installation / operation manual

ML-101
Micro Level Measurement System

COSENSE INC

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UNPACKING INSTRUCTIONS

Remove the Packing List and verify that you have received all equipment, including the following (quantities in parentheses):

Ultrasonic Level Measurement System (1)

Operator's Manual (1)

If you have any questions about the shipment, please call the COSENSE Customer Service Department. When you receive the shipment, inspect the container and equipment for signs of damage. Note any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

Note:
The carrier will not honor damage claims unless all shipping material is saved for inspection. After examining and removing contents, save packing material and carton in the event reshipping is necessary.

ML-101 SYSTEM SPECIFICATIONS

DEADBAND: _____

RANGE: _____

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SYSTEM DESCRIPTION 1

SYSTEM SPECIFICATIONS

Input Power:	15VDC - 24VDC to board
Output:	Two solid state relays, continuous output of 4-20mA (0-20mA) current output or 2-10VDC (0-10VDC) voltage output, RS-232 (PC compatible), Digital Display (Optional).
Programmability:	via RS-232, two switch banks located on board, and optional handheld display unit.
RS-232:	9600 baud, 8 data bits, 1 stop bit, no parity, full duplex, hardware handshake (RTS & CTS) available upon request.
Setpoints (Alarms):	Two solid state relays. Each alarm point can be individually set.
Operation Mode:	Distance measurement, Height measurement, and Acceptance Band (contact factory for volume measurement capabilities).
Operating Range:	0.5" to 20" (Dependent on installed sensor)
Accuracy:	±0.005" (±0 .127mm) or 0.1% of full scale (temperature compensation optional) at room temperature.
Repeatability:	±0.05% of full scale range.

SYSTEM DESCRIPTION

The Cosense model ML-101 is a state-of-the-art level measurement instrument based on the latest ultrasonic technologies. The ML-101 provides an efficient, reliable and cost-effective means of level control. The ML-101 consists of two major components: the sensor and the electronic control board.

The ML sensor is available in a variety of sizes and materials to suit virtually any application. The size of the sensor is dependent on the needed range and the material required depends on the environment in which the unit is intended to be used. Sensor materials include, but are not limited to 316SS, CPVC, Kynar and Teflon. Contact the factory for assistance in sensor selection.

PRINCIPLES OF OPERATION 2

PRINCIPLES OF OPERATION

In operation the electronics generate an electronic signal which is converted by the sensor to an ultrasonic burst. This burst is then transmitted through the air towards the target surface. When the burst reaches the surface it is reflected back to the sensor. The received echo is converted by the sensor to an electronic signal and then amplified and digitized before being sent to the microprocessor. The microprocessor uses the echo signal to calculate the transit time of the ultrasonic burst. This transit time is directly proportional to the target distance from the sensor. The microprocessor then compares the calculated values with the user programmed settings to provide the required control of the system.

SETUP CONSIDERATIONS

- The PC Board can be mounted in any position without detriment to its operation.
- The sensor should be mounted perpendicular to the surface it is detecting. An error of a few degrees from perpendicular will adversely affect the effective range of the unit.
- The sensor should be mounted in a plastic holder of some nature. Use of metal is not recommended.
- The design of the sensor mounting should be that no physical contact with the sensor face is ever encountered. While casual contact with the sensor or the sensor face has no lasting adverse effects on the sensor, contact of a forceful nature can permanently damage the sensor.
- The sensor wire should not be bent without allowing a radius of one inch or more. Bending the wire excessively can cause an internal break in the wire.
- The board should never be mounted in a sealed enclosure without adequate ventilation. The components on the board do generate heat and need air circulation for cooling.
- Be sure when connecting the DC supply lines from the power supply to observe the connection information silkscreened onto the board. Connecting the power cable or ground to the wrong terminal on the terminal block can cause permanent damage to vital components.
- When using the Temperature Compensation option, the remote temperature sensor should be mounted / placed as close to the area that actual measurements are to be performed as possible. Mounting the sensor away from the actual measurement location can result in erroneous temperature corrections being made.

PROGRAMMING SECTION

The programming section allows the user to access the parameters which are used to control the operation of the ML-101 unit. The user can access the parameters by sending the character "P" via the RS-232 connection followed by a carriage return (note the capital letter 'P'). See Appendix B of this manual for the pinout of the DB-9 connector. Pressing Escape at anytime immediately saves all parameters and returns the user to the run mode. The parameters available are, in their programming order:

1) Repetition Rate [1 - 20 ms] { 5}
2) Transmit Width Usec [0.3 - 500.0 usec] {10.0}
3) AGC Width Usec [1-190 usec] { 5}
4) Processing Mode [M = Median, A = Avg] {M}
5) Samples [5 - 50] {10}
6) Output Units [M = Millimeter, I = Inch] {I}
7) Temperature Compensation Enabled [Y = Yes, N = No] {N}
8) Use Volume Tables [Y = Yes, N = No] {N}
9) Media T/D Factor in Usec/Inch [15.00 - 500.00] {147.76}
10) Window Open in Inches [0.50 - 10.00] {2.00}
11) Window Close in Inches [1.00 - 99.99] {10.00}
12) Acquisition Mode [C = Continuous, S = Software Str,H = Hardware Str] {C}
13) Unit Output Mode [S = Standard, A = Acceptance band] {S}
14) DAC Enabled [Y = Yes, N = No] {N}
14a) On lost echo hold last value of DAC? [Y = Yes, N = No] {N}
14b) DAC Offset [Y = Yes, N = No] {N}
15) Alarm Enabled [Y = Yes, N = No] {N}
15a) Alarm 1 in Inches [1.00 - 10.00] {3.00}
15b) Alarm 2 in Inches [1.00 - 10.00] {6.00}
16) Local Display Enabled [Y = Yes, N = No] {N}
17) Distance Correction In Inches (0.000-1.000)

1) REPETITION RATE

The Repetition Rate parameter controls the frequency at which readings are taken. The lower the value of the Rep Rate parameter, the more often a reading will be taken. The higher the value of the Rep Rate, the less often a reading will be taken. This parameter directly reflects the perceived speed of the unit.

VALID SETTINGS: from 1 to 20 msecs
FACTORY DEFAULT: 5 msecs

2) TRANSMIT WIDTH (FACTORY SET)

The transmit width parameter controls the width of the pulse which is sent from the face of the sensor to the target and then reflected back. The wider the width the more signal which is then reflected back to the sensor. The width is set according to the type of sensor being used and the application.

VALID SETTINGS: from 0.3 to 500.0 µsecs
FACTORY DEFAULT: 10 µsecs

3) AGC WIDTH (FACTORY SET)

The AGC width parameter controls the time at which the automatic gain is used in controlling the signals at the sensor face. The lower the value of the AGC parameter, the more signal will be seen as a receive signal from the sensor. The higher the value of the AGC parameter, the less signal will be observed at the sensor face.

VALID SETTINGS: from 1 to 190 µsecs
FACTORY DEFAULT: 10 µsecs

4) PROCESSING MODE

Data Averaging is used to smooth raw data for output. It is usually desirable to use an averaging method to produce good results. The two methods available are median and average. The median method collects the number of samples set in the Samples parameter, sorts them and selects the value which represents the middle of all values (i.e. where half the samples are above and half the samples are below the median value.) The average method collects the number of samples specified in the Samples parameter and takes an average of all of these samples. You can see that when using the average method that even erroneous readings are included in the data.

VALID SETTINGS: M = MEDIAN or A = AVERAGE
FACTORY DEFAULT: M = MEDIAN

5) SAMPLES

The Samples parameter dictates the number of samples which will be used in the processing method selected. The range of the number of samples will depend on which processing method is chosen. For the median method the number of samples will range from 1 to 15. For the averaging method the range will be from 1 to 250.

VALID SETTINGS: for Median 1 to 15, for Average 1 to 250
FACTORY DEFAULT: 10

6) OUTPUT UNITS

The Output Units parameter dictates in what units the system will report the readings. Currently the choices are millimeters and inches. The millimeters setting reports readings in the format XXX.XXX. The inches setting formats its output as XX.XXX.

VALID SETTINGS: M = MM, I = INCHES
FACTORY DEFAULT: M = MM

7) TEMPERATURE COMPENSATION ENABLED (OPTIONAL)

The Temperature Compensation parameter allows the unit to operate with or without using temperature compensation. Temperature Compensation is valuable if the measurements to be made are in an atmosphere where the temperature is not maintained at a controlled temperature. Setting the Temperature Compensation parameter to yes indicates that a temperature probe has been attached and the probe is located such that it senses the temperature in the environment in which the measurements are to be made. Setting the Temperature Compensation parameter to yes when no temperature probe is connected will yield erroneous readings. Temperature compensation should only be enabled

when performing measurements through air. Temperature compensation should be set to NO if no temperature probe is present or if measurements are being done through a medium other than air.

VALID SETTINGS: Y = YES, N = NO
FACTORY DEFAULT: N = NO

8) USE VOLUME TABLES (CONSULT FACTORY)

Volume tables is a feature which allows the ML-101 to automatically convert a distance reading to a volume output. This eases any computations which would otherwise have to be done by the receiving computer. In conjunction with the local display, this feature can eliminate the need for any external processing to produce true volume measurements of non-cylindrical tanks. NOTE: When using volume tables the normal distance measurement will not be displayed on the RS-232 output. Instead a calculated value based on the entered volume table will be displayed. Use of the volume table is further explained in the volume calculations section.

VALID SETTINGS: Y = YES, N = NO
FACTORY DEFAULT: N = NO

9) MEDIA T/D FACTOR (FACTORY SET)

The Media T/D Factor parameter lets the operator enter in a specific Time/Distance factor for the medium in which measurements are to be made. This parameter will not appear if temperature compensation is enabled (Air is assumed). Setting the Media T/D Factor to a lower value indicates that the medium being used allows sound to travel faster than in air. Setting the Media T/D Factor to a higher value indicates that the medium being used allows sound to travel slower than in air. NOTE: Enabling the temperature compensation parameter automatically resets the Media T/D Factor to that in air at sea level (147.76 µsecs/inch).

VALID SETTINGS: from 15.0 to 500.0 µsecs/inch
FACTORY DEFAULT: 147.76 µsecs/inch

10) RECEIVE WINDOW OPEN (FACTORY SET)

The Receive Window Open parameter signifies the time at which a received pulse is recognized as a return, or stop signal. Only after the Receive Window Open value and before the Receive Window Close value will a pulse be detected as a return signal and therefore be recognized as a stop signal. The Receive Window Open needs to be greater than the ringing of the sensor. If the Receive Window Open parameter is set too small then erroneous results will be reported. This has a direct correlation to the type of sensor and the setting of the Transmit Width parameter.

VALID SETTINGS: from 0.50 to 10.00 inches
FACTORY DEFAULT: 2.00 inches

11) RECEIVE WINDOW CLOSE (FACTORY SET)

The Receive Window Close parameter signifies the time at which a received pulse is no longer recognized as a return, or stop signal. After the Receive Window Close value a pulse is no longer detected as a return signal and is therefore not recognized as a stop signal. The Receive Window Close needs to be greater than

the maximum distance you wish to measure, otherwise erroneous results will be reported for distance.

VALID SETTINGS: from 1.00 to 99.99 inches
FACTORY DEFAULT: 10.00 inches

12) ACQUISITION MODE

The Acquisition Mode parameter selects how and when readings are to be taken. When the Mode parameter is set to Continuous then readings are performed at the rate specified by the Rep Rate parameter and all enabled outputs are written to or updated (RS232, local display, current output, voltage output, relay outputs). When the acquisition mode parameter is set to Software Strobe, then the unit waits for a strobe input (command "P") to the unit to perform a reading. When the acquisition mode parameter is set to Hardware Strobe, then the unit waits for a strobe input from hardware strobe input to perform a reading.

VALID SETTINGS: C = CONTINUOUS, S = SOFTWARE STROBE,
H = HARDWARE STROBE
FACTORY DEFAULT: C = CONTINUOUS

13) UNIT OUTPUT MODE (FACTORY SET)

The Unit Output Mode parameter determines how the unit will process the readings gathered and control the relay outputs. The Standard Mode setting allows the user to enter the zero point and active span for the current and voltage outputs for the unit using the two banks of switches located on the electronics board. In the Acceptance Band Mode the setpoint is set by the first bank of switches on the electronics board in the format X.XX (using inches) or XXX (using millimeters). The acceptance band is set by the second bank of switches in the format .XXX (using inches) or XXX (using millimeters). In Acceptance band mode the relays are complementary. One will always be off when the other is on. When the target falls outside the acceptance band both relays will change state. See sections for more details on modes and analog output setup.

VALID SETTINGS: S = STANDARD, A = ACCEPTANCE BAND
FACTORY DEFAULT: S = STANDARD

14) DAC ENABLED

The DAC Enabled parameter allows the operator to turn on and off the use of the current (4-20mA or 0-20mA) and voltage (2-10VDC or 0-10VDC) outputs. If working in Acceptance band mode then the DAC Enabled parameter will not be shown and no current or voltage output will be available. NOTE: Even with this parameter set to No (off) there will still be a current or a voltage on the outputs, although its value will be meaningless.

VALID SETTINGS: Y = YES, N = NO
FACTORY DEFAULT: N = NO

14a) ON LOST ECHO HOLD LAST VALUE OF DAC

This parameter allows the operator to select the desired function of the DAC when a lost echo condition occurs. A lost echo condition can occur due to sloshing of liquid, air currents, or a number of other conditions. With this parameter set to No the DAC output will swing to the full scale extreme. With this parameter set to Yes the DAC output will remain at its last value for which a valid reading was received.

VALID SETTINGS: Y = YES, N = NO
FACTORY DEFAULT: N = NO

14b) DAC OFFSET
The DAC Offset parameter allows the operator to select the desired scaling for the current and voltage outputs. With the DAC Offset parameter set to No the current output observed on the current output terminal block will be 0-20mA and the voltage output observed on the voltage output terminal block will be 0-10VDC. With the DAC Offset parameter set to Yes the current output observed on the current output terminal block will be 4-20mA and the voltage output observed on the voltage output terminal block will be 2-10VDC. If working in Acceptance band mode then the DAC Offset parameter will not be shown and no current or voltage output will be available.

VALID SETTINGS: Y = YES, N = NO
FACTORY DEFAULT: N = NO

15) ALARM ENABLED
The Alarm Enabled parameter allows the operator to turn on and off the use of the relay outputs. When the Alarm Enabled parameter is set to No, the relays will always be in an off state. If working in Acceptance band mode then the Alarm Enabled parameter will not be shown and no alarms will be available.

VALID SETTINGS: Y = YES, N = NO
FACTORY DEFAULT: N = NO

15a) ALARM 1 IN INCHES
Alarm 1 can be set when operating in standard mode and when the measured distance exceeds the alarm point, relay K1 will turn on. When the measured distance does not exceed the alarm point or when there is no return echo the relay K1 will turn off.

VALID SETTINGS: from 1.00 to 10.00 inches
FACTORY DEFAULT: 3.00 inches

15b) ALARM 2 IN INCHES
Alarm 2 can be set when operating in standard mode and when the measured distance exceeds the alarm point, relay K2 will turn on. When the measured distance does not exceed the alarm point or when there is no return echo the relay K2 will turn off.

VALID SETTINGS: from 1.00 to 10.00 inches
FACTORY DEFAULT: 6.00 inches

16) LOCAL DISPLAY ENABLED (OPTIONAL)
The Local Display Enabled parameter allows the output of the displayed distance onto an external LED display (optional). Setting this parameter to Yes allows the microprocessor to output to the external display. Setting the Local Display Enabled parameter to No disables this feature and the external display will not show any readings.

VALID SETTINGS: Y = YES, N = NO
FACTORY DEFAULT: N = NO

This section will describe in detail the standard functions and applications for the features of the ML-101. The ML-101 has been designed with many years of customer requested features built-in to serve the widest range of customer applications.

Acceptance Band Mode (FACTORY SET - PROGRAMMING SECTION 13)

The acceptance band mode of operation allows the setting of a tolerance band (acceptance band) around a predetermined reference point (setpoint), or center band. This can be useful for operations such as test tube or vial filling, or "Go/No-Go" material thickness inspection.

The acceptance band mode is selected from the programmable parameters screen via the RS-232 connection (see programming section) under the Unit Output Mode parameter. When the acceptance band mode is selected, the reference point (setpoint) is set via the first bank of BCD switches labeled 'Z'.

