte first. C and D are written to 443 with byte C first (since that is the high byte).

Apply the span static pressure to the Flow King (the factory calibration is for 2000 PSI) and wait for the live reading to stabilize.

Write the appropriate IEEE 754 32-bit floating value to register 7422. In this case write 2000 to that register.

In the case of the equivalent 16 bit registers the value would be written to 444 and 445. The format would be that byte A and B are written to register 444 high byte first. C and D are written to 445 with byte C first (since that is the high byte).

It is important to note that the firmware has built in limit checking to prevent the register values from being corrupted. It is also important to note that the firmware performs limit checking between the live reading and the “calibrate to” value. This checking helps to determine if a calibration can take place.

## A6. How to Calibrate PT Input using a Modbus RTU Master

This procedure applies to the PT process variable. The zero and span trim math is performed in the Flow King. The only requirement of the host is that it must write the "calibrate to" value to the appropriate register. The zero calibration and span calibration registers should not be written to simultaneously. The following example applies to the PT process variable.

Apply a known resistance that corresponds to the ice point of water (the default would be 0°C) to the Flow King transmitter RTD terminations and wait for the reading to stabilize.

Write the appropriate IEEE 754 32-bit floating value to register 7424. In this case write a zero to that register.

In the case of the equivalent 16 bit registers the value would be written to registers 448 and 449. The format would be that byte A and B are written to register 448 high byte first. C and D are written to 449 with byte C first (since that is the high byte).

Apply the known resistance that corresponds to the temperature span to the Flow King transmitter RTD terminations (the factory calibration is for 557.57°C) and wait for the live reading to stabilize.

Write the appropriate IEEE 754 32-bit floating value to register 7425. In this case write 557.57 to that register.

In the case of the equivalent 16 bit registers the value would be written to 450 and 451. The format would be that byte A and B are written to register 450 high byte first. C and D are written to 451 with byte C first (since that is the high byte).

It is important to note that the firmware has built in limit checking to prevent the register values from being corrupted. It is also important to note that the firmware performs limit checking between the live reading and the “calibrate to” value. This checking helps to determine if a calibration can take place.

## A7. Flow King Modbus Explanation

The Flow King communicates using Enron Modbus. This differs from standard Modbus by the fact that there is no offset used in Enron Modbus. In the following Flow King Modbus Register map this means that the register listed is the register to use for composing a Modbus command. For example, a multivariable transmitter that uses standard Modbus would list the DP, SP and Temperature (RTD) registers as the range 401-406 (7401-7403). In the Flow King that offset is not used. This means that our register map will show the DP, SP and Temperature registers as the range 400-405 (7400-7402) without an offset.

### A7.1 A brief overview of Modbus function codes

A brief overview of Modbus function codes is as follows:

1. Public Function Codes

a. These are comprised of the widely used function codes 1, 3, 16 etc.
   i. These are the well documented function codes.
2. User Defined Function Codes
   a. These can range from the decimal values of 65-72 and 100-110.
      i. In the case of the Flow King we are using 0x43 = 67 and 0x45 = 69 for archive functionality.
3. Reserved Function Codes
   a. Created by some companies for legacy products and not available for public use.

More detail on these different kinds of function codes can be found in the link below on page 10: http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b3.pdf

## A8. JT500 Modbus Register Map

**Table 1. Holding Registers**

| Addr 16-bit | Description | Size | Initial Value | Access Type |
|---|---|---|---|---|
| 4 | Sensor Block Low | 0 Bytes | Factory set | read only |
| 5 | Sensor Block High | 2 Bytes, unsigned integer | Factory set | read only |
| 6 | Sensor Serial Number | 4 bytes, unsigned integer | Factory set | read only |
| | | | | |
| 8 | Sensor Series Number | Byte, unsigned integer | Factory set | read only |
| | | | | |
| 10 | Sensor Type | Byte, unsigned integer | Factory set | read only |
| 11 | JT500 Firmware Revision Number | 4 bytes, unsigned integer | J4xxx.xxx, J6xxx.xxx rev | read only |
| | | | | |
| 15 | JT500 unit address (Modbus, BSAP) | Byte, signed integer | 1 | read/write |
| 16 | JT500 DP Range Code | Byte, signed integer | 14 | read only |
| 17 | JT500 SP Range Code | Byte, signed integer | 2 | read only |
| | | | | |
| 35 | ASCII user description | 16 Bytes, ASCII | space | read/write |
| 36 | ASCII DP zero Calibration date | 10 Bytes, ASCII | space | read/write |
| 37 | ASCII DP Span Calibration date | 10 Bytes, ASCII | space | read/write |
| 38 | ASCII SP zero Calibration date | 10 Bytes, ASCII | space | read/write |
| 39 | ASCII SP Span Calibration date | 10 Bytes, ASCII | space | read/write |
| 40 | ASCII RTD zero Calibration date | 10 Bytes, ASCII | space | read/write |
| 41 | ASCII RTD Span Calibration date | 10 Bytes, ASCII | space | read/write |
| | | | | |
| 59 | DP unit code | Byte, signed integer | 6 = inH2Oat68F | read/write |
| 60 | SP unit code | Byte, signed integer | 10 = kiloGramPerSqCm | read/write |
| 61 | RTD unit Code | Byte, signed integer | 20 = Degree C | read/write |
| | | | | |
| 115 | JT500 Hardware Rev | Byte, signed integer | Factory set | read only |
| | | | | |

## A8.1 Important Note(s) about Table 1

In looking at Table 1 it should be noted that all Modbus requests to the JT500 are sent initially using a 16-bit register value. However, when this request is received by the JT500 the way the JT500 processes it is different than just requesting a single register. This means that the "size" column in Table 1 refers to the bytes received (for conversion) by a given Modbus Master from the JT500 responding to the request. For example, in the case of sending a request to register 6 (with a JT500 of address 1):

Request: *01 03 00 06 00 01 64 0B*
JT500 Response: 01 03 04 3B 9A CA 3C 81 89 20

The response can be broken down as follows:

01 03 04 3B 9A CA 3C 81 89 20

Where:

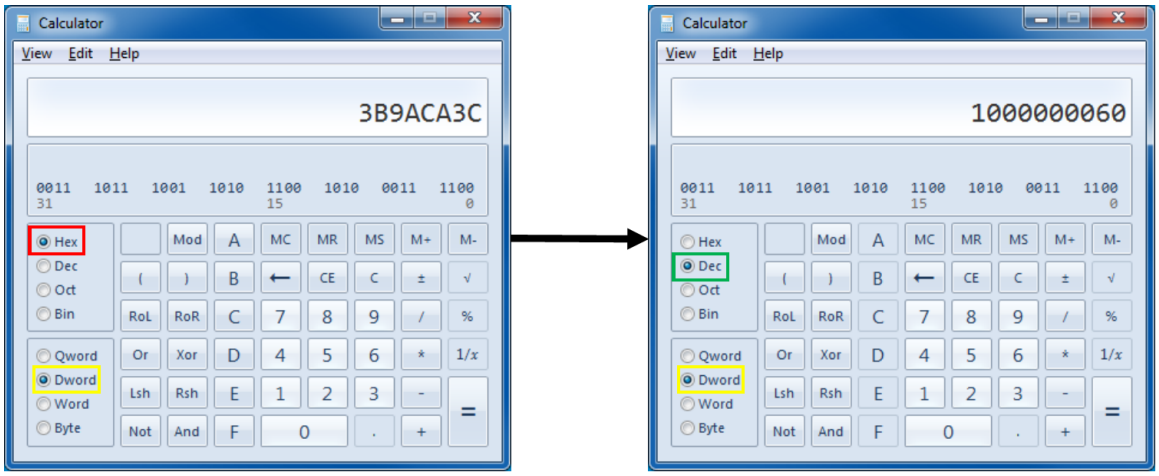
01 = JT500 Address
03 = function code for reading a register
04 = Size in bytes of the response
3B 9A CA 3C = the 4-byte response
81 89 = CRC
20 = Extra byte sent out if the JT500 is being communicated with over RS485 or RS232.

(*NOTE: the extra byte may not always be 0x20. In all cases on RS-485 or RS-232 since it is 'extra' it can be discarded*.)

Looking further at the 4 byte response:

3B 9A CA 3C

Table 1 in our manual states that this response should be converted to a 32 bit unsigned integer (a Hex to Dec conversion). As shown by the Windows Calculator in "Programmer" mode:



Converted to a decimal number becomes the example serial number of the given JT500.

As an additional example let's look at register 35.

Request: *01 03 00 23 00 01 75 C0*
Response: 01 03 10 **4A 54 34 30 30 20 20 20 20 20 20 20 20 20 20 20** B7 71 FF

In the above response the bytes that require a conversion from hex to ASCII are bolded. Looking at an ASCII table:

| Ctrl | Dec | Hex | Char | Code |
|---|---|---|---|---|
| ^@ | 0 | 00 | | NUL |
| ^A | 1 | 01 | | SOH |
| ^B | 2 | 02 | | STX |
| ^C | 3 | 03 | | ETX |
| ^D | 4 | 04 | | EOT |
| ^E | 5 | 05 | | ENQ |
| ^F | 6 | 06 | | ACK |
| ^G | 7 | 07 | | BEL |
| ^H | 8 | 08 | | BS |
| ^I | 9 | 09 | | HT |
| ^J | 10 | 0A | | LF |
| ^K | 11 | 0B | | VT |
| ^L | 12 | 0C | | FF |
| ^M | 13 | 0D | | CR |
| ^N | 14 | 0E | | SO |
| ^O | 15 | 0F | | SI |
| ^P | 16 | 10 | | DLE |
| ^Q | 17 | 11 | | DC1 |
| ^R | 18 | 12 | | DC2 |
| ^S | 19 | 13 | | DC3 |
| ^T | 20 | 14 | | DC4 |
| ^U | 21 | 15 | | NAK |
| ^V | 22 | 16 | | SYN |
| ^W | 23 | 17 | | ETB |
| ^X | 24 | 18 | | CAN |
| ^Y | 25 | 19 | | EM |
| ^Z | 26 | 1A | | SUB |
| ^[ | 27 | 1B | | ESC |
| ^\ | 28 | 1C | | FS |
| ^] | 29 | 1D | | GS |
| ^^ | 30 | 1E | ▲ | RS |
| ^- | 31 | 1F | ▼ | US |

| Dec | Hex | Char |
|---|---|---|
| 32 | 20 | |
| 33 | 21 | ! |
| 34 | 22 | " |
| 35 | 23 | # |
| 36 | 24 | $ |
| 37 | 25 | % |
| 38 | 26 | & |
| 39 | 27 | ' |
| 40 | 28 | ( |
| 41 | 29 | ) |
| 42 | 2A | * |
| 43 | 2B | + |
| 44 | 2C | , |
| 45 | 2D | - |
| 46 | 2E | . |
| 47 | 2F | / |
| 48 | 30 | 0 |
| 49 | 31 | 1 |
| 50 | 32 | 2 |
| 51 | 33 | 3 |
| 52 | 34 | 4 |
| 53 | 35 | 5 |
| 54 | 36 | 6 |
| 55 | 37 | 7 |
| 56 | 38 | 8 |
| 57 | 39 | 9 |
| 58 | 3A | : |
| 59 | 3B | ; |
| 60 | 3C | < |
| 61 | 3D | = |
| 62 | 3E | > |
| 63 | 3F | ? |

| Dec | Hex | Char |
|---|---|---|
| 64 | 40 | @ |
| 65 | 41 | A |
| 66 | 42 | B |
| 67 | 43 | C |
| 68 | 44 | D |
| 69 | 45 | E |
| 70 | 46 | F |
| 71 | 47 | G |
| 72 | 48 | H |
| 73 | 49 | I |
| 74 | 4A | J |
| 75 | 4B | K |
| 76 | 4C | L |
| 77 | 4D | M |
| 78 | 4E | N |
| 79 | 4F | O |
| 80 | 50 | P |
| 81 | 51 | Q |
| 82 | 52 | R |
| 83 | 53 | S |
| 84 | 54 | T |
| 85 | 55 | U |
| 86 | 56 | V |
| 87 | 57 | W |
| 88 | 58 | X |
| 89 | 59 | Y |
| 90 | 5A | Z |
| 91 | 5B | [ |
| 92 | 5C | \ |
| 93 | 5D | ] |
| 94 | 5E | ^ |
| 95 | 5F | _ |

| Dec | Hex | Char |
|---|---|---|
| 96 | 60 | ` |
| 97 | 61 | a |
| 98 | 62 | b |
| 99 | 63 | c |
| 100 | 64 | d |
| 101 | 65 | e |
| 102 | 66 | f |
| 103 | 67 | g |
| 104 | 68 | h |
| 105 | 69 | i |
| 106 | 6A | j |
| 107 | 6B | k |
| 108 | 6C | l |
| 109 | 6D | m |
| 110 | 6E | n |
| 111 | 6F | o |
| 112 | 70 | p |
| 113 | 71 | q |
| 114 | 72 | r |
| 115 | 73 | s |
| 116 | 74 | t |
| 117 | 75 | u |
| 118 | 76 | v |
| 119 | 77 | w |
| 120 | 78 | x |
| 121 | 79 | y |
| 122 | 7A | z |
| 123 | 7B | { |
| 124 | 7C | \| |
| 125 | 7D | } |
| 126 | 7E | ~ |
| 127 | 7F | ⌂ |

* ASCII code 127 has the code DEL. Under MS-DOS, this code has the same effect as ASCII 8 (BS). The DEL code can be generated by the CTRL + BKSP key.

We find that the user description of this JT500 is in fact "JT500" with eleven spaces following it (spaces are indicated by the 0x20's). The final three bytes are the CRC (0xB7 0x71) and the extra byte for RS-485/RS-232 (0xFF).

To recap: The request sent to a JT500 register in Table 1 uses a 16-bit register. However, the JT500 will respond to that request with a "string of data" defined by the byte size instead of a single 16-bit register value. All subsequent tables detailing the JT500 register map follow the standard response format from a given request for a register or multiple registers.

| Table 2. Holding Registers | | | | |
|---|---|---|---|---|
| **Addr 16-bit** | **Description** | **Size** | **Initial Value** | **Access Type** |
| **118** | JT500 Device Status 0 | 2 bytes, signed integer | 0 | read only |
| **119** | JT500 Device Status 1 | 2 bytes, signed integer | 0 | read/write |
| **120** | JT500 Device Status 2 | 2 bytes, signed integer | 0 | read only |
| **121** | JT500 Device Status 3 | 2 bytes, signed integer | 0 | read /write |
| **122** | JT500 Device Status 4 | 2 bytes, signed integer | 0 | read/write |
| **123** | JT500 Device Status 5 | 2 bytes, signed integer | 0 | read only |
| **124** | RTD Fail to State | 2 bytes, signed integer | 1 | read/write |
| | | | | |
| **126** | RS485/RS232 RTS delay interval | 2 bytes, signed integer | 2 | read/write |
| **127** | LCD enable/disable control bits | 2 bytes, signed integer | 127 | read/write |
| **128** | LCD holding time interval | 2 bytes, signed integer | 3 | read/write |
| | | | | |
| **130** | RS485/RS232 RTS delay interval | 2 bytes, signed integer | 2 | read/write |
| **131** | JT500 Protocol Mode Status Register | 2 bytes, signed integer | Consult Factory | read/write |
| | | | | |
| **137** | LCD enable/disable control bits | 2 bytes, signed integer | 0 | read/write |
| | | | | |
| **144** | JT500 D_IO status | 2 bytes, signed integer | 0 | read/write |
| **145** | JT500 D_IO control | 2 bytes, signed integer | 0 | write only |
| **146** | VarLabel1 - Low | 2 bytes, signed integer | space | read/write |
| **147** | VarLabel1 - Mid | 2 bytes, signed integer | space | read/write |
| **148** | VarLabel1 - Mid | 2 bytes, signed integer | space | read/write |
| **149** | VarLabel1 - High | 2 bytes, signed integer | space | read/write |
| **150** | VarLabel2 - Low | 2 bytes, signed integer | space | read/write |
| **151** | VarLabel2 - Mid | 2 bytes, signed integer | space | read/write |
| **152** | VarLabel2 - Mid | 2 bytes, signed integer | space | read/write |
| **153** | VarLabel2 - High | 2 bytes, signed integer | space | read/write |
| **154** | VarLabel3 - Low | 2 bytes, signed integer | space | read/write |
| **155** | VarLabel3 - Mid | 2 bytes, signed integer | space | read/write |
| **156** | VarLabel3 - Mid | 2 bytes, signed integer | space | read/write |
| **157** | VarLabel3 - High | 2 bytes, signed integer | space | read/write |
| **158** | VarLabel4 - Low | 2 bytes, signed integer | space | read/write |
| **159** | VarLabel4 - Mid | 2 bytes, signed integer | space | read/write |
| **160** | Varlabel4 - Mid | 2 bytes, signed integer | space | read/write |
| **161** | Varlabel4 - High | 2 bytes, signed integer | space | read/write |
| **162** | Varlabel5 - Low | 2 bytes, signed integer | space | read/write |
| **163** | Varlabel5 - Mid | 2 bytes, signed integer | space | read/write |
| **164** | Varleble5 - Mid | 2 bytes, signed integer | space | read/write |
| **165** | VarLabel5 - High | 2 bytes, signed integer | space | read/write |
| **166** | VarLabel6 - Low | 2 bytes, signed integer | space | read/write |
| **167** | VarLabel6 - Mid | 2 bytes, signed integer | space | read/write |
| **168** | VarLabel6 - Mid | 2 bytes, signed integer | space | read/write |
| **169** | VarLabel6 - High | 2 bytes, signed integer | space | read/write |
| **170** | VarLabel7 - Low | 2 bytes, signed integer | space | read/write |
| **171** | VarLabel7 - Mid | 2 bytes, signed integer | space | read/write |
| **172** | VarLabel7 - Mid | 2 bytes, signed integer | space | read/write |
| **173** | VarLabel7 - High | 2 bytes, signed integer | space | read/write |

| Table 3. Holding Registers | | | | |
|---|---|---|---|---|
| **Addr 16-bit** | **Description** | **Size** | **Initial Value** | **Access Type** |
| **174** | VarLabel8 - Low | 2 bytes, signed integer | space | read/write |
| **175** | VarLabel8 - Mid | 2 bytes, signed integer | space | read/write |
| **176** | VarLabel8 - Mid | 2 bytes, signed integer | space | read/write |
| **177** | VarLabel8 - High | 2 bytes, signed integer | space | read/write |
| **178** | VarLabel9 - Low | 2 bytes, signed integer | space | read/write |
| **179** | VarLabel9 - Mid | 2 bytes, signed integer | space | read/write |
| **180** | VarLabel9 - Mid | 2 bytes, signed integer | space | read/write |
| **181** | VarLabel9 - High | 2 bytes, signed integer | space | read/write |
| **182** | Unit1 - Low | 2 bytes, signed integer | space | read/write |
| **183** | Unit1 - Mid | 2 bytes, signed integer | space | read/write |
| **184** | Unit1 - High | 2 bytes, signed integer | space | read/write |
| **185** | Unit2 - Low | 2 bytes, signed integer | space | read/write |
| **186** | Unit2 - Mid | 2 bytes, signed integer | space | read/write |
| **187** | Unit2 - High | 2 bytes, signed integer | space | read/write |
| **188** | Unit3 - Low | 2 bytes, signed integer | space | read/write |
| **189** | Unit3 - Mid | 2 bytes, signed integer | space | read/write |
| **190** | Unit3 - High | 2 bytes, signed integer | space | read/write |
| **191** | Unit4 - Low | 2 bytes, signed integer | space | read/write |
| **192** | Unit4 - Mid | 2 bytes, signed integer | space | read/write |
| **193** | Unit4 - High | 2 bytes, signed integer | space | read/write |
| **194** | Unit5 - Low | 2 bytes, signed integer | space | read/write |
| **195** | Unit5 - Mid | 2 bytes, signed integer | space | read/write |
| **196** | Unit5 - High | 2 bytes, signed integer | space | read/write |
| **197** | Unit6 - Low | 2 bytes, signed integer | space | read/write |
| **198** | Unit6 - Mid | 2 bytes, signed integer | space | read/write |
| **199** | Unit6 - High | 2 bytes, signed integer | space | read/write |
| **200** | Unit7 - Low | 2 bytes, signed integer | space | read/write |
| **201** | Unit7 - Mid | 2 bytes, signed integer | space | read/write |
| **202** | Unit7 - High | 2 bytes, signed integer | space | read/write |
| **203** | Unit8 - Low | 2 bytes, signed integer | space | read/write |
| **204** | Unit8 - Mid | 2 bytes, signed integer | space | read/write |
| **205** | Unit8 - High | 2 bytes, signed integer | space | read/write |
| **206** | Unit9 - Low | 2 bytes, signed integer | space | read/write |
| **207** | Unit9 - Mid | 2 bytes, signed integer | space | read/write |
| **208** | Unit9 - High | 2 bytes, signed integer | space | read/write |
| | | | | |

| Table 4. Floating Point Registers | | | | | |
|---|---|---|---|---|---|
| Addr 16-bit | Addr 32-bit | Description | Size | Initial Value | Access Type |
| 382-383 | 7391 | DP Span Calibration Left Value | 4 bytes, floating | | read only |
| 384-385 | 7392 | SP Span Calibration Left Value | 4 bytes, floating | | read only |
| 386-387 | 7393 | RTD Span Calibration Left Value | 4 bytes, floating | | read only |
| 388-389 | 7394 | DP Zero Calibration Left Value | 4 bytes, floating | | read only |
| 390-391 | 7395 | SP Zero Calibration Left Value | 4 bytes, floating | | read only |
| 392-393 | 7396 | RTD Zero Calibration Left Value | 4 bytes, floating | | read only |
| 394-395 | 7397 | (Reserved for Future Use) | 4 bytes, floating | (TBD) | read/write |
| 396-397 | 7398 | (Reserved for Future Use) | 4 bytes, floating | (TBD) | read/write |
| 398-399 | 7399 | (Reserved for Future Use) | 4 bytes, floating | (TBD) | read only |
| 400-401 | 7400 | Sensor 1 DP readings | 4 bytes, floating | depends on the sensor | read only |
| 402-403 | 7401 | Sensor 1 SP readings | 4 bytes, floating | depends on the sensor | read only |
| 404-405 | 7402 | JT500 Temeprature (RTD) reading | 4 bytes, floating | depends on the sensor | read only |
| 406-407 | 7403 | JT500 status 0 | 4 bytes, unsigned interger | 0 | read only |
| 408-409 | 7404 | JT500 status 2 | 4 bytes, unsigned interger | 0 | read only |
| 410-411 | 7405 | JT500 status 4 | 4 bytes, unsigned interger | 0 | read only |
| 412-413 | 7406 | DP upper range linits | 4 bytes, floating | Factory set | read only |
| 414-415 | 7407 | DP Lower range Limits | 4 bytes, floating | -Upper range Limit | read only |
| 416-417 | 7408 | DP Alarm Upper value | 4 bytes, floating | Upper range Limit | read/write |
| 418-419 | 7409 | DP Alarm Lower value | 4 bytes, floating | -Upper range Limit | read/write |
| 420-421 | 7410 | SP upper range linits | 4 bytes, floating | Factory set | read only |
| 422-423 | 7411 | SP Lower range Limits | 4 bytes, floating | 0 | read only |
| 424-425 | 7412 | SP Alarm Upper value | 4 bytes, floating | Upper range Limit | read/write |
| 426-427 | 7413 | SP Alarm Lower value | 4 bytes, floating | Lower range Limit | read/write |
| 428-429 | 7414 | RTD upper range limits | 4 bytes, floating | 600C | read only |
| 430-431 | 7415 | RTD Lower range Limits | 4 bytes, floating | -40C | read only |
| 432-433 | 7416 | RTD Upper range value | 4 bytes, floating | 600C | read/write |
| 434-435 | 7417 | RTD Lower range value | 4 bytes, floating | -40C | read/write |
| 436-437 | 7418 | DP zero trim | 4 bytes, floating | 0 | read/write |
| 438-439 | 7419 | DP span cal | 4 bytes, floating | Upper range limit | read/write |
| 440-441 | 7420 | DP Damping in seconds | 4 bytes, floating | 1 | read/write |
| 442-443 | 7421 | SP zero trim | 4 bytes, floating | 0 | read/write |
| 444-445 | 7422 | SP span cal | 4 bytes, floating | Upper range Limit | read/write |
| 446-447 | 7423 | SP Damping in seconds | 4 bytes, floating | 1 | read/write |
| 448-449 | 7424 | RTD zero trim | 4 bytes, floating | 0 | read/write |
| 450-451 | 7425 | RTD span cal | 4 bytes, floating | 1 | read/write |
| 452-453 | 7426 | RTD Damping in seconds | 4 bytes, floating | 4 | read/write |
| 454-455 | 7427 | RTD zero Offset | 4 bytes, floating | 0 | read/write |
| 456-457 | 7428 | Sensor 1 Estimate temperature | 4 bytes, floating | Always in degrees C | read only |
| 458-459 | 7429 | DP span trim | 4 bytes, floating | 1 | read/write |
| 460-461 | 7430 | SP span trim | 4 bytes, floating | 1 | read only |
| 462-463 | 7431 | RTD coefficent A | 4 bytes, floating | 0.113908300 | read/write |
| 464-465 | 7432 | RTD coefficient B | 4 bytes, floating | -5.775000E-07 | read/write |
| 466-467 | 7433 | (Reserved for Future Use) | 4 bytes, floating | (TBD) | read only |
| | | | | | |

| Table 5. Floating Point Registers | | | | | |
|---|---|---|---|---|---|
| Addr 16-bit | Addr 32-bit | Description | Size | Initial Value | Access Type |
| 470-471 | 7435 | DP zero calibration as found | 4 bytes, floating | 0 | read only |
| 472-473 | 7436 | SP zero calibration as found | 4 bytes, floating | 0 | read only |
| 474-475 | 7437 | RTD zero Calibration as found | 4 bytes, floating | 0 | read only |
| 476-477 | 7438 | RTD Span Calibration as Found | 4 bytes, floating | 0 | read only |
| 478-479 | 7439 | RTD user defined R0 | 4 bytes, floating | 100 | read/write |
| 480-481 | 7440 | RTD calibrated on Board R0 reference | 4 bytes, floating | Factory Set | read/write |
| 482-483 | 7441 | (Reserved for Future Use) | 4 bytes, floating | (TBD) | read only |
| 484-485 | 7442 | JT500 Board temperature (in C) | 4 bytes, floating | 0 | read only |
| 486-487 | 7443 | RTD fail to value | 4 bytes, floating | 0 | read/write |
| 488-489 | 7444 | JT500 RS485 communication baud rate | 4 bytes, floating | 9600 | read/write |
| 490-491 | 7445 | JT500 RS232 communication baud rate | 4 bytes, floating | 9600 | read/write |
| | | | | | |
| 494-495 | 7447 | (Reserved for Future Use) | 4 bytes, floating | (TBD) | read/write |
| 496-497 | 7448 | (Reserved for Future Use) | 4 bytes, floating | (TBD) | read only |
| 498-499 | 7449 | (Reserved for Future Use) | 4 bytes, floating | (TBD) | read only |
| | | | | | |
| 526-527 | 7463 | Analog input 0 channel value | 4 bytes, floating | depends on the input | read only |
| 528-529 | 7464 | Analog input 1 channel value | 4 bytes, floating | depends on the input | read only |
| 530-531 | 7465 | (Reserved for Future Use) | 4 bytes, floating | (TBD) | read/write |
| 532-533 | 7466 | User Defined Value1 | 4 bytes, floating | NaN | read/write |
| 534-535 | 7467 | User Defined Value2 | 4 bytes, floating | NaN | read/write |
| 536-537 | 7468 | User Defined Value3 | 4 bytes, floating | NaN | read/write |
| 538-539 | 7469 | User Defined Value4 | 4 bytes, floating | NaN | read/write |
| 540-541 | 7470 | User Defined Value5 | 4 bytes, floating | NaN | read/write |
| 542-543 | 7471 | User Defined Value6 | 4 bytes, floating | NaN | read/write |
| 544-545 | 7472 | User Defined Value7 | 4 bytes, floating | NaN | read/write |
| 546-547 | 7473 | User Defined Value8 | 4 bytes, floating | NaN | read/write |
| 548-549 | 7474 | User Defined Value9 | 4 bytes, floating | NaN | read/write |
| | | | | | |

## A9. JT500 Unit Definitions

**Table 6. JT500 Modbus Unit Definitions**

| BSAP Integer | Modbus Integer | MODBUS Registers 59, 60, and 61 Def. |
|---|---|---|
| | 1 | = inH2Oat 60F |
| | 2 | = Pascals |
| 1 | 3 | = KiloPascals |
| 2 | 4 | = megaPascals |
| 0 | 5 | = PSI |
| 4 | 6 | = inH2Oat 68F |
| 8 | 7 | = Bars |
| 7 | 8 | = MilliBars |
| 9 | 9 | = gramPerSqCm |
| 10 | 10 | = KiloGramPersqCm |
| 6 | 11 | = inHgat 0C |
| 11 | 12 | = ftH2Oat 68F |
| | 13 | = torr |
| | 14 | = atm |
| 3 | 15 | = mmH2Oat 68F |
| 5 | 16 | = mmHgat 0C |
| 0 | 20 | = degree C [Register 61 Only] |
| 1 | 21 | = degree F [Register 61 Only] |
| | 34 | = Rankine [Register 61 Only] |
| | 35 | = Kelvin [Register 61 Only] |
| | 238 | = inH2Oat 4C |
| | 239 | = mmH2Oat 4C |

# A10. JT500 Modbus Transmitter Status and Diagnostics Registers

| Table 7. Transmitter Status and Diagnostic Registers | | | |
|---|---|---|---|
| Modbus register type/address | | | Status definitions |
| 32-bit floating point register | 16-bit floating point register | Holding register | Description |
| Register 7403 | Register 406 | Register 118 | |
| bit 15 | bit 15 | bit 15 | Calibration pass Flag |
| bit 14 | bit 14 | bit 14 | Calibration Flag |
| bit 13 | bit 13 | bit 13 | PVs > specification, set/release when t |
| bit 12 | bit 12 | bit 12 | DP signal above Upper Range Limit + 10% |
| bit 11 | bit 11 | bit 11 | DP signal above Upper Range Limit |
| bit 10 | bit 10 | bit 10 | DP signal above Upper Operating Limit |
| bit 9 | bit 9 | bit 9 | DP signal below Lower Operating Limit |
| bit 8 | bit 8 | bit 8 | DP signal below Lower Range Limit |
| bit 7 | bit 7 | bit 7 | DP signal below Lower Range Limit - 10% |
| bit 6 | bit 6 | bit 6 | SP signal above Upper Range Limit + 10% |
| bit 5 | bit 5 | bit 5 | SP signal above Upper Range Limit |
| bit 4 | bit 4 | bit 4 | SP signal above Upper Operating Limit |
| bit 3 | bit 3 | bit 3 | SP signal below Lower Operating Limit |
| bit 2 | bit 2 | bit 2 | SP signal below Lower Range Limit |
| bit 1 | bit 1 | bit 1 | SP signal below Lower Range Limit - 10% |
| bit 0 | bit 0 | bit 0 | Sensor 1 not installed |
| Register 7403 | Register 407 | Register 119 | Description |
| bit 31 | bit 31 | bit 15 | (Reserved for Future Use) |
| bit 30 | bit 30 | bit 14 | PT signal above Upper Range Limit + 10% |
| bit 29 | bit 29 | bit 13 | PT signal above Upper Range Limit |
| bit 28 | bit 28 | bit 12 | PT signal above Upper Operating Limit |
| bit 27 | bit 27 | bit 11 | PT signal below Lower Operating Limit |
| bit 26 | bit 26 | bit 10 | PT signal below Lower Range Limit |
| bit 25 | bit 25 | bit 9 | PT signal below Lower Range Limit - 10% |
| bit 24 | bit 24 | bit 8 | RTD is disconnected |
| bit 23 | bit 23 | bit 7 | ST signal is above Upper Internal Limit |
| bit 22 | bit 22 | bit 6 | ST signal is below Lower Internal Limi |
| bit 21 | bit 21 | bit 5 | DP trims set to factory default |
| bit 20 | bit 20 | bit 4 | SP trims set to factory default |
| bit 19 | bit 19 | bit 3 | RTD trims set to factory default |
| bit 18 | bit 18 | bit 2 | Update the firmware - only specific tasks |
| bit 17 | bit 17 | bit 1 | RTD - fail to user defined value or last good value? |
| bit 16 | bit 16 | bit 0 | (Reserved for Future Use) |

| Table 8. Transmitter Status and Diagnostic Registers | | | |
|---|---|---|---|
| Modbus register type/address | | | Status definitions |
| 32-bit floating point register | 16-bit floating point register | Holding register | Description |
| Register 7404 | Register 408 | Register 120 | |
| bit 15 | bit 15 | bit 15 | Sensor DAC |
| bit 14 | bit 14 | bit 14 | DP Zero calibration |
| bit 13 | bit 13 | bit 13 | DP Span calibration |
| bit 12 | bit 12 | bit 12 | SP Zero calibration |
| bit 11 | bit 11 | bit 11 | SP Span calibration |
| bit 10 | bit 10 | bit 10 | RTD Span calibration |
| bit 9 | bit 9 | bit 9 | RTD Span calibration |
| bit 8 | bit 8 | bit 8 | MSP A0 input calibration |
| bit 7 | bit 7 | bit 7 | MSP A1 input calibration |
| bit 6 | bit 6 | bit 6 | MSP VCC calibration |
| bit 5 | bit 5 | bit 5 | MSP Temp calibreation |
| bit 4 | bit 4 | bit 4 | 2Wire RTD connected |
| bit 3 | bit 3 | bit 3 | 3wire RTD connected |
| bit 2 | bit 2 | bit 2 | Port rx message start |
| bit 1 | bit 1 | bit 1 | Write Protect Status |
| bit 0 | bit 0 | bit 0 | Sensor estimate temperature less or greater than -40C |
| Register 7404 | Register 409 | Register 121 | Description |
| bit 31 | bit 31 | bit 15 | Hardware version |
| bit 30 | bit 30 | bit 14 | (Reserved for Future Use) |
| bit 29 | bit 29 | bit 13 | Reset MSP temperature calibration |
| bit 28 | bit 28 | bit 12 | RS485 Character Speed Indicator |
| bit 27 | bit 27 | bit 11 | Process slower than RTS timer |
| bit 26 | bit 26 | bit 10 | ADC wake indicator |
| bit 25 | bit 25 | bit 9 | (Reserved for Future Use) |
| bit 24 | bit 24 | bit 8 | Reset R0 calibration |
| bit 23 | bit 23 | bit 7 | Sensor 1 data |
| bit 22 | bit 22 | bit 6 | (Unused) |
| bit 21 | bit 21 | bit 5 | JT500 ROC Protocol Disable |
| bit 20 | bit 20 | bit 4 | Reset AI0 calibration |
| bit 19 | bit 19 | bit 3 | Reset AI1 calibration |
| bit 18 | bit 18 | bit 2 | Start the RTC calibration , enable clock output |
| bit 17 | bit 17 | bit 1 | (Unused) |
| bit 16 | bit 16 | bit 0 | JT500 ROC Protocol Enable |

| Table 9. Transmitter Status and Diagnostic Registers | | | |
|---|---|---|---|
| Modbus register type/address | | | Status definitions |
| 32-bit floating point register | 16-bit floating point register | Holding register | Description |
| Register 7405 | Register 410 | Register 122 | |
| bit 15 | bit 15 | bit 15 | Reset DP span trim to factory default |
| bit 14 | bit 14 | bit 14 | Reset SP span trim to factory default |
| bit 13 | bit 13 | bit 13 | Define the RTD ADC is good |
| bit 12 | bit 12 | bit 12 | Reset PT span trim to fatory default |
| bit 11 | bit 11 | bit 11 | Reset all trims to factory default |
| bit 10 | bit 10 | bit 10 | RS485 baudrate reset |
| bit 9 | bit 9 | bit 9 | DP enable user unit |
| bit 8 | bit 8 | bit 8 | RTD calibration of on-board R0 |
| bit 7 | bit 7 | bit 7 | SP enable user unit |
| bit 6 | bit 6 | bit 6 | RTD coefficient reset to factory defaults |
| bit 5 | bit 5 | bit 5 | Operation limit reset to factory defaults |
| bit 4 | bit 4 | bit 4 | Reset dampling to factory defaults |
| bit 3 | bit 3 | bit 3 | (Reserved for Future Use) |
| bit 2 | bit 2 | bit 2 | Reset DP zero trim to factory default |
| bit 1 | bit 1 | bit 1 | Reset SP zero trim to factory default |
| bit 0 | bit 0 | bit 0 | Reset PT zero trim to factory default |
| Register 7405 | Register 411 | Register 123 | Description |
| bit 31 | bit 31 | bit 15 | (Unused) |
| bit 30 | bit 30 | bit 14 | (Unused) |
| bit 29 | bit 29 | bit 13 | (Unused) |
| bit 28 | bit 28 | bit 12 | (Unused) |
| bit 27 | bit 27 | bit 11 | (Unused) |
| bit 26 | bit 26 | bit 10 | (Unused) |
| bit 25 | bit 25 | bit 9 | (Unused) |
| bit 24 | bit 24 | bit 8 | (Unused) |
| bit 23 | bit 23 | bit 7 | (Unused) |
| bit 22 | bit 22 | bit 6 | (Unused) |
| bit 21 | bit 21 | bit 5 | (Unused) |
| bit 20 | bit 20 | bit 4 | (Unused) |
| bit 19 | bit 19 | bit 3 | (Unused) |
| bit 18 | bit 18 | bit 2 | (Unused) |
| bit 17 | bit 17 | bit 1 | (Unused) |
| bit 16 | bit 16 | bit 0 | (Unused) |

| Table 10. Digital I/O Control and Status Register | |
|---|---|
| **Holding register** | **Bit Status Definitions** |
| **Register 144** | |
| **bit 15** | (Unused) |
| **bit 14** | (Unused) |
| **bit 13** | (Unused) |
| **bit 12** | (Unused) |
| **bit 11** | Channel 3 - Input Status (0 = low, 1 = high) |
| **bit 10** | Channel 2 - Input Status (0 = low, 1 = high) |
| **bit 9** | Channel 1 - Input Status (0 = low, 1 = high) |
| **bit 8** | Channel 0 - Input Status (0 = low, 1 = high) |
| **bit 7** | Channel 3 - Output Control (0 = high, 1 = low) |
| **bit 6** | Channel 2 - Output Control (0 = high, 1 = low) |
| **bit 5** | Channel 1 - Output Control (0 = high, 1 = low) |
| **bit 4** | Channel 0 - Output Control (0 = high, 1 = low) |
| **bit 3** | Channel 3 - I/O Direction (0 = input, 1 = output) |
| **bit 2** | Channel 2 - I/O Direction (0 = input, 1 = output) |
| **bit 1** | Channel 1 - I/O Direction (0 = input, 1 = output) |
| **bit 0** | Channel 0 - I/O Direction (0 = input, 1 = output) |

| Table 11. Control Register for 12V Out and Display LED | |
|---|---|
| **Holding register** | **Bit Status Definitions** |
| **Register 145** | |
| **bit 15** | (Unused) |
| **bit 14** | (Unused) |
| **bit 13** | (Unused) |
| **bit 12** | (Unused) |
| **bit 11** | (Unused) |
| **bit 10** | (Unused) |
| **bit 9** | (Unused) |
| **bit 8** | (Unused) |
| **bit 7** | (Unused) |
| **bit 6** | (Unused) |
| **bit 5** | (Unused) |
| **bit 4** | (Unused) |
| **bit 3** | (Reserved for Future Use) |
| **bit 2** | (Reserved for Future Use) |
| **bit 1** | (Reserved for Future Use) |
| **bit 0** | (Reserved for Future Use) |

# A11. JT500 BSAP Signal Lists

| Table 12. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 1 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | PRESSURE.VAL.INP | CE | MI | -1.809 | INH2O |
| 2 | STATIC.VAL.INP | CE | MI | 0.084 | KG/CM2 |
| 3 | TEMP.VAL.INP | CE | MI | -1.103 | DEG C |
| 4 | ESTTEMP.VAL.LIVE | CE | MI | 23.261 | DEG C |
| 5 | ERRFLAGS.. | CE | ME | 0.000 | |

| Table 13. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 2 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | PRESSURE.UNITS. | CE | ME | 4.000 | INH2O |
| 2 | STATIC.UNITS. | CE | ME | 10.000 | KG/CM2 |
| 3 | TEMP.UNITS. | CE | ME | 0.000 | |
| 4 | TEMP.UNITS. | CE | ME | 0.000 | |
| 5 | TAGNAME.. | CE | ME | JT400 | |
| 6 | REV3508.. | CI | MI | N3 | |

| Table 14. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 3 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | PRESSURE.SPAN.CAL | CE | ME | 300.000 | |

| Table 15. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 4 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | STATIC.SPAN.CAL | CE | ME | 2000.000 | |

| Table 16. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 5 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | EXECUTE.CALIB. | CE | ME | 0.000 | |

| Table 17. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 6 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | PRESSURE.TARGET. | CE | ME | 0.000 | |
| 2 | STATIC.TARGET. | CE | ME | 0.000 | |

| Table 18. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 7 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | TEMP.OFFSET.CFG | CE | ME | 0.000 | |

| Table 19. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 8 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | A.USER.CAL | CE | ME | 0.004 | |
| 2 | B.USER.CAL | CE | ME | 0.000 | |
| 3 | R0.USER.CAL | CE | ME | 100.000 | |

| Table 20. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 9 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | TEMP.SPAN.CAL | CE | ME | 1.000 | |

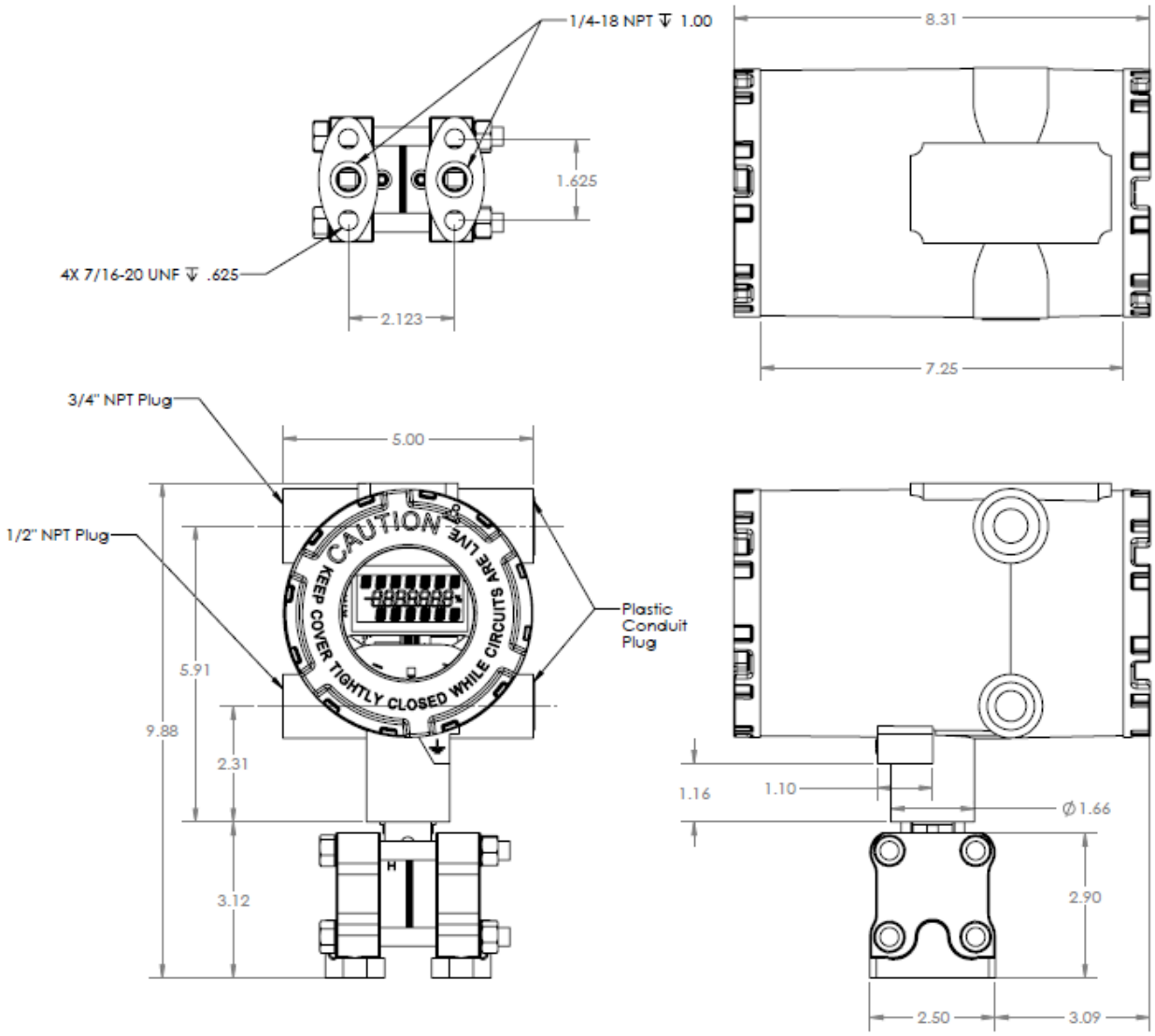
| Table 21. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 10 | | | | | |
| **Index** | **BSAP Signal** | **Control Bits** | | **Value** | **Units** |
| **1** | PRESSURE.UNITS. | CE | ME | 4.000 | INH2O |
| **2** | STATIC.UNITS. | CE | ME | 0.000 | PSI |
| **3** | TEMP.UNITS. | CE | ME | 0.000 | |
| **4** | OUTPUT.SOURCE. | CE | MI | 6.000 | |
| **5** | OUTPUT.VAL.EXT | CE | MI | 0.000 | % |
| **6** | OUTPUT.VAL.LRV | CE | MI | 0.000 | |
| **7** | OUTPUT.VAL.URV | CE | MI | 0.000 | |
| **8** | BSAP.ADDR.CFG | CE | ME | 3.000 | |
| **9** | BSAP.GROUP.CFG | CE | ME | 0.000 | |
| **10** | MODBUS.ADDR.CFG | CE | ME | 3.000 | |
| **11** | MODBUS.MODE.CFG | CE | ME | 0.000 | |
| **12** | BAUDRATE..CFG | CE | ME | 9600.000 | BPS |
| **13** | RTS.DELAY.CFG | CE | ME | 50.000 | MSEC |
| **14** | TEMP.VAL.DAMP | CE | ME | 1.000 | SEC |
| **15** | A.USER.CAL | CE | ME | 0.004 | |
| **16** | B.USER.CAL | CE | ME | 0.000 | |
| **17** | R0.USER.CAL | CE | ME | 100.000 | |
| **18** | RTD.ZERO.CAL | CE | ME | 0.083 | |
| **19** | PRESSURE.VAL.DAMP | CE | ME | 1.000 | SEC |
| **20** | STATIC.VAL.DAMP | CE | ME | 1.000 | SEC |
| **21** | PRESSURE.VAL.LRV | CE | ME | -300.000 | |
| **22** | PRESSURE.VAL.URV | CE | ME | 300.000 | |
| **23** | TEMP.VAL.LRV | CE | ME | -40.000 | |
| **24** | TEMP.VAL.URV | CE | ME | 600.000 | |
| **25** | STATIC.VAL.LRV | CE | ME | -15.000 | |
| **26** | STATIC.VAL.URV | CE | ME | 2000.000 | |
| **27** | OUTPUT.FAIL. | CE | MI | 0.000 | |
| **28** | TEMP.FAIL. | CE | ME | 1.000 | |
| **29** | TEMP.FAIL.CFG | CE | ME | 11000010.000 | |
| **30** | BSAP.ANYADR.CFG | CE | ME | 0.000 | |
| **31** | TEMP.OFFSET.CFG | CE | ME | 0.000 | |
| **32** | MANUAL.LOCK.CFG | CE | MI | 0.000 | |
| **33** | CU.SEL.CFG | CE | MI | 0.000 | |
| **34** | CU.LRV.CFG | CE | MI | 0.000 | |
| **35** | CU.URV.CFG | CE | MI | 0.000 | |
| **36** | STATIC.LRLADJ.CFG | CE | ME | 0.000 | |
| **37** | STATIC.MODE. | CE | ME | OFF | |
| **38** | TEMP.MODE. | CE | ME | OFF | |
| **39** | OUTPUT.ACTION. | CE | ME | RVS | |
| **40** | OUTPUT.MODE. | CE | ME | SQROOT | |
| **41** | PW.. | CE | MI | 666666 | |
| **42** | TAGNAME.. | CE | ME | JT400 | |
| **43** | SENSOR.TYPE.CODE | CE | MI | 32.000 | |

| Table 22. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 11 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | PRESSURE.RESTR.DEF | CE | ME | OFF | |
| 2 | STATIC.RESTR.DEF | CE | ME | OFF | |
| 3 | TEMP.RESTR.DEF | CE | ME | OFF | |

| Table 23. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 80 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | PROGREV.. | CE | MI | 2.700 | MVT |
| 2 | PRESSURE.SPAN.CAL | CE | ME | 300.000 | |
| 3 | STATIC.SPAN.CAL | CE | ME | 2000.000 | |
| 4 | PRESSURE.VAL.LRV | CE | ME | -300.000 | |
| 5 | PRESSURE.VAL.URV | CE | ME | 300.000 | |
| 6 | TEMP.VAL.LRV | CE | ME | -40.000 | |
| 7 | TEMP.VAL.URV | CE | ME | 600.000 | |
| 8 | PRESSURE.VAL.LRL | CE | MI | -300.000 | |
| 9 | PRESSURE.VAL.URL | CE | MI | 300.000 | |
| 10 | STATIC.VAL.LRL | CE | MI | -15.000 | |
| 11 | STATIC.VAL.URL | CE | MI | 2000.000 | |
| 12 | STATIC.VAL.LRV | CE | ME | -15.000 | |
| 13 | STATIC.VAL.URV | CE | ME | 2000.000 | |
| 14 | PRESSURE.TARGET. | CE | ME | 0.000 | |
| 15 | STATIC.TARGET. | CE | ME | 0.000 | |
| 16 | SENSOR.BLOCK.NUM | CI | MI | 26854 | |
| 17 | BOARD.SERIAL.NUM | CI | MI | 65 | |

| Table 24. JT500 BSAP Signal Information | | | | | |
|---|---|---|---|---|---|
| List 140 | | | | | |
| Index | BSAP Signal | Control Bits | | Value | Units |
| 1 | SCROLL.LCDT.CFG | CE | ME | 3.000 | |
| 2 | LCD_BIT.MASK.CFG | CE | MI | 127.000 | |
| 3 | USERVAL.LABEL.1 | CE | ME | | |
| 4 | USERVAL.PARAM.1 | CE | ME | 0.000 | |
| 5 | USERVAL.UOFM.1 | CE | ME | | |
| 6 | USERVAL.LABEL.2 | CE | ME | | |
| 7 | USERVAL.PARAM.2 | CE | ME | 0.000 | |
| 8 | USERVAL.UOFM.2 | CE | ME | | |
| 9 | USERVAL.LABEL.3 | CE | ME | | |
| 10 | USERVAL.PARAM.3 | CE | ME | 0.000 | |
| 11 | USERVAL.UOFM.3 | CE | ME | | |
| 12 | USERVAL.LABEL.4 | CE | ME | | |
| 13 | USERVAL.PARAM.4 | CE | ME | 0.000 | |
| 14 | USERVAL.UOFM.4 | CE | ME | | |
| 15 | USERVAL.LABEL.5 | CE | ME | | |
| 16 | USERVAL.PARAM.5 | CE | ME | 0.000 | |
| 17 | USERVAL.UOFM.5 | CE | ME | | |
| 18 | USERVAL.LABEL.6 | CE | ME | | |
| 19 | USERVAL.PARAM.6 | CE | ME | 0.000 | |
| 20 | USERVAL.UOFM.6 | CE | ME | | |
| 21 | USERVAL.LABEL.7 | CE | ME | | |
| 22 | USERVAL.PARAM.7 | CE | ME | 0.000 | |
| 23 | USERVAL.UOFM.7 | CE | ME | | |

## A12. JT500 Product Dimensions



## A13. JT500 Neck Mount Bracket Drawing