PARAGON CONTROLS INCORPORATED

OAFE-2000

Outdoor Airflow Measurement System

Installation, Operation & Maintenance Manual

THE SENSEABLE SOLUTION

TABLE OF CONTENTS

1. INTRODUCTION 1
1.1. Description 1
1.2. Basic Operation 1
1.3. Specifications 2
1.4. Safety 2
1.4.1. Electrical Connections 2
1.4.2. Static Electricity 2
2. AIRFLOW MEASUREMENT STATION 3
2.1. Typical Installations 3
2.2. Installation Guidelines for Ducted Applications 4
2.3. Maintenance 4
2.4. Site Storage, Handling, and Spare Parts 4
3. MTSE INSTALLATION 5
3.1. Product Installation Dimensions 5
3.2. Electrical Connections 6
3.2.1. Common Electrical Connections 7
3.3. Pneumatic Connections 10
4. MTSE CONFIGURATIONS 11
4.1. Display Overview 11
4.2. System Configurations 12
4.2.1. Display Types 12
4.3. Display Features 13
4.3.1. Sensor Data Page Shortcut 13
4.3.2. Keypad 14
5. MENU INFORMATION 15
5.1. Levels of Menus 15
5.2. Setup Menus 16
5.2.1. Operating Range Menu 18
5.2.2. K-Factor 19
5.2.3. Analog I/O Configuration 20
5.2.4. System Filters 21
5.2.5. Network Communications 21
5.2.6. Temperature Compensation & Altitude 22
5.2.7. Alarm Options 23
5.2.8. Units and Precision 25
5.2.9. ΔP Settings (Optional) 26
5.3. Diagnostics Menu 27
5.3.1. Sensor Data Page 28
5.3.2. System Overview 29
5.3.3. Factory Defaults 30
5.3.4. Software Update 31
5.3.5. ScreenSaver 32
5.3.6. AutoZero Settings 32
5.4. K-Factor Page Shortcut 33
5.5. Notification Page 33
5.6. Troubleshooting and Help Pages 35

ATTACHMENTS

A BACnet PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT
B MODBUS SOFTWARE CONFIGURATION PARAMETERS

1. INTRODUCTION

1.1. Description

The **OAFE-2000** is a packaged and specifiable outdoor airflow measuring system capable of producing an overall ±0.5% of reading accuracy and will satisfy LEED, ASHRAE 62.1, ASHRAE 189.1, ASHRAE 170 and California Title 24 requirements for verifying the required ventilation rates or air changes per hour.

The **OAFE-2000** is designed to tackle the challenges of outside airflow measurement which is often low velocity, loaded with particulate, and application specific. The packaged system consists of an integral transmitter and multiple airflow elements, factory mounted and pre-piped in a casing designed for flanged connection to ductwork, control dampers, louvers, etc. The airflow measurement station is constructed to comply with ASHRAE Standard 111 for equal area traversing of an airflow measurement plane.

Utilizing Paragon Controls' full sheet metal capabilities, the **OAFE-2000** can match up with almost any new or existing ductwork, hood, or outside air opening for a seamless engineered solution. An optional inlet bell is available for plenum applications. Application specific materials such as 316 Stainless Steel are available where salt-air may be a concern.

The integral (Multi-Trans Smart Ecosystem) **MTSE** Transmitter is a flow and pressure transmitter that has been engineered to provide a cost-effective solution for accurate airflow measurement of up to three systems; perfect for air handling or rooftop units requiring ventilation rate monitoring at the outside air intake and supply and return fan/fan array airflow monitoring. The MTSE can connect to each fan's existing piezometer-ring airflow sensors or to field installed airflow stations; up to five flow sensing points. The MTSE can simultaneously measure up to four additional differential pressure sensing points such as pressure drop across filters or coils, duct static pressure, and plenum pressure. The total (summed) airflow rate for the individual flow systems differential pressure points is indicated on a 3.5-inch HMI touch screen.

The total airflow rate of each system is available to the BMS or local controller via dedicated field selectable 0-10 VDC or 4-20 mA analog outputs and via field selectable BACnet®-MS/TP Master or Modbus® RTU Slave network communications. Independent flow and pressure values for each of the nine sensing points is also available to the BMS or local controller via network communication.

1.2. Basic Operation

The airflow measuring station produces pneumatic output signals referred to as total (high) and static (low) pressure. These two pressure signals are piped to the MTSE where the static pressure is subtracted from the total and the result indicated as velocity pressure (differential pressure). This measured differential pressure is equal to the average velocity of the air stream moving through the plane that the airflow measuring station is located in. This signal can be converted to air velocity and flow using the following equations:

$$\rho_a = 1.325 \times \frac{29.921}{460 + T_a} \qquad V = 1096.7\sqrt{\frac{P_V}{\rho_a}} \qquad Q = V \times A$$

Where:

$\rho_a =$ Actual density of air, in lb/ft^3 (0.075 lb/ft^3 at sea level and 68°F)

$T_a =$ Actual temperature, in °F (default value is 68°F)

$P_V =$ Velocity pressure, in inches H_2O

V = Velocity, in fpm

Q = Flow, in cfm

A = Area, in ft^2

This signal is scaled and linearized before being displayed and transmitted out as a 4-20mA or 0-10VDC signal.

The AutoZero option detects and corrects any zero offset caused by large ambient temperature changes. The Temperature Compensation option compensates the flow and velocity signal for density changes caused by variations in the process air temperature.

1.3. Specifications

Power Requirements	20 - 28VAC/VDC	Supported Protocols	BACnet MS/TP Modbus RTU Slave
Power Consumption	8.5W, 15.3VA Max	Max communication length	4000 ft. (EIA-485)
Protection	Circuit Polarity Protected Self-Resetting Fuse	Operating Temperature	-20°F to 158°F (-29°C to 70°C)
Digital Outputs	(2) Open Collector Digital Outputs	Temperature Compensated Range	-4°F to 158°F (-20°C to70°C)
Digital Inputs	(2) Dry Contact Digital Inputs	Storage Temperature	-40°F to 257°F (-40°C to 125°C)
Analog Outputs	(4) 16-bit Analog Outputs Field Selectable 0-10V & 4-20mA Overvoltage and Overcurrent Protected	Enclosure	Impact Resistant Polycarbonate IP-66, NEMA 4X Rated Fire Retardant UL 94 V-0
Analog Inputs	(4) 12-bit Analog Inputs Field Selectable 0-5V, 0-10V & 4-20mA	Dimensions	9.50" L x 5.69" W x 3.56" H
Terminal Blocks	Pluggable Screw Type 16 to 24 AWG	Pressure Connections	1/4" OD Barbed Brass Fittings
Accuracy	+/- 0.25% F.S.		

1.4. Safety

1.4.1. Electrical Connections

Before any electrical connections are made, ensure the **POWER SWITCH** is in the **OFF** position.

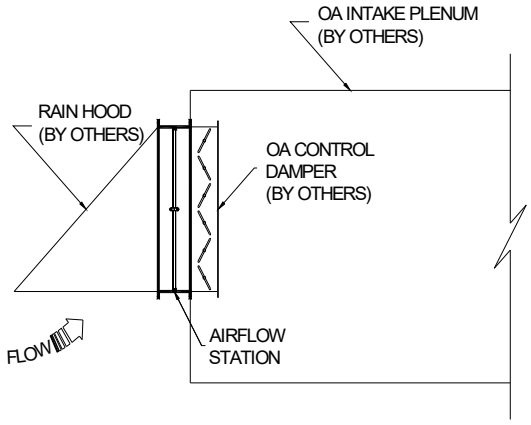
1.4.2. Static Electricity

The circuit board contains components which are susceptible to damage caused by static electrical discharge. Should it be necessary to remove the circuit board from the enclosure, appropriate precautions must first be taken to ensure that the operator and the circuit board are at the same electrical potential.

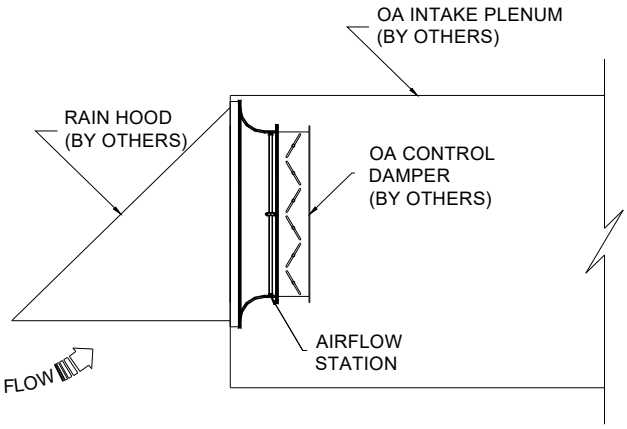
2. AIRFLOW MEASUREMENT STATION

2.1. Typical Installations

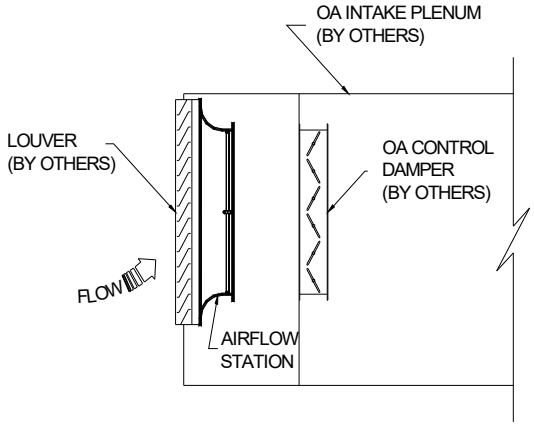
ROOFTOP AHU WITH RAIN HOOD EXTERIOR MOUNTED AIRFLOW STATION



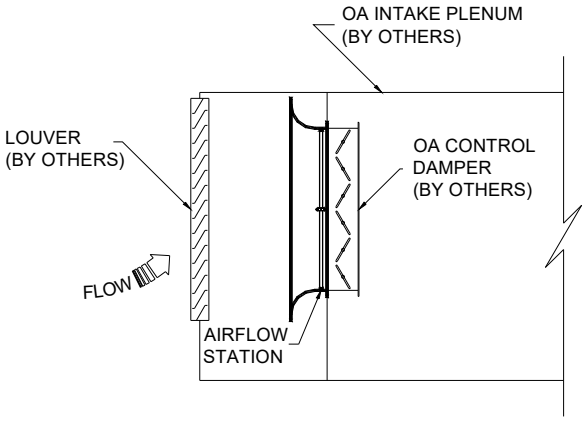
ROOFTOP AHU WITH RAIN HOOD INTERIOR MOUNTED AIRFLOW STATION



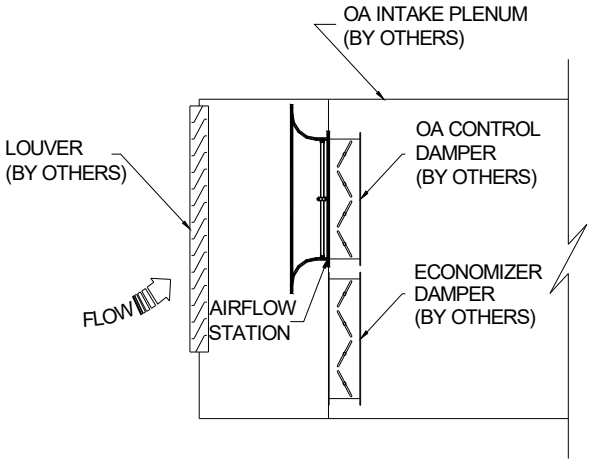
OUTDOOR AIR PLENUM MOUNTED AIRFLOW STATION



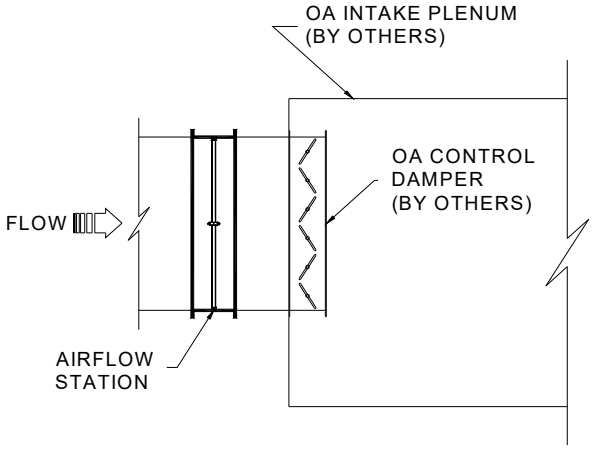
OUTDOOR AIR PLENUM MOUNTED AIRFLOW STATION

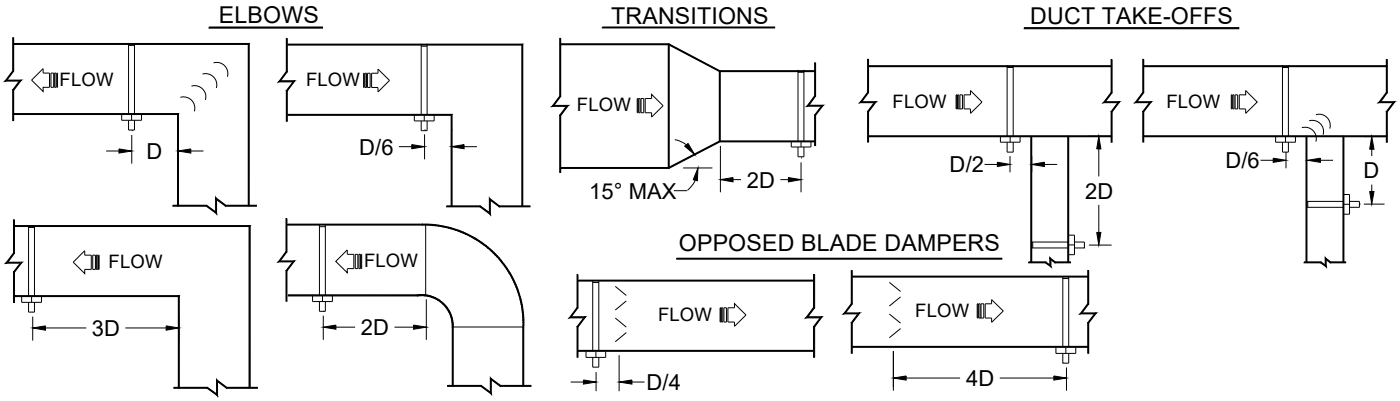


PLENUM MOUNTED MINIMUM OUTDOOR AIRFLOW STATION



DUCTED OUTDOOR AIRFLOW STATION





Notes:

Rectangular Ducts:

$$D = \sqrt{\frac{4HW}{\pi}}$$ H = Duct height W = Duct width

2.3. Maintenance

Since the sensing elements have no moving parts, only periodic cleaning may be required. The sensing elements should be inspected for fouling of the sensing holes as part of an annual preventative maintenance program. Installations having viscous airborne particles may require more frequent inspection. If the sensing holes on the elements have become fouled or plugged, the following procedure is recommended. ***Caution, all instruments must be isolated (removed) from the sensing lines prior to performing the following cleaning procedure.***

- ***Backpurging:*** Connect clean/dry compressed air, set at a maximum pressure of 25 psi, to the output pressure ports (total and/or static) of the sensing element being cleaned. While purging the sensing element, wipe the surface of the cylinder with a cloth or brush to loosen and remove all contaminant buildup.
- ***Cleaning:*** In applications where the sensing elements are subject to viscous contaminants it is recommended that the surface be washed with a cleaning agent. The cleaning agent used must be suitable for use on the type of material the sensing element is constructed of (i.e. aluminum, stainless steel, etc.)

2.4. Site Storage, Handling, and Spare Parts

The sensing elements must be stored indoors, in the original shipping package, and in a dry place. Failure to do so may result in internal blockage of averaging chambers due to dust migration and/or insect infestation. Although the sensing elements are not fragile by design, care must be taken not to damage or disfigure the cylinder surface when handling and installing. Particular attention must be given to the surface areas in which sensing ports are located. The sensing elements come as a complete fabricated assembly. ***No spare parts are required.***

3. MTSE INSTALLATION

The MTSE is rated for either indoor or outdoor installation. It can be mounted near the supply/return/exhaust fans reducing the pneumatic tubing runs. Since the MTSE comes standard in a NEMA 4X Enclosure it can also be mounted in the OA intake where it may be exposed to rain/snow or near cooling coils, providing flexibility in the mounting location. Avoid locations that are subject to high vibration. When installed outdoors, **do not install the MTSE where the display screen is in direct sunlight**.

3.1. Product Installation Dimensions

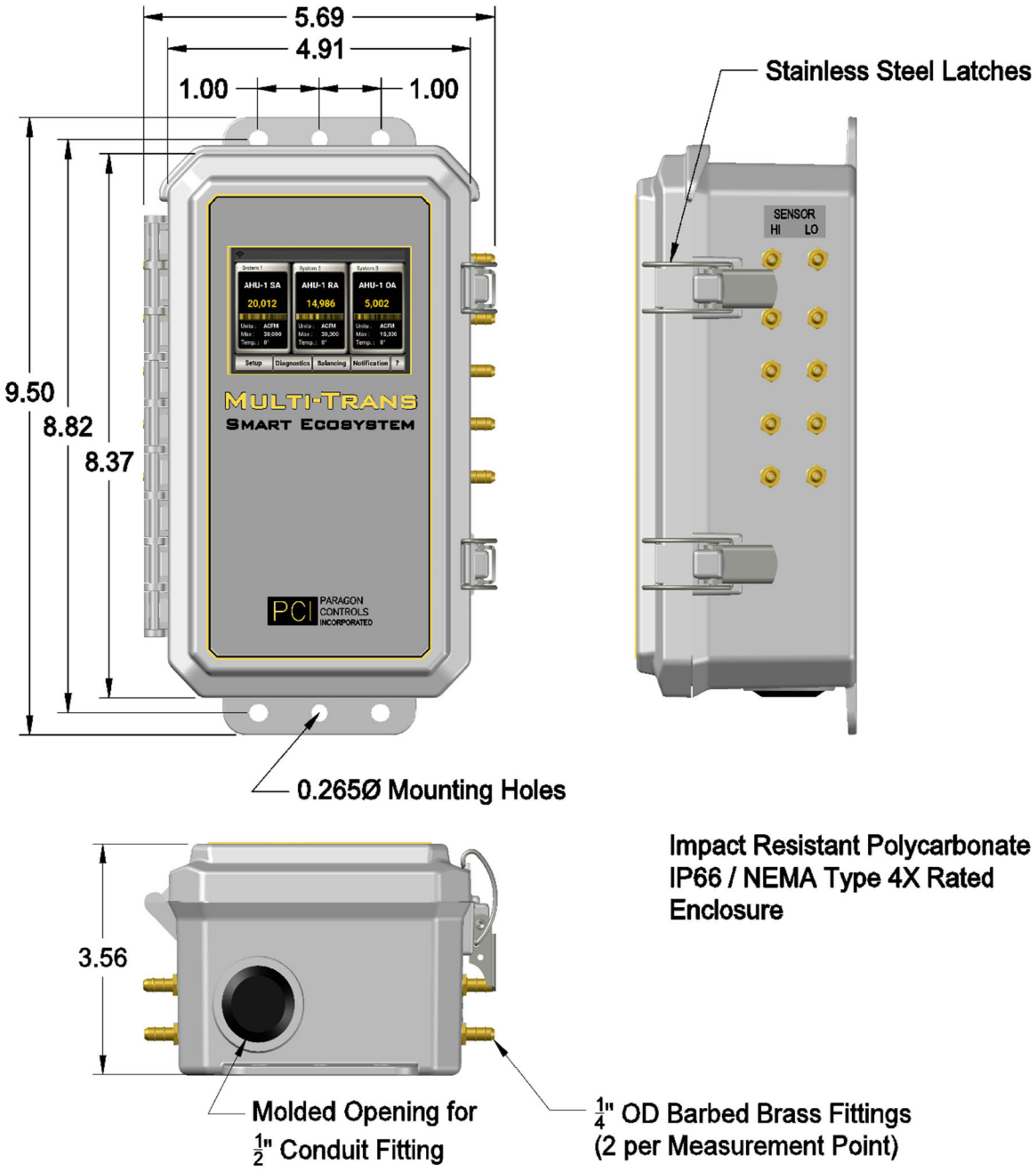


Figure 3.1 – MTSE Enclosure

3.2. Electrical Connections

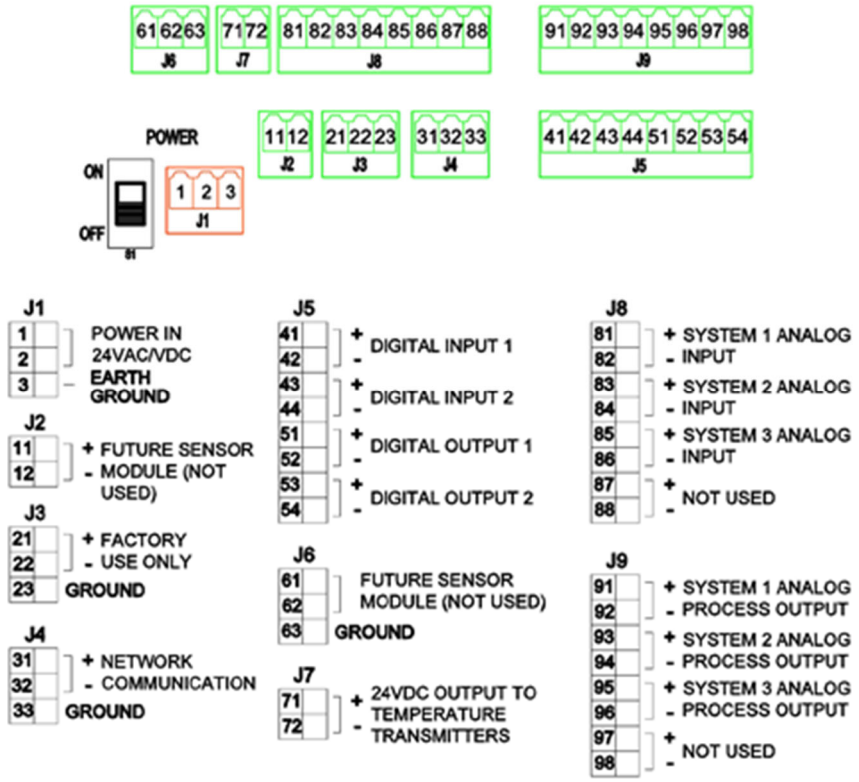


Figure 3.2 – Terminal Block Description

J1 – Power In	The MTSE can be powered with 24VAC or 24VDC. Allowable range is 20-28V. Pin 1 on the power supply terminal is the positive leg, however the device is reverse polarity protected.
J2 – Future Sensor Module Expansion	Additional remote MTSE units will be daisy-chained together to expand the sensing capability. Currently not available.
J3 - Service Communication	Communication pins for Factory programming. DO NOT CONNECT TO THESE PINS.
J4 - Network Communication	BACnet/Modbus communication pins.
J5 - Digital Inputs and Digital Outputs	Not Used
J6 - Future Sensor Module Expansion	Will provide power for additional MTSE sensor module units. Currently not available.
J7 - 24VDC Output to Temp. Transmitters	Supplies power for external temperature transmitter(s).
J8 - Analog Inputs	Analog Inputs are tied to the temperature inputs and are scaled to the minimum and maximum values set in *Temperature Compensation & Altitude* Setup Menus.
J9 - Analog Outputs	System 1 Analog Process Output is System 1 Total Summed Flow (Process Value) of the sensors in System 1. This is scaled to the *Operating Range* set in the Setup Menus where 0V or 4 mA is 0 flow and 10V or 20 mA is the operating range.

3.2.1. Common Electrical Connections

PCI recommends cable should be low capacitance, shielded 24 AWG (minimum) twisted wire for all electrical connections. When connecting multiple MTSE units on a common communication network, connect shielding wires together and connect only one side of the shielding wire to earth ground at the building automation system; do not connect both ends of the shield wire to earth ground.

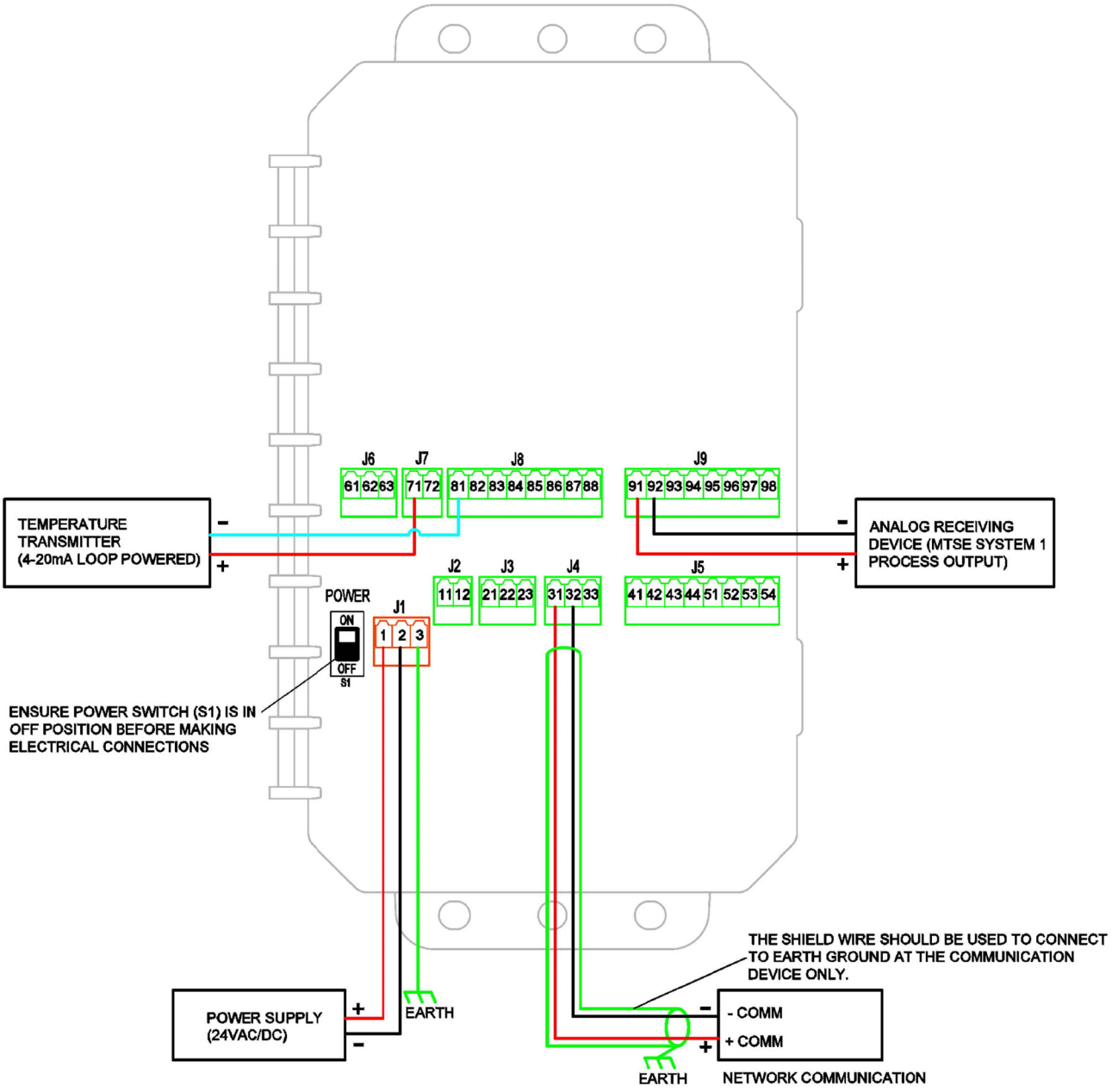


Figure 3.3 – Typical 1 System connection to 24VAC/DC power, 4-20mA loop-powered temperature transmitter, analog receiving device, or network communication.

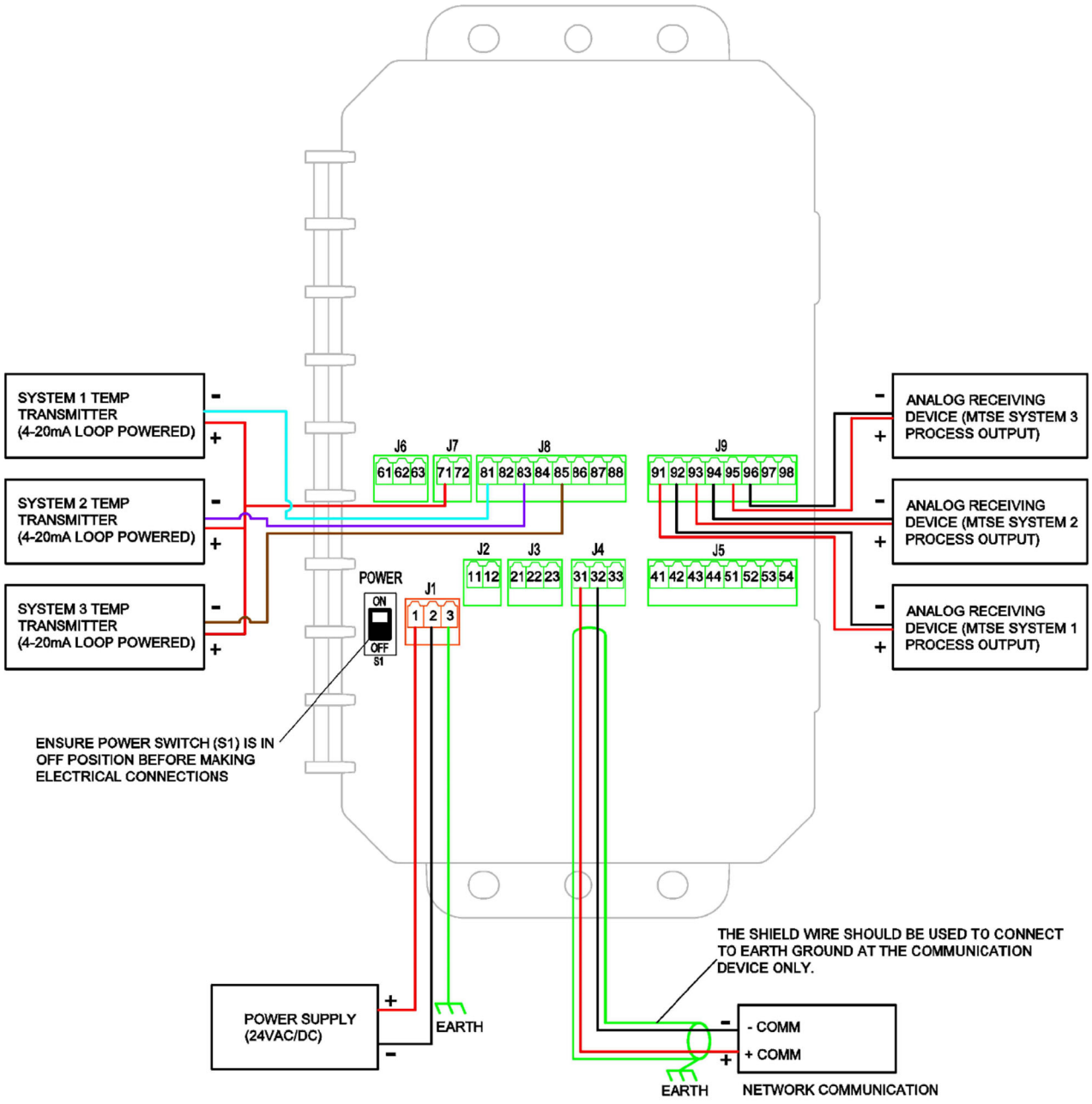


Figure 3.4 – Typical 3 System connection to 24VAC/DC power, 4-20mA loop-powered temperature transmitters, analog receiving devices, or network communication.

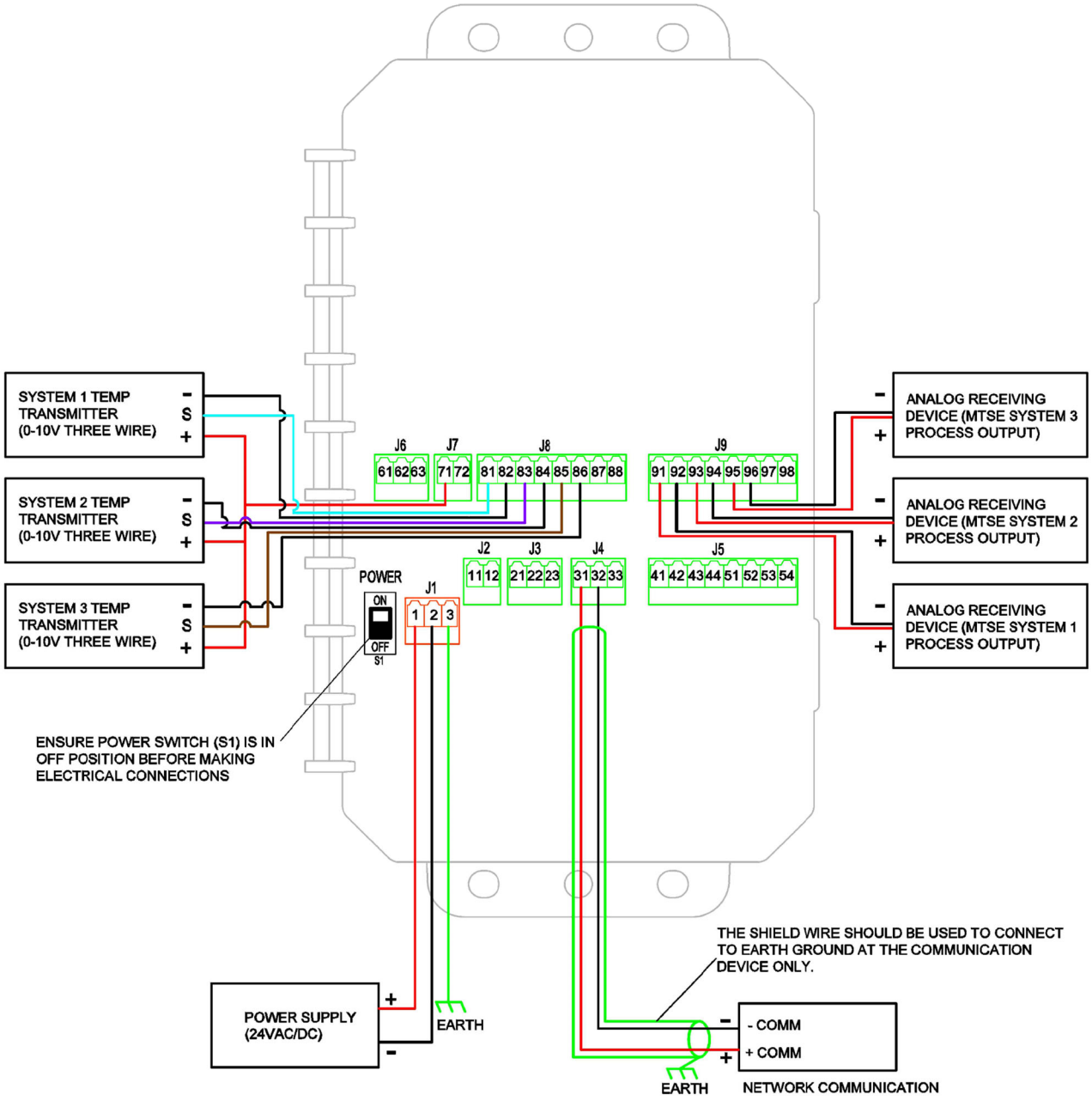


Figure 3.5 – Typical 3 System connection to 24VAC/DC power, 0-10V three-wire temperature transmitters, analog receiving devices, or network communication.

3.3. Pneumatic Connections

The MTSE can measure a maximum of five airflow points in up to three systems and monitor up to four ΔP points for a total of 9 sensing points. Two pneumatic plenum-rated signal tubing lines are required to be connected to the MTSE for each sensing point, a high (or Total) and a low (or Static) connection. Transducers in the MTSE are numbered sequentially; therefore, all connections for System 1 must be made in order starting at Sensor 1, and then System 2 will start immediately after the last sensor in System 1, and so on. See label inside cover of MTSE for sensor numbering. Shown below is an example of an MTSE configured to measure two Supply Fans, two Return Fans, and a single Outside Air opening.

Figure 3.6 – Typical pneumatic connections to piezometer rings on fans and outside air flow measurement station

4. MTSE CONFIGURATIONS

The MTSE can be configured to measure airflow in up to 3 unique Systems and monitor up to 4 additional differential pressure (ΔP) points up to a total of 9 sensing points.

4.1. Display Overview

Shown below is a fully loaded MTSE monitoring (3) independent systems and (4) ΔPs.

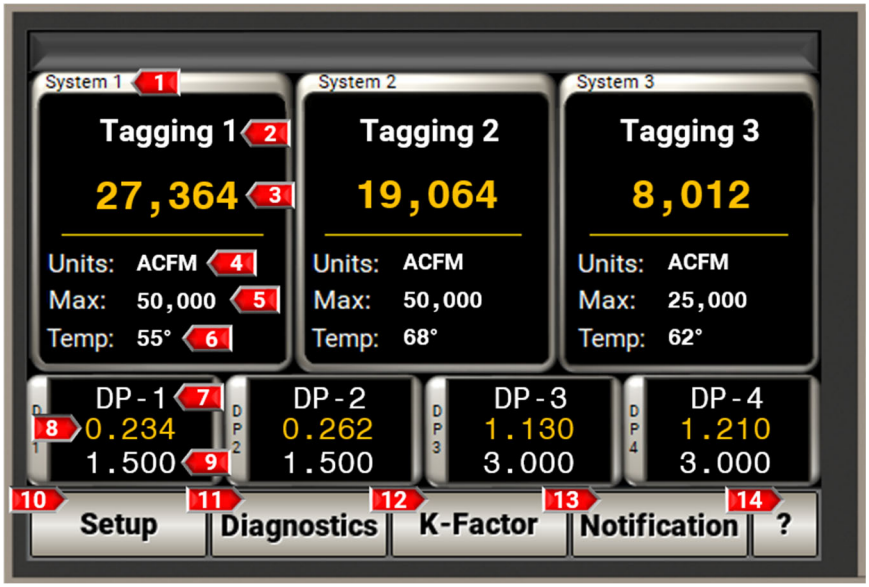


Figure 4.1 – Main Screen showing 3 Systems and 4 ΔP measurement points.

1) System Number: Static text indicating the specific system number.
2) System Tagging: Custom entered tagging information for a more meaningful representation of where measurement is taking place.
3) System Measurement: Live measurement of flow, velocity, or pressure for the System.
4) Units: Field selectable units for the System Measurement.
5) Max Operating Range: Upper limit of allowed flow measurement value. System Bar graph and System Analog Output are scaled to this value (Max = 10V or 20mA).
6) Temperature: System Temperature reading from Input source.
7) ΔP1 Tag: Customer field entered tagging information for individual, non-System measured differential pressures.
8) ΔP Pressure Measurement: Live measurement of individual, non-System measured pressures.
9) ΔP Alarm Value: Field adjustable alarm setpoint value for ΔP Pressure Measurement. Can be high or low triggered setpoint.
10) Setup Menus
11) Diagnostics Menus
12) K-Factor Menu Shortcut
13) Notification: Alarms and Warning Notifications
14) (?) Troubleshooting and Support Pages

4.2. System Configurations

The MTSE can be custom configured to match most applications to measure, sum, and report up to 3 systems and 4 ΔP points for a total of up to 9 sensing points, as described below:

System

Each System is defined as having all the following unique properties:

1. Single or multiple transducers to measure a single point or multiple points of differential pressure (i.e., fan array, duct, outside air, supply air, return air, or exhaust air).
   a) Multiple points are summed if measuring flow.
   b) Multiple points are averaged if measuring pressure or velocity.
2. A single entry for a transducer span, piezometer coefficient, and/or area factor for flow calculations, i.e., all fans or airflow measurement stations must be exactly the same.
3. Temperature compensation and an Analog Input for a dedicated temperature sensor input.
4. Ability to correct for "System Effect" with user defined K-Factor.
5. Selectable operating range, engineering units, and dedicated analog output signal relative to operating range.
6. Adjustable rolling-average sample filters.
7. High and Low alarms.

In addition to the (3) Systems there are also two other sensor measurement types with their own unique properties which are described below.

Sub System (Commonly used as 2nd OA)

Many air handling unit manufacturers are offering dual outside air intakes for greater turndown capability. The MTSE has the ability to measure a unique and independent 2nd OA intake. The 2nd OA flow measurement is similar to a System as explained above, but with some key differences:

1. The 2nd OA is limited to a sensor quantity of (1).
2. The 2nd OA is summed into the last System, which may or may not be System 3.
3. The 2nd OA has <u>most</u> of its own unique parameters to be entered independently from the 1st OA, i.e., operating range, area factor, K-factor, and alarms, but also shares the following settings with the last system.
   i. Analog Output represents summed flow value
   ii. Filter
   iii. Temperature
   iv. Engineering units

Differential Pressure (ΔP) Points

ΔP's are individual pressure measurements of interest. ΔP is made available on the MTSE to monitor things such as total fan static, duct static pressure, or filter banks – to name a few examples.
ΔP's will have no settings other than the following characteristics:

1. Same span for all ΔPs
2. Same engineering unit's selection for all ΔPs (in pressure)
3. Individual tagging
4. Individual Alarm Trigger (High or Low)
5. Individual Alarm Value Setpoint

4.2.1. Display Types

Depending on how your MTSE was ordered, the System quantity and ΔP quantity will change the appearance of the Main Screen. Shown below are images of a single system and a two-system configuration with no ΔP points of measurement. If ΔP points of measurement were ordered, they will appear at the bottom of the display similar to what is shown and described in Figure 4.1.

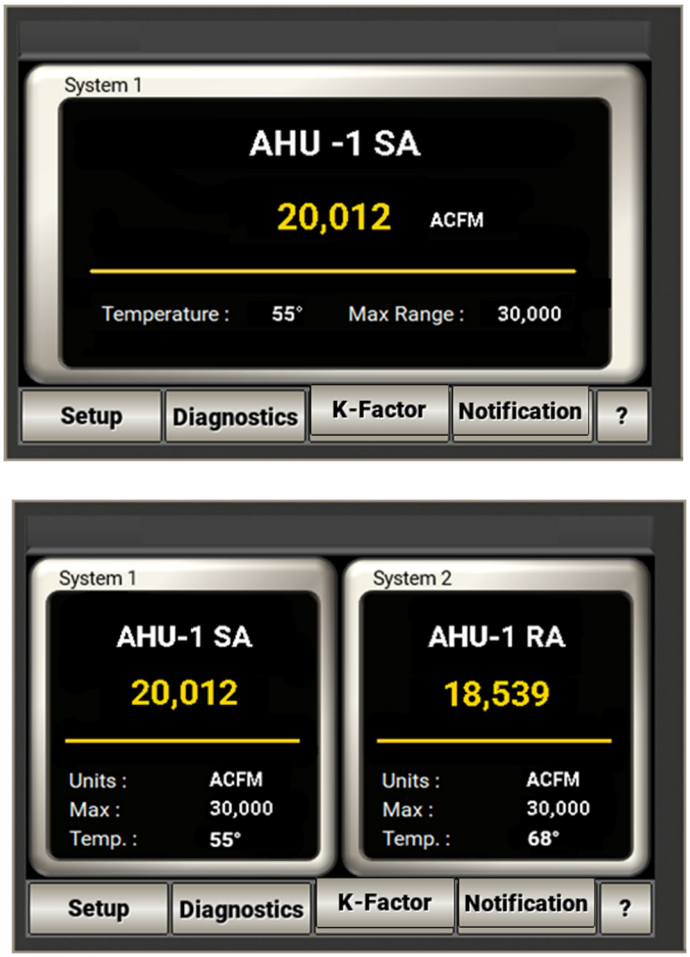
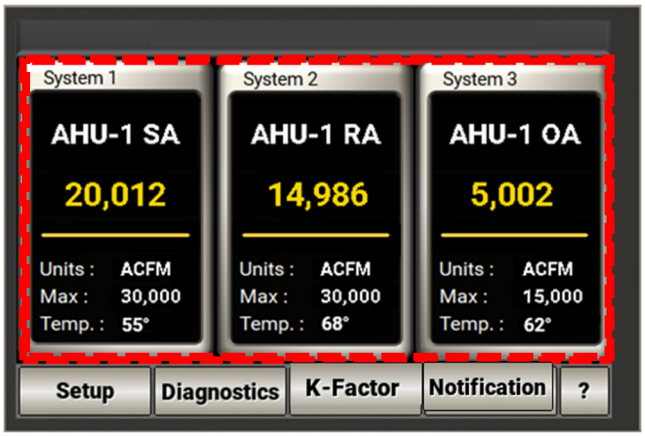


Figure 4.2 – Main Screen for a single system and two systems.

4.3. Display Features

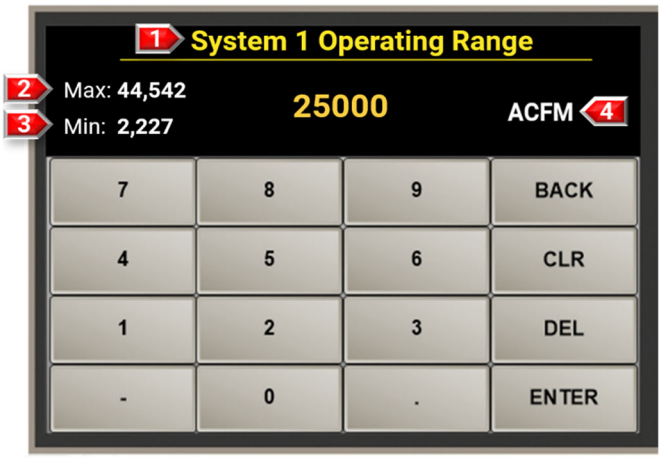
4.3.1. Sensor Data Page Shortcut

Touch anywhere within the dashed red box on any of the Main Screen Types (whether it is one system or up to three systems) and the user will be taken to the Sensor Data Page which displays the flow rate and pressure for each individual sensor. See Section 5.3.1, Senor Data Page Section for more details.



4.3.2. Keypad

In most setup menus, it is necessary to enter numeric values for the settings. These values will be entered through a popup keypad, like the one shown below:



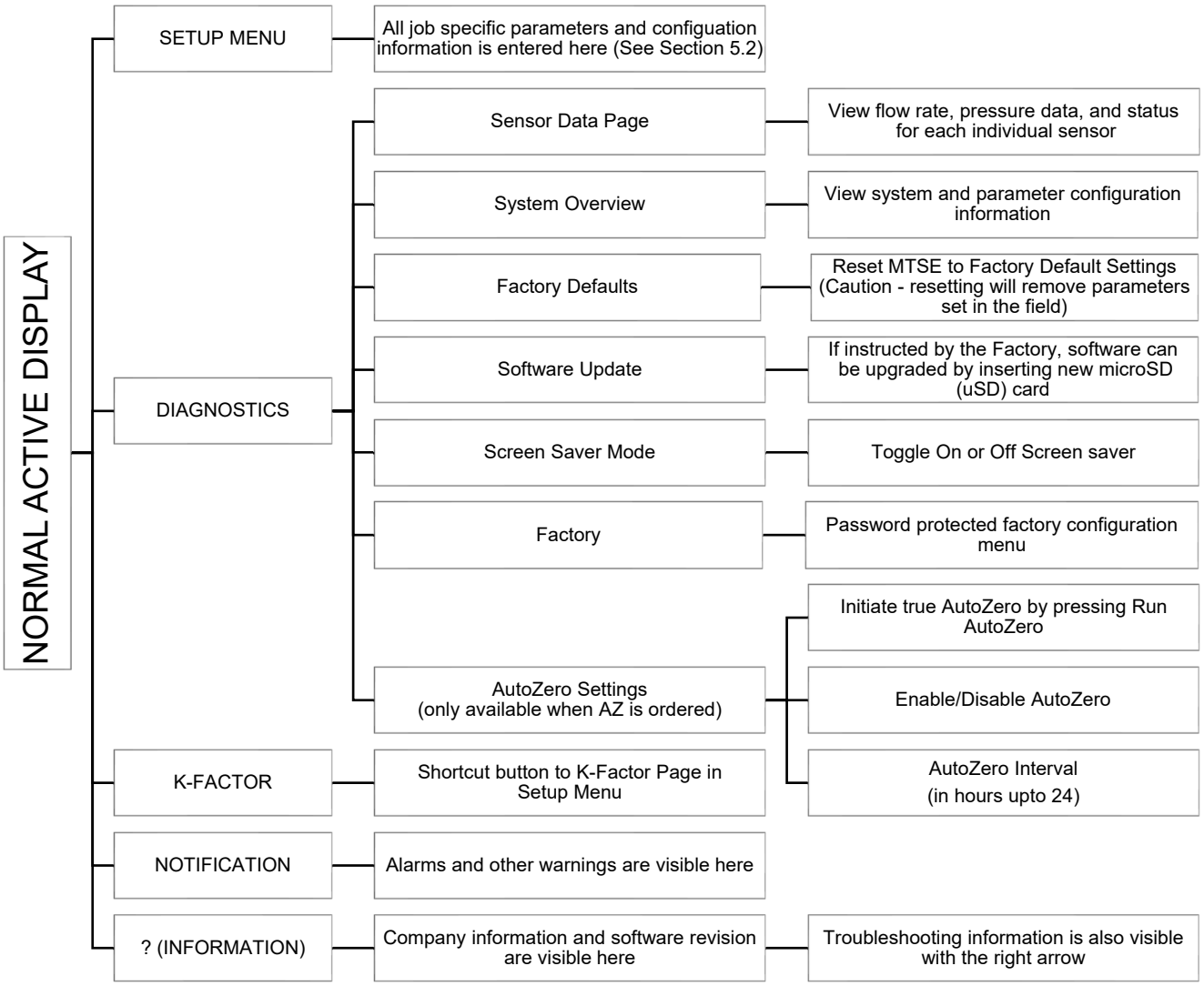
1. Parameter Information: Indicates what parameter is currently being entered
2. Max: Maximum allowable value to be entered for the given parameter
3. Min: Minimum allowable value to be entered for the given parameter
4. Units: Displays the units for the given parameter being entered

The acceptable range of values that can be entered for a given parameter are shown in the popup keypad as Max and Min, Item 2 and 3 in the above image. After keying in the desired value press Enter to save the value and return to the previous menu. If you press BACK, you will be returned to the previous menu and no values will have been saved or modified.

5. MENU INFORMATION

5.1. Levels of Menus

The following is a tree view of the available menu pages on the bottom of the Main Screen (see Figure 4.1). Pressing one of these menu buttons loads a separate menu as described below. An icon with a back-arrow key is present in every menu page in the lower left corner of the screen. This arrow key will return you to the previous page.



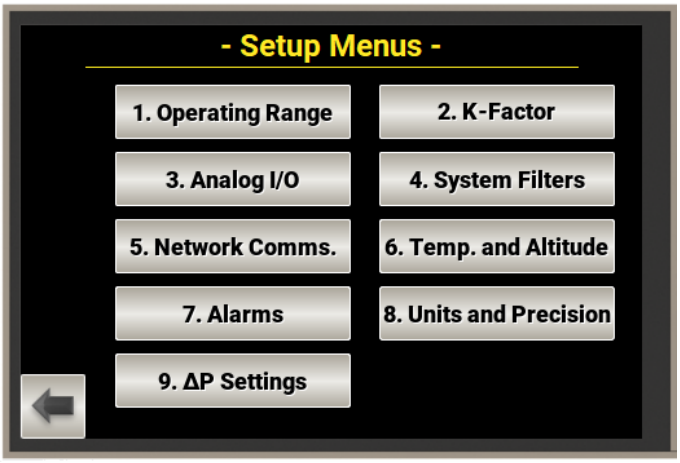
5.2. Setup Menus

In each of these menus, the parameters for Systems 1, 2, and 3 (description of a System can be found in Section 4.2) will be configured. For example, if the user is in the Operating Range Menu the operating range for Systems 1, 2 and 3 will be set in this page. Only Systems that have been configured in the Factory menu will be displayed in the Setup Menus. Therefore, the pages in the Setup Menus may look different from your setup if the sensor quantities were only entered for one or two systems at the Factory.

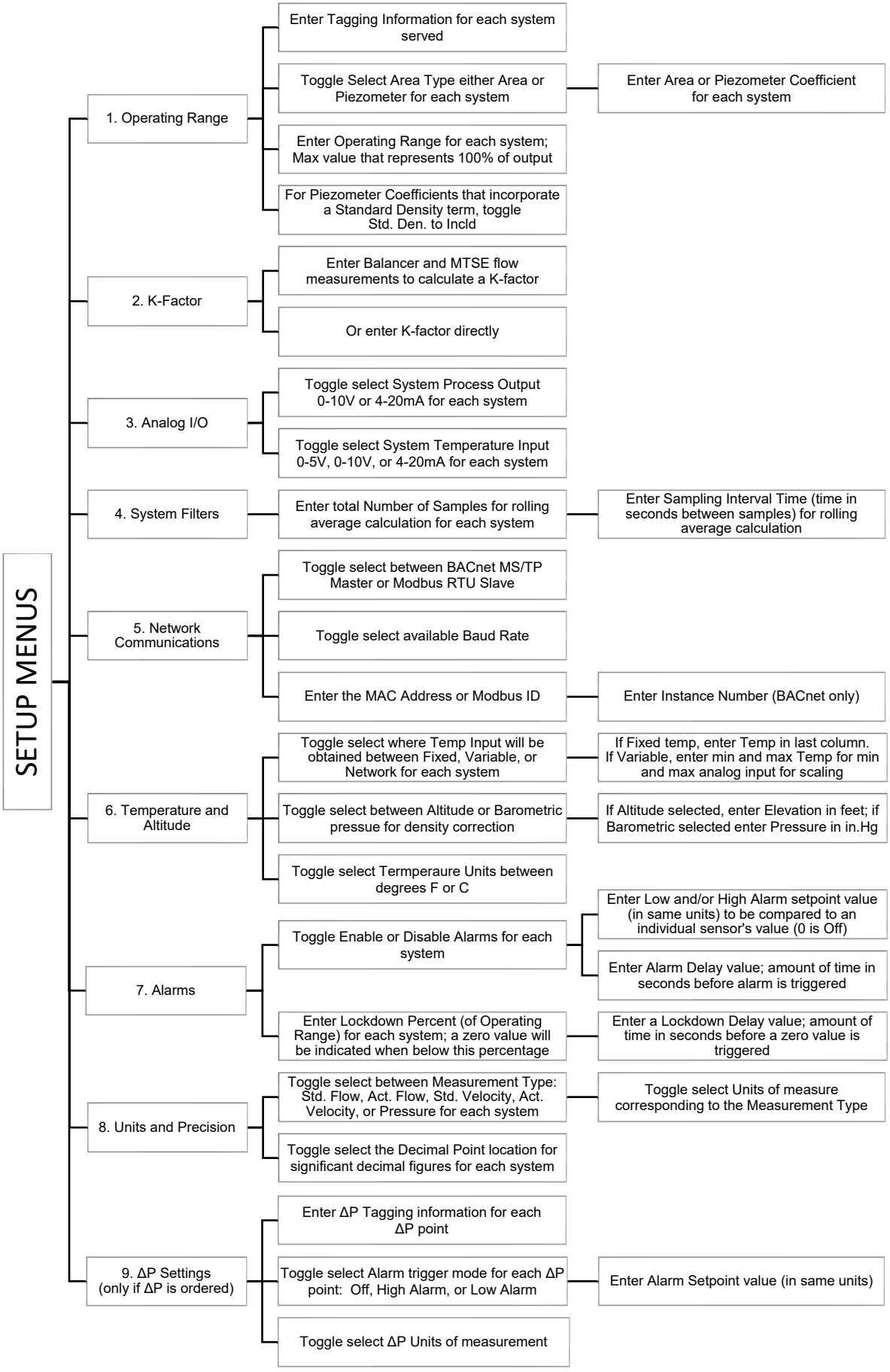
All Setup Menu pages will write each System's parameters to internal memory and also be backed up on the microSD card. Some settings are not System specific and will be applied to all (3) Systems. These settings are as follows:

a) Altitude and Altitude Units
b) Temperature Units
c) Communications

Each page has a question mark icon (?) in the bottom right corner for Help Dialogue. Selecting this icon will navigate to a help screen detailing the parameters and their functions of the previous page. Shown below is the Setup Menu Main page.

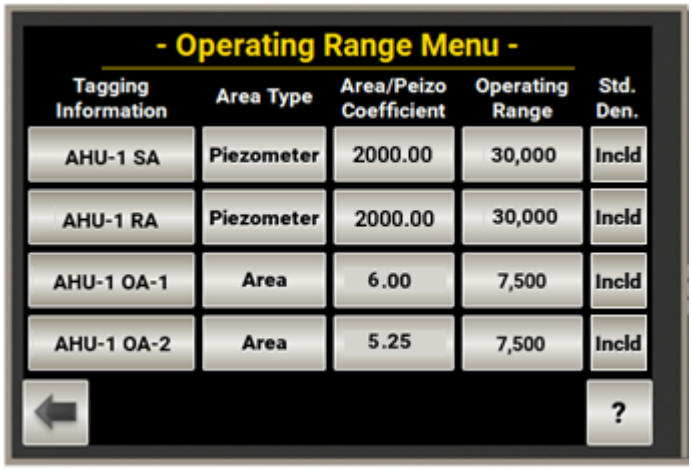


The structure of the Setup Menu is shown in the flow chart below. A detailed explanation of each Setup Menu item is described in the following subsections.


SETUP MENUS
1. Operating Range
Enter Tagging Information for each system served
Toggle Select Area Type either Area or Piezometer for each system
Enter Area or Piezometer Coefficient for each system
Enter Operating Range for each system; Max value that represents 100% of output
For Piezometer Coefficients that incorporate a Standard Density term, toggle Std. Den. to Incld
2. K-Factor
Enter Balancer and MTSE flow measurements to calculate a K-factor
Or enter K-factor directly
3. Analog I/O
Toggle select System Process Output 0-10V or 4-20mA for each system
Toggle select System Temperature Input 0-5V, 0-10V, or 4-20mA for each system
4. System Filters
Enter total Number of Samples for rolling average calculation for each system
Enter Sampling Interval Time (time in seconds between samples) for rolling average calculation
5. Network Communications
Toggle select between BACnet MS/TP Master or Modbus RTU Slave
Toggle select available Baud Rate
Enter the MAC Address or Modbus ID
Enter Instance Number (BACnet only)
6. Temperature and Altitude
Toggle select where Temp Input will be obtained between Fixed, Variable, or Network for each system
If Fixed temp, enter Temp in last column. If Variable, enter min and max Temp for min and max analog input for scaling
Toggle select between Altitude or Barometric pressue for density correction
If Altitude selected, enter Elevation in feet; if Barometric selected enter Pressure in in.Hg
Toggle select Termperaure Units between degrees F or C
7. Alarms
Toggle Enable or Disable Alarms for each system
Enter Low and/or High Alarm setpoint value (in same units) to be compared to an individual sensor's value (0 is Off)
Enter Alarm Delay value; amount of time in seconds before alarm is triggered
Enter Lockdown Percent (of Operating Range) for each system; a zero value will be indicated when below this percentage
Enter a Lockdown Delay value; amount of time in seconds before a zero value is triggered
8. Units and Precision
Toggle select between Measurement Type: Std. Flow, Act. Flow, Std. Velocity, Act. Velocity, or Pressure for each system
Toggle select Units of measure corresponding to the Measurement Type
Toggle select the Decimal Point location for significant decimal figures for each system
9. ΔP Settings (only if ΔP is ordered)
Enter ΔP Tagging information for each ΔP point
Toggle select Alarm trigger mode for each ΔP point: Off, High Alarm, or Low Alarm
Enter Alarm Setpoint value (in same units)
Toggle select ΔP Units of measurement

5.2.1. Operating Range Menu

This menu allows the user to modify the fields shown and described below. This page may look different from your setup if the sensor quantities were only entered for one or two systems. Navigate to this menu from the Main Screen by pressing **Setup » 1. Operating Range**.



Tagging Information

Selecting this box will provide a keypad popup to allow entry of unique System tagging information. The tagging information will be displayed on the Main Screen and any other place indicating System 1, System 2, or System 3 Tagging in the Setup Menus. Twelve characters can be entered as the System tag.

Area Type

Allows user to toggle between flow calculation method for either Area or Piezometer ring equations. Area should be selected if the MTSE is connected to a flow station or flow sensors with known cross-sectional area. Piezometer should be selected if connected to a fan's piezometer ring that has a manufacturer-provided fan coefficient.

Area/Piezometer Coefficient

Allows user to enter or modify an existing Area Factor if Area is selected in Area Type. The cross-sectional area of the flow station or duct is used to determine volumetric flow in the MTSE. If a new Area Factor value is entered and causes the previous entered Operating Range value to exceed the new minimum or maximum calculated full-scale range, the new area factor will be set, and operating range will be the new full-scale maximum.

If Piezometer is selected in Area Type, allows user to enter a manufacturer-specified fan coefficient when connected to a piezometer ring. See Standard Density below for different ways manufacturers present fan coefficients.

Operating Range

Allows user to enter a value which will represent 100% of the process output signal also referred to as Max on the Main Screen page. Touching this box will bring up the Keypad which identifies the maximum and minimum values that can be entered. The maximum value is calculated at full scale transducer span, and the minimum value is calculated using the low limit value entered by the Factory (**Operating Range Low Limit Default = 5% of maximum Vp value**).

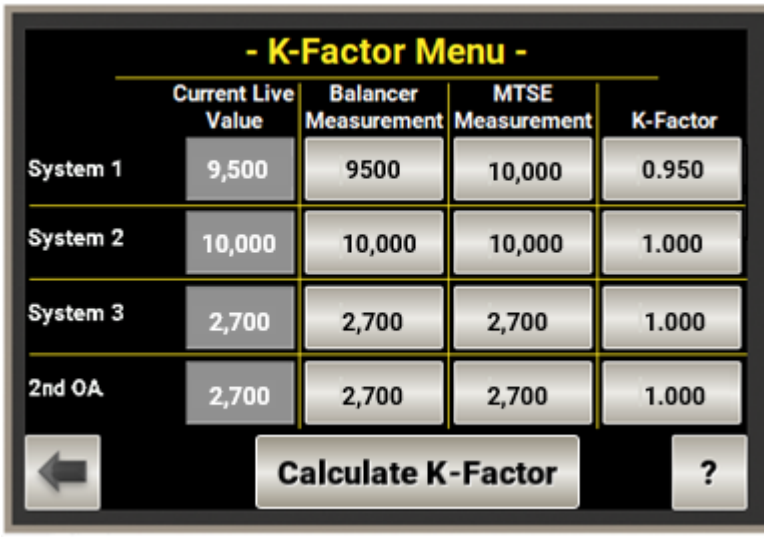
If an operating range value is entered outside of the allowable minimum/maximum range, the operating range will be set to the maximum value if the new operating range is higher and set to the minimum if the new operating range is lower.

Standard Density

Some manufacturers include standard density in their fan coefficients, sometimes referred to as F factor. The MTSE is able to remove this standard density term so that actual airflow measurement can be calculated with density correction. When this field is set to Incld. in the MTSE, this means that standard density is included in the manufacturer-supplied fan coefficient and therefore the MTSE removes standard density for airflow calculations. This is not to be confused with correction to standard flow or velocity; that selection is made in Units and Precision, see Section 5.2.8. This is solely for convenience in the different ways fan manufacturers present their fan coefficients.

5.2.2. K-Factor

The K-Factor menu is used to make corrections to the display and output values to account for system effects. The K-Factor menu can be used to correct the MTSE values from zero to entered Operating Range value as compared to a reference flow value such as a balancer. This page shows a Current Live Value as seen by the MTSE, and boxes for direct entry of a Balancer Measurement, MTSE Measurement, or manual K-Factor entry for all three Systems. The K-Factor page is shown below. Navigate to this menu from the Main Screen by pressing **Setup » 2. K-Factor**.



The K-Factor calculation can be done internally by the MTSE itself. This is done by entering the MTSE Measurement as seen on the display at the time of the balancer's reading and the Balancer Measurement in the boxes for the system needing correction. Pressing the Calculate K-Factor button will then calculate the percent change and store the new K-Factor Value. For reference, a current live reading of flow or velocity measurement are displayed on this page.

Alternatively, if the user knows the percent change required to match the balancer's reading, the K-Factor can be entered directly by pressing the K-Factor box for that system and entering the desired value in the popup keypad.

The K-Factor has a limit of 0.5 and 2.0. If values are required outside these limits troubleshooting should be conducted to determine the device is configured correctly and that there are no problems with installation, such as kinked or leaking signal tubing.

FLOW CORRECTION EXAMPLE

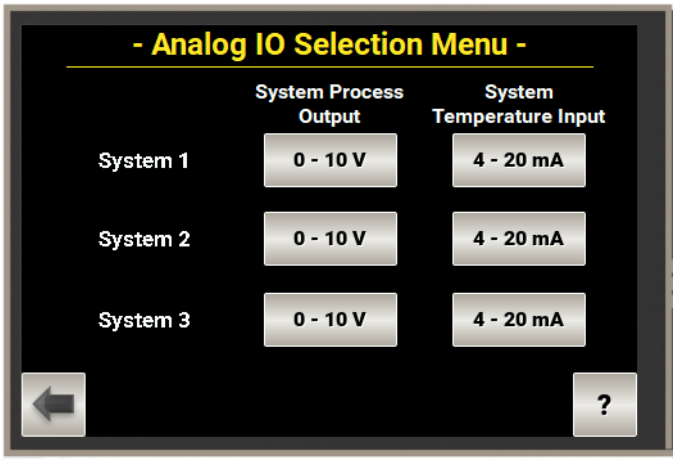
The balancer is consistently measuring a value of 9,500 CFM, which is 500 CFM less than the 10,000 CFM MTSE value at the time of the balancer measurement. The user would then perform the following math function:

Balancer Measurement / MTSE Measurement = K-Factor, so
9,500 CFM / 10,000 CFM = 0.950

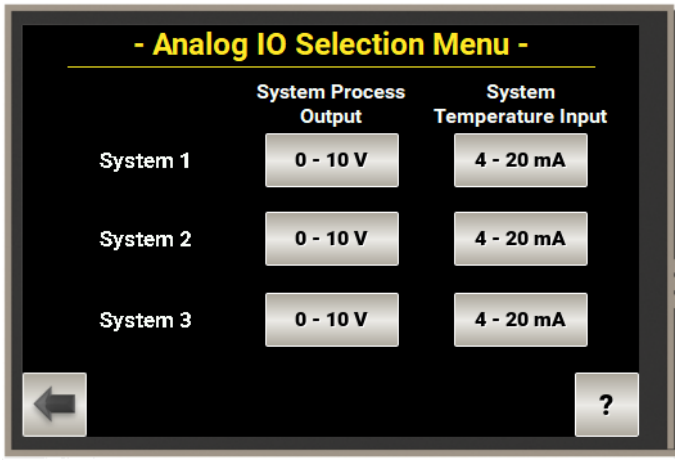
The user would enter 0.950 for the K-Factor Flow Correction. If the K-Factor Calculator is used and the values entered into the boxes on this menu and the calculate button is pressed, the K-Factor Flow Correction would automatically update the K Factor.

5.2.3. Analog I/O Configuration

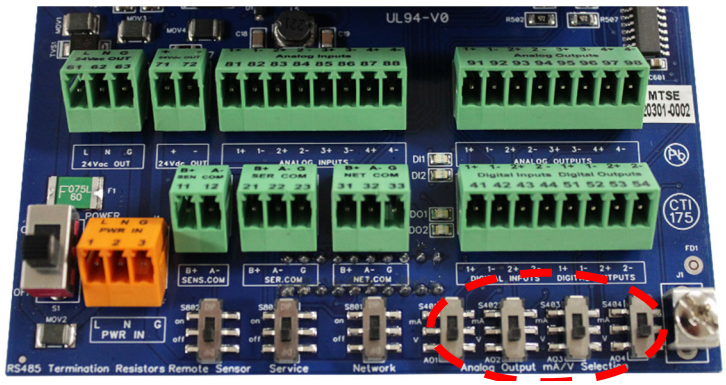
In this menu the user can select the signal type for analog input and analog output for each system. Selections are made through toggle buttons of available options on the touchscreen. Selections available for the System Process Outputs are 0-10V and 4-20mA. For board hardware revision 4.00 and later, use dipswitches on the bottom right of the board to select analog outputs with the up position for 4-20mA and down for 0-10V. Selections available for the System Temperature Inputs are made on the touchscreen for all board hardware revisions and are 0-5V, 0-10V, and 4-20mA. **Default will be 0-10V for Analog Outputs and 4-20mA for Analog Inputs.** The Analog IO page is shown below. Navigate to this menu from the Main Screen by pressing **Setup » 3. Analog I/O**.



Analog Page for Board Revision 3.3 and earlier



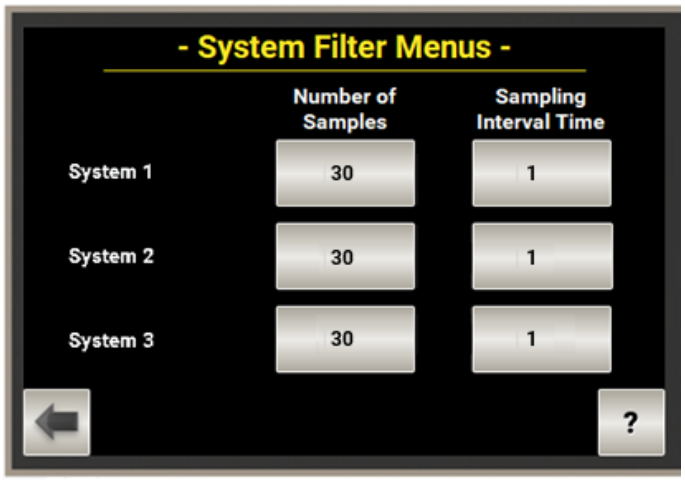
Analog Page for Board Revision 4.00 and later



Process Output Dipswitches for Board Revision 4.00 and later

5.2.4. System Filters

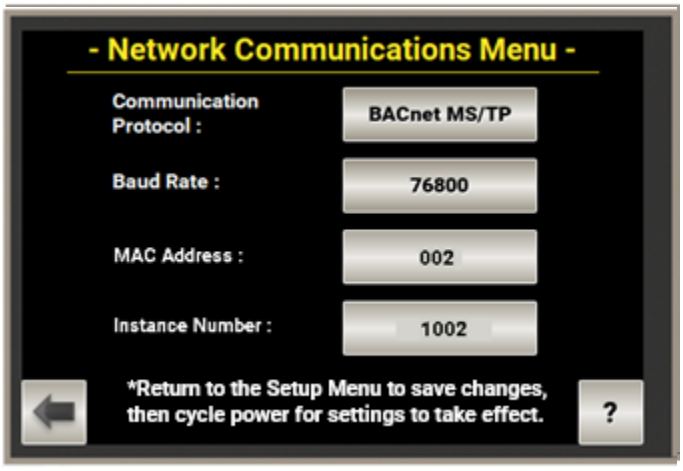
The System Filters menu allows the user to independently adjust the rolling average calculation by setting the Number of Samples count and the Sampling Interval Time value in seconds for each System. The Number of Samples count range is 1 to 99 sample counts. The adjustment range of the Sample Interval Time is 1 to 65 seconds. The system filters effect the display values, network communication values, and analog process output values for each system. **Default is 30 samples and a sample interval time of 1 second.** Shown below is the System Filter Menus page. Navigate to this menu from the Main Screen by pressing **Setup » 4. System Filters**.

