# MONITEK

# MODEL AT3

## PARTICLE CONTAMINATION MONITOR

**Operating/Installation Manual**

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GALVANIC

APPLIED SCIENCES

101 Billerica Avenue
Bldg 5, Ste104,
North Billerica,
MA 01862, USA
www.galvanic.com

Tel: 978-848-2701
Toll Free:1.866.254.5420
Email: support@galvanic.com

# MONITEK

## TECHNICAL NOTE MODEL: AT3

*Operational Note:*
Section 3: Calibration Procedure

CAUTION: It has come to our attention that in some experiments with calibration plots containing high sample concentration values and plotted in 3rd and 4th order poly, a memory overflow condition may occur with the calculated coefficient data, causing a "CPU" reset in some menu operations.

Should this problem occur, it is important to write down all setup values and contact Galvanic's Monitek customer service (support@galvanic.com) for unit reset instructions.

## LONG TERM STORAGE

If for any reason this instrument will not be installed within thirty (30) days after receiving it, it is suggested that it remain in its sealed shipping container and stored in a clean, dry and protected area until time of installation.

If the instrument has already been unpacked for inspection or testing, or if it has been removed from a process, and it is not to be installed or reinstalled for a period exceeding thirty (30) days, the following procedure should be observed:

1. If the instrument has been in service, the wetted portion of the Sensor should be thoroughly flushed with clean water and then thoroughly dried.

2. Each instrument should be placed in a separate, sealed heavy plastic bag with a desiccant added to assure clean and dry storage.

3. The instrument should then be stored in a protected area until time of installation.

If these precautions are observed, problems at the time of installation and start-up will be eliminated.

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## SECTION I – INTRODUCTION

### OVERVIEW

The AT3 monitor is a microprocessor based, real-time, in-line instrument used to monitor liquid-borne particle concentration and oil contaminants in various process liquids. Use of the microprocessor and graphics display provides a user friendly interface for setup and calibration. Because it is acoustically based, Monitek's patented transducer measures independent of the liquid's color, opacity, density, flowrate or photosensitivity. The sensor is relatively immune to the effects of coatings that would blind an optical sensor. Sensors mount directly into process piping, thus eliminating the handling error and dead time associated with grab sampling. The unit's dot matrix LCD display can present any user defined engineering unit (i.e., PPM, PCT, #/ml, etc.) along with the ability to plot calibration curves. The raw data is displayed as "counts".

Upset Monitor: The most common use of the AT3 is to monitor equipment upsets (i.e., oil separators, filters, Dissolved Air Floatation devices, catalyst carryover). Here, the AT3 can be set up to read in "counts" only. A reading in "counts" can be noted when a good or acceptable condition exists. Then an "upset" can be simulated and an alarm point established. This eliminates the need for taking samples to establish a calibration curve when all that is needed is for the AT3 to notify an upset condition.

Concentration Monitor: The AT3 can also monitor suspended solids concentrations through the microprocessor establishing a correlation between "counts" and the known concentration (PPM, mg/L, %, etc.) can be determined, and the display will read out in engineering units.

However, to establish an accurate correlation a few conditions must be noted:

1. The particle size distribution must remain relatively constant at the point of sampling.
2. The temperature should be fairly constant. Temperature surges will affect the speed of sound through the liquid medium.

**Theory:** The AT3 transmits acoustic pulses across the path of a liquid; these pulses are created by electrically exciting the transducer's piezoelectric crystal. Acoustic energy is reflected off any particles or bubbles encountered in the monitored liquid. Acoustic reflections received at the transducer are converted back into an electrical signal, which is amplified by a preamplifier and set to the receiver. Its amplitude is then compared to a reference voltage level known as the detection threshold. The signal is also time-gated to process only reflections from particles in the focal region. Signals that occur in the focal region and are greater than the detection threshold are analyzed by the software algorithm that accumulates counts. The total counts are processed by a mathematical curve fitting algorithm and a correspondent concentration value is displayed on the front panel of the system.

In addition to the return signals from contaminants in the monitored liquid, there are also reflections from the chamber wall opposite the transducer (far wall pulses) and from sound resonated in the transducer (main bang). Figure 1-1 illustrates these signals as well as how the receiver window is used to ensure that only reflections occurring in the focal region are processed.

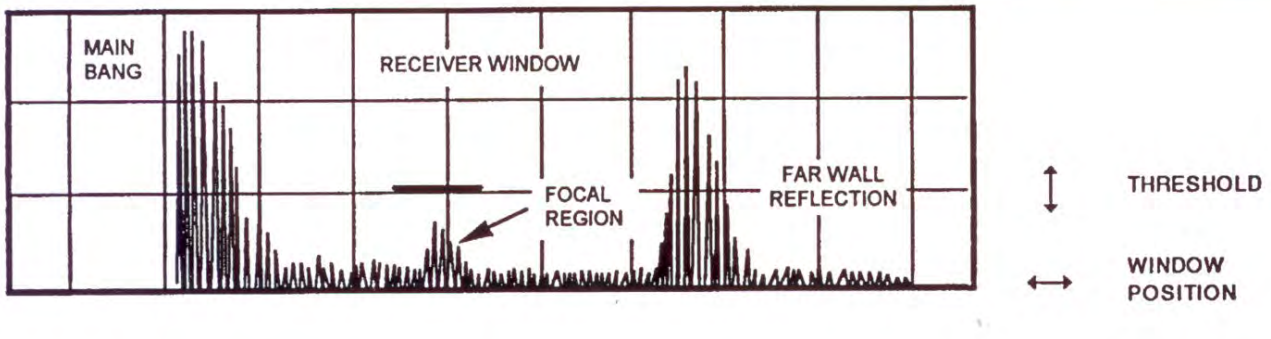



Figure 1-1: Typical Return Reflections from Oscilloscope Trace.

The far wall pulses and the main bang, although not counted, provide an indication of the operating characteristics of the transducer. Changes in these signals may indicate a transducer problem. At 128 times a second the AT3 sends out a burst of energy into the process liquid, turns around and listens for echoes that return to the transducer, and then analyzes the data to determine a measurement.

## THE FRONT PANEL

The AT3 uses a 240 x 64 dot liquid crystal graphics display in conjunction with a 24 key keypad as a user interface. See Figure 1-2. Three keys on the left and three on the right of the display are “soft”, having different functions depending on what appears adjacent to them on the display.

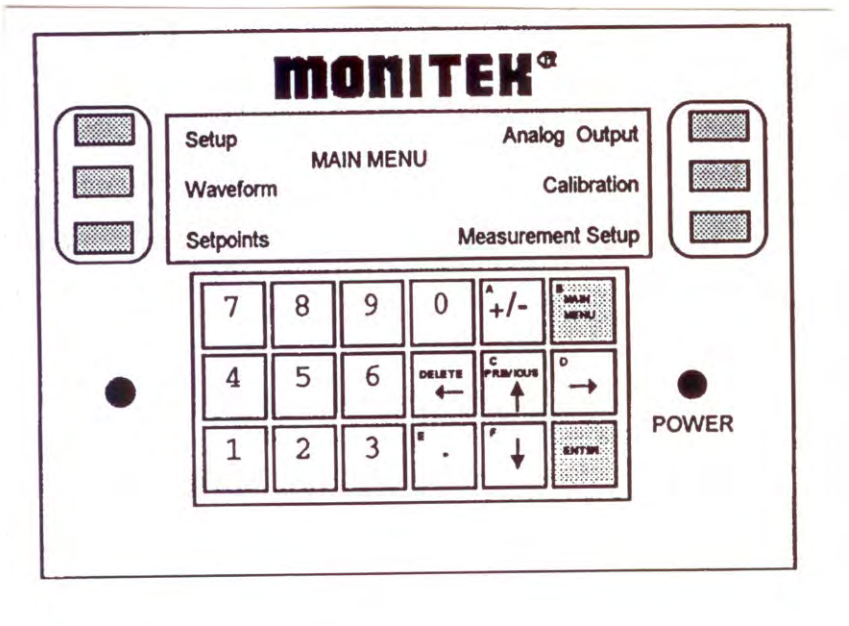



Figure 1-2: AT3 Front Panel Controls

## INSTRUMENT OUTPUTS

The analog output option may be one of the following: 4-20 mA or 0-20 mA or 0-1 mA, or the inverse of these (i.e., 20-4 mA or 20-0 mA or 1-0 mA).

## USER CARE

The following precautions will help ensure trouble-free operation and protect the instrument from possible damage.

1. Always turn power off before connecting or disconnecting the sensor or any of the circuit cards or the ribbon cable inside the instrument.
2. The door on the instrument enclosure must be kept tightly secured to reduce possible corrosion.
3. It is very important to make sure the printed circuit boards are plugged into the correct sockets on the motherboard.

## SECTION II – INSTALLATION

### SYSTEM INSPECTION

Check to ensure that all components of the AT3 monitor have arrived safely. Included should be: the AT3 system electronics, sensor, and cable set. If there is any damage to the equipment or if anything is missing, please contact the Monitek sales representative immediately. Fill in the first nine (9) lines of the AT3 Installation Check-out Report on the last page of this section of the manual. Save the packing material for future system storage or shipping.

### POWER REQUIREMENTS

Ensure that the proper power is available at the installation site. The AT3 requires AC power voltage range of 85-265 VAC single phase, 50/60 Hz. All power connections must be made to a properly grounded power source to protect both the operator and the system. Be sure that the system power is OFF before attempting to make any power Connections.

The power supply connection is made on the terminal strip at the lower right hand corner of the system enclosure box. The terminal strip is labeled “L, G, and N” (Line, Ground and Neutral). Connect the appropriate AC connections to L, G and N. The terminal strip is made to accept either fork or ring terminals for easy connection. All connections should be routed through the sealing fitting on the bottom of the system enclosure in order to maintain water tightness.

### CIRCUIT BREAKER

The AT3 utilizes a 2amp slow blow thermal circuit breaker for added protection and convenience. If the circuit breaker trips, reset it by pressing the reset button.

### SENSOR INSTALLATION

Caution: Handle the sensor assembly with care. Rough handling could cause damage.

### SENSOR LOCATION

Location of the sensor is very important! See Figure 2-1. It should be placed well downstream (ideally greater than 10 pipe diameters) of any major flow disturbances, such as diaphragm or gate valves, elbows, flowmeters, or pumps. Ultrasound demands a full pipe for best results; back pressure valves downstream of the sensor can be used to throttle the flow if necessary. When used in a sampling stream, isolation valves should be installed. The downstream valve should be capable of providing back pressure to minimize bubble formation.

In order to prevent gas bubbles from becoming trapped on the transducer’s concave lens surface, it should never be placed on top of the pipe pointing down into the fluid. There is no special orientation for vertical pipe legs.

Mounting on vertical pipe legs is recommended for applications involving large amounts of suspended solids. Flow in vertical pipe sections should be upward to prevent pressure drop and cavitation caused by gravitational acceleration of the process liquid.

To mount the insertion adapter, you must first weld the Monitek supplied 1” NPT weldment to the side of your pipe. When this is done, the insertion adapter can be screwed into the weldment and, after checking to make sure that the ball valve is closed, flow through the line can be resumed. There is no need to shut the line down to insert the probe. Simply follow these steps:

1. With valve closed, check to see that the Swage-Lok fitting is loose and the 0-ring seals are not compressed.
2. Insert probe into insertion adapter far enough to allow the longer safety cable to be fastened.

   DO NOT TWIST PROBE. Slide probe out of insertion adapter far enough to take the slack out of the safety cable.
3. Open ball valve.
4. Fully insert probe into insertion adapter. DO NOT TWIST.
6. Slide probe back until safety cable is taut.
7. Tighten Swage-Lok fitting.

**CAUTION: Galvanic Applied Sciences USA Inc. recommends that our AS3 probe <u>should not</u> exceed operating temperature of 80ºC without air cooling or 110ºC with air cooling.**

With the insertable probe configuration, the preamplifier and explosion proof enclosure are an integral part of the probe. Once the probe has been inserted, simply connect the two cables to the preamplifier and your unit is ready. It should be noted that when the probe is fully inserted the lens is extended into the flow stream. This will allow you to rotate the probe to align your conduit connections without damaging the lens. Remember, do not rotate the probe while in the process of inserting or removing the sensor.

**NOTE:** If it is acceptable in your application, Monitek recommends the use of flexible conduit for the final conduit section before the preamp. This will make it much easier to connect and disconnect the conduit in the future when you need to remove or reinsert the probe.

## SYSTEM INSTALLATION SITE

An appropriate installation site must be chosen for the AT3. The system should be mounted on a permanent, rigid surface (vertical or horizontal) using the mounting tabs or holes that extend from the system enclosure. See Figure 2-2 and Table 1. The AT3 should be mounted to avoid direct sunlight, preferably indoors. The AT3 will operate properly between 14 °F to 122 °F (0 °C to 50°C); the workspace environment should be free of harmful chemical vapors to prevent damage to the system.

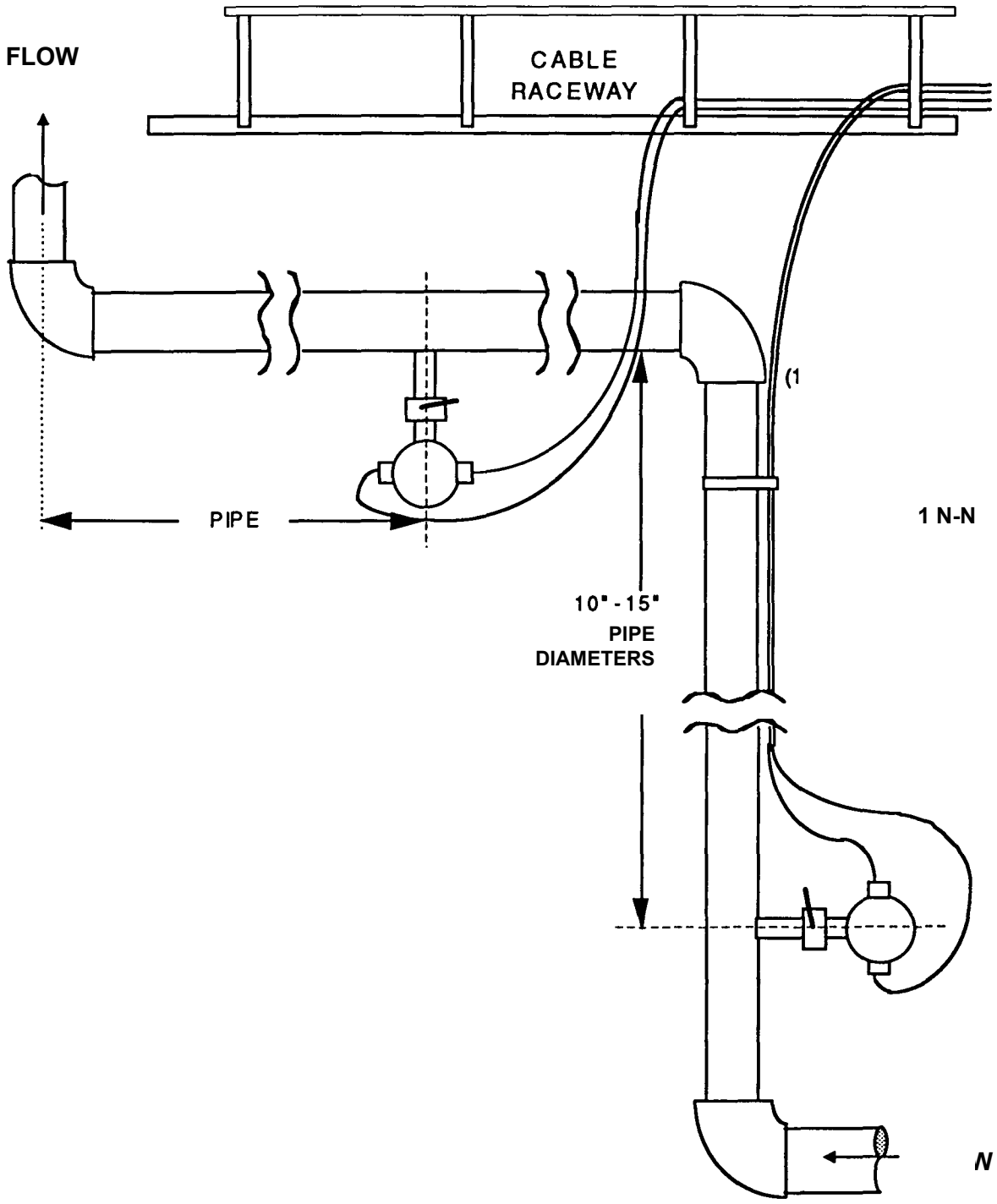



**Figure 2-1: Typical Sensor Assembly Placement and Installation.**

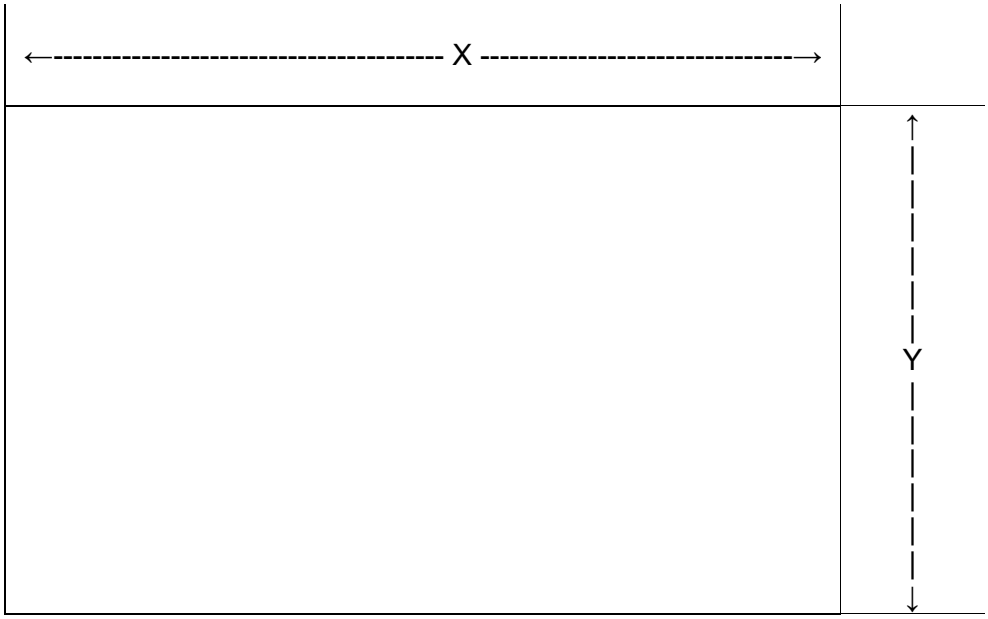



**Figure 2-2: SYSTEM ENCLOSURE MOUNTING PATTERN**

**Table 3-1: Window Width Guideline.**

| ENCLOSURE TYPE | X (INCHES) | Y (INCHES) |
|---|---|---|
| NEMA4X, PLASTIC | 12.00 | 18.90 |
| NEMA 4X, STAINLESS STEEL | 8.00 ACROSS END HOLES OF TOP AND BOTTOM BRACKET.<br><br>2.50 ACROSS TWO MIDDLE HOLES OF SAME BRACKETS | 16.75 |
| NEMA7, EXPLOSION PROOF | 19.75 | 11.00 |

## CONNECTING THE CABLES

After the system is mounted, only three cables need to be connected to complete the installation process. Connect the transmitter and receiver cables to the preamplifier and the appropriate connectors on the AT3. Then plug the power supply cable to an AC outlet to power up the AT3 monitor. Connectors supplied with the system enclosure will seal the conduit to the box.

The system is now ready to be checked out and adjusted. Refer to Section III - Operation.

**AT3 INSTALLATION CHECK-OUT REPORT**

| | |
|---|---|
| 1) | Customer and location: |
| 2) | Installation date: |
| 3) | AT3 serial number and operating frequency: |
| 4) | Preamplifier serial number: |
| 5) | Transducer serial number: |
| 6) | Transducer lens material: |
| 7) | Chamber description (size and material): |
| 8) | Cable length (feet): |
| 9) | Liquid description: |
| 10) | Noise without pulse (mVolts RMS): |
| 11) | Main Bang duration (µsec): |
| 12) | Number of Far Walls: |
| 13) | Amplitude and delay of first Far Wall reflection (Volts peak-to-peak): |
| 14) | Window width (µsec): |
| 15) | Window delay (µsec): |
| 16) | Detection threshold: |
| 17) | Power level setting: |

**COMMENTS:**

☐ DC preamplifier power checked.

☐ 4-20 mA span adjusted.

☐ 4-20 mA zero adjusted.

## SECTION III – OPERATION

### INTRODUCTION

Once the system has been installed, the hardware must be set up for your particular application, and checked to ensure that it is operating properly. The system operates by sending out a 5 or 15 MHz RF pulse (depending of sensor type) to the transducer, where it is converted to an acoustic pulse. This pulse travels through the monitored liquid. Reflections from contaminants and the chamber wall radiate back to the transducer. These reflections are converted to electrical pulses, amplified by the preamplifier, and transmitted to the receiver. The signals are then time-gated by the receiver window and compared to a detection threshold. Signals that occur in the focal region and are greater than the detection threshold are detected by a software algorithm; the results are processed by a mathematical curvefitting algorithm which converts the raw counts into a corresponding concentration which is displayed on the LCD display on the front of the system.

### BRIEF MENU DESCRIPTION

Pressing "MAIN MENU" displays all of the menu choices available to the user, as shown in Figure 3-1.

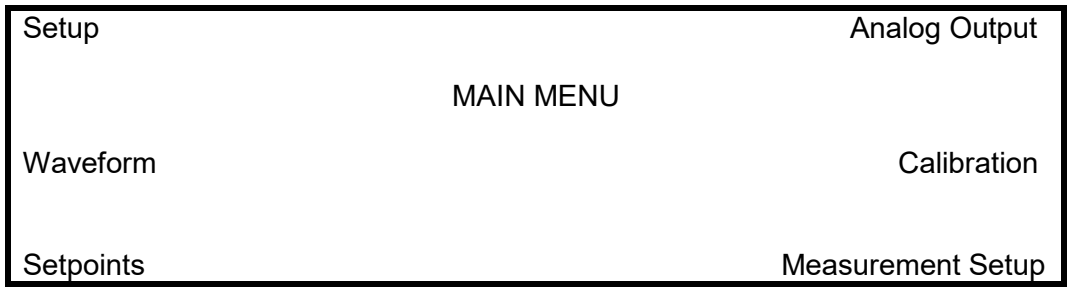



**Figure 3-1: Main Menu**

"SETUP" Used to set some initial system parameters to match the user's application. These include the measurement units, damping, the display resolution, and whether the instrument displays raw data (counts) or a curvefit reading (user-defined measurement units), or system summary, which consists of raw data, reading, analog output, relay outputs, and sensor frequency.

"WAVEFORM" Graphically displays the output of the sensor and whatever is reflected back, similar to an oscilloscope. The user has a choice of three views, depending on whether the farwall or the measurement window is the main Interest. To get the big picture select "0-154 µS", while "0-38 µS" gives more detail around the measurement window; "0-77 µS" is a compromise between the two.

"CALIBRATION" Used to correlate raw data coming from the sensor to a corresponding concentration. Up to 16 different samples can be read by the instrument. From this information the instrument can construct a lookup table or perform a polynomial fit of degrees 1 to 4. The user can graphically plot the resulting curvefit to visually check how it corresponds to the samples. Samples can be edited or deactivated and curvefitting can be tried again quickly to improve the calibration. This menu is password protected.

"MEASUREMENT SETUP" Used to set up the parameters which affect the measurement. This includes the output power, detection threshold, window position and waveform adjust. This menu is pass word protected.

"ANALOG OUTPUT" Adjusts parameters involving the instrument's control current output. These include the "ZERO", "SPAN", and "RANGE"

"SETPOINTS" Consists of all the parameters that can be set up to activate the four relays at certain conditions. Each setpoint value can have a Hysteresis, a time delay (the condition must be met for at least this time before the relay trips), and a mode ("HIGH" means make-on-rise, "LOW break-on-rise).

## MENU OPERATION

All menu choices can be modified or activated merely by pressing the button corresponding to the menu item. If a screen contains more than six menu items the choice "<More>" will appear as the lower right menu choice, and pressing this will take the user to the next page of choices. See Figure 3-<2. Some menu items act as gateways, and pressing them takes the user to another screen. Other menu items can cause a certain action to be performed when they are pressed. Most items, however, allow the user to change the parameters and operation of the instrument

| | |
|---|---|
| Setpt1: XXX.XXX PPM | Setpt Mode: High |
| SETPOINTS | |
| Setpt1 Hysteresis: XXX.XXX PPM | |
| Setpt1 Delay: XX Sec | <More> |

**Figure 3-2: <More> Example**

*Numerical items,* when pressed, display a flashing cursor to prompt for an input and expect the user to enter a number. The numerical keys, decimal point, and +/- key may all come into play depending on the type of number the instrument expects. See Figure 3-3. If a mistake is made, the left arrow can be used as a backspace. If the number entered is outside the expected range, the Instrument will flash in the center of the bottom line "NUMBER TOO HIGH" or "NUMBER TOO LOW' and the entered number will be rejected. In general, the bottom line is dedicated to messages to the user. See Figure 3-4. If an item is expressed in scientific notation, the UP arrow can be used to enter the exponent

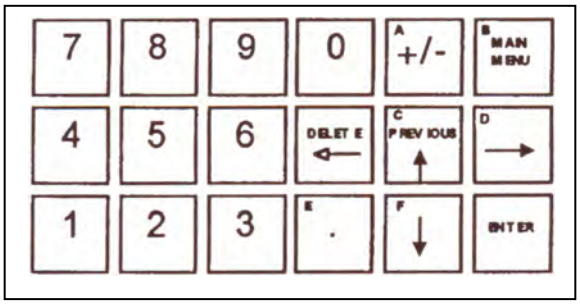



**Figure 3-3: AT3 Front Panel Numerical Control Pad**

| | |
|---|---|
| | Low X value: X.XXX CNTS |
| PARTIAL PLOT | |
| | High X Value: X.XXX CNTS |
| NUMBER TOO HIGH | PLOT |

**Figure 3-4: Example of Message Location**

*Option list items,* when pressed, allow the user to choose from a list of possible options. The user selects the desired option by pressing its corresponding button. The currently selected option is shown In inverse characters

At any time "MAIN MENU" can be pressed to go back to the main menu screen. If "MAIN MENU" is pressed when already in the main menu screen, the instrument will return to the top screen (showing the instrument reading and the bar graph). "PREVIOUS" can be pressed to go back one screen previous to the current screen. On very few screens the previous key takes on its other identity as an UP arrow and will not return to the previous screen. On these screens pressing any key other than an arrow key will return the user to the previous screen.

**QUICK START UP**

1. The "SETUP" menu. The parameters that can be chosen are: units (use the arrows), the resolution of the main display in digits to the right of the decimal point, and the instrument damping. See Figure 3-5. The "Display" menu allows the user to set the top screen to display "Raw Data" (which is given In COUNTS) or "Reading" that is the "Raw Data" mathematically transformed into the user-defined units and system summary. Press "PREVIOUS" or "MAIN MENU" to return to the main menu

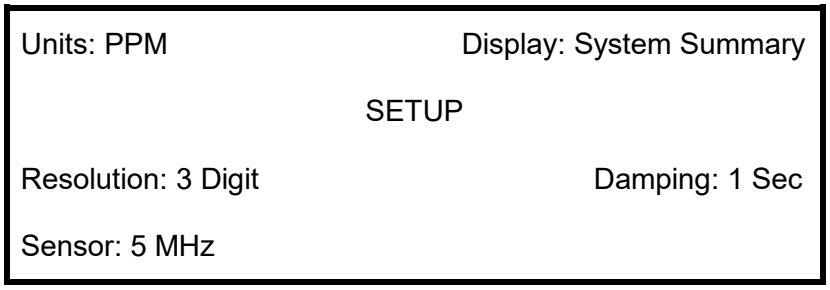



**Figure 3-5: Setup Menu**

1.a. Press “Display in the setup menu to select the “Raw Data” System Summary or Reading. See Figure 3-6.

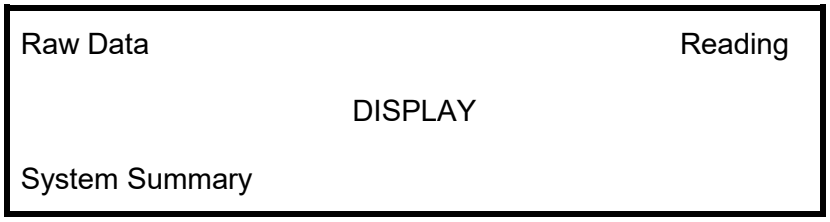



**Figure 3-6: Display Menu**

1.b. First the sensor frequency must be set to match the sensor being used (“5 MHz or 15 MHz). See Figure 3-7.

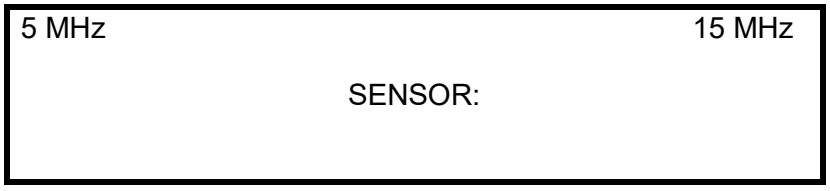



**Figure 3-7: Sensor Menu**

2. The "Measurement Setup" menu. These are parameters that intimately affect the measurement and must be set before samples are taken. See Figure 3-8. If any of these are changed after samples have been taken, the measurement environment is different enough that the previous samples are no longer valid. Most of the default values work just fine for most cases, but adjustments may have to be made for particular applications. The default password is 0000.


**Figure 3-8: Measurement Setup Menu**

NOTE: For applications with high concentrations, (i.e., over 2000 PPM) the "Output Power" may have to be reduced to avoid having large echoes saturate the instrument.

2.a. The "Window Width" menu. These parameters control the Window width as seen on the graphics display. See Figure 3-9 and Table 3-1.

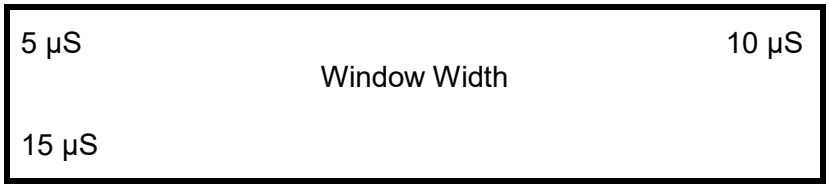



**Figure 3-9: Window Width**

**Table 3-1: Window Width Guideline.**

| Window Width, µSec | Counts |
|---|---|
| 5 | 0–5000 |
| 10 | 0–10000 |
| 15 | 0–15000 |

2.b. The "Window Posn" and "Threshold" parameters affect where the measurement window is in relation to the main burst and how large an echo must be to affect the reading. These parameters can be adjusted either by entering numerical values or graphically In the "Waveform Adjust" menu. If the "Waveform Adjust" menu is used the arrow keys can be used to adjust the "Window Posn" and "Threshold" parameters and then the user must press the "ENTER" key to save the values.

2.c. The "Threshold" value needs to be set above the noise yet not so high that echoes are not seen at all.

**NOTE**: For concentration measurement, a good rule of thumb is to set the "Threshold" so that the typical process concentration gives a reading of 2000 counts (the total range is 0 to 5000). This allows room for reading much higher concentrations during an upset condition.

**NOTE**: For ultra pure applications, the strategy is to set the "Threshold" just above the noise level so that everything is seen. Of course this means the instrument will saturate at a relatively low concentration

2.d. The “Window Posn”·is used to set the window in the focal point of the transducer, where the echoes should be at their highest levels. The default value usually works well, but occasionally it can be seen that the window does not quite match the position of the highest echoes, in which case it is appropriate to adjust the '"Window Posn”.

2.e. Finally, the “Password" menu allows the user to set a personal 4 digit password to protect the “Calibration” and "Measurement Setup" menus from unauthorized personnel. See Figure 3-10. The default password is 0000.

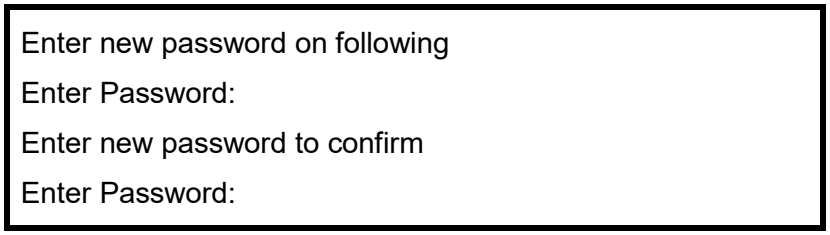



**Figure 3-10: Change Password Menu**

3. The "CALIBRATION" menu. Calibration is simply a matter of correlating the raw count level to reflect the concentration amount in the process. See Figure 3-11. The instrument allows the user to enter up to 16 different samples and their respective concentrations. These samples are stored in the "SAMPLE TABLE".

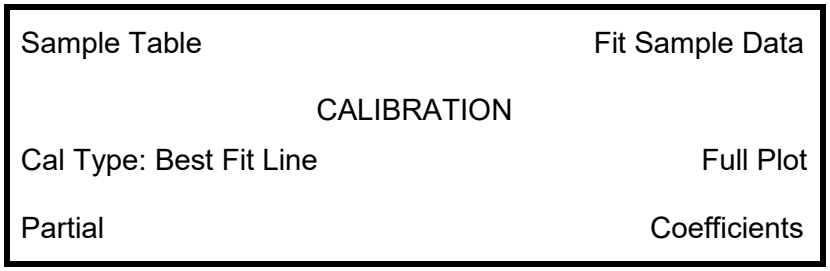



**Figure 3-11: Calibration Menu.**

3.a. Press "SAMPLE TABLE" and you will see a summary of the 16 samples. See Figure 3-12. If a sample has not been entered yet, it will read "INACTIVE". Otherwise it will display the raw data and corresponding concentration for the sample. The instrument prompts the user for a sample number (1 to 16), which is entered by the keypad.

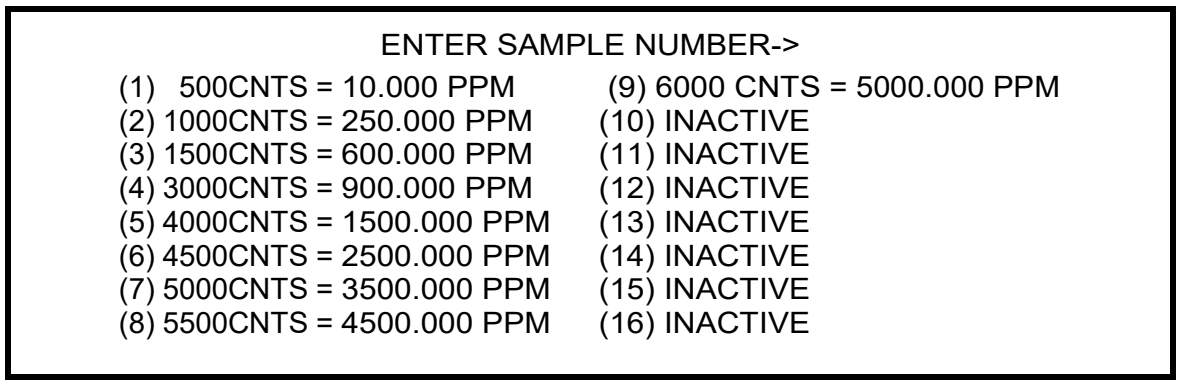



**Figure 3-12: Sample Table Menu Example.**

Once in the sample menu, the user can read a sample, enter a sample value by hand, activate an inactive sample, or deactivate an active sample. Only "active" samples are used in the calibration procedure. See Figure 3-13. By deactivating a sample the data is not lost but is simply ignored by the calibration procedure. See Figure 3-14. By activating it again it can once again have an effect on the calibration. When a sample is read, it reads the sensor for 1 minute and stores the result. The user must enter the concentration of the sample, although this can be at a later time.

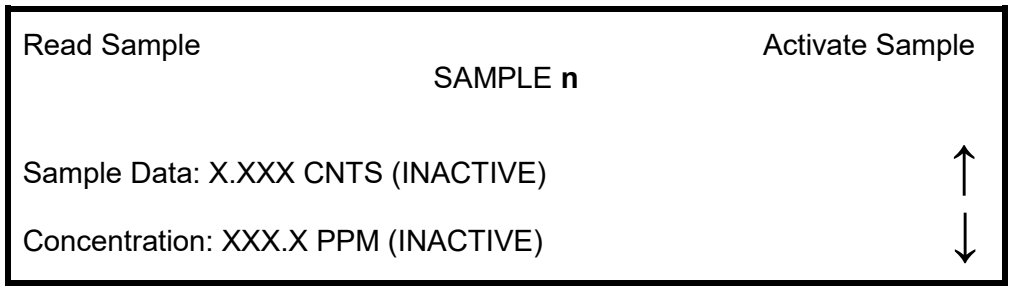



**Figure 3-13: Inactive Sample Number "n" Menu.**

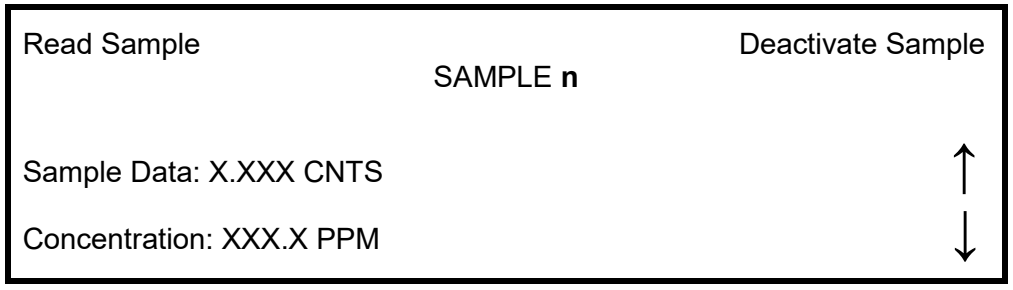



**Figure 3-14: Active Sample Number "n" Menu**

3.b. The user must decide what type of curve fitting to perform on the data, and this Is done in the "Cal Type" menu. See Figure 3-15.

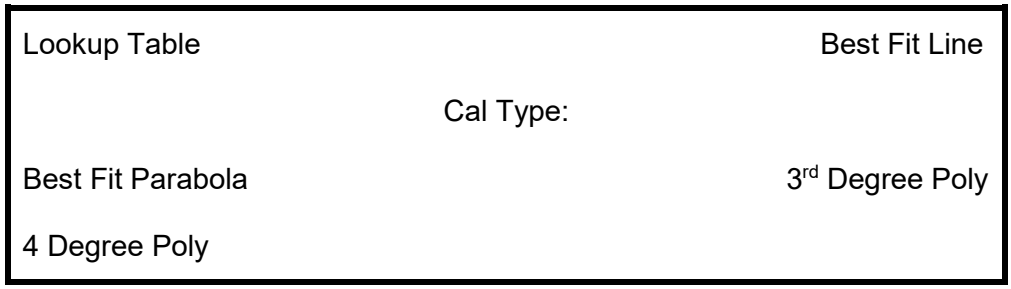


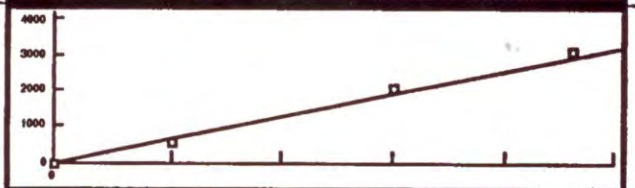
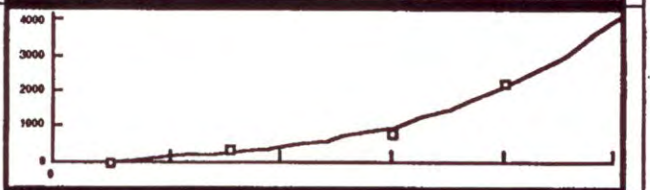
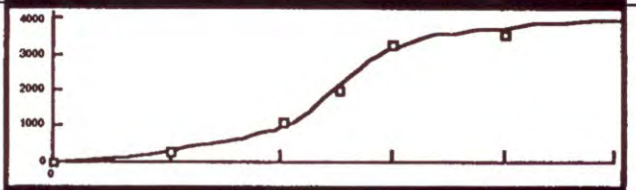
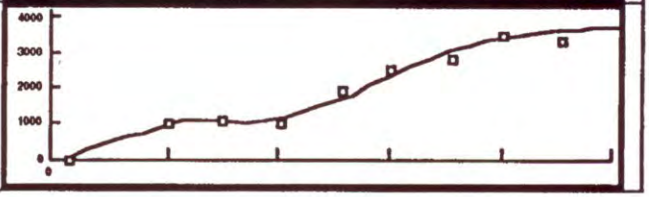

**Figure 3-15: Cal Type Menu**

3.c. Once the "Cal Type" is chosen, the user presses the "Fit Sample Data" menu to perform the curvefitting calibration routine using the active samples.

NOTE: If "Lookup Table" is chosen, the instrument will do a "connect the dots" type of calibration on all the active samples. This can be viewed by pressing the "Plot" menu, which graphs all the samples and the resultant curvefit.

If "Best Line Fit" is chosen, upon pressing the "Fit Sample Data" menu the instrument will calculate the 2 coefficients that define the line that best matches the active samples. "Best Fit Parabola" is similar except it will require 3 coefficients, and "3rd Order Poly" and "4th Order Poly" require 4 and 5 coefficients respectively. In the "Coefficients" menu are the parameters calculated from polynomial curvefitting to define the curve. There is always one more coefficient than the degree of the polynomial. See Table 3-2. If a lookup table is used the "COEFFICIENT" menu is disabled.

**Table 3.2: Calibration Type and Number of Active Samples Required.**

| Calibration Type | Number of Active Samples | Example |
|---|---|---|
| Lookup Table | At Least 2; Maximum 16 |  |
| Line | At Least 2; Maximum 16 |  |
| Parabola | At Least 3; Maximum 16 |  |
| 3rd Degree | At Least 4; Maximum 16 |  |
| 4th Degree | At Least 5; Maximum 16 |  |

**NOTE:** The user can try many different types of "Cal Types"; however, a "Fit Sample Data" must be done after any change to update the calibration. See Figure 3-17.

If only a portion of the curve is of interest, the user can go into the "Partial Plot" menu and choose the desired range to plot (by specifying the Low and High X values). See Figures 3-16 and 3-18. By viewing the graphs produced by the various methods the user can get a feel as to the best match for the process being monitored, and can experiment with activating and deactivating particular samples to see their effect on the calibration curve. Once a suitable curve is found, the coefficients that define it should be recorded.

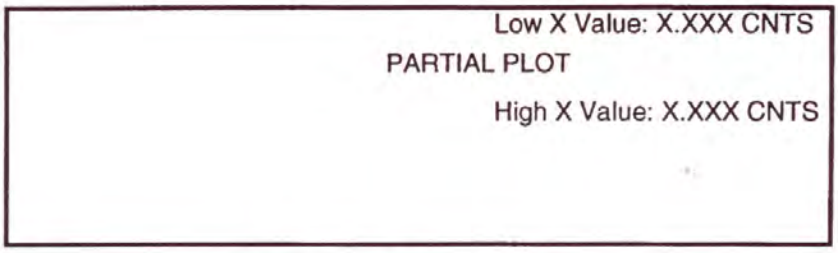



**Figure 3-16: Partial Plot Menu.**

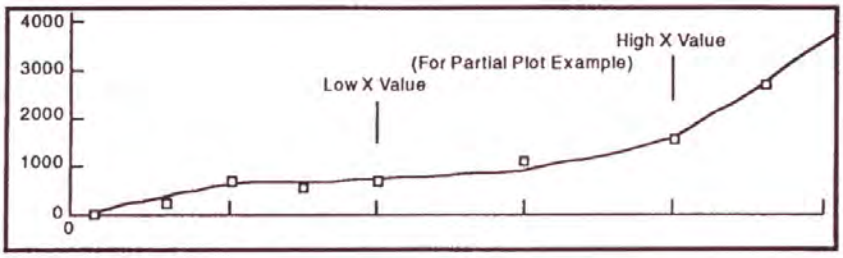



**Figure 3-17: Fit Sample Data Example.**

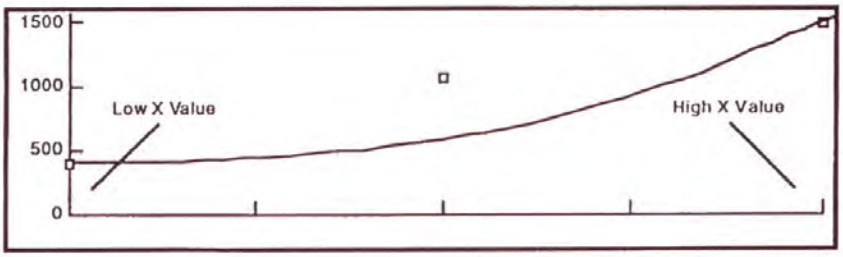



**Figure 3-18: Partial Plot Example.**

4. The “ANALOG OUTPUT” menu consists of the parameters to perform the Analog Output Test. See Figure 3-19.

| | |
|---|---|
| Zero: X.XXX PPM | Range: 4 to 20 mA |
| ANALOG OUTPUT | |
| Span: XXX.X PPM | |

**Figure 3-19: Calibration Menu**

4.a Press “RANGE” to select the output analog current range (i.e., 4 to 20 mA).

4.b. Press “ZERO” to enter the output low value (i.e., 0 PPM = 4 mA).

4.c. Press “SPAN” to enter the output high value (i.e., 550 PPM = 20 mA

4.d. Analog Output Test: Allows entering of any value within selected range to check scaling or response.

5. The “SET POINT” menu. Allows entering value of operation for 1-4 output alarm relays. The parameters that can be entered are Hysteresis, a time delay (an alarm condition must be met for this time before the relay actuates) and mode (make or break on activity count rise). See Figure 3-20.

| | |
|---|---|
| Setpt1:: XXX.XX PPM | Setpt Mode: High |
| SET POINTS | |
| Setpt1 Hysteresis: XXX.XX PPM | |
| Setpt1 Delay: XX Sec | <More> |

**Figure 3-20: Calibration Menu**

Note: Each of the four alarm relays are solid state devices that control an output of 20-280VAC and 1A max. An example of the alarm control wiring is shown in Figure 3-21.

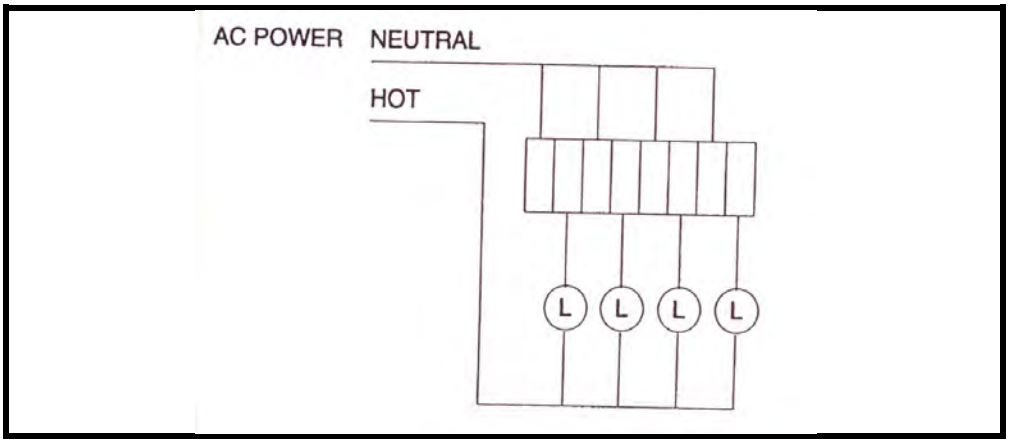



**Figure 3-21: Example of Alarm Control Wiring**

**AT3/ AS3 SAMPLE CALIBRATION PROCEDURE**

Sample 0-1000 ppm for 5 mhz and 15mhz systems using diatomaceous earth typically using 5 calibration points.

Steps:

1. Mix 2.0 grams of diatomaceous into 2 liters of DI water. This will be 100% of range (1000ppm).

2. Take 500ml of 100% mixed solution into a jar.
   Ensure sample is constantly being mixed (e.g. magnetic stirrer).
   Cut remaining sample into the following concentrations: 75%, 50% and 25%.

3. Insert probe; shake probe to eliminate any bubbles stuck under tip.

4. Using AT3 front panel keypad, go to Main Menu / Set UP / Display Raw Data.
   Refer to section III "Quick Start Up" pg. 3-5.

5. Once in "RAW DATA" Press Main Menu two times; this will show the counts.

6. Set total counts to read between 2000 and 50000.This is done by adjusting the potentiometer on the pre-amp board (figure 3-22), the threshold and window position.
   Refer to section III "Measurement Setup" pg. 3-6.

7. Return to Main Menu-Setup.
   Press calibration {password 0000 or other set by customer).
   Press Sample table #5 to view existing calibration table.
   At this window choose concentration 1000ppm {sample #5)
   Press Read Sample 3 times.

8. Repeat step 8 for 75% on sample #4, 50% on #3, 25% on #2 and #l DI water.
   Once all 5 data points are completed, return to calibration window and select which "Cal Type" to use. (e..g. "Best Fit Line" or "Best Fit Parabola").

9. Return to Calibration. Press Fit Sample Data.

10. At Main Menu, Set Analog Output 4-20ma and Setpoints to read 0-1000ppm.

11. Go to Setup to Display System Summary this will show: counts, ppm and graph output.

12. Once calibration is completed, hit the previous button until the display reads.

**NOTE**: For added assistance, follow section III of the AT3 manual, along with this procedure.

## SECTION IV MAINTENANCE

### GENERAL SYSTEM CLEANING:

Disengage the A T3 from its power source before any cleaning. The unit can be cleaned with a soft cloth dampened with water. A mild detergent may be used if necessary. Do not allow water inside the unit. Also be sure that no water remains near the power connections to eliminate the possibility of electrical shock.

### TROUBLESHOOTING

Below is a preliminary list of the steps to take in diagnosing a system problem.

**If there are no system outputs or display:**

- Make sure that there is power to the A T3.
- Ensure that the system power switch is in the ON position.
- Check that the circuit breaker is not tripped. Press it to reset.

**If there is erratic data or off-scale values in the absence of an upset condition:**

- Ensure that the cables to the preamplifier are connected; check to see if they are shorted.
- Make sure that the pipeline is full.
- Ensure that the preamplifier is firmly attached to the transducer.

If none of these items correct the problem, go to the "Waveform" menu and verify that the system output is normal. Follow the system setup procedure; readjusting the receiver window, detection threshold, or power level may correct the problem. Contact your Customer Service Representative if the problem cannot be found.

### REPAIR AND SERVICE

If you have determined that your A T3 is in need of service or repair, do the following before calling Monitek for service information:

Leave the system in its malfunctioning configuration.
Have a description of the malfunction readily available.
Have a list of the equipment's serial numbers.

### SHIPPING INSTRUCTIONS

If it becomes necessary to ship all or part of the AT3 system back to the factory for repair, be sure that it is packaged with care. For return shipments it is best to use the original packaging materials. Damage incurred during shipment is not covered under warranty; therefore, it is suggested that all shipments be properly insured.

## SECTION V APPENDIX

### GLOSSARY OF TERMS

**Chamber**: The short piece of piping in which the AT3 transducer is positioned (see sensor).

**Detection threshold**: The level that the signal from an acoustic reflection must exceed before it Is counted by the receiver. A number from 1 to 255, it is usually shortened to DT.

**Far wall pulse**: Acoustic reflections from the inside diameter of the pipe opposite the transducer. There will usually be two or three such pulses.

**Focal region**: The area about the focal point where particle measurements are made.

**Lens**: The material (usually plastic) onto which the transducer crystal is bonded. The lens focuses acoustic energy to increase system sensitivity, just as a magnifying glass focuses light energy. The lens is that part of the transducer that comes into contact with the process fluid.

**Main bang**: The signal returned from sound resonating in the transducer.

**Main bang duration**: A characteristic of the transducer related to the length of *time* it reverberates as a result of the main bang. The transducer must "ringdown" quickly to allow detection of the return echoes.

**Piezoelectric**: The property possessed by some substances to deform when a voltage is applied across them. Many common substances, like quartz, are piezoelectric.

**Piezoelectric crystal**: The small disk of material in the transducer that converts the electrical energy from the pulser into acoustic (sound) energy. Crystals in the AT3 transducers are generally made of lithium niobate (LiNb03).

**Preamplifier**: The circuit that amplifies the signals from particle echoes before they are transmitted to the receiver. This minimizes interference from cable noise.

**Pulse-echo**: A configuration in which the same transducer transmits pulses and receives acoustic reflections. The AT3 operates in the pulse-echo configuration.

**Pulser**: The circuitry that creates the electrical pulses sent to the transducer. The pulser transmits pulses at either 5 or 15 MHz

**RF**: Short for radio frequency, which is any frequency in the range that radio waves may be transmitted (10KHz to 300 GHz).

**Receiver**: The receiver circuitry processes the signals from acoustic reflections from contaminants in the monitored liquid.

**Receiver window**: The time gate used to define the region in the monitored liquid in which acoustic reflections must occur in order to be counted. This prevents echoes from anywhere outside the focal region from being counted. The window width is factory set to 5µs and is adjustable.

**Resonant frequency**: The "natural" frequency of oscillation of a circuit or crystal, or that frequency at which the most power is produced or transmitted. Crystals used in the AT3 transducers have resonant frequencies of either 5 or 15 MHz.

**Sensor assembly**: The unit comprised of a transducer and preamplifier.

**Transducer**: A device that converts one form of energy to another. Specifically. the AT3 transducers convert electrical pulses to acoustic pulses and acoustic energy back to electrical energy.

## APPLICATION AFTER DISSOLVED AIR FLOTATION (OAF) EQUIPMENT

Dissolved air flotation devices such as Wemcos Introduce a considerable amount of entrained air to the process stream. These bubbles of entrained air will reflect acoustic energy In the same way a particle or oil droplet will. To obtain a reliable reading after a DAF, it is necessary to remove this entrained air from the process stream. This can be done with a simple stilling well such as the one shown in Figure 5-1.

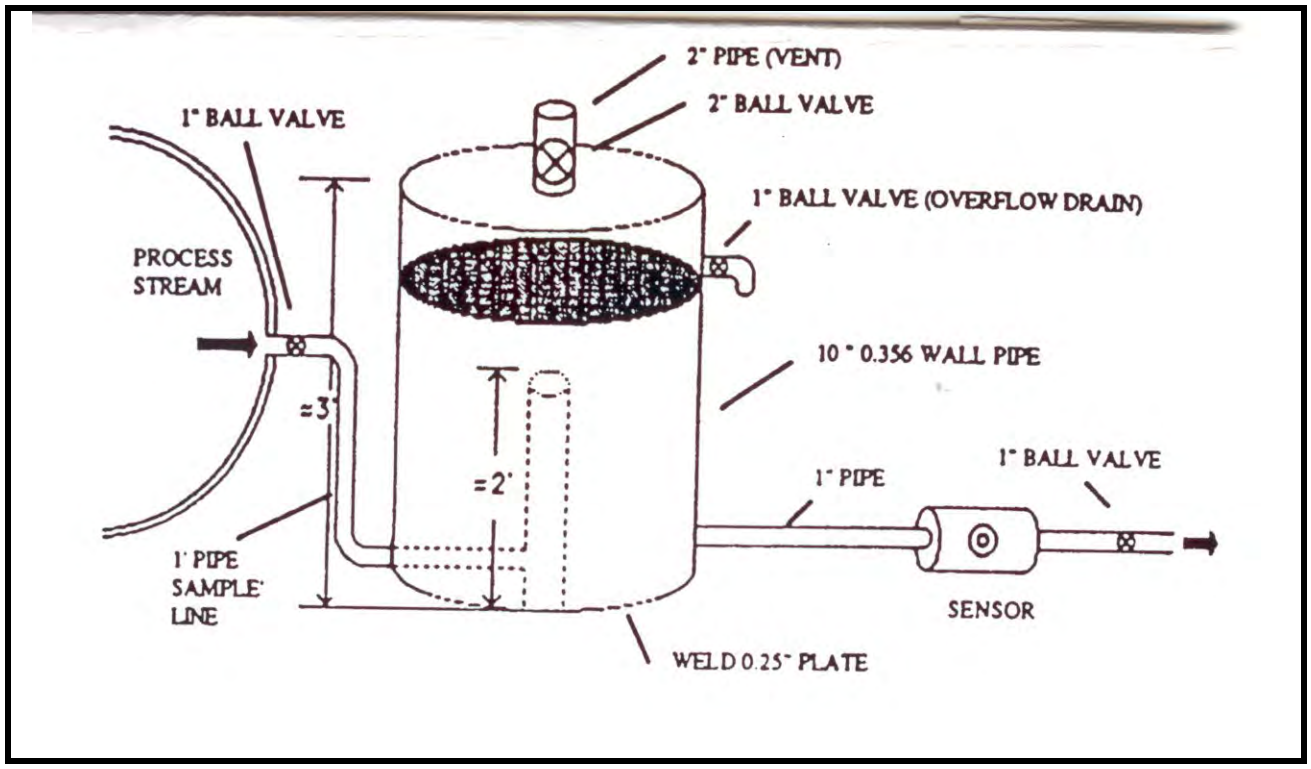



**Figure 5-1: Dissolved Air Flotation Equipment Installation**

The idea of the stilling well is to allow air to escape through the vent in the stilling well's top while drawing your de-aerated sample from the stilling well's bottom. It is important to include a valve on the Inlet to your stilling well to allow you to regulate flow and to maintain a pocket of air between the liquid level and the vent. Likewise, a valve after the sensor in the effluent stream is useful to assure that you will always have a full line at the sensing point. The stilling well dimensions are not critical, and those shown in Figure 5-1 should only be used as guidelines. A 3 foot section of 10 to 12 inch diameter stainless steel pipe makes a fine stilling well body. Also, in most cases, PVC will work as well as stainless steel.

## SPARE PARTS LIST – PARTICLE CONTAMINATION MONITOR, MODEL AT3

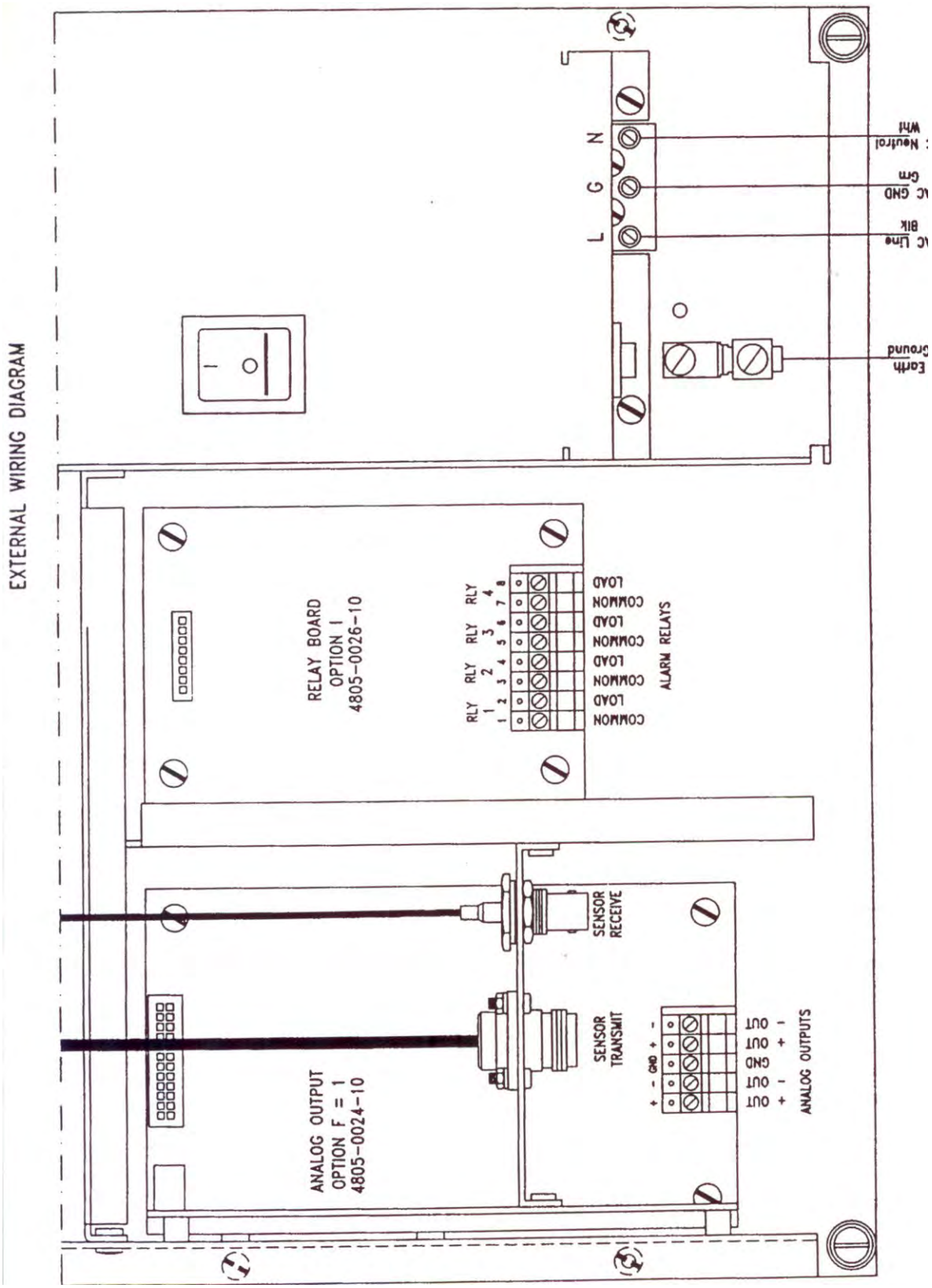
| DESCRIPTION | PART NUMBER |
|---|---|
| Motherboard | 4805-0020-10 |
| Receiver Board | 4805-0022-10 |
| Pulser Board | 4805-0021-10 |
| I/O Board | 4805-0023-10 |
| CPU Board | 3000-1050-11 |
| Power Supply | C609-0020-00 |
| DC Power Cable | 4805-0096-00 |
| Cable Assy, Ribbon, AT3 | 4805-0055-00 |
| Cable Assy, Coax - A, AT3 | 4805-0056-00 |
| Cable Assy, Coax - B, AT3 | 4805-0057-00 |
| I C Eprom, Prog. GmbH, AT3 | 4805-0035-00 |

## ENGINEERING DRAWINGS

Monitek will supply upon request any or all drawings associated with the A T3 product. Requests are to be directed to the Customer Service Department.

| Drawing Title | Drawing Number | Revision |
|---|---|---|
| Schematic Preamp 5 MHz | 40204 | B |
| Schematic Preamp 15 MHz | 40139 | A |
| Mount Dimensions of MPS Preamp/Sensor with Standard Sightglass | 0900-0607-00 | B |
| Outline Dimensions MPS-D Insertable Probe | 0900-0628-00 | B |

## ELECTRICAL WIRING DIAGRAM



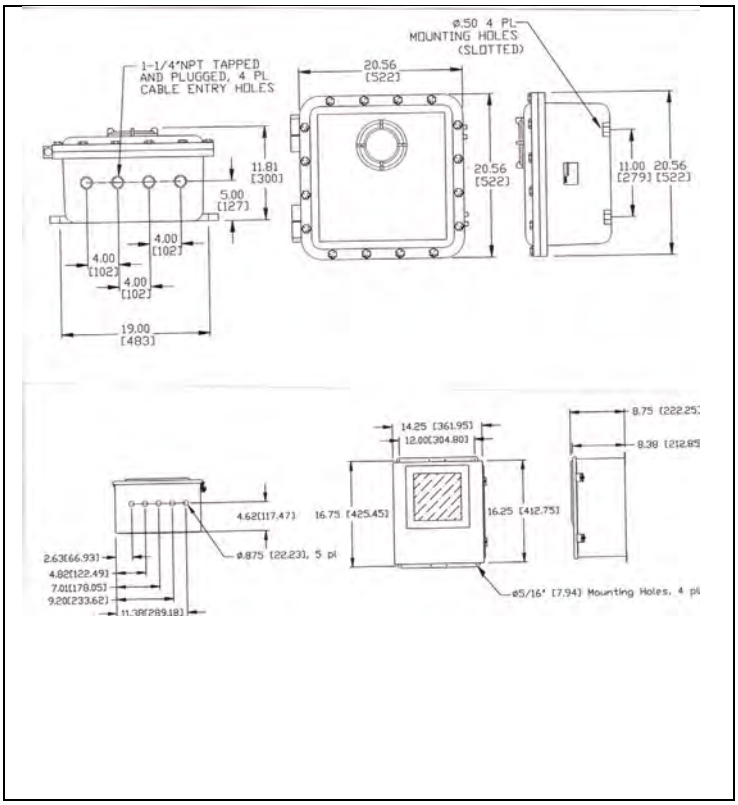
# AT3 ACOUSTIC TRANSMITTER
## (SUSPENDED SOLIDS MONITOR)

### SUMMARY OF FEATURES

- Focused acoustic energy is resistant to coatings
- Monitors panicles in light-sensitive liquids
- Insensitive to optically opaque liquids. like dyes & inks
- Virtually maintenance free

The AT3 transmitter is a microprocessor-based, online instrument used to monitor liquid-borne particle concentration and oil contaminants in various process liquids. Use of the microprocessor and graphics display provides a user-friendly interface for setup and calibration (self-prompting menu). Because it is acoustically-based, Monitek's patented transducer measures independently of the liquid's color, opacity, density and flow rate. The unit's dot matrix LCD display can present any user defined engineering unit (i.e., PPM, PCT, #/ml. etc.) along with the ability to plot calibration curves and trending graphs. The raw data is displayed as "counts".

Sensors mount directly into process piping, eliminating handling error and dead time associated with grab sampling.



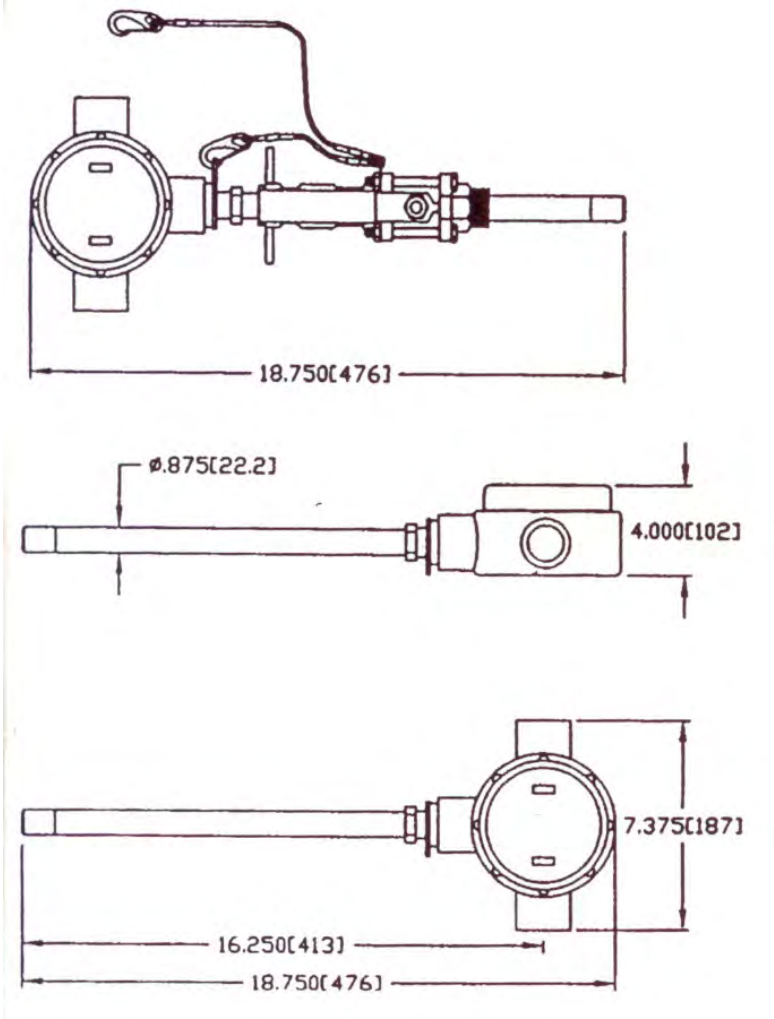

### DESIGN SPECIFICATIONS

| | |
|---|---|
| Size Range: | 0.8 µm to a few millimeters (material and concentration dependent) |
| Conc. Range: | 0.5 ppm -3% TSS (Total Suspended Solids) of ACFTD (Air Cleaner Fine Test Dust), application dependent |
| Enclosure: | NEMA 4X, UL & CSA listed, Noryl plastic, clear polycarbonate cover, hinged & gasketed lid (1/8" thick UL approved gasket), wall-mounting base.<br>H x W x D: 17.7in x 14.25in x 8.7in<br>(449.6mm x 362mm x 221mm) |
| Power Supply: | 85-265 VAC, 50;60 Hz. 65 watts |
| Circuit Breaker: | 2 Amp slow blow thermal circuit breaker |
| Relay Contacts: | 4 AC triac. 85-280 V @ 1 amp |
| Sensor to Transmitter Distance: | 400ft (130m) max cable length |
| Display: | LCD graphics. with backlight |
| Output: | Analog 4-20, 0-20. 0-1 mA or inverse |
| Setpoints: | High/Low |
| Alarm Delay: | 0-250 seconds, selectable |
| Dampening: | 0-250 seconds. selectable |
| Hysteresis: | User defined |
| Sample Rate: | 128 times/second |
| Temperature:<br>Plastic enclosure:<br>XP enclosure:<br>Stainless Steel: | <br>-4 to 104ºF (-20ºC to 40ºC)<br>-4 to 140ºF (-20ºC to 600ºC)<br>-4 to 122ºF (-20ºC to 500ºC) |
| Weight: | Approx. 36 lbs (13.2kg) |
| **OPTIONS:**<br>CE Approval Enclosure: | <br>NEMA 4X, 304 Stainless Steel<br>NEMA 7/4, Class 1, Group D. Div. 1 |
| **ACCESSORIES:**<br>Sample Chamber: | <br>Off-line system performance verification kit |

## AS3 INSERTABLE PROBE

The AS3 insertable probe is an in-line device which uses pulsed, focused ultrasound to detect particles, bubbles and suspended droplets in a variety of flowing liquids.

- It operates in the pulsed-echo mode.
- The ultrasonic frequency is generated by a piezoelectric crystal that converts electrical energy into acoustical (ultrasound) energy.
- To insert this probe under pressure, a Monitek-supplied pipe insertion adapter with ball valve and weldment is required.




**DESIGN SPECIFICATIONS**

| | |
|---|---|
| Type: | Focused acoustic |
| Frequency: | 5 or 15 MHz |
| Materials: | Body – 316SS<br>Lens – PEEK<br>O-ring – Kalrez |
| Mountings: | In-line 316 SS pipe adapter and weldment or open channel mounting |
| Chamber Materials | PVC, 316SS; other materials available upon request |
| Liquid Compatibility | Must be compatible with PEEK |
| Operating Pressure: | 150 psig maximum, with safety chain (for higher pressure, consult factory) |
| Shipping Weight: | 9 lbs (4.08 kg) |
| Max. Operating Temp. | 80ºC without air cooling; 110ºC with air cooling |
| OPTIONS: | Explosion Proof Sensor (suitable for Class I, Group D, Div.1; NEMA 7 areas).<br>Permanent Swage-Lok adaptor. |

# Manufacturer's Warranty Statement

Galvanic Applied Sciences Inc. ("Seller") warrants that its products will be free from defects in materials and workmanship under normal use and service in general process conditions for 12 months from the date of Product start-up or 18 months from the date of shipping from Seller's production facility, whichever comes first (the "Warranty Period"). Products purchased by Seller from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. Buyer agrees that Seller has no liability for Resale Products beyond making a reasonable commercial effort to arrange for procurement and shipping of the Resale Products. Buyer must give Seller notice of any warranty claim prior to the end of the Warranty Period. Seller shall not be responsible for any defects (including latent defects) which are reported to Seller after the end of the Warranty Period.

THIS WARRANTY AND ITS REMEDIES ARE IN LIEU OF ALL OTHER WARRANTIES OR CONDITIONS EXPRESSED OR IMPLIED, ORAL OR WRITTEN, EITHER IN FACT OR BY OPERATION OF LAW, STATUTORY OR OTHERWISE, INCLUDING BUT NOT LIMITED TO, WARRANTIES OR CONDITIONS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH SELLER SPECIFICALLY DISCLAIMS.

Seller's obligation under this warranty shall not arise until Buyer notifies Seller of the defect. Seller's sole responsibility and Buyer's sole and exclusive remedy under this warranty is, at Seller's option, to replace or repair any defective component part of the product upon receipt of the Product at Seller's production facility, transportation charges prepaid or accept the return of the defective Product and refund the purchase price paid by Buyer for that Product. If requested by Buyer, Seller will use its best efforts to perform warranty services at Buyer's facility, as soon as reasonably practicable after notification by the Buyer of a possible defect provided that Buyer agrees to pay for travel time, mileage from the Seller's facility or travel costs to the airport / train station closest to Buyer's facility plus all other travel fees, hotel expenses and subsistence.

Except in the case of an authorized distributor or seller, authorized in writing by Seller to extend this warranty to the distributor's customers, the warranty herein applies only to the original purchaser from Seller ("Buyer") and may not be assigned, sold, or otherwise transferred to a third party. No warranty is made with respect to used, reconstructed, refurbished, or previously owned Products, which will be so marked on the sales order and will be sold "As Is".

**Limitations**
These warranties do not cover:

- Consumable items such as lamps.
- Analyzer components which may be damaged by exposure to contamination or fouling from the process fluid due to a process upset, improper sample extraction techniques or improper sample preparation, fluid pressures in excess of the analyzer's maximum rated pressure or fluid temperatures in excess of the analyzer's maximum rated temperature. These include but are not limited to sample filters, pressure regulators, transfer tubing, sample cells, optical components, pumps, measuring electrodes, switching solenoids, pressure sensors or any other sample wetted components.
- Loss, damage, or defects resulting from transportation to Buyer's facility, improper or inadequate maintenance by Buyer, software or interfaces supplied by Buyer, operation outside the environmental specifications for the instrument, use by unauthorized or untrained personnel or improper site maintenance or preparation.
- Products that have been altered or repaired by individuals other than Seller personnel or its duly authorized representatives, unless the alteration or repair has been performed by an authorized factory trained service technician in accordance with written procedures supplied by Seller.

Revision Date: June 2019

- Products that have been subject to misuse, neglect, accident, or improper installation.
- The sole and exclusive warranty applicable to software and firmware products provided by Seller for use with a processor internal or external to the Product will be as follows: Seller warrants that such software and firmware will conform to Seller's program manