ADVANCED TECHNICAL MANUAL ATM 076-0001

ML-11/ML-01/ML-02 SERIES

System specifications

Input Power:	24VDC to board
Output:	Two solid state relays, one continuous output of 4-20mA current output or 0-10VDC voltage output (ML-11 only), RS-232 (PC compatible), Digital LED Display (Optional).
Programmability:	via RS-232
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 in one of two different modes.
Operation Mode:	Distance measurement, Height measurement, and Acceptance Band
Operating Range:	0.5" to 5"
Accuracy:	±0.0075" (±0.19mm) or ±0.15% of measured range at constant room temperature
Repeatability:	±0.05% of full-scale range.

System description

The TE model ML-01/ML-02/ML-11 is a state-of-the-art level measurement instrument based on the latest ultrasonic technologies. The ML-01/ML-02/ML-11 provides an efficient, reliable and cost-effective means of level control. The ML-01/ML-02/ML-11 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 are 316SS or epoxy. Contact the factory for assistance in sensor selection.

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's 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 design of the sensor mounting should be that no physical contact with the sensor face. 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 sensor should be mounted in a plastic holder of some nature. Use of metal is not recommended.
- 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.

Customer programming

The customer programming section allows the user to access the parameters which are used to control the operation of the ML-01/ML-02/ML-11 unit. The user can access the parameters by sending the character "P" via the RS-232 connection followed by a carriage return. See Appendix D of this manual for the pinout of the DB-9 connector. The parameters available are, in their programming order:

1) Acquisition Mode [C = Continuous, S = Software Str, H = Hardware Str] {C}
2) Output Units [M = Millimeter, I = Inch] {M}
3) Alarm Enabled [Y = Yes, N = No] {N} (if No, then skips to item 8)
4) Alarm Output Mode [S = Standard, A = Acceptance band] {S} 5)
5) Alarm 1 in Millimeters [10.00 – 3810.00] {38.10}
6) Alarm 2 in Millimeters [10.00 – 3810.00] {50.80}
7) Alarm Hysteresis in Millimeters [0.00 – 25.00] {2.54}
   4A) Alarm Output Mode [S = Standard, A = Acceptance band] {A}
   4B) Setpoint in Millimeters [12.70 – 3810.000] {38.10}
   4C) Acceptance Band in Millimeters [0.025 – 254.00] {2.54}
8) DAC output Mode [D = Distance, H = Height] {D}
9) Zero DAC Range in Millimeters [5.0 – 3810.00] {15.00}
10) Span DAC Range in Millimeters [5.0 – 3810.00] {150.0}
11) On lost echo hold last value of DAC? [Y = Yes, N = No] {Y}

NOTE: P/N: 17623 is available only with display and alarms.

1) 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

2) Output units

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

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

3) Alarm enabled

The Alarm Enabled parameter allows the operator to turn on and off the use of the relay out- puts. When the Alarm Enabled parameter is set to No, the relays will always be in an off state. If the Alarm Output Mode is set to Acceptance band then the Alarm 1 parameter will not be shown, and Alarm 1 will act as a master output alarm as described in the Acceptance Band Mode section.

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

4) Alarm output mode

The Alarm 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. In the Acceptance Band Mode, the setpoint is the midpoint value of the acceptable range. The acceptance band is the 'tolerance' around the setpoint and is set in the format .XXX (using inches) or XXX (using millimeters). In Acceptance band mode the relays are complementary. One will al- ways be off when the other is on. When the target falls outside of the acceptance band, both relays will change state.

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

5) Alarm 1 in millimeters (only shown in standard alarm output mode)

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 10.00 to 3810.00 Millimeters
FACTORY DEFAULT: 38.10 Millimeters

6) Alarm 2 in millimeters

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 25.40 to 254.00 Millimeters
FACTORY DEFAULT: 50.80 Millimeters

7) Alarm hysteresis

When the alarm is in standard mode, this parameter is used to prevent undesired relay “clacking” that may occur under certain conditions. These conditions arise if the target is extremely close to the alarm setpoint and having slight variations in measured distance. This can be caused by waves on a liquid surface or mechanical vibrations in the measuring system.

VALID SETTINGS: from 0.00 to 25.40 Millimeters
FACTORY DEFAULT: 2.54 Millimeters

7A) setpoint in millimeters (only shown in acceptance band mode)

The setpoint is the theoretical target point for the system. Together with the Acceptance Band parameter, this allows a simple Go-No/Go output to be implemented for fill verification or tolerance on other applications.

VALID SETTINGS: from 12.70 to 3810.00 Millimeters FACTORY DEFAULT: 38.10 Millimeters

7B) Acceptance band in millimeters (only shown in acceptance band mode)

The acceptance band is a theoretical plus/minus from the setpoint which is allowable for your application. Any target reading greater than ‘setpoint + acceptance band’ or less than ‘set- point - acceptance band’ would be reported as “out of band” or out of tolerance.

VALID SETTINGS: from 0.0254 to 254.00 Millimeters
FACTORY DEFAULT: 2.54 Millimeters

8) DAC output mode

The DAC Output Mode controls how the current / voltage output is used. When set to Distance mode, the Zero point (nearest the sensor face) will be 4mA and the Span + Zero point will be 20mA. When used in Height mode, the Zero point will be 20mA and the Span + Zero point will be 4mA.

VALID SETTINGS: D = Distance or H = Height
FACTORY DEFAULT: D = Distance

9) Zero DAC range

This is the distance from the face of the sensor at which the current output will read 4mA in Distance Mode, or 20mA in Height mode.

VALID SETTINGS: from 5.00 to 3810.00 Millimeters
FACTORY DEFAULT: 30.50 Millimeters;

10) SPAN DAC RANGE

The point from the zero point at which the current output will read 20mA in Distance Mode, or 4mA in Height mode.

VALID SETTINGS: from 5.00 to 3810.00 Millimeters
FACTORY DEFAULT: 25.40 Millimeters

11) 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 cur- rents, 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

Factory programming

Consult factory for any modification

The factory programming section allows the user to access the parameters which are used to control the operation of the ML-01/ML-02/ML-11 unit. The user can access the parameters by sending the character "F" via the RS-232 connection followed by a carriage return. See Appendix D of this manual for the pinout of the DB-9 connector. The parameters available are, in their programming order:

12) Repetition Rate [1 - 50 ms] {10}
13) Processing Mode [M = Median, A = Avg] {M}
14) Samples [5 - 500] {250}
15) Temperature Compensation Enabled [Y = Yes, N = No] {N}
16) Sensor Frequency in Mhz [0.5 – 2.250] {0.700}
17) Transmit Width Usec [0.3 - 100.0 usec] {5.0}
18) AGC Width Usec [1-190 usec] {10}
19) Window Open in Millimeters [2.54 – 254.00] {12.70}
20) Window Close in Millimeters [25.40 – 2540.00] {254.00}
21) DAC Mode Current or Voltage [I = Current, V = Voltage] {I}
22) Number of Decimal Places [1 – 5] {3}

12) 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 50 msecs
FACTORY DEFAULT: 5 msecs

13) 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

14) 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 5 to 500. For the averaging method the range will be from 1 to 500.

VALID SETTINGS: from 5 to 500 (median) or 1 to 500 (average)
FACTORY DEFAULT: 10

15) 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: Y = YES

16) SENSOR FREQUENCY IN MHZ

The ML-01/ML-02/ML-11 is a factory set parameter and controls the transmit frequency of the unit. Normally, this parameter should never be changed by the operator/user. This value should only be changed if told to do so by TE.

VALID SETTINGS: from 0.5 to 2.25 MHz
FACTORY DEFAULT: 0.714 MHz

17) Transmit width

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 greater the signal is that is 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 100.0 µsecs
FACTORY DEFAULT: 10.0 µsecs

18) AGC width

The AGC width parameter controls the time at which the automatic gain is used in control- ling 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 350 µsecs
FACTORY DEFAULT: 50 µsecs

19) Window open

The Window Open parameter signifies the time at which a received pulse is recognized as a return or stop signal. Only after the Window Open value and before the Window Close value will a pulse be detected as a return signal and therefore be recognized as a stop signal. The Window Open needs to be greater than the ringing of the sensor. If the 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 2.54 to 254.00 Millimeters
FACTORY DEFAULT: 50.80 Millimeters;

20) Window close

The Window Close parameter signifies the time at which a received pulse is no longer recognized as a return or stop signal. After the Window Close value, a pulse is no longer detected as a return signal and is therefore not recognized as a stop signal. The 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 25.4 to 2540.00 Millimeters
FACTORY DEFAULT: 254.00 Millimeters;

21) DAC mode current or voltage

The DAC Mode parameter allows the operator to select the use of the current or voltage out- put. If current mode is selected, then the analog output from the unit will be 4-20mA. If voltage mode is selected, then the analog output will be 0-10VDC. Note that when in current mode that an offset is used to provide the 4mA point.

VALID SETTINGS: I = CURRENT, V = VOLTAGE
FACTORY DEFAULT: I = CURRENT

22) Number of decimal places

The Number of Decimal Place parameter allows the operator to select the number of decimal places to display on the optional LED display. This parameter has no effect on the data pro- vided via the RS-232.

VALID SETTINGS: from 1 to 5
FACTORY DEFAULT: 3
WINDOW OPEN

This section will describe the standard functions and applications for the features of the ML- 01/ML-02/ML-11. The ML-01/ML-02/ML-11 has been designed with many years of customer re- quested features built-in to serve the widest range of customer applications.

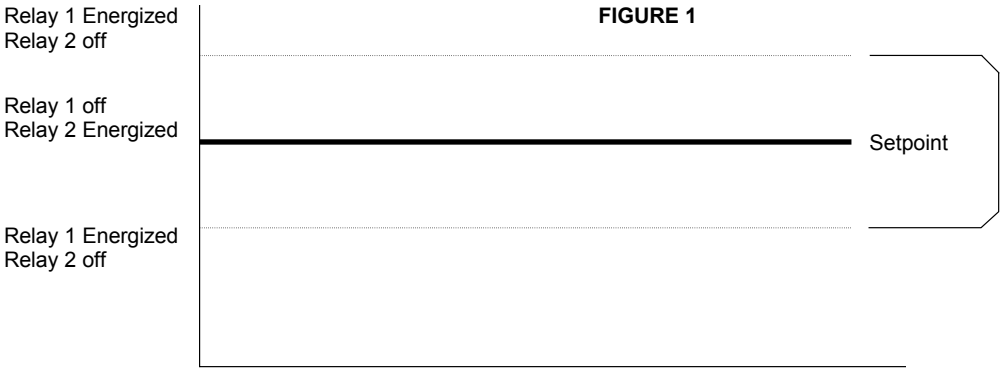
Acceptance Band Mode

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 Alarm Output Mode parameter. When the acceptance band mode is selected, the reference point (setpoint) is set via the **Setpoint** parameter.

To set the tolerance (or acceptance band) around the previously determined setpoint use the **Acceptance Band** parameter.

Alarm Relay 1 is energized when the target is outside the acceptance band. Conversely, Alarm Relay 2 is energized when the target is inside of the acceptance band. See Figure 1.

FIGURE 1



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

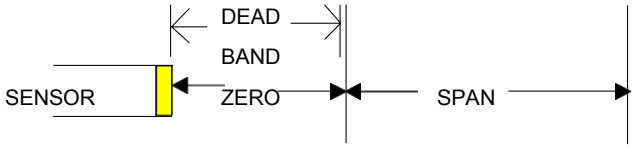
The current and voltage output of the ML-01/ML-02/ML-11 is supplied on two of the pins of the input/output terminal block located on the edge of the board (see Appendix A, B or C for the power/output connector wiring diagram of the ML-01, ML-02 or ML-11 unit respectively). The current and output voltages both represent the height or distance seen by the unit. The current or volt- age output is a linear function of the measured distance.

In order to use the current or voltage output you must enable the DAC output by setting the DAC Enabled parameter to **Yes** in the F-Menu. The choices between these current and voltage off- sets (V or I) are set automatically by the DAC Output mode parameter in the F-Menu. 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 ZERO DAC RANGE and SPAN DAC RANGE parameters. The **Zero** point is set via the ZERO DAC RANGE parameter in the selected output units. The **Span** is set via the SPAN DAC RANGE parameter in the selected output units.

FIGURE 2

DAC OUTPUT 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, Span and Dead Band points are independent from the Window Open and Window Close parameters.

Using the Alarms (Relay Outputs)

The alarms for the ML-01/ML-02/ML-11 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 Millimeters*, and Alarm 2 in Millimeters*. These alarm points will control the two on-board relays. When the observed distance is equal to or less than the alarm point, the relay will be ON or energized (closed contacts). When the observed distance is more than the alarm point, the relay will be OFF or de-energized (open 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 Inches when Output Units is set to Inches.

Strobe Modes (Hardware & Software) vs. Continuous Output

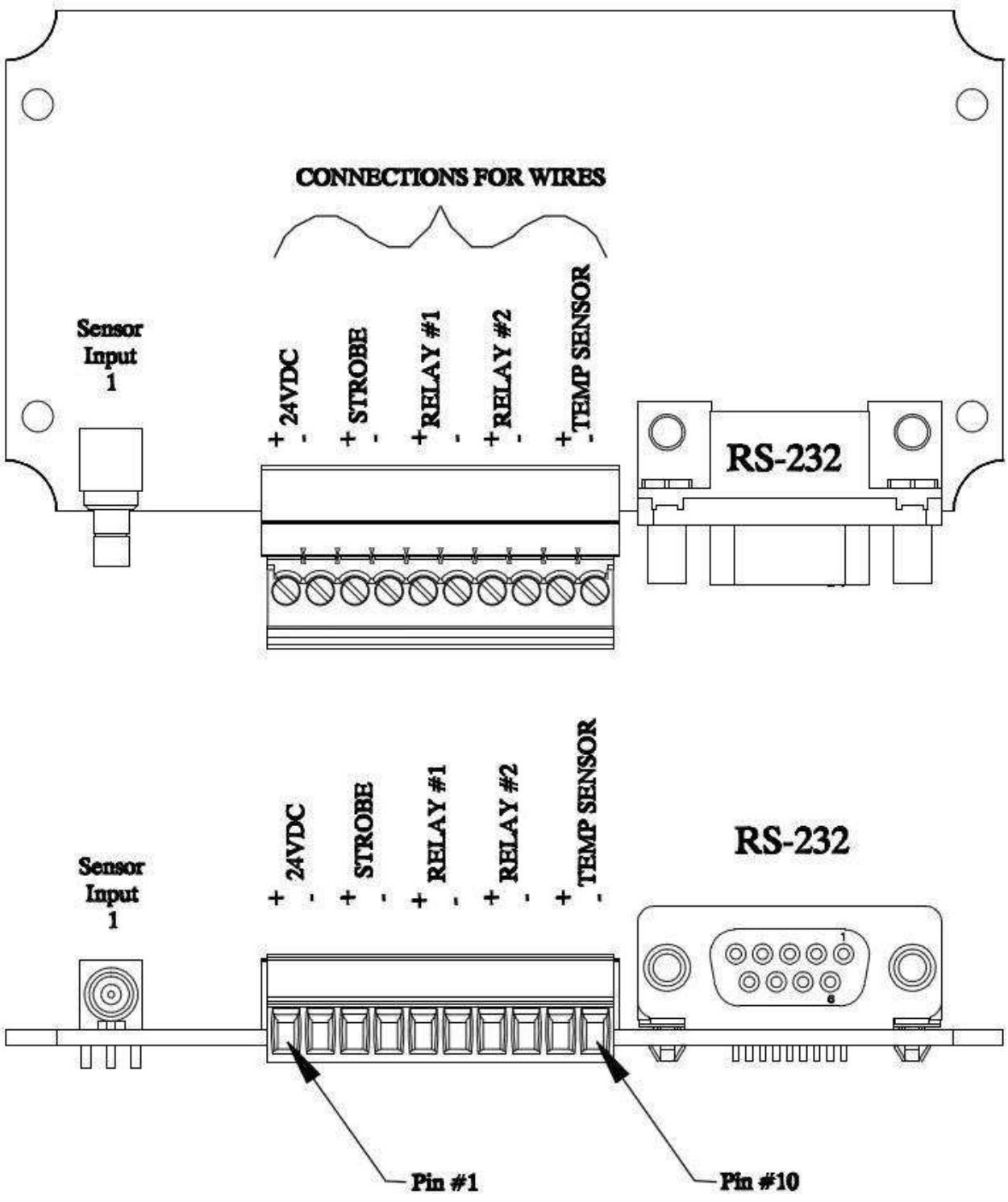
The use of the ML-01/ML-02/ML-11 is accomplished in one of two ways. Continuous operation allows the unit to run continuously at the set repetition rate and outputting the results in a constant manner. Selecting one of the strobe modes allows an outside device to dictate when a reading will be taken 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-01/ML-02/ML-11 board when to take a reading. A software strobe is initiated when the computer sends the “s” or “S” character followed by a carriage return to the ML-01/ML-02/ML-11 unit. The ML-01/ML-02/ML-11 then processes a single reading according to the parameters set and outputs the results as per those parameters. The ML-01/ML-02/ML-11 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** behaves very similar to the software strobe. The ML-01/ML-02/ML-11-unit acts in the same manner when receiving a hardware strobe as it does when receive a software strobe. The hardware strobe is a signal hardwired to the ML-01/ML-02/ML-11 board (see Appendix A, B or C for the wiring diagram for the ML-01, ML-02 or ML-11 unit respectively) 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 low line (<0.2 VDC) which is pulled high (+2.5VDC to 5VDC) to initiate a hardware strobe signal. This line must be held high for a minimum of 10 milliseconds and must be released low and allowed to remain low for a minimum of 10 milli- seconds before another hardware strobe sequence can be initiated.

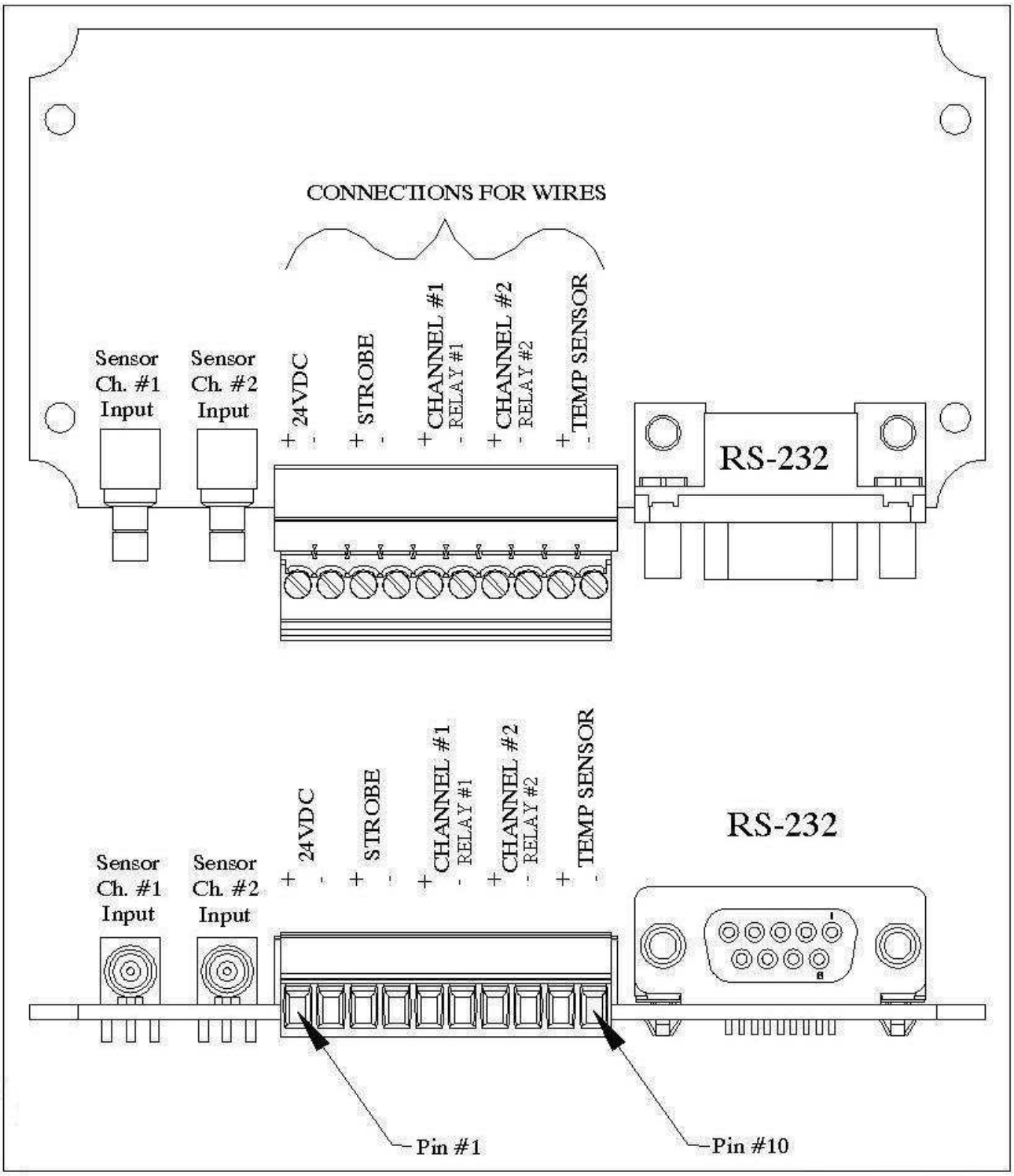
APPENDIX A – ML-01

Power and Output Connector Wiring Diagram of PCB



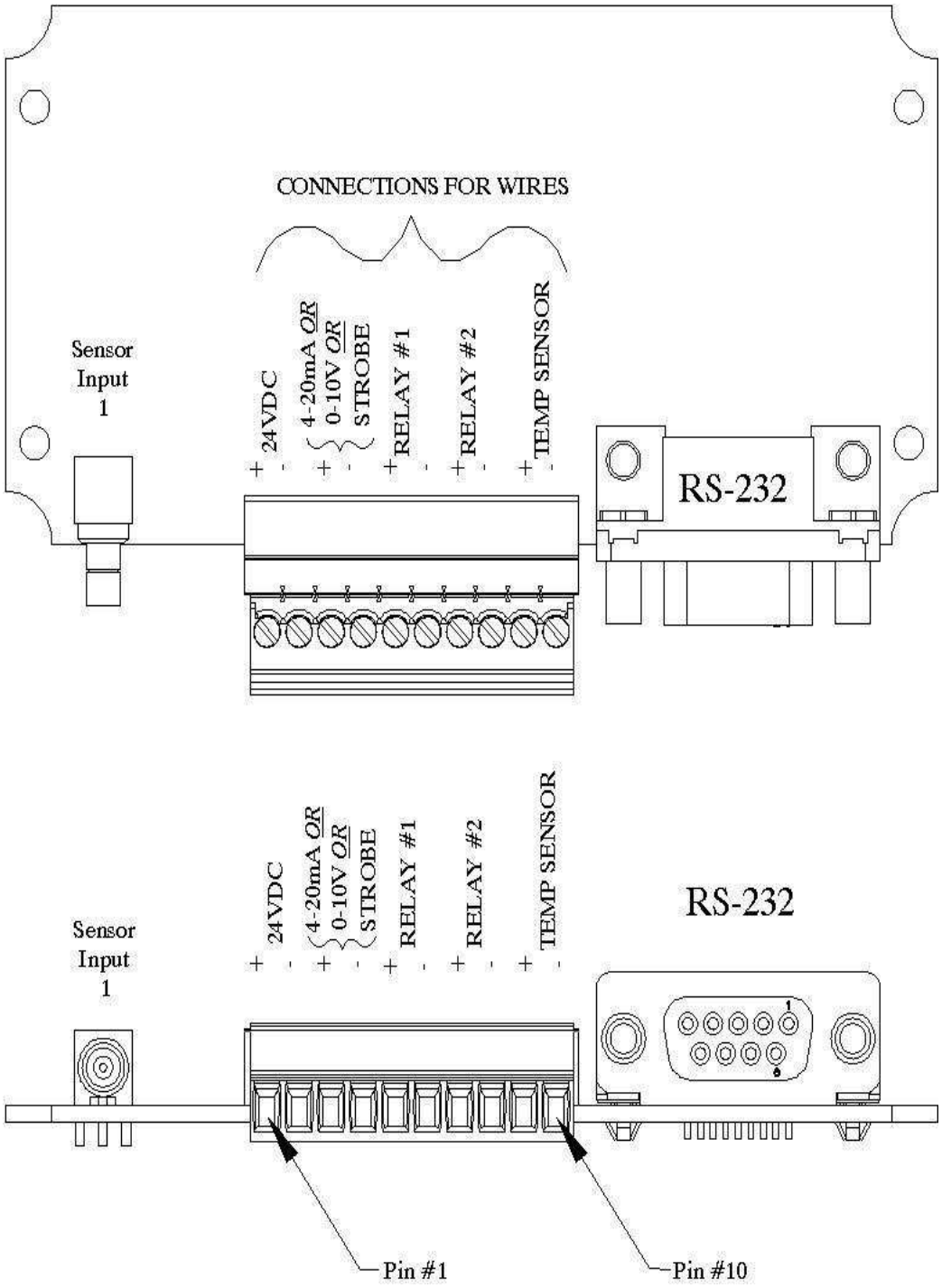
APPENDIX B – ML-02

Power and Output Connector Wiring Diagram of PCB



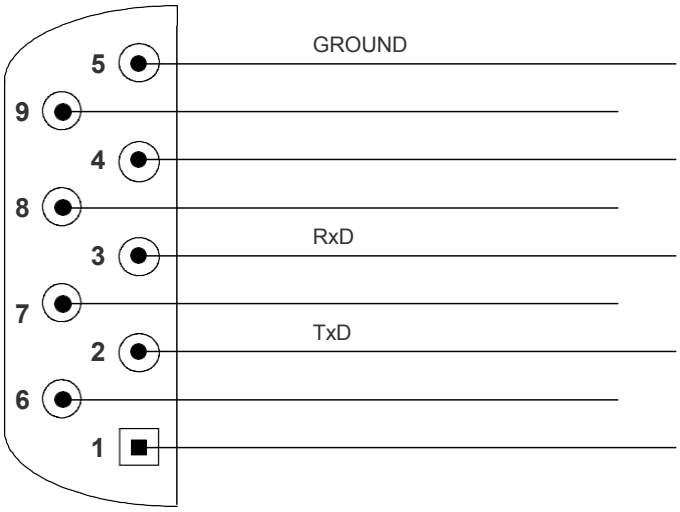
APPENDIX C – ML-11

Power and Output Connector Wiring Diagram of PCB



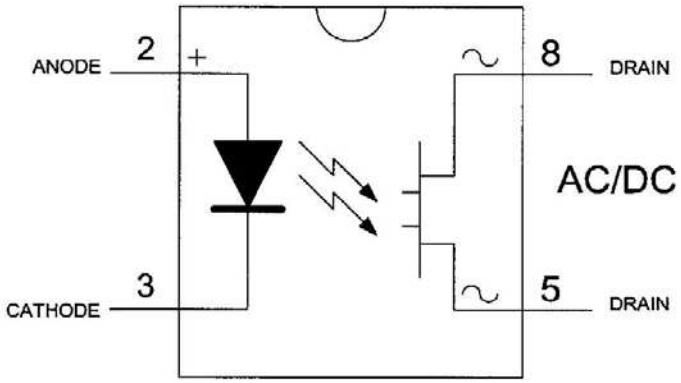
APPENDIX D

RS-232 Wiring Diagram DB9 (RS232) CONNECTOR [J1]



APPENDIX E

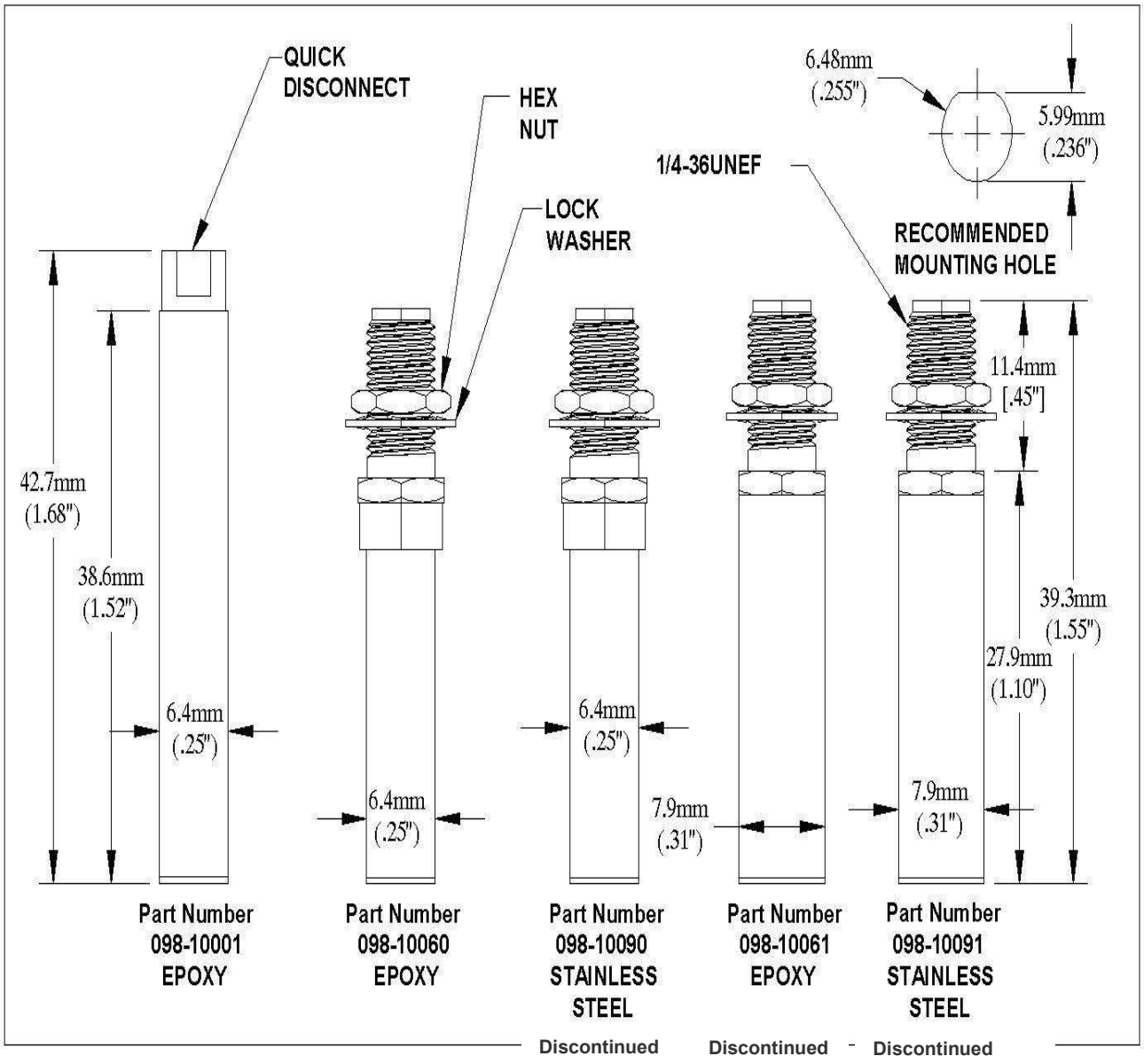
Typical Opto Relay-Output Wiring



Opto-Relay Manufacturer: International Rectifier
Manufacturer's Part Number: **PVU414S**

APPENDIX F

Sensor dimensions



ML-11: Part Number – 17621
Part Number – 17622
Part Number – 17623
Part Number – 17624
Part Number – 17625

ML-01: Part Number – 17608

ML-02: Part Number – 17609

Revision history

Date	Revision	Details of Change(s)
02/06/12	A	Initial Release

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