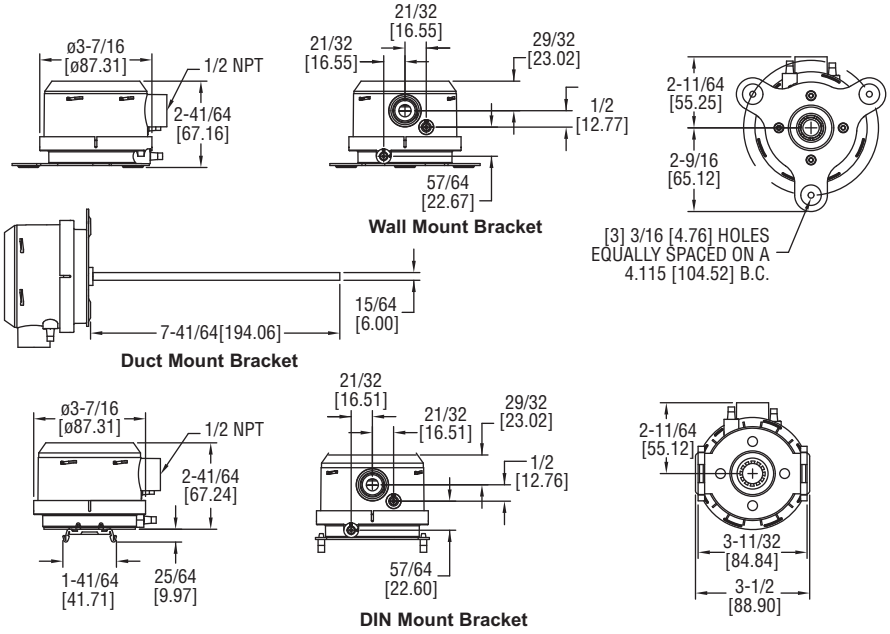
Series MS2 Magnesense® II Differential Pressure Transmitter with Modbus® Communication

Specifications - Installation and Operating Instructions



The Series MS2 Magnesense® II Differential Pressure Transmitter with Modbus® Communication Protocol combines the proven stable Piezo sensing technology of our original MS Series with additional features to reduce installation time and simplify ordering. When using the pluggable integral display, either Metric or English engineering units can be selected by changing the dip switch position. A major benefit of the communications is the transmitters can be daisy-chained together to reduce wiring time and installation cost. The communications allow for the transmitter to integrate seamlessly into the existing building automation control.

Like the original Series MS, the second generation transmitter can display pressure or velocity with the square root extraction internal to the transmitter. Additional parameters have been included to expand the square root capability to include flow measurements.

INSTALLATION

Surface Mount:
The transmitter should be mounted on a vertical surface with the connections directed down to prevent moisture from entering either the pressure ports or the electrical cable entry. The diaphragm must be vertical to minimize gravity effects on the diaphragm. Attach the mounting flange to a flat surface using three #8 x 1/2″ pan head sheet metal screws. Do not over tighten.

Duct Mount:
The transmitter should be mounted away from fans, corners, heating and cooling coils and other equipment that will affect the measurement of the pressure.
1. To mount the transmitter, drill a 9/16″ (12.70 mm) diameter hole into the duct.
2. Insert transmitter probe into the duct.
3. Mark location of three mounting holes on duct using mounting flange as template. Drill holes.
4. Attach mounting flange to duct with three #8 x 1/2″ pan head sheet metal screws. Do not over tighten screws.

SPECIFICATIONS

Service: Air and non-combustible, compatible gases.
Wetted Materials: Consult factory.
Accuracy: ±1% FS for 0.25″ (50 Pa), 0.5″ (100 Pa), 2″ (500 Pa), 5″ (1250 Pa), 10″ (2 kPa), 15″ (3 kPa), 25″ (5 kPa); ±2% FS for 0.1″ (25 Pa), 1″ (250 Pa), and all bi-directional ranges.
Stability: ±1% / year FSO.
Temperature Limits: 0 to 150°F (-18 to 66°C).
Pressure Limits: 1 psi max., operation; 10 psi burst.
Power Requirements: 10 to 36 VDC or isolated 21.6 to 33 VAC.
Output Signals: Modbus® RTU or ASCII 2-wire RS-485 communication protocol.
Response Time: Averaging, adj 0 to 240 s.
Zero & Span Adjustments: Digital push buttons.
Current Consumption: 40 mA max.
Display (optional): 5-digit LCD.
Electrical Connections: 5-wire terminal block, 22 to 28 AWG.
Electrical Entry: 1/2″ NPS thread; Accessory (A-151): Cable gland for 5 to 10 mm diameter cable.
Process Connection: 3/16″ ID tubing (5 mm ID); Max. OD 9 mm.
Enclosure Rating: NEMA 4X (IP66).
Mounting Orientation: Diaphragm in vertical position.
Weight: 8.0 oz (230 g).
Agency Approvals: CE.

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Electrical Wiring

NOTICE Wiring should comply with *Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems, TIA/EIA-485-A-1998*, Telecommunications Industry Association, 1998.

NOTICE Wiring should comply with Modbus® Communication Protocol *over Serial Line Specification and Implementation Guide V1.02*, Modbus Organization, Inc., 2006

NOTICE Communications wiring must be in a daisy-chain fashion. Star connections are not permitted.

NOTICE Cable shield must be connected to earth ground at one location only.

Figure 1 shows how to connect the MS2 in a network containing a common power supply. Use a cable containing two twisted pairs. One pair is to be used for B(+) and A(-). The other pair is to be used for power and common. This configuration is not suitable for AC supplies. Use a DC supply only. Care should be taken that there are not too many devices powered from the same supply as voltage drops will occur in the wiring. If you have many devices, or have long cable runs, the local supply configuration may be a better choice.

Figure 2 shows how to connect the MS2 in a network containing individual local supplies. Use a cable containing a twisted pair and a single conductor. The pair is to be used for B(+) and A(-). The single conductor is to be used for common. Both AC and DC supplies are suitable for this configuration.

In either configuration you must use shielded cable. The MS2 has a shield terminal for a convenient location to make connections. It is not electrically connected to the MS2. Connect the shield to earth ground at one location only to prevent ground loops.

All devices in the network should be daisy chained. Star connections and T connections are not permitted.

The B(+) and A(-) lines must be terminated at both ends with a 120 ohm resistor. If the MS2 is an end device it has an on-board resistor that may be used. See DIP SWITCH SETTINGS to enable it.

The network must be biased properly. If needed, there are bias resistors on-board the MS2. No more than two sets of bias resistors should be enabled in the network. See DIP SWITCH SETTINGS to enable them.

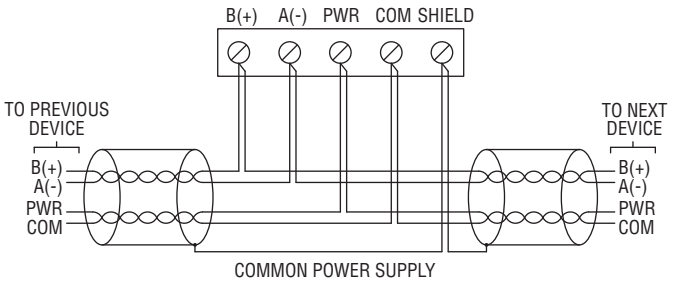


Figure 1

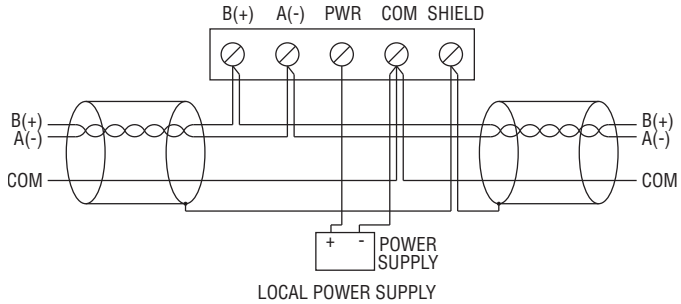


Figure 2

Dip Switch Configurations

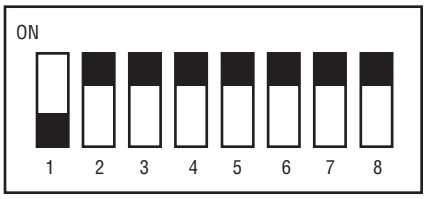


Figure 3

Use the left DIP Switch SW1 to configure the Modbus® Communication Protocol address of the device. The LCD will show the address when the transmitter is powered on. Valid addresses range from 1 to 247. By default, the device is shipped with the address 127 (as shown in Figure 3). A valid and unused address should be set before connecting to an existing network. However, the address can be changed while the device is operational. If the address is changed, the device will stop responding to the currently configured address immediately. The device waits 15 seconds after the last switch change before applying the new address. The device will not function properly if an invalid address is set. The red LED will periodically blink once indicating an invalid address. The LCD will display "*A ERR*" when the transmitter is powered on if the address is invalid. See Appendix I for setting the Modbus® Communication Protocol address of the device.

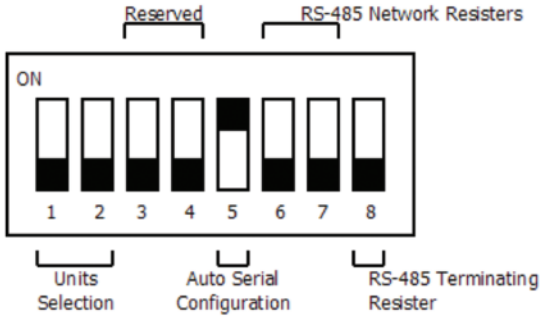


Figure 4

Use the right DIP Switch SW2 to configure other hardware and software options.

Table 1: DIP Switch SW2 Functions

Switch	On	Off
1-2 – Display Units Selection (See Table 2)		
3-4 – Reserved		
5 – Full Intelligent Serial Configuration	Enabled	Disabled
6 – B(+) Network Resistor	511Ω Pull-up to 5V	Pull-up not connected
7 – A(-) Network Resistor	511Ω Pull-down to GND	Pull-down not connected
8 – Terminating Resistor	120Ω between A(-) & B(+)	Open

Table 2: Display Units Selection

Switch 1	Switch 2	Unit
OFF	OFF	Inches of Water Column (in WC)
ON	OFF	Pascal (Pa)
OFF	ON	Millimeters of Water Column (mm WC)
ON	ON	Kilo-Pascal (kPa)

NOTICE When using the on-board buttons, there is a 5 second delay from the time the zero or span calibration button is released until the time that the change in calibration takes place. This delay is used to prevent stress related offsets on the lower ranges.

NOTICE The security level that is set in the Programming Menu Section of the manual will determine which calibrations, if any, may be adjusted by the user through the on-board buttons, but the calibration can be changed at any time through the communications.

Zero Calibration
The zero calibration can be set by applying zero pressure to both the pressure ports and pressing the zero button for 3 seconds. If the local LCD is present, the display will read ZERO and then sequence back to the home display.

Span Calibration
The span calibration can be adjusted only after setting the zero adjustment. It must be completed within 5 minutes of the last zero calibration. The span calibration button will be ignored until the zero calibration is completed. Apply pressure to the port of the transmitter that is associated with the maximum end of the transmitter range. Press and hold the span button for 3 seconds. If the local LCD is present, the display will read SPAN and then sequence back to the home display. If the span calibration is attempted before adjusting the zero calibration, the FAIL error message will flash on the display.

LCD Display
The Magnesense® II Differential Pressure Transmitter can be ordered with an optional, integral LCD. If the display is not needed for normal operation, the transmitter can be ordered without the LCD. A Model A-MS2-LCD field upgradeable display is available. It comes with a housing cover with the overlay cut out for the display. The display will plug into the pins as shown in Figure 5.

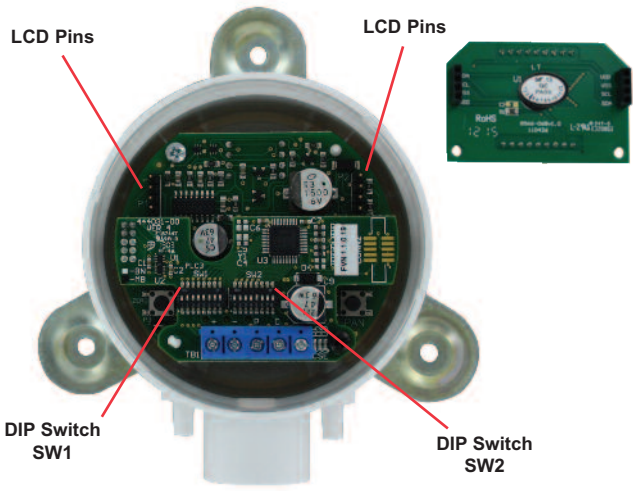


Figure 5

Display Error Messages
OVER = The applied pressure is greater than the maximum span value causing an Over Range Error.
UNDER = The applied pressure is less than the minimum span value causing an Under Range Error.
FAIL = When the span or zero buttons are pressed, the pressure value is out of the range to allow a correct setting. This may be due to a sensor failure or incorrect pressure being applied.
ERR1 = The sensor is damaged.

PROGRAMMING MENUS

Home Menu
During normal operation, the display will be in the Home Menu and will display the current measured pressure and the engineering units.

Menu Access Security
While in the Home Menu, press and hold the Zero and Span buttons simultaneously until SECUR appears on the display in order to access the other programming menus. Upon releasing the buttons, the display will indicate the current security level.

If the current security level is the security level desired (i.e. Security Level 0), press and hold the span button for three seconds to enter the Pressure, Velocity, or Air Flow Menu.

If the security level is not the desired level, it can be changed temporarily to a lower security level or permanently to a higher level of security by pressing the zero button. A security code will be shown on the display and it can be changed to one of the codes listed in the below table. The span button chooses which digit and the zero button increments the value of that digit. Pressing and holding the span button will store the value.

Security Level	Setting	Access			
		View Menu	Edit Menu	Span	Zero
0	000	Yes	Yes	Yes	Yes
1	111	Yes	No	No	Yes
2	222	No	No	No	Yes
3	333	No	No	No	No

The level of access to the programming menus and the calibration is limited based on the security level. The above table details the level of access for each security level.

Programming Via Modbus® Communication Protocol

Supported Modbus® Communication Protocol Configurations

Modbus® Mode	Supported Baud Rates	Data Size	Parity	Stop Bits
RTU	9600 19200 38400 57600 76800 115200	8	Even Odd None[1]	1
			None	2
ASCII		7	Even Odd	1
			None	2

Intelligent Serial Configuration

Intelligent serial configuration enables the device to determine the baud rate, data size, party, stop bits and even the Modbus® Communication Protocol mode directly from the serial traffic. This allows the Series MS2 to be quickly and easily deployed after a valid Modbus® Communication Protocol address is chosen.

To activate intelligent serial configuration, set a valid Modbus® Communication Protocol address using the left DIP switch SW1, connect the serial bus and power wires, and then apply power. The device will power up and begin examining the serial bus for communication. The Red LED will repeatedly flash twice, indicating that intelligent serial configuration is in progress.

If the device is setup offline or away from the main network, it is necessary to generate Modbus® Communication Protocol traffic in order to configure the serial communication. Attempting to read input registers is a good method to generate Modbus® Communication Protocol traffic. Note that while serial configuration is in progress, the device may not respond to requests. The device may require multiple read requests to complete the serial configuration process.

The intelligent serial configuration process will complete once a message addressed to the device is received and processed successfully. The serial configuration parameters are then saved to non-volatile storage and loaded by default each time the device starts. If the serial configuration of the bus changes, a power cycle of the device is required to restart the Intelligent Serial Configuration process.

[1] The serial configuration, no parity with one stop bit is not officially supported by the Modbus® Communication Protocol standard. However, if this configuration is desired, set switch 5 on DIP switch SW2 to off. The device will configure itself in Modbus® RTU Communication Protocol mode with a data size of 8, no parity, and 1 stop bit. The baud rate will still be determined automatically.

Modbus® Communication Protocol Functions
The device supports the following functions

Function Name	Function Code
Read Coils	01
Read Holding Registers	03
Read Input Registers	04
Write Single Coil	05
Write Single Register	06
Write Multiple Registers	16

The String data type is read as a stream of ASCII characters, with the first character sent in the MSB of the first register, and the second character sent in the LSB of the first register and so on. If the string is shorter than the allotted size, the remaining bytes will be zero padded.

Holding Registers

Register	Description	Data Type	Value	Range	Multi-Address Supported
0001	Use default K value. (Default value: 1)	Unsigned 16 bit integer	0...1	False-True	Yes
0002-0003	Velocity K value	Float	0...9.999	0...9.999	Yes
0004-0005	Area (ft^2)	Float	0.01...999.99	0.01...999.99	Yes

The holding registers allow configuration of the Velocity K value and Area associated with velocity and flow calculations. Register 0001 must be set to 0 (False) in order to use K value/Area for actual velocity/flow values with units. Otherwise, the device uses default values to output range 0-1.0 based on the full scale of the instrument.

Coils
The coil registers represent functions of the device. The value returned when reading a coil register indicates the status of the last function execution. If the value is 1, then the last time the function executed was a success. If the value is 0, then the function has either not been executed since power on or failed during the last execution. To execute a function, write 1 to the corresponding register. A response will be returned immediately and the value of the coil will be set to 0. Once the function completes, the value of the coil will be set to 1 if the operation was a success. An application should poll the value of the coil periodically during this time to determine if the function succeeded. If the coil value does not transition to 1 after at most 10 seconds, then the operation failed.

Register	Description	Data Type	Value	Range	Multi-Address Supported
0001	Perform Zero function	Boolean	0...1	False-True	No
0002	Perform Span function	Boolean	0...1	False-True	No
0003	Reset Factory Defaults	Boolean	0...1	False-True	No
0004	Reset Device	Boolean	0...1	False-True	No

Coil 1 – Zero Function
The zero function will attempt to recalibrate the zero point. This may be needed if the pressure sensor has drifted over time. Note that the zero function will only re-zero the sensor if the current pressure is within ±2% of span pressure of the previous zero. If the current pressure is outside the valid band, the zero function will fail and the coil value will remain 0. If the sensor has drifted far enough that the zero function fails, then pressure will have to be applied to bring the current pressure closer to the current zero, and the zero function will have to be executed multiple times until the actual zero is reached.

Coil 2 – Span Function
The span function will attempt to recalibrate the maximum positive or negative pressure. Note that accurate span pressure depends on an accurate zero pressure. The span function will fail if the zero function has not been executed within the last 5 minutes.

Coil 3 – Reset Factory Defaults Function
The reset factory defaults function resets the zero, span, Velocity K value, Area, and Use Default K Value variables back to their factory default values.

Coil 4 – Reset Device Function
The reset device function allows this device to be reset remotely from Modbus®. When the reset device function coil is written with a value of 1, the device will immediately respond with success. The reset will take place approximately 5 seconds after the command was received. Writing the value 0 to this coil has no effect.

Multi-Address Support
Multi-Address support allows a register to be read or written to using different byte orientations specified by the address range. For example, input register 0003 can also be read at 2003, 4003 and 6003 with different byte orientations as listed in the below table. Registers that do not have multi-address support are only available in Big-Endian byte orientation (Modbus® Communication Protocol standard).

		Float/32Bit Values				16Bit Values	
		Register 1		Register 2		Register 1	
Byte Order	Address Range	MSB			LSB	MSB	LSB
Big-Endian	1 – 2000	A	B	C	D	A	B
Byte Swap	2001 – 4000	B	A	D	C	B	A
Word Swap	4001 – 6000	C	D	A	B	A	B
Little-Endian	6001 – 8000	D	C	B	A	B	A

LED Status
The device provides three LEDs to indicate status and activity. The LEDs are located to the right of the terminal block and are arranged from left to right as green, yellow, and red. The green LED indicates communication with the pressure sensor. This LED will flash very quickly most of the time, even without requests from the Modbus® interface. The yellow LED indicates Modbus® communication addressed to this specific device. The frequency and duration of this LED depends on the baud rate and size of request sent. The red LED indicates error states by flashing specific error codes periodically.

Number of Flashes	Error Description
Solid On (not flashing)	Invalid Factory Configuration
1	Invalid Modbus® Communication Protocol Address
2	Intelligent Serial Configuration in progress, unit may not respond to requests
3	Communication with pressure sensor failed

MAINTENANCE/REPAIR
Upon final installation of the Series MS2 Differential Pressure Transmitter, no routine maintenance is required. The Series MS2 is not field serviceable and it is not possible to repair the unit. Field repair should not be attempted and may void warranty.

WARRANTY/RETURN
Refer to “Terms and Conditions of Sales” in our catalog and on our website. Contact customer service to receive a Return Goods Authorization number before shipping the product back for repair. Be sure to include a brief description of the problem plus any additional application notes.

Appendix I: Setting Modbus® Communication Protocol Address of Unit

Switch Position	1	2	3	4	5	6	7	8
Address Value	128	64	32	16	8	4	2	1

The address assignment is determined by adding the values for each of the switches that are in the ON position. The transmitter comes from the factory with all of the dip switches, except position 1, in the ON position as shown in Figure 6 below. The address of the transmitter would be 127 as it would be 64+32+16+8+4+2+1=127. Another example would be if the address desired was eight, the only dip switch position in the ON position would be position 5 as shown in Figure 7 below. When power is applied to the transmitter, the LCD (if connected) will display the current address for approximately 10 seconds. If the current address is invalid, the LCD will display "A ERR".

Figure 6: Address of Transmitter is 127

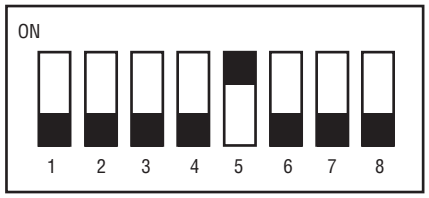
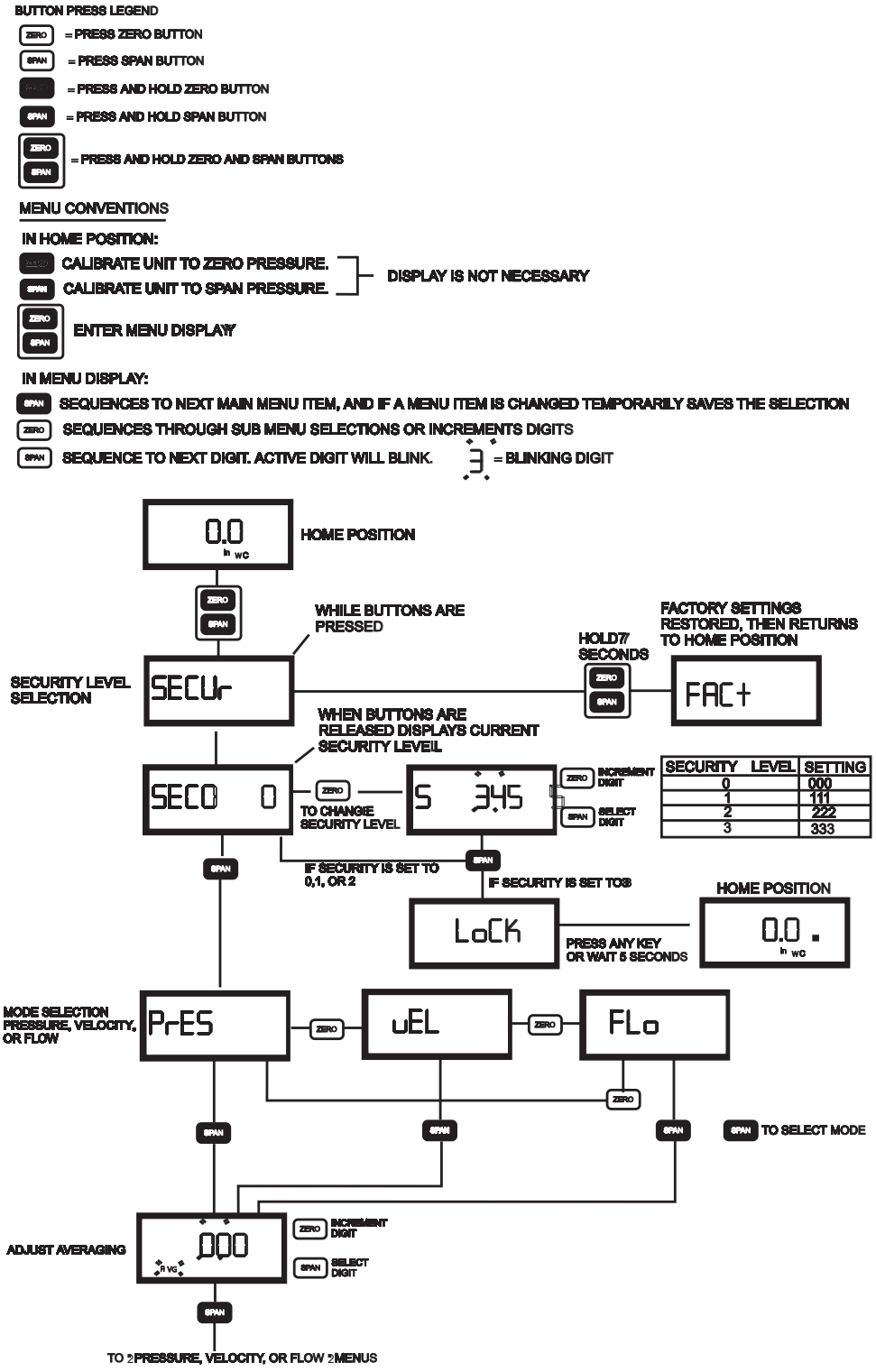


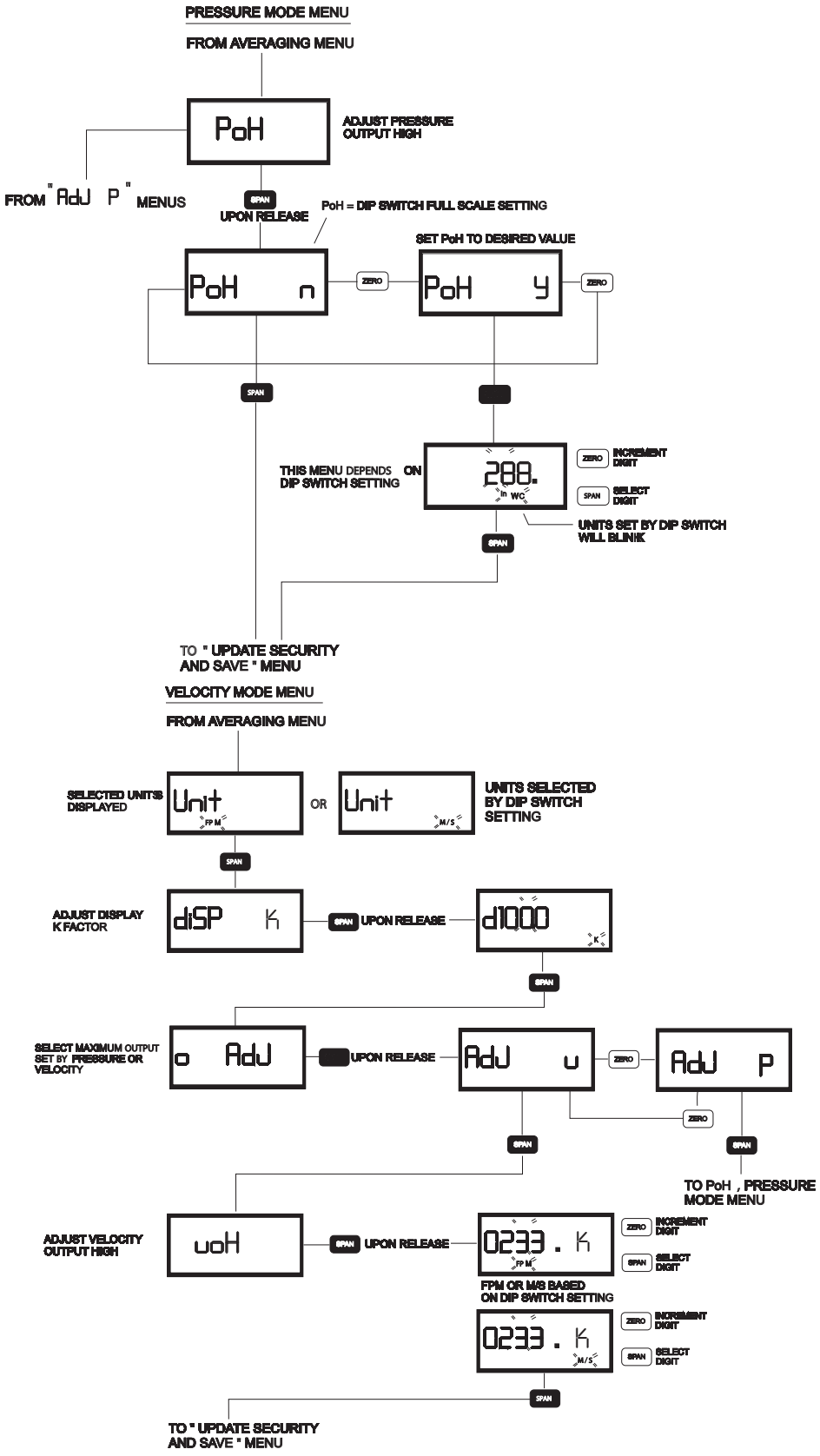
Figure 7: Address of Transmitter is 8

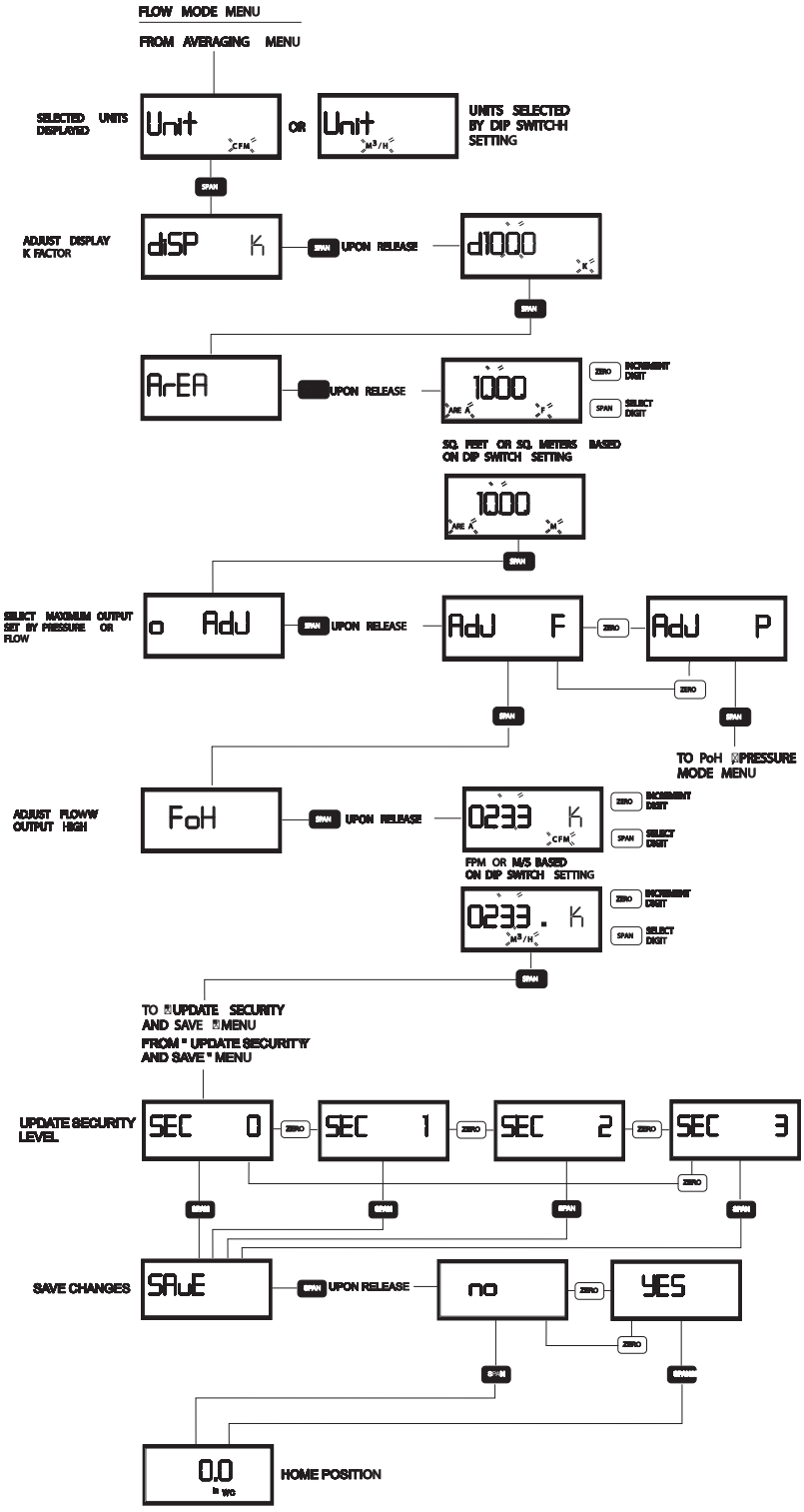
NOTICE Though the minimum possible address would be address 0 when all the dip switch positions were set to OFF, and the maximum possible address would be address 255 when all of the dip switches were set to ON, the transmitter only has valid address from 1 to 247. Any address outside of this range will give an error code.

Appendix II: Modbus® Registers

Register	Description	Data Type	Value	Range	Multi-Address Supported
0001	Pressure in 0.001 inches of water column	Signed 16Bit integer			Yes
0002	Pressure in Pascal	Signed 16Bit integer			Yes
0003-0004	Pressure in inches of water column	Float			Yes
0005-0006	Pressure in Pascal	Float			Yes
0007-0008	Pressure in mm of water column	Float			Yes
0009-0010	Pressure in kilopascals	Float			Yes
0011-0012	Velocity in feet per minute	Float			Yes
0013-0014	Velocity in meters per seconds	Float			Yes
0015-0016	Flow in cubic feet per minute	Float			Yes
0017-0018	Flow in cubic meters per second	Float			Yes
0019	Sensor Type	Unsigned 16Bit integer	0...3	0-None, 1-Hall, 2-Piezo, 3-Capcell	Yes
0020	Pressure Sensor Operational	Unsigned 16Bit integer	0...1	Operational-Nonoperational	Yes
0021-0022	Pressure Sensor Errors	Unsigned 32Bit integer	$0...2^{32}-1$	$0...2^{32}-1$	Yes
8001-8006	Modbus® Application Firmware Version	String			No
8007-8012	Sensor Application Firmware Version	String			No
8013-8018	Modbus® Application Serial Number	String			No
8019-8024	Sensor Application Serial Number	String			No


BUTTON PRESS LEGEND
ZERO = PRESS ZERO BUTTON
SPAN = PRESS SPAN BUTTON
= PRESS AND HOLD ZERO BUTTON
SPAN = PRESS AND HOLD SPAN BUTTON
ZERO SPAN = PRESS AND HOLD ZERO AND SPAN BUTTONS
MENU CONVENTIONS
IN HOME POSITION:
CALIBRATE UNIT TO ZERO PRESSURE.
CALIBRATE UNIT TO SPAN PRESSURE.
DISPLAY IS NOT NECESSARY
ZERO SPAN ENTER MENU DISPLAY
IN MENU DISPLAY:
SPAN SEQUENCES TO NEXT MAIN MENU ITEM, AND IF A MENU ITEM IS CHANGED TEMPORARILY SAVES THE SELECTION
ZERO SEQUENCES THROUGH SUB MENU SELECTIONS OR INCREMENTS DIGITS
SPAN SEQUENCE TO NEXT DIGIT. ACTIVE DIGIT WILL BLINK. 3 = BLINKING DIGIT
0.0 in WC
HOME POSITION
ZERO SPAN
WHILE BUTTONS ARE PRESSED
FACTORY SETTINGS RESTORED, THEN RETURNS TO HOME POSITION
HOLD7 SECONDS
ZERO SPAN
SECURITY LEVEL SELECTION
SECUr
FAC+
WHEN BUTTONS ARE RELEASED DISPLAYS CURRENT SECURITY LEVEIL
SECU 0
ZERO TO CHANGE SECURITY LEVEL
S 345
ZERO INCREMENT DIGIT
SPAN SELECT DIGIT
SECURITY LEVEL | SETTING
0 | 000
1 | 111
2 | 222
3 | 333
SPAN
IF SECURITY IS SET TO 0,1, OR 2
SPAN
IF SECURITY IS SET TO3
LoCK
PRESS ANY KEY OR WAIT 5 SECONDS
HOME POSITION
0.0 . in WC
MODE SELECTION PRESSURE, VELOCITY, OR FLOW
PrES
ZERO
uEL
ZERO
FLo
ZERO
SPAN
SPAN
SPAN
SPAN TO SELECT MODE
ADJUST AVERAGING
000
AVG
ZERO INCREMENT DIGIT
SPAN SELECT DIGIT
SPAN
TO 2PRESSURE, VELOCITY, OR FLOW 2MENUS


PRESSURE MODE MENU
FROM AVERAGING MENU
PoH
ADJUST PRESSURE OUTPUT HIGH
FROM " AdJ P " MENUS
SPAN
UPON RELEASE
PoH = DIP SWITCH FULL SCALE SETTING
SET PoH TO DESIRED VALUE
PoH n
ZERO
PoH y
ZERO
SPAN
SPAN
THIS MENU DEPENDS ON DIP SWITCH SETTING
288.
in WC
ZERO INCREMENT DIGIT
SPAN SELECT DIGIT
UNITS SET BY DIP SWITCH WILL BLINK
SPAN
TO " UPDATE SECURITY AND SAVE " MENU
VELOCITY MODE MENU
FROM AVERAGING MENU
SELECTED UNITS DISPLAYED
Unit
FPM
OR
Unit
M/S
UNITS SELECTED BY DIP SWITCH SETTING
SPAN
ADJUST DISPLAY K FACTOR
diSP K
SPAN
UPON RELEASE
d1000
K
SPAN
SELECT MAXIMUM OUTPUT SET BY PRESSURE OR VELOCITY
o AdJ
UPON RELEASE
AdJ u
ZERO
AdJ P
ZERO
SPAN
SPAN
TO PoH , PRESSURE MODE MENU
ADJUST VELOCITY OUTPUT HIGH
uoH
SPAN
UPON RELEASE
0233 . K
FPM
ZERO INCREMENT DIGIT
SPAN SELECT DIGIT
FPM OR M/S BASED ON DIP SWITCH SETTING
0233 . K
M/S
ZERO INCREMENT DIGIT
SPAN SELECT DIGIT
SPAN
TO " UPDATE SECURITY AND SAVE " MENU



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