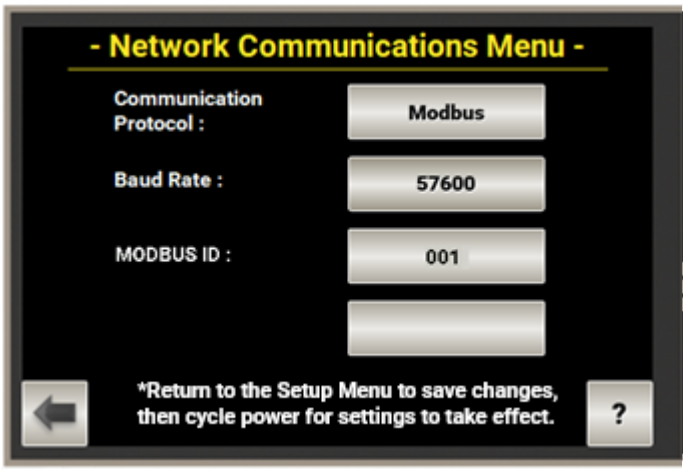


For example, if the MTSE is measuring OA flow on a roof top unit and is experiencing large fluctuations in readings caused by wind, slow the response time by increasing the number of samples and increasing the interval time. Conversely, reduce the number of samples and/or interval time to make the response time faster.

5.2.5. Network Communications

Modbus and BACnet communications are selectable in this menu page. Shown below is the Network Communications page. The layout on the left is displayed if BACnet MS/TP is selected. The layout on the right is displayed if Modbus is selected. See BACnet PIC statements and Modbus registers for complete communication specifications in Attachment A and B, respectively. Navigate to this menu from the Main Screen by pressing **Setup » 5. Network Comms**.





Power must be cycled for network changes to take effect. After making changes to the below network parameters, please press the left arrow to return to the main screen to save any changes, then turn off the MTSE at the power switch (S1) for several seconds and then turn the unit back on.

Baud Rate

The Baud Rate menu allows the user to set a BACnet network baud rate from 9.6K to 76.8Kbps or from 9.6K to 115.2Kbps for Modbus. The selected baud rate should match the network baud rate. **The default is 38.4Kbps.**

MAC Address

The MAC Address menu allows the user to set a device address when connecting to a BACnet network. The MAC Code identifies each device on a branch of the network and can range from 2 to 127. The MAC Code must be unique within a particular branch of a network however, MAC Codes can repeat if on another branch of the network. **The default is 002. Displayed only if BACnet is selected.**

Instance Number

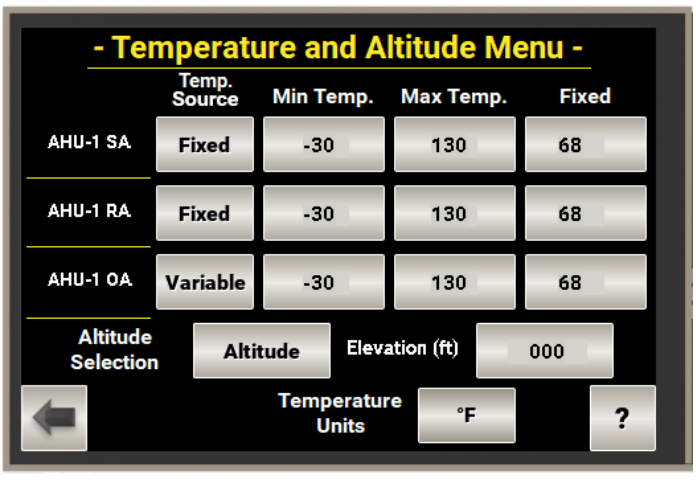
The Instance Number menu allows the user to set a unique device address when connecting to a BACnet network. The Instance Number is a unique device ID that identifies the device on the entire network; Instance Numbers cannot repeat within any part of a network and can range from a value of 1,002 to 4,194,302. **The default is 1002**. **Displayed only if BACnet is selected.**

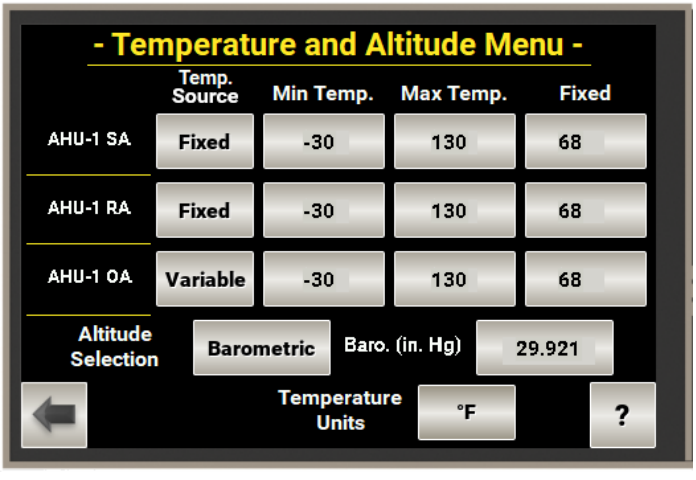
Modbus ID

The Modbus ID menu allows the user to enter the unique device address when connect to a Modbus network. The range is from 001 to 254**. Default is 001. Displayed only if Modbus is selected.**

5.2.6. Temperature Compensation & Altitude

This page is for configuring temperature and altitude values for density correction. The temperature and altitude menu are shown below. Navigate to this menu from the Main Screen by pressing **Setup » 6. Temp. and Altitude**.





Temperature Source

The Temperature Source allows the user to select between three temperature input options (Fixed, Variable, and Network) for the source of temperature for density correction calculations. If Fixed is

selected, the temperature value entered in the Fixed box is used. If Variable is selected, an external analog temperature input signal from a temperature sensor is required (see Sections 5.2.3). If Network is selected, the temperature input is obtained through network communications. The temperature value is only displayed on the main screen if the Temperature Source is set to Variable or Network. If Fixed is selected, temperature will not be displayed on the main screen.

Min and Max Temperature

The minimum and maximum temperature range (scaling) will be entered in two respective boxes when Variable is selected as the Temperature Source. This range will scale relative to the analog input with minimum being 0V or 4mA and maximum being either 5V, 10V, or 20mA, depending on the Analog Input signal selected in Section 5.2.3.

Fixed Temperature Value

The fixed temperature value can be entered or modified in this box when Fixed is selected as the Temperature Source. **The standard/default Fixed Value is 68˚F.**

Temperature Units

The user can select between the temperature units of Fahrenheit or Celsius via toggle buttons. **Default is Fahrenheit.**

Altitude Selection

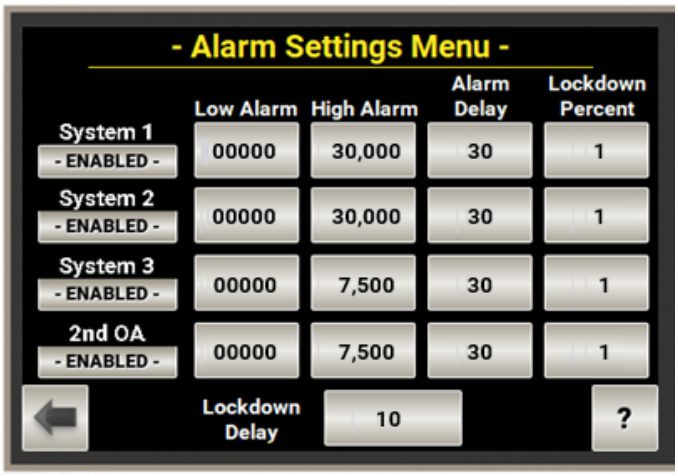
Allows user to select from two different atmospheric pressure standards, Altitude or Barometric. Actual air density will be calculated accordingly dependent upon the selection. Toggling between Altitude or Barometric changes the user input field for the reference atmospheric pressure between Elevation (left image) or Barometric (right image). **Default is Altitude.**

Elevation and Barometric Pressure

If the Altitude Selection is in Elevation, this box allows the user to enter a specific elevation in feet above mean sea level for density corrections. **The standard/default value for elevation is 0 feet or sea level.** If the Altitude Selection is in Barometric, this box allows the user to enter a specific barometric pressure. The value entered will need to be converted to Inches of Mercury (in.Hg) for density correction.

5.2.7. Alarm Options

High and Low alarms are available for each System in the MTSE to alert the user to a situation defined on this menu page. Alarms are available for flow and pressure modes and trigger when an individual sensor's value goes outside the alarm setpoint. Alarms can be useful to alert a user when a single fan in an array goes down and the system automatically ramps up to accommodate the fan-failed scenario; in this situation the total system flow will be maintained and therefore the system is satisfied however there may be no other failed-fan notification. Navigate to this menu from the Main Screen by pressing **Setup » 7. Alarms**.



Enable/Disable Alarms

The Alarms can be enabled or disabled by pressing the toggle button beneath the system tagging. Both the high and low alarms will be enabled when a value is entered by touching the respective box and entering a value from the popup keypad. A disable alarms option is available should the user wish to completely disable the caution alarm. No warning message for the high/low measurement caution alarms will be displayed as outlined in Section 5.5 if the alarm toggle button is in the "DISABLED" state. **Default is Alarms DISABLED.**

Alarm (Low and High)

The Alarm allows the user to change the low or high alarm indication values from 1 to the System's operating range. If any individual sensor is below or above the set low or high alarm value and maintains that value for the set alarm delay duration, an alarm state is displayed as outlined in Section 5.5 on the Main Screen. A value of zero (0) entered in the low or high alarm box will turn that alarm off, even if the system Alarm is enabled. Therefore, 0 is not an alarm condition; if the user desires an alarm state at this value a value other than 0 must be entered. A high alarm value cannot be entered if it less than the low alarm value and the high alarm value will default to the System's operating range should that occur. **Default value is set to off (0) for both the low alarm and the high alarm.**

Alarm Delay

The Alarm delay allows the user to enter the amount of time required until a high or low alarm is triggered after the alarm value is reached. The alarm condition must remain for the duration of the Alarm Delay value before the MTSE will acknowledge and indicate an alarm. This is useful when a fan is operating near an alarm value and the user does not want unnecessary alarm faults from a fluctuating flow value. Values accepted are from 0 to 999 seconds and **default is 30 seconds**.

Lockdown

Lockdown is useful in applications where the air handling unit or system is turned off and the user does not want to see flow because the MTSE is extremely sensitive at very low velocities and may show flow through leaking closed dampers or backdraft through a fan. Lockdown locks the display and process values to zero when the system flow values are below the specified Lockdown value entered, as calculated by percentage of operating range. Once the Lockdown value is exceeded, the display and output process values are displayed. The Lockdown value can be changed from 0 to 20% of Operating Range value in 1% increments. Each System and the 2nd OA have their own Lockdown % input for individual tuning of the system to account for system effects. **The default Lockdown value is 3%.**

If Lockdown is set too low
The MTSE may show flow when the air handling unit or system is off; increase Lockdown. Adjustments should be small as it may take the duration of the lockdown delay and the rolling average in the system filters to catch up before flow is locked to zero.

If Lockdown is set too high
1) The MTSE may show no flow on the Main Screen while the system is running. Navigate to the Sensor Data Page and determine whether the individual sensors show flow and pressure; if so, decrease Lockdown a little at a time until flow is displayed on the main screen. Adjustments should be small as it may take the duration of the lockdown delay and the rolling average in the system filters to catch up before flow begins to be displayed.
2) If Lockdown is set that is above a low flow alarm value, the system will enter into an alarm state when the reading falls below the lockdown value after the set lockdown delay. For example, with the following settings:
    - Operating Range at 10,000 cfm,
    - Lockdown set at 10%, which equals 1,000 cfm
    - Low flow alarm set at 500 cfm

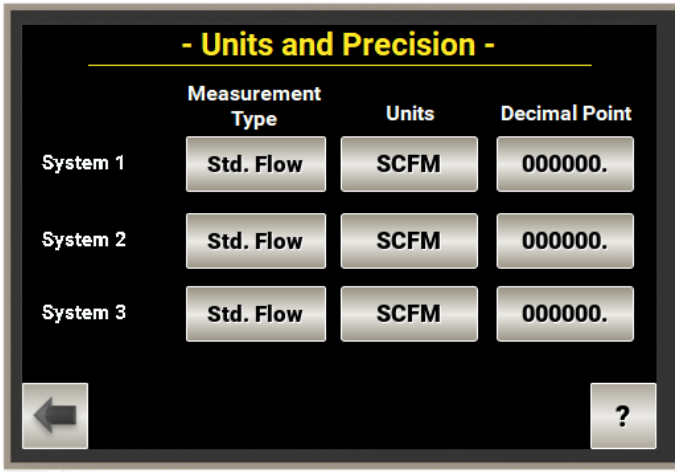
    The MTSE will report zero flow and therefore enter a low flow alarm when the measured flowrate falls below 1,000 cfm for the duration of the lockdown delay. Therefore, a low flow alarm will be triggered at about 1,000 cfm, not the desired 500 cfm. If the user wishes to read flowrates down to and alarm at flows below 500 cfm in the above example, decrease the lockdown percentage below the alarm value (≤5%).

Lockdown Delay

The Lockdown Delay allows the user to enter a lockdown time delay from 0 to 999 seconds that will delay the display and output locking to zero from occurring until the process value has remained below the lockdown value for that duration. Lockdown Delay is useful when systems are operating very close to the lockdown value but because of project limitations the lockdown value cannot be reduced; when the system flows fluctuate momentarily below the lockdown value the system will still show flow until this delay time is exceeded. The Lockdown Delay will be global across all Systems and 2nd OA. **The default Lockdown Delay value is 10 seconds**.

5.2.8. Units and Precision

Selecting this menu allows the user to set the measurement type (pressure, velocity, or flow), the engineering units depending on the measurement type selected, and the number of significant figures. Shown below is the Units and Precision page. Navigate to this menu from the Main Screen by pressing **Setup » 8. Units and Precision**.



Measurement Type

Allows user to configure the device for Standard Flow, Actual Flow, Standard Velocity, Actual Velocity, or Pressure measurement by toggle button. The selected System Measurement Type limits selection of Engineering Units to only those applicable. Upon changing the Measurement Type, the Engineering Units will start at the first applicable unit shown on the table below.

Engineering Units

Allows user to configure the device for the available engineering units shown in the table below by toggle button. The appropriate units will only be made available depending on which measurement type is selected. For example, if standard flow is selected, only standard flow units will be selectable for that system. Changing the engineering units will not convert the values entered for Operating Range or Alarms; new values will need to be entered in the correct units. **Default units is ACFM.**

Standard Flow Units	Actual Flow Units	Standard Velocity Units	Actual Velocity Units	Pressure Units
SCFM	ACFM	SFPM	AFPM	In. W.C.
SCFH	L/S	Sm/s	Am/s	Pa
SL/S	Am^3/S			kPa
Sm^3/S	Am^3/M			mm W.C.
Sm^3/M	Am^3/HR			
Sm^3/HR				

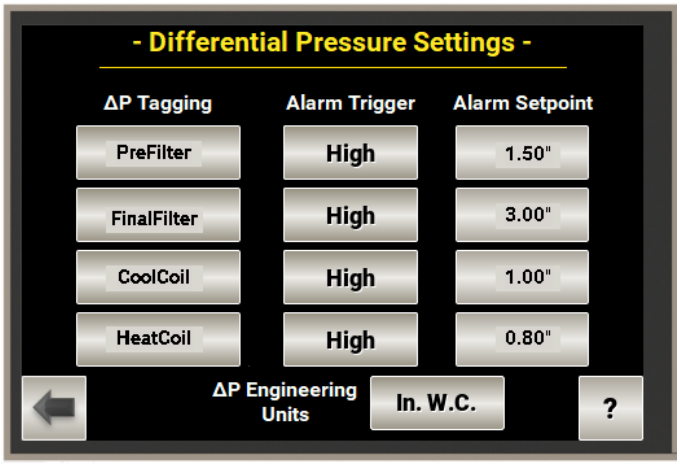
Decimal Points (Significant Figures)

Allows user to change number of digits shown to the right of the decimal point. When a new engineering unit is selected, the Decimal Point will be automatically updated according to the table below. The user can then toggle through moving the decimal point to the left with each press of the gray box.

Significant Figures	Units						
000000.	SCFM	SCFH	SL/s	Sm^3/Hr	ACFM	AL/s	Am^3/hr
00000.0	Sm^3/min	Am^3/min	SFPM	AFPM.	Pa		
0000.00	mm W.C.						
000.000	Sm^3/s	Am^3/s	Sm/s	Am/s	Inch W.C		
00.0000	kPa						

5.2.9. ΔP Settings (Optional)

If the MTSE was configured at the Factory to include ΔP measurement points, i.e., pre-filter, final filter, coils, etc., the following menu items and parameters will be available for user settings. This menu may look different from your setup if the ΔP quantities were only entered for one or two points at the Factory. Navigate to this menu from the Main Screen by pressing **Setup » 9. ΔP Settings**.



ΔP Tagging

Selecting this box will provide a keypad popup to allow entry of unique ΔP tagging information. The tagging information will be displayed on the Main Screen and any other place indicating ΔP in the setup menus. Eight characters can be entered as the ΔP tag.

Alarm Trigger

The Alarm Trigger allows the user to toggle select between either a low or a high alarm for each ΔP measurement point depending on the desired application of pressure measurement alarming.

Alarm Setpoint

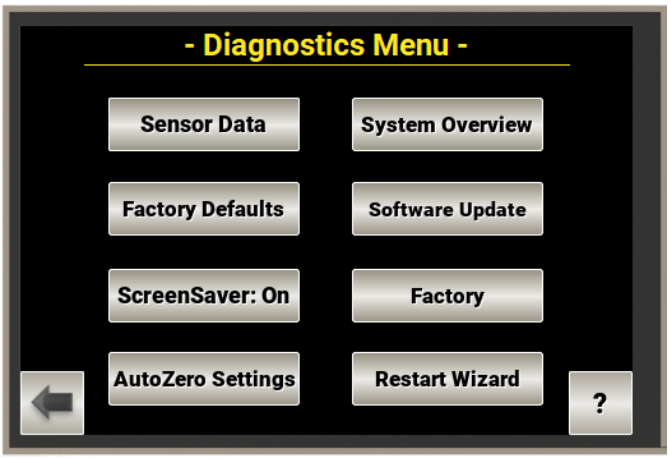
If the ΔP value goes below the low Alarm Setpoint or above the high Alarm Setpoint, an alarm state is displayed as outlined in Section 5.5 on the Main Screen. A value of zero (0) entered in the Alarm Setpoint box will turn the alarm off, regardless of the Alarm Trigger state. Therefore, 0 is not an alarm condition; if the user desires an alarm state at this value a value other than 0 must be entered. **Default Alarm Setpoint is off (0) for all ΔP points.**

ΔP Engineering Units

Allows user to configure the device for the following engineering units by toggle button: in. W.C., Pa, KPa, and mm W.C. Changing the engineering units will not convert the Alarm Setpoint value; the user must enter the Alarm Setpoint value in the correct engineering units.

5.3. Diagnostics Menu

The Diagnostics Menu includes information to easily assess and diagnose devices in the field. Access the Diagnostics Menu by pressing the Diagnostics button on the Main Screen. Shown below are available menu items in the Diagnostics Menu.

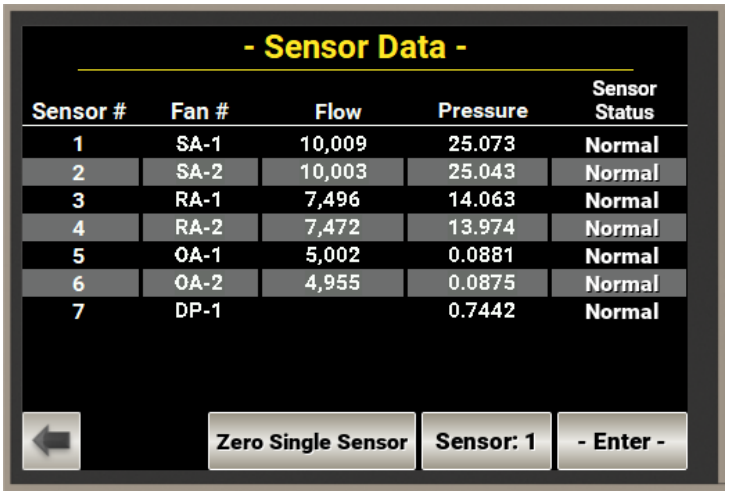


5.3.1. Sensor Data Page

The Sensor Data Page button will navigate to a page displaying measured values for the number of transducers in the MTSE. The transducers are in sequential order from (1) to (10) and display the Fan # tagging, flow, pressure, and status. The Fan # tagging is not set at the Factory and can be entered here by touching the box area next to the corresponding Sensor # to bring up the keypad. (We understand the box and font are small, but we are fitting a lot into this mighty package; a stylus or closed pen works best for this process.)

The number of sensors displayed on this page is the sum of the following:

- System 1 Transducer Quantity
- System 2 Transducer Quantity
- System 3 Transducer Quantity
- +1 for Dual OA if set to “On”
- ΔP Quantity



The Sensor Data Page can be useful as a check for proper installation or for some basic troubleshooting of the MTSE.

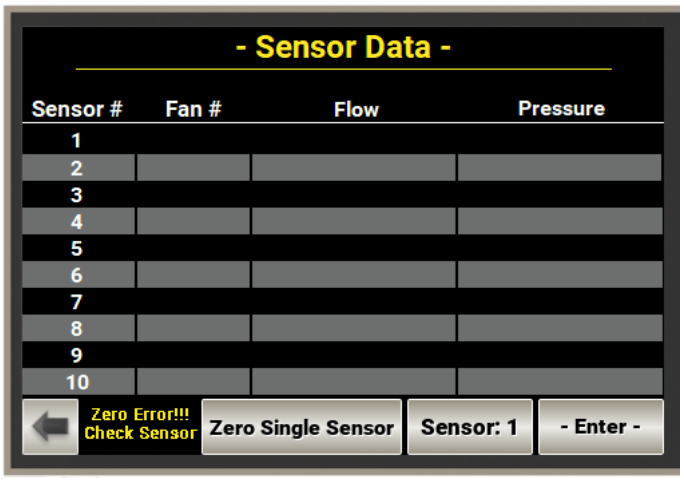
1) A negative pressure reading indicates reversed tubing to a sensor (other than a very small negative pressure value from possible zero drift); swap the low and high signal tubing for that sensor number.
2) S_Err in the Pressure column indicates a “sensor acknowledge error” from an unresponsive sensor. This could be due to an over pressurized sensor, a faulty sensor or sensor

quantities were incorrectly assigned during factory setup; for example, if there are only 6 sensors in the MTSE however the unit is setup such that the total quantity entered for all systems and OA is 7 sensors, there is no 7th sensor available and therefore an error would be reported for the missing (unresponsive) 7th sensor during acknowledgment. Cycle power and contact the Factory if not resolved.

3) If flow and pressure are being displayed on Sensor Data page but there is no system flow displayed on Main Screen, the MTSE is in lockdown for that system; reduce the lockdown percent as described in Section 5.2.7.
4) If a single fan in a system array is reading near zero or very different from other fans in the same system, this could indicate either a fan failure, closed fan backdraft damper, or a problem with the pneumatics (i.e., kinked or blocked signal tubing, etc), please check for these issues.
5) Verification of either flow or no flow (if air handling unit is off) can be confirmed for individual sensors during building commissioning, if required.

Zero Calibration

Allows user to perform a zero calibration to eliminate any possible transducer zero drift. This value will be placed in a different memory location then the factory zero memory location. The device will only accept the calibration if the new value is within ±20% of the original factory calibration value. If not, an error message would appear stating the value was not accepted as shown below. Zero calibration is not to be confused with AutoZero; Zero calibration requires that pneumatic tubing be disconnected from the sensors and can be performed on any single sensor or on all sensors in a system. (AutoZero is automatically performed when ordered as described below in Section 5.3.5.)

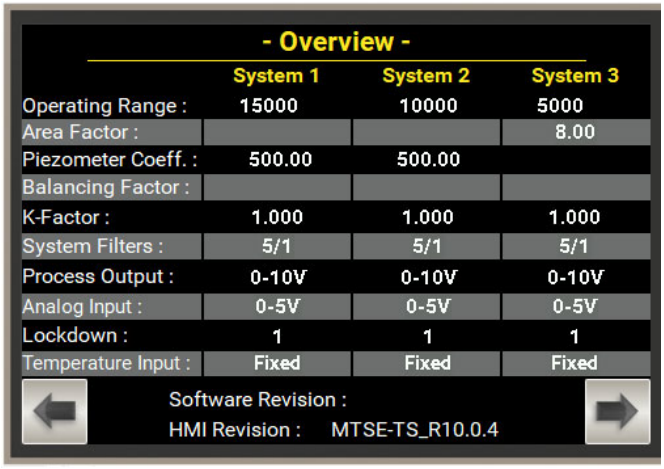


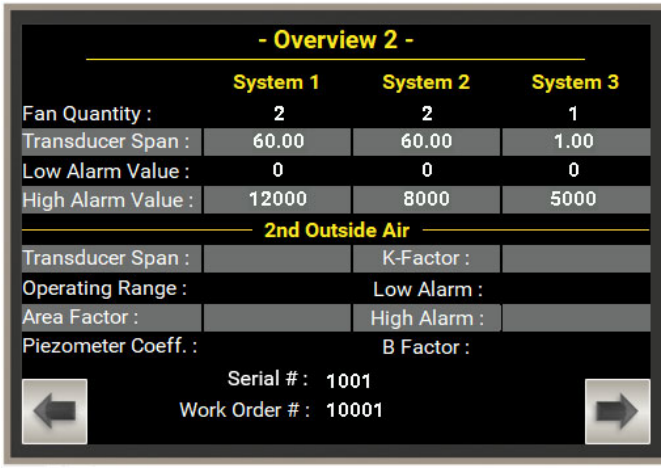
Zero Error – Zero calibration outside +/-20% of factory calibrated zero

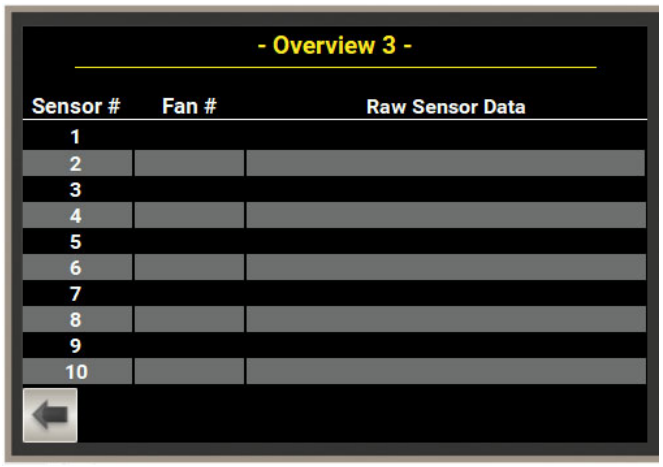
It is imperative that pneumatic tubing to the sensors is disconnected before Zero calibration can be performed. The user can either select a single sensor, or a whole system to be zeroed by toggling the "Zero Single Sensor" button. When in "Zero Single Sensor" mode, pressing "Sensor: 1" button will toggle through the available sensors or will toggle through systems if set to Zero System. Pressing "-Enter-" begins calibration for the given sensor or system selection.

5.3.2. System Overview

The system overview pages display many of the parameters configured on the device and can be used to confirm that the device is setup properly. Software revision levels, Work Order #, and Serial # can be found on this page when contacting the Factory for potential troubleshooting concerns. Press right arrows to navigate to pages 2 and 3.

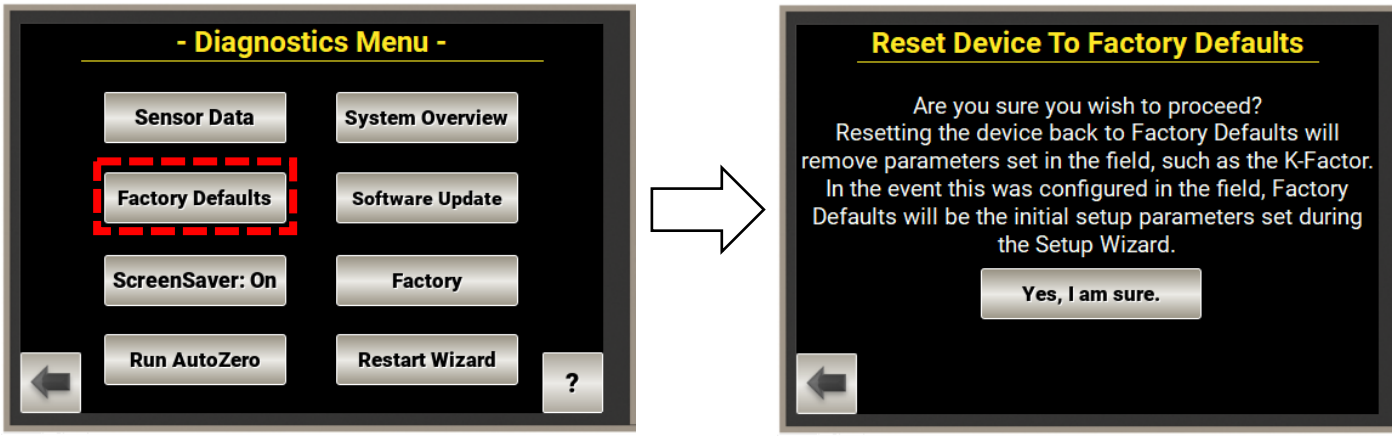






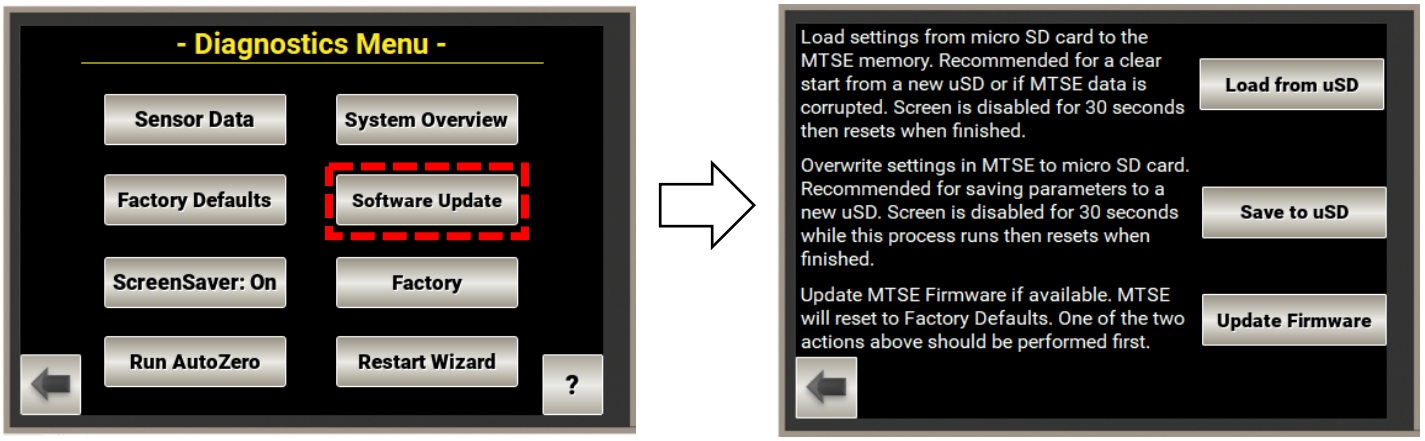
5.3.3. Factory Defaults

The Factory Defaults button allows the user to return all values in the MTSE to the values entered at the Factory. Pressing the "Yes, I am sure." button from the factory defaults page loads all the parameters saved from the original Factory setup. CAUTION, parameters that were set or adjusted in the field, such as K-Factor, Operating Range, Filtering, etc., will be lost.



5.3.4. Software Update

The Software Update page allows users to update the MTSE software in the field when a new microSD (uSD) card has been sent to them. If directed by the Factory to update software and you have received a new uSD card, ensure the **POWER SWITCH** is in the **OFF** position, replace the uSD card in the MTSE to update the software; the uSD card slot is located just below the display and is labeled "SD CARD". Gently press in the existing uSD card to remove it and gently insert the new uSD card. Turn the device back on. If a firmware update is available with the new uSD, a notification will be present on the home screen, as described in Section 5.5.5 Notifications Page.



Load from uSD

When a new uSD card is provided by Paragon Controls, the field technician has the option of loading the parameters from the new uSD card to the device. This is effectively resetting the device to factory defaults and saving those factory defaults to non-volatile memory when done with a new uSD card.

Save to uSD

When a new uSD card is provided, the field technician has the option of saving parameters set or adjusted in the field to the uSD from the MTSE settings. This action should be performed when the user wishes to keep the settings currently on the MTSE and save those to the new uSD provided by Paragon Controls (i.e., if K-factors or fan tagging were added after Factory setup).

Update Firmware

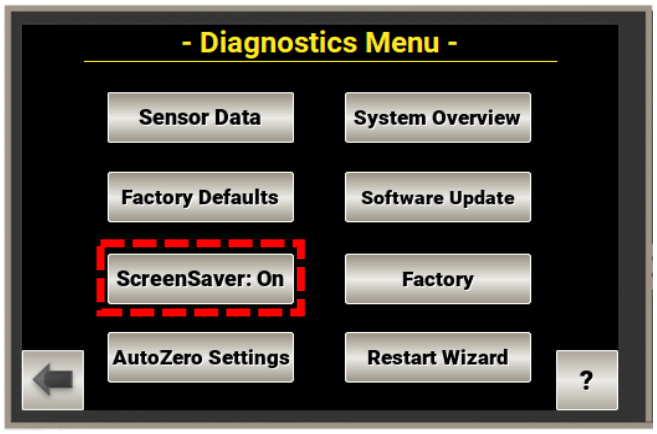
Checks the current MTSE host MCU firmware against the firmware present on the uSD card. If the firmware on the uSD is a newer version, selecting this button will update the device firmware (this may take several minutes, please wait for the white box in the upper left corner of the display to disappear which indicates the update is complete). PLEASE CYCLE POWER ON THE MTSE AFTER UPDATING FIRMWARE BY TURNING THE DEVICE OFF FOR SEVERAL SECONDS AND THEN BACK ON.

HMI Update

If new display software is provided with an updated uSD card, the display will automatically update to the new software version. If for any reason the display did not update or the display was updated with the incorrect uSD with a newer timestamp and needs to be changed, selecting this button will force a display update.

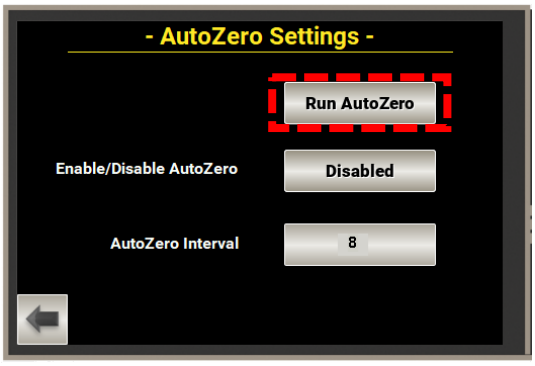
5.3.5. ScreenSaver

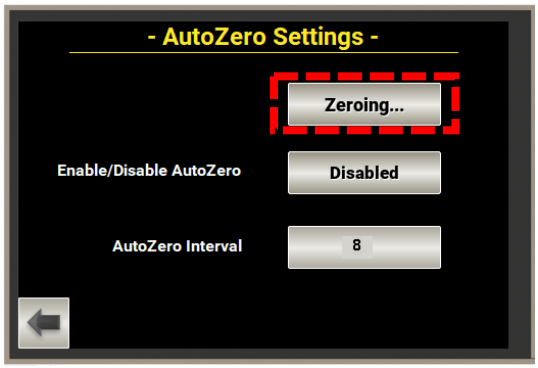
To increase the longevity of the touchscreen, the touchscreen will automatically dim after 90 minutes. Select this button to toggle on and off the ScreenSaver.



5.3.6. AutoZero Settings

AutoZero, if included at the Factory at time of order, will run automatically as set on this screen or can be run manually upon pressing the “Run AutoZero” button on this page as shown below. The AutoZero function will engage a solenoid valve to common mode the transducer creating a zero-pressure differential. During this time the flow, velocity, or pressure values being read by the device and the resulting System outputs will be held at their current state prior to the AutoZero function. The AutoZero calibration will be stored to a different memory location than that of the Factory Zero Calibration. The AutoZero function is optional and typically applies to OA applications where very low differential pressure could have high square root gain in flow calculations.





AutoZero Enable/Disabled

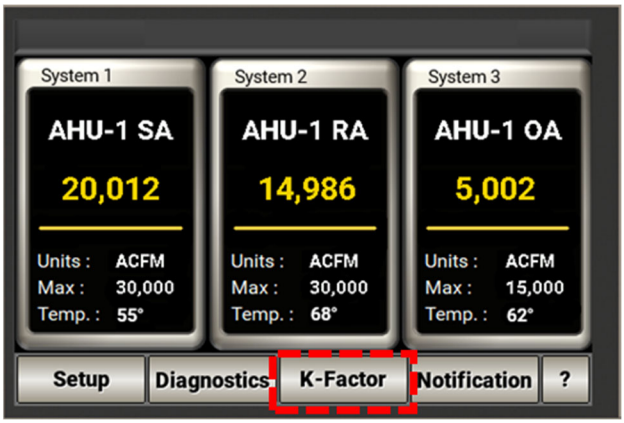
If the user wishes to disable the AutoZero function for whatever reason, the following enable/disable selector switch has been made available.

AutoZero Interval

The AutoZero interval settings adjusts the frequency at which the AutoZero runs. The range is 1 to 24 hours at 1-hour increments. (Values greater than 24 can be entered however the units are then in seconds, not hours. This is for troubleshooting purposes and PCI does not recommend running the autozero valve at that frequency.) **Default is 8 hours.**

5.4. K-Factor Page Shortcut

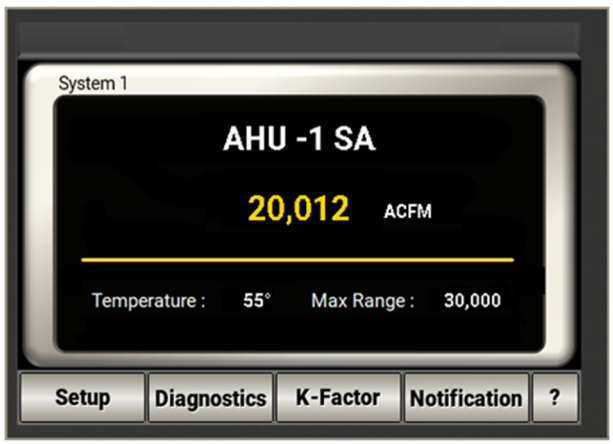
Touch the K-Factor Button on the Main Screen and the user will be taken to the K-Factor Page. See Section 5.2.2, K-Factor Section for more details.

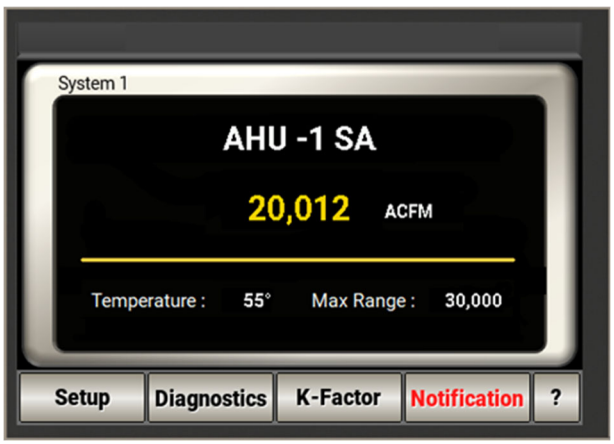


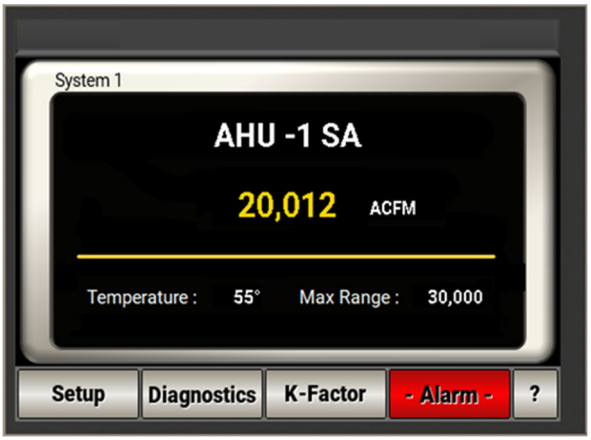
5.5. Notification Page

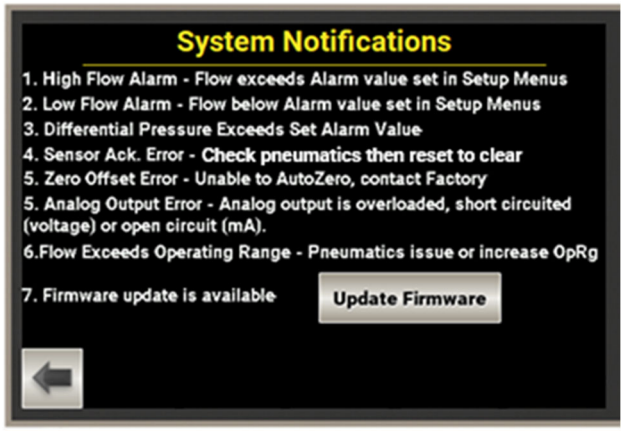
All warning messages (with the exception of the transducer zero calibration error shown on the Sensor Data Page) will be displayed on the systems notification page. The Main Screen will show indication that one or more alarm conditions are present as shown in the image below. An alarm indication is displayed on the Main Screen per the following sequence listed below:

1. "Notification" button in black text if no alarms or notifications are present.
2. "Notification" button in red text if noncritical alarm is present. List of noncritical alarms:
    a. Operating Range Exceeded
    b. Firmware Update
    c. Analog Output Error (short circuit, open circuit, circuit overload)
3. Red "Alarm" button when a critical alarm is active. List of critical alarms:
    a. High Flow Alarm
    b. Low Flow Alarm
    c. ΔP Alarm
    d. Zero Offset Error
    e. Sensor Acknowledge Error
4. Selecting any one of the buttons mentioned above navigates to the System Notifications page where all present alarms are displayed.
5. No alarms are latching – if an alarm is cleared the "Notification" button will go back to black text state.









High Flow Alarm

If any system alarm is enabled and the flow for that respective system's fan exceeds the individual fan high flow alarm value set in the Setup Menu Section 5.2.7 Alarms, then a High Flow Alarm will occur.

Low Flow Alarm

If any system alarm is enabled and the flow for that respective system's fan falls below the individual fan low flow alarm value set in the Setup Menu Section 5.2.7 Alarms, then a Low Flow Alarm will occur.

Differential Pressure Alarm

If any ΔP alarm is enabled and the pressure for that respective ΔP exceeds or falls below the set alarm value (dependent on ΔP alarm trigger type being high or low set in the Setup Menu Section 5.2.9) then a Differential Pressure Alarm will occur.

Sensor Acknowledge Error

If any one of the sensors that are present in the MTSE loses communication with the host MCU, then a Sensor Acknowledge Error will occur.

Analog Output Error

If any of the four analog outputs are short circuited while set to voltage, open circuit while set to mA, or the circuit is overloaded, an Analog Output Error alarm will occur. Analog output error will be displayed if the process output is set to 4-20mA and there is no receiving device connected (this is an open circuit).

Flow Exceeds Operating Range

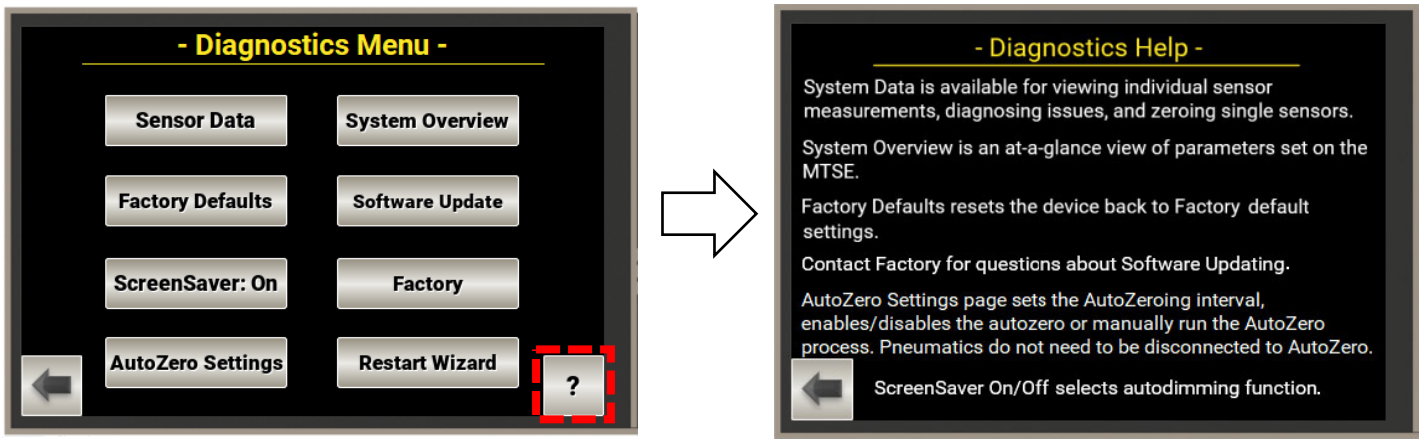
If the measured flow value exceeds the entered Operating Range value for any system, a Flow Exceeds Operating Range alarm will occur. The MTSE will continue to read and display values above the operating range however the operating range sets the process output scale and therefore the output will be saturated at 20mA or 10V.

Firmware Update

During the bootup sequence of the MTSE the host MCU will check its firmware against the firmware present on the uSD card. If the uSD card has newer firmware available this message and button will appear.

5.6. Troubleshooting and Help Pages

On most Diagnostic Menu and Setup Menu pages there will be a “?” located in the lower right-hand corner of the screen. Selecting this button will redirect the user to a page with contextual help for the parameters on the previous page and their function in the MTSE. Shown below is an example.



The Sensor Data Page (discussed in Section 5.3.1) and the System Overview Page (discussed in Section 5.3.2) can be useful for basic troubleshooting of proper installation and configuration, respectively. Navigate to these menus from the Main Screen by pressing the **Diagnostics** button.

The firmware for the MTSE resides on the uSD card located just below the display and must not be removed for proper operation. If the screen is black at start up and states “Drive Not Mounted” the uSD is missing or not completely pressed into the drive. If this occurs, switch the MTSE off, press the uSD card into the drive until it clicks, and then switch the unit on. Additionally, if the uSD card is removed or not completely pressed into the drive while the MTSE is in operation, the flow values will disappear on the Main Screen. If this occurs, switch the MTSE off, press the uSD card into the drive until it clicks, and then switch the unit on.

ATTACHMENT A

BACnet PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT

MTSE Unit BACnet Protocol Implementation Conformance Statement

Rev 7 3/31/22

BACnet Standardized Device Profile (Annex L):
BACnet Application Specific Controller (B-ASC)

BACnet Interoperability Building Blocks Supported (Annex K):
DS-RP-B
DS-RPM-B
DS-WP-B
DS-WPM-B
DM-DDB-B
DM-DOB-B
DM-DCC-B

Segmentation Capability:
NONE

Standard Object Types Supported:
Analog Input
Analog Value
Binary Input
Binary Value
Multistate Input
Multistate Value
CharacterString Value

Data Link Layer Options:
MS/TP master (Clause 9), baud rate(s): 9600, 19200, 38400, 76800

Device Address Binding:
NO

Networking Options:
NONE

Character Sets Supported:
ISO 10646 (UTF-8), ANSI 3.4

Supported Services:

ReadProperty	Execute
ReadPropertyMultiple	Execute
WriteProperty	Execute
WritePropertyMultiple	Execute
DeviceCommunicationControl	Execute
Who-Is	Execute
I-Am	Initiate
Who-Has	Execute
I-Have	Initiate

Gateway:
This product does not support gateway functionality for any types of non-BACnet equipment/network(s).

Object	*Object Name (max 32 Char)*	*Create Object Service*	*Delete Object Service*	*Optional Properties Supported*	*Writeable Properties*	*Property Data Type*	*Data Value Description (State Text)*
DEVICE		No	No	• Object Name • Description • Location • Object Identifier • APDU Timeout • Max Info Frames • Max Master	• Object Name • Location		
Analog Input-1	System 1 Total Flow	No	No	• Description • Eng Units	R	REAL	
Analog Input-2	System 2 Total Flow	No	No	• Description • Eng Units	R	REAL	
Analog Input-3	System 3 Total Flow	No	No	• Description • Eng Units	R	REAL	
Analog Input-4	Sub System Flow	No	No	• Description • Eng Units	R	REAL	
Analog Input-5	System 1 Temperature	No	No	• Description • Eng Units	R/W	REAL	Min = -99 Max = 9,999
	***Note: Only Write Access when Multi State Value-5 is set to Network**						
Analog Input-6	System 2 Temperature	No	No	• Description • Eng Units	R/W	REAL	Min = -99 Max = 9,999
	***Note: Only Write Access when Multi State Value-6 is set to Network**						
Analog Input-7	System 3 Temperature	No	No	• Description • Eng Units	R/W	REAL	Min = -99 Max = 9,999
	***Note: Only Write Access when Multi State Value-7 is set to Network**						
Analog Input-8	Sub System Temperature	No	No	• Description • Eng Units	R/W	REAL	Min = -99 Max = 9,999
	***Note: Only Write Access when OA Systems Multi State Value is set to Network**						
Analog Value-1	System 1 Operating Range	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-2	System 2 Operating Range	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-3	System 3 Operating Range	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-4	Sub System Operating Range	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-5	System 1 High Alarm Value	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-6	System 2 High Alarm Value	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-7	System 3 High Alarm Value	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-8	Sub System High Alarm Value	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-9	System 1 Low Alarm Value	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-10	System 2 Low Alarm Value	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-11	System 3 Low Alarm Value	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-12	Sub System Low Alarm Value	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = Varies
Analog Value-13	Controller 1 Output	No	No	• Description • Eng Units	R/W	UNSIGNED	Min = 0 Max = 100
Analog Value-14	Controller 2 Output	No	No	• Description • Eng Units	R/W	UNSIGNED	Min = 0 Max = 100
Analog Value-15	Controller 3 Output	No	No	• Description • Eng Units	R/W	UNSIGNED	Min = 0 Max = 100
Analog Value-16	Controller 4 Output	No	No	• Description • Eng Units	R/W	UNSIGNED	Min = 0 Max = 100

Object	Object Name (max 32 Char)	Create Object Service	Delete Object Service	Optional Properties Supported	Writeable Properties	Property Data Type	Data Value Description (State Text)
Analog Value-17	Differential Pressure 1 Alarm Setpoint	No	No	• Description • Eng Units	R/W	REAL	Min = 0.0 Max = 99.0
Analog Value-18	Differential Pressure 2 Alarm Setpoint	No	No	• Description • Eng Units	R/W	REAL	Min = 0.0 Max = 99.0
Analog Value-19	Differential Pressure 3 Alarm Setpoint	No	No	• Description • Eng Units	R/W	REAL	Min = 0.0 Max = 99.0
Analog Value-20	Differential Pressure 4 Alarm Setpoint	No	No	• Description • Eng Units	R/W	REAL	Min = 0.0 Max = 99.0
Analog Value-21	System 1 K-Factor	No	No	• Description	R/W	REAL	Min = 0.500 Max = 2.000
Analog Value-22	System 2 K-Factor	No	No	• Description	R/W	REAL	Min = 0.500 Max = 2.000
Analog Value-23	System 3 K-Factor	No	No	• Description	R/W	REAL	Min = 0.500 Max = 2.000
Analog Value-24	Sub System K-Factor	No	No	• Description	R/W	REAL	Min = 0.500 Max = 2.000
Analog Value-25	System 1 Samples	No	No	• Description	R/W	UNSIGNED	Min = 1 Max = 99
Analog Value-26	System 1 Sample Time	No	No	• Description • Eng Units	R/W	UNSIGNED	Min = 1 Max = 10
Analog Value-27	System 2 Samples	No	No	• Description	R/W	UNSIGNED	Min = 1 Max = 99
Analog Value-28	System 2 Sample Time	No	No	• Description • Eng Units	R/W	UNSIGNED	Min = 1 Max = 10
Analog Value-29	System 3 Samples	No	No	• Description	R/W	UNSIGNED	Min = 1 Max = 99
Analog Value-30	System 3 Sample Time	No	No	• Description • Eng Units	R/W	UNSIGNED	Min = 1 Max = 10
Analog Value-31	System 1 Lockdown	No	No	• Description	R/W	UNSIGNED	Min = 0 Max = 20
Analog Value-32	System 2 Lockdown	No	No	• Description	R/W	UNSIGNED	Min = 0 Max = 20
Analog Value-33	System 3 Lockdown	No	No	• Description	R/W	UNSIGNED	Min = 0 Max = 20
Analog Value-34	Sub System Lockdown	No	No	• Description	R/W	UNSIGNED	Min = 0 Max = 20
Analog Value-35	Altitude	No	No	• Description • Eng Units	R/W	REAL	Min = 0 Max = 65000
Binary Input-1	Digital Input 1	No	No	• Description	R	ENUMERATED	
Binary Input-2	Digital Input 2	No	No	• Description	R	ENUMERATED	
Binary Value-1	System 1 Alarm Enable	No	No	• Description	R/W	ENUMERATED	1: Off 2: On
Binary Value-2	System 2 Alarm Enable	No	No	• Description	R/W	ENUMERATED	1: Off 2: On
Binary Value-3	System 3 Alarm Enable	No	No	• Description	R/W	ENUMERATED	1: Off 2: On
Binary Value-4	Sub System Alarm Enable	No	No	• Description	R/W	ENUMERATED	1: Off 2: On
Binary Value-5	Digital Output 1	No	No	• Description	R/W	ENUMERATED	
Binary Value-6	Digital Output 2	No	No	• Description	R/W	ENUMERATED	
Multi State Value-1	System 1 Engineering Units	No	No	• Description	R/W	UNSIGNED	See **Table 2.**
	Note: Unit Selection Dependent on Multi State Value-9						
Multi State Value-2	System 2 Engineering Units	No	No	• Description	R/W	UNSIGNED	See **Table 2.**
	Note: Unit Selection Dependent on Multi State Value-10						
Multi State Value-3	System 3 Engineering Units	No	No	• Description	R/W	UNSIGNED	See **Table 2.**

Object	Object Name (max 32 Char)	Create Object Service	Delete Object Service	Optional Properties Supported	Writeable Properties	Property Data Type	Data Value Description (State Text)
	Note: Unit Selection Dependent on Multi State Value-11						
Multi State Value-4	Temperature Engineering Units	No	No	• Description	R/W	UNSIGNED	1: F° 2: C°
Multi State Value-5	System 1 Temperature Source	No	No	• Description	R/W	UNSIGNED	1: Fixed 2: Analog 3: Network
Multi State Value-6	System 2 Temperature Source	No	No	• Description	R/W	UNSIGNED	1: Fixed 2: Analog 3: Network
Multi State Value-7	System 3 Temperature Source	No	No	• Description	R/W	UNSIGNED	1: Fixed 2: Analog 3: Network
Multi State Value-9	System 1 Process Type	No	No	• Description	R/W	UNSIGNED	1: Standard Flow 2: Actual Flow 3: Standard Velocity 4: Actual Velocity 5: Pressure
Multi State Value-10	System 2 Process Type	No	No	• Description	R/W	UNSIGNED	1: Standard Flow 2: Actual Flow 3: Standard Velocity 4: Actual Velocity 5: Pressure
Multi State Value-11	System 3 Process Type	No	No	• Description	R/W	UNSIGNED	1: Standard Flow 2: Actual Flow 3: Standard Velocity 4: Actual Velocity 5: Pressure
Multi State Value-12	DP1 Alarm Enable	No	No	• Description	R/W	UNSIGNED	1 = Off 2 = Low 3 = High
Multi State Value-13	DP2 Alarm Enable	No	No	• Description	R/W	UNSIGNED	1 = Off 2 = Low 3 = High
Multi State Value-14	DP3 Alarm Enable	No	No	• Description	R/W	UNSIGNED	1 = Off 2 = Low 3 = High
Multi State Value-15	DP4 Alarm Enable	No	No	• Description	R/W	UNSIGNED	1 = Off 2 = Low 3 = High
CharacterString Value-1	System 1 Tag	No	No	• Description	R/W	STRING	
CharacterString Value-2	System 2 Tag	No	No	• Description	R/W	STRING	
CharacterString Value-3	System 3 Tag	No	No	• Description	R/W	STRING	
CharacterString Value-4	Sub System Tag	No	No	• Description	R/W	STRING	
Analog Input-21	System 1 Sensor 1 Flow	No	No	• Description • Eng Units	R	REAL	
Analog Input-22	System 1 Sensor 1 Pressure	No	No	• Description • Eng Units	R	REAL	

Object	*Object Name (max 32 Char)*	*Create Object Service*	*Delete Object Service*	*Optional Properties Supported*	*Writeable Properties*	*Property Data Type*	*Data Value Description (State Text)*
Multi State Input-11	System 1 Sensor 1 Status	No	No	• Description	R	UNSIGNED	1 = Normal 2 = Alarm 3 = Failure
Analog Input-23	System 1 Sensor 2 Flow	No	No	• Description • Eng Units	R	REAL	
Analog Input-24	System 1 Sensor 2 Pressure	No	No	• Description • Eng Units	R	REAL	
Multi State Input-12	System 1 Sensor 2 Status	No	No	• Description	R	UNSIGNED	1 = Normal 2 = Alarm 3 = Failure
/..							
../							
Analog Input-39	Sub System Sensor 1 Flow	No	No	• Description • Eng Units	R	REAL	
Analog Input-40	Sub System Sensor 1 Pressure	No	No	• Description • Eng Units	R	REAL	
Multi State Input-20	Sub System Sensor 1 Status	No	No	• Description	R	UNSIGNED	1 = Normal 2 = Alarm 3 = Failure

Note:
Sensors # assignment is as follows:
The Analog Input and Multi State Input objects numbers are assigned based on the System # and the Sensor # within that system. Order of Systems is as follows: **System 1**, **System 2**, **System 3**, **Sub System**, **Differential Pressure(s)**. Sub System follows the last System in use.

Analog Input-xx	System x Sensor xx Flow
Analog Input-xx	System x Sensor xx Pressure
Multi State Input-xx	System x Sensor xx Status

TABLE 2 – MSV1, MSV2 and MSV3 Engineering Units State_Text List

Multi State Value-9, 10, 11	1. Standard Flow Units	2. Actual Flow Units	3. Standard Velocity Units	4, Actual Velocity Units	5. Pressure Units
Engineering Units	SCFM	ACFM	SFPM	AFPM	In. W.C.
	SCFH	L/S	Sm/s	Am/s	Pa
	SL/S	Am^3/S			kPa
	Sm^3/S	Am^3/M			mm W.C.
	Sm^3/M	Am^3/HR			
	Sm^3/HR				

ATTACHMENT B

MODBUS SOFTWARE CONFIGURATION PARAMETERS

MTSE MODBUS SOFTWARE CONFIGURATION PARAMETERS

Rev 3 4/13/2021

Communication type: Serial
Protocol: RTU - Slave
Modbus ID: First device starts at 1 and increments up to 254
Baud Rate: 9.6K, 19.2k, 38.4K(Default), 57.6K & 115.2K
Data bits: 8
Parity: None
Stop bit: 1
Flow Control: None
Time Out: 150msec (minimum)
Poll time interval; 100msec (minimum)
Address Type: Decimal 40000 – 40999 (Holding Register address)
16 bit Data type Byte order: Motorola (Default) High Byte bits 15 - 8, Low Byte bits 7 - 0
32 bit Data type Byte order: Mid-Little-Endian CD AB
Float Data type Byte order: Mid-Little-Endian CD AB, IEEE 754 specification is used.
Start Address: 0-based
Max. block size: (Holding registers): 16
Function Code: (0x03h) Read registers, (0x06h) Write single register, (0x10h) Write multiple registers
Datatype Key: 0 = reserved, 1 = integer, 2 = unsigned integer, 3 = Unsigned Long, 4 = Float,
5 = String(20) 6 = String(12)

(**Note 1: When using a USB to RS-485 converter, make sure to set Echo to OFF if applicable)**

Monitoring Variables

Object Description	Min	Max	Default	R/W	Address	Datatype	Data Value Description
System 1 Total Flow	0	999999	0	R	40301	3	*Note 1
System 2 Total Flow	0	999999	0	R	40303	3	*Note 1
System 3 Total Flow	0	999999	0	R	40305	3	*Note 1
SubSystem Flow	0	999999	0	R	40307	3	
System 1 Temperature	-99	9999	68	W	40311	1	Write access only if Address 40699 set to 3
System 2 Temperature	-99	9999	68	W	40312	1	Write access only if Address 40700 set to 3
System 3 Temperature	-99	9999	68	W	40313	1	Write access only if Address 40701 set to 3
Sensor 1 Flow	0	99999	0	R	40357	3	Default Units = ACFM
Sensor 2 Flow	0	99999	0	R	40359	3	Default Units = ACFM
Sensor 3 Flow	0	99999	0	R	40361	3	Default Units = ACFM
Sensor 4 Flow	0	99999	0	R	40363	3	Default Units = ACFM
Sensor 5 Flow	0	99999	0	R	40365	3	Default Units = ACFM
Sensor 6 Flow	0	99999	0	R	40367	3	Default Units = ACFM
Sensor 7 Flow	0	99999	0	R	40369	3	Default Units = ACFM
Sensor 8 Flow	0	99999	0	R	40371	3	Default Units = ACFM
Sensor 9 Flow	0	99999	0	R	40373	3	Default Units = ACFM
Sensor 10 Flow	0	99999	0	R	40375	3	Default Units = ACFM
Sensor 1 Pressure	0	99.99	0	R	40437	4	Pressure Units = in. W.C.
Sensor 2 Pressure	0	99.99	0	R	40439	4	Pressure Units = in. W.C.
Sensor 3 Pressure	0	99.99	0	R	40441	4	Pressure Units = in. W.C.
Sensor 4 Pressure	0	99.99	0	R	40443	4	Pressure Units = in. W.C.
Sensor 5 Pressure	0	99.99	0	R	40445	4	Pressure Units = in. W.C.
Sensor 6 Pressure	0	99.99	0	R	40447	4	Pressure Units = in. W.C.
Sensor 7 Pressure	0	99.99	0	R	40449	4	Pressure Units = in. W.C.
Sensor 8 Pressure	0	99.99	0	R	40451	4	Pressure Units = in. W.C.
Sensor 9 Pressure	0	99.99	0	R	40453	4	Pressure Units = in. W.C.
Sensor 10 Pressure	0	99.99	0	R	40455	4	Pressure Units = in. W.C.
Sensor 1 Status	0	3	0	R	40517	2	1=Normal, 2=Caution, 3=Failure
Sensor 2 Status	0	3	0	R	40518	2	1=Normal, 2=Caution, 3=Failure
Sensor 3 Status	0	3	0	R	40519	2	1=Normal, 2=Caution, 3=Failure
Sensor 4 Status	0	3	0	R	40520	2	1=Normal, 2=Caution, 3=Failure
Sensor 5 Status	0	3	0	R	40521	2	1=Normal, 2=Caution, 3=Failure
Sensor 6 Status	0	3	0	R	40522	2	1=Normal, 2=Caution, 3=Failure
Sensor 7 Status	0	3	0	R	40523	2	1=Normal, 2=Caution, 3=Failure
Sensor 8 Status	0	3	0	R	40524	2	1=Normal, 2=Caution, 3=Failure
Sensor 9 Status	0	3	0	R	40525	2	1=Normal, 2=Caution, 3=Failure
Sensor 10 Status	0	3	0	R	40526	2	1=Normal, 2=Caution, 3=Failure

Note 1: If SubSystem is present, it is summed together with last system in use. Typical SubSystem application would be a 2nd OA, for example.

Commonly Adjusted Variables

Object Description	Min	Max	Default	R/W	Address	Data type	Data Value Descriptions
System 1 K-Factor	0.50	2.000	1	W	40013	4	*Note 1
System 2 K-Factor	0.50	2.000	1	W	40019	4	*Note 1
System 3 K-Factor	0.50	2.000	1	W	40025	4	*Note 1
SubSystem K-Factor	0.50	2.000	1	W	40031	4	*Note 1
System 1 Operating Range	0	*Note 2	*Note 2	W	40077	3	
System 2 Operating Range	0	*Note 2	*Note 2	W	40085	3	
System 3 Operating Range	0	*Note 2	*Note 2	W	40093	3	
SubSystem Operating Range	0	*Note 2	*Note 2	W	40101	3	
System 1 Number of Samples	1	99	30	W	40103	2	*Note 3
System 1 Sample Interval Time	1	10	1	W	40104	2	*Note 3
System 2 Number of Samples	1	99	30	W	40105	2	*Note 3
System 2 Sample Interval Time	1	10	1	W	40106	2	*Note 3
System 3 Number of Samples	1	99	30	W	40107	2	*Note 3
System 3 Sample Interval Time	1	10	1	W	40108	2	*Note 3
System 1 Fixed Temperature	-99	999	68	W	40115	1	
System 2 Fixed Temperature	-99	999	68	W	40118	1	
System 3 Fixed Temperature	-99	999	68	W	40121	1	
System 1 Low Alarm	0	999999	0	W	40125	3	
System 1 High Alarm	0	999999	0	W	40127	3	
System 1 Alarm Delay	0	999	0	W	40129	2	
System 1 Lockdown	0	20	3	W	40130	3	
System 2 Low Alarm	0	999999	0	W	40132	3	
System 2 High Alarm	0	999999	0	W	40134	3	
System 2 Alarm Delay	0	999	0	W	40136	2	
System 2 Lockdown	0	20	3	W	40137	3	
System 3 Low Alarm	0	999999	0	W	40139	3	
System 3 High Alarm	0	999999	0	W	40141	3	
System 3 Alarm Delay	0	999	0	W	40143	2	
System 3 Lockdown	0	20	3	W	40144	3	
SubSystem Low Alarm	0	999999	0	W	40146	3	
SubSystem High Alarm	0	999999	0	W	40148	3	
SubSystem Alarm Delay	0	999	0	W	40150	2	
Sub System Lockdown	0	20	3	W	40151	3	
Lockdown Delay	0	999	10	W	40153	2	
System 1 Tagging	0	12	0	W	40197	6	*Note 4
System 2 Tagging	0	12	0	W	40203	6	*Note 4
System 3 Tagging	0	12	0	W	40209	6	*Note 4
SubSystem Tagging	0	12	0	W	40215	6	*Note 4
ΔP1 Alarm Setpoint	0	99.0	0	W	40273	4	
ΔP2 Alarm Setpoint	0	99.0	0	W	40275	4	
ΔP3 Alarm Setpoint	0	99.0	0	W	40277	4	
ΔP4 Alarm Setpoint	0	99.0	0	W	40279	4	
System 1 Temperature Source	1	3	1	W	40699		1 = Fixed, 2 = Variable, 3 = Network
System 2 Temperature Source	1	3	1	W	40700		1 = Fixed, 2 = Variable, 3 = Network
System 3 Temperature Source	1	3	2	W	40701		1 = Fixed, 2 = Variable, 3 = Network
System 1 Alarm Enable	0	1	0	W	40705	2	0 = Disabled, 1 = Enabled
System 2 Alarm Enable	0	1	0	W	40706	2	0 = Disabled, 1 = Enabled
System 3 Alarm Enable	0	1	0	W	40707	2	0 = Disabled, 1 = Enabled
SubSystem Alarm Enable	0	1	0	W	40708	2	0 = Disabled, 1 = Enabled
ΔP1 Alarm Enable	0	2	0	W	40726	2	0 = Off, 1 = Low Trigger, 2 = Hi
ΔP2 Alarm Enable	0	2	0	W	40727	2	0 = Off, 1 = Low Trigger, 2 = Hi
ΔP3 Alarm Enable	0	2	0	W	40728	2	0 = Off, 1 = Low Trigger, 2 = Hi
ΔP4 Alarm Enable	0	2	0	W	40729	2	0 = Off, 1 = Low Trigger, 2 = Hi

Note 1: K-Factor adjustment is done during system balancing to compensate for system effect in MTSE readings.
Note 2: System Operating Range and maximum Operating Range are dependent on numerous, application specific parameters.
Note 3: Number of Samples and Sampling Interval Time effect response rate seen by sensor. Increasing interval time will slow response and increasing number of samples will increase sample quantity for the rolling average filter.
Note 4: String is 6 register width, 2 characters per register. 12 characters total + null terminator. Example: System 1 Tagging = "AHU-1 SA " would be 01 10 00 C4 00 06 0C 48 41 2D 55 20 31 41 53 20 20 20 20 46 EA

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