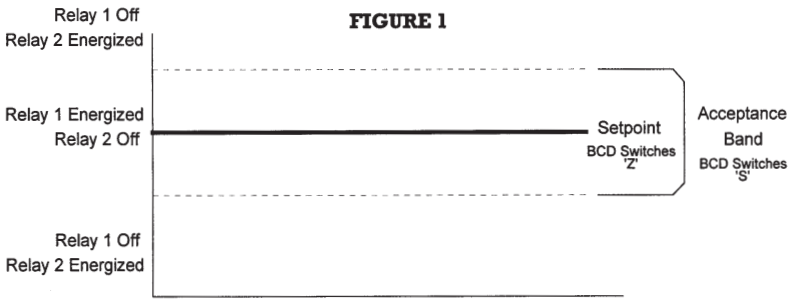
1) When the requested Output Units is inches, the first switch bank is read as XX.X inches. This allows a setpoint of 00.0 to 99.9 inches. When the requested Output Units is millimeters, the first switch bank is read as XXX millimeters. This allows a setpoint of 000 to 999 millimeters.

2) To set the tolerance (or acceptance band) around the previously determined setpoint use the second bank of switches, labeled 'S'. When the requested Output Units is inches, the second bank of BCD switches is read as .XXX inches. This allows an acceptance band of .000 to .999 inches. When the requested Output Units is millimeters, the second switch bank is read as X.XX millimeters. This allows an acceptance band of 0.00 to 9.99 millimeters.

3) Relay 1 (K1) is energized when the target is within the acceptance band.

Conversely, relay 2 (K2) is energized when the target is outside of the acceptance band. See Figure 1.

FIGURE 1



Setting and Using the DAC Output (Current and Voltage Output)

The current and voltage output of the ML-101 is supplied on two terminal blocks located on the edge of the board (see Appendix A for the board layout and wiring diagram). The current and output voltages both represent the height or distance seen by the unit.

NOTE: If Acceptance Band mode is selected in the Unit Output Mode then the current and voltage output terminals will not function and will be set to a steady, but unknown value between the lower and upper limits.

In order to use the current or voltage output you must enable the DAC output by setting the DAC Enabled parameter to Yes. The DAC Offset parameter needs to

be set to Yes or No depending on the desired output range (see below). The choices between these current and voltage ranges is set by the DAC Offset parameter and the Height/Distance Jumper (JP2). The Height/Distance Jumper is located near the RS-232 connector (J2). See Appendix A for the board layout and location of components. See Figure 2 for a pictorial of the use of the DAC Output options.

The **Zero** point and **Span** for the DAC output are set using the two sets of BCD switches located on the PC board. The **Zero** point is set via the first BCD switch bank labeled 'Z'. When the requested Output Units is **inches,** the first switch bank is set as XX.X inches which allows a **Zero** point of 00.0 to 99.9 inches. When the requested Output Units is **millimeters,** the first BCD switch bank is set as XXX millimeters which allows a **Zero** point of 000 to 999 millimeters. The **Span** is set via the second BCD switch bank labeled 'S'. When the requested Output Units is **inches,** the second switch bank is set as XX.X inches which allows a **Span** of 00.0 to 99.9 inches. When the requested Output Units is **millimeters,** the second BCD switch bank is set as XXX millimeters which allows a **Span** of 000 to 999 millimeters.

For Current Output:

1) Set the Height Distance Jumper (JP2) to the desired operation (H or D).

2A) With the Height/Distance Jumper (JP2) set to Distance (D):

a) Setting the DAC Offset parameter to **No** will use the 0mA to 20mA range.

b) Setting the DAC Offset parameter to **Yes** will use the 4mA to 20mA range.

2B) With the Height/Distance Jumper (JP2) set to Height (H):

a) Setting the DAC Offset parameter to **No** will use the 20mA to 0mA range.

b) Setting the DAC Offset parameter to **Yes** will use the 20mA to 4mA range.

For Voltage Output:

1) Set the Height Distance Jumper (JP2) to the desired operation (H or D).

2A) With the Height/Distance Jumper (JP2) set to Distance (D):

a) Setting the DAC Offset parameter to **No** will use the 0VDC to 10VDC range.

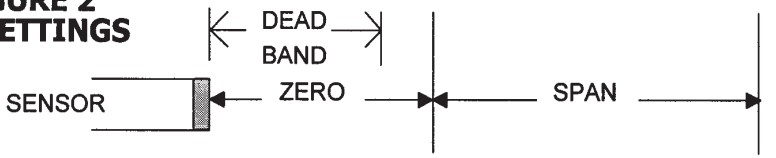
b) Setting the DAC Offset parameter to **Yes** will use the 2VDC to 10VDC range.

2B) With the Height/Distance Jumper (JP2) set to Height (H):

a) Setting the DAC Offset parameter to **No** will use the 10VDC to 0VDC range.

b) Setting the DAC Offset parameter to **Yes** will use the 10VDC to 2VDC range.

FIGURE 2
DAC SETTINGS



HEIGHT MODE (w/offset):	20mA (20mA) 10V (10V)	0mA (4mA) 0V (2V)
DISTANCE MODE (w/offset):	0mA (4mA) 0V (2V)	20mA (20mA) 10V (10V)

NOTE: The Zero and Span points are independent from the Window Open and Window Close parameters.

NOTE: Output either current (current mode) or voltage (voltage mode). Both outputs are not available, and should not be used, simultaneously.

Using the Alarms (Relay Outputs)

The alarms for the ML-101 can only be set via the RS-232 communications port. Accessing the parameters screen allows the user to enable the alarm relays by setting the Alarm Enabled parameter to Yes. Once enabled the parameters screen shows two additional parameters, Alarm 1 in Inches*, and Alarm 2 in Inches*. These alarm points will control the two on board relays. When the observed distance is less than the alarm point, the relay will be off or de-energized (open contacts). When the observed distance is more than the alarm point, the relay will be on or energized (closed contacts). When the alarm points are disabled, Alarm Enabled set to No, both relays will be de-energized (open contacts).

* = alarm point settings will be in millimeters when Output Units is set to millimeters.

Strobe Modes (Hardware & Software) vs. Continuous Output

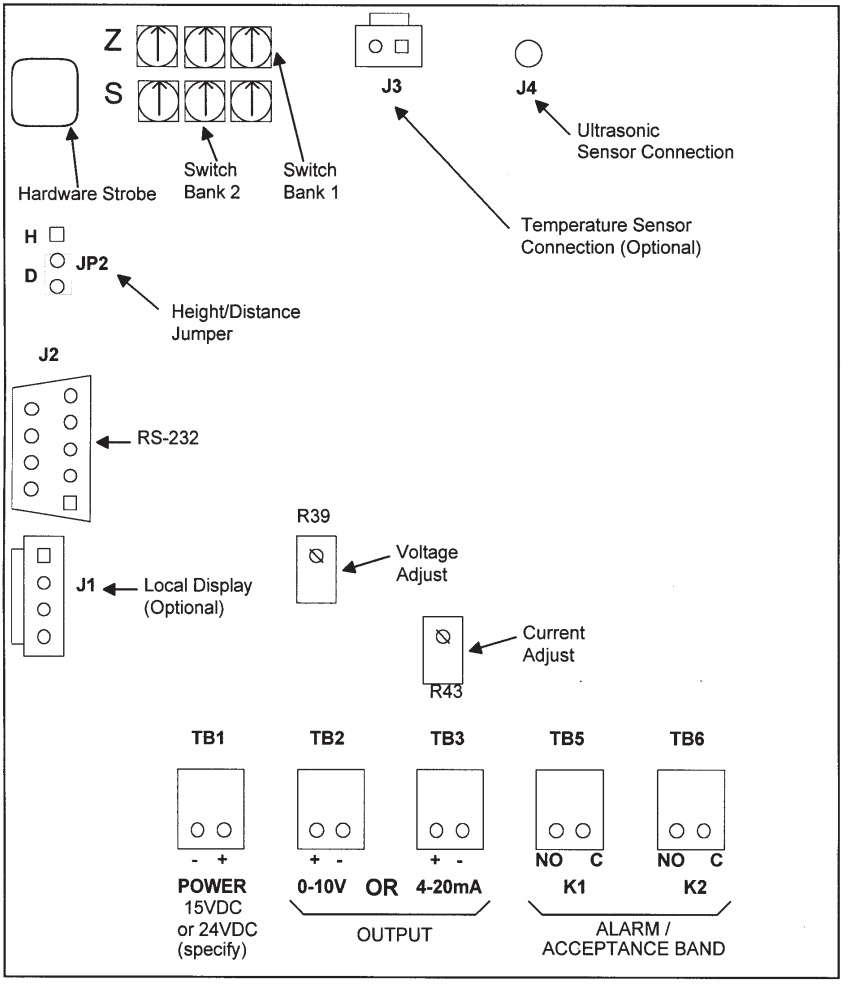
The use of the ML-101 is accomplished in one of two ways. Continuous operation allows the unit to run continuously at the set repetition rate and outputting the results in a constant manner. Selecting one of the strobe modes allows an outside device to dictate when a reading will be taken and output. The two types of strobes are discussed further below.

The **Software Strobe** is used when it is desired for the data collection computer to signal the ML-101 board when to take a reading. A software strobe is initiated when the computer sends the "S" character followed by a carriage return (note the capital "S") to the ML-101 unit. The ML-101 then processes a single reading according to the parameters set and outputs the results as per those parameters. The ML-101 will then enter an idle mode where no updating or outputting will result until the next software strobe or another valid RS-232 command is received.

The **Hardware Strobe** is very similar to the software strobe. The ML-101 unit acts in the same manner when receiving a hardware strobe as it does when receiving a software strobe. The hardware strobe is a signal hardwired to the ML-101 board (see Appendix A for board layout and wiring diagram) and triggers the unit to perform a reading according to the parameters set and outputs the results as per those parameters. The hardware strobe is a normally high line (+5VDC) which is pulled low (<0.2VDC) to initiate a hardware strobe signal. This line must be held low for a minimum of 10 milliseconds and must be released high and allowed to remain high for a minimum of 10 milliseconds before another hardware strobe sequence can be initiated.

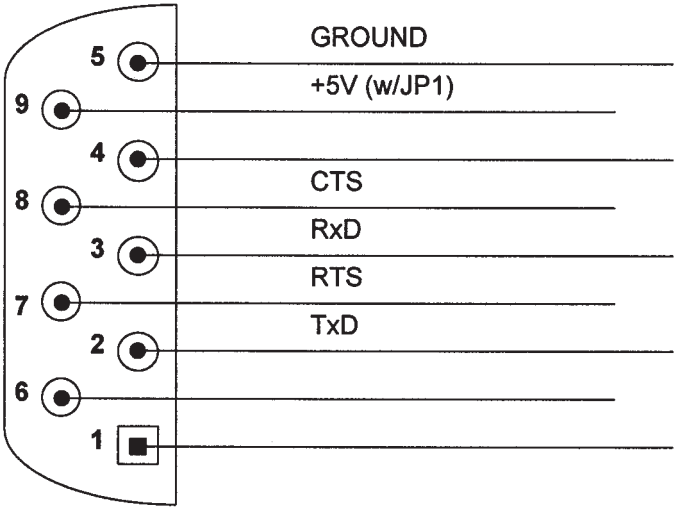
APPENDIX A

Board Layout and Wiring Diagram



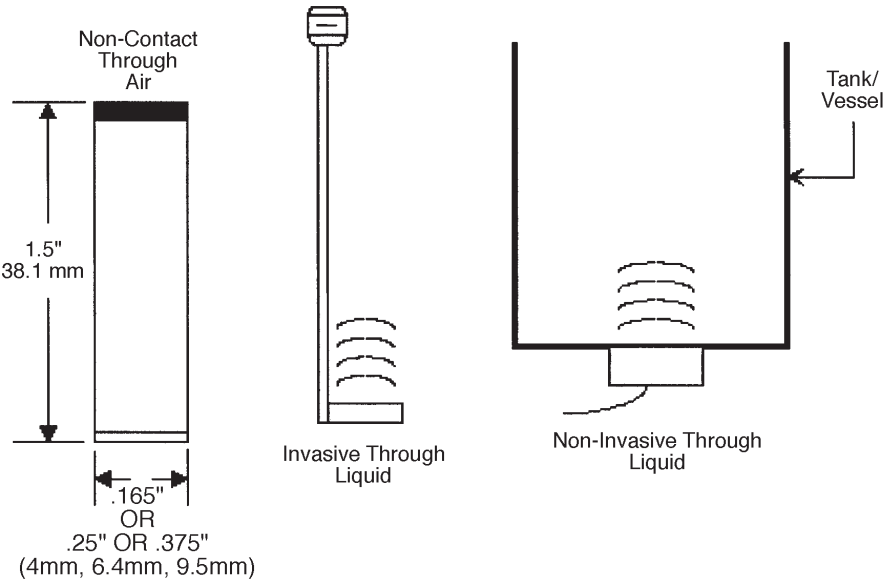
APPENDIX B

DB9 (RS232) Connector (J2)



APPENDIX C

Sensor Dimensions



Housings

1) Plastic
2) Epoxy
3) Teflon
4) 316 SS

w/Optional

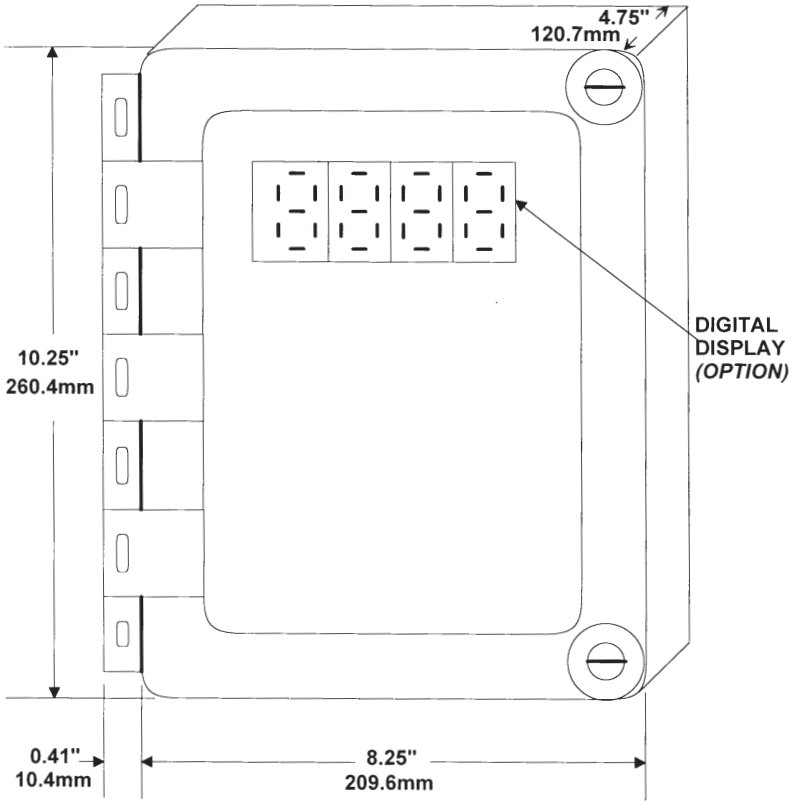
1) Connector
2) NPT Thread Specify

Consult Factory For Part Numbers On Specific Sensors

APPENDIX D

Enclosure Dimensions

ENCLOSURE MATERIAL: STAINLESS STEEL (NEMA 4)
FIBERGLASS (NEMA 4X)



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All components of Cosense Inc. are warranted to be free from defects in material and workmanship for a period of eighteen months from the date of shipment to the original purchaser. This warranty applies to general purchaser and to components installed, serviced and operated according to Cosense Installation Manuals. Cosense will repair or replace, at its option, F.O.B. at its plant or any other location designated, any part which proves to be defective in manufacture or workmanship.

All claims must be made within the warranty period. No claims outside of the warranty period will be honored.

Warranties are not applied to any components which have been damaged by improper installation, exposure to unusual atmospheric conditions or components which have been mis-used, misapplied, abused and/or damaged by neglect or accident. This warranty shall not apply to any components which may have been altered or repaired without the prior written consent of Cosense.

Cosense assumes no responsibility or liability for any labor, material, or back charges, without written authorization. Any products returned must be with prior written authorization.

The foregoing is in lieu of all other warranties, expressed or implied, including any warranties of merchantability and/or for fitness for particular purpose. Cosense assumes no other liabilities expressed or implied. Cosense shall not be liable for normal wear and tear, nor for direct, incidental or consequential damages. In no event shall Cosense's liability exceed the price of its product at the time of purchase.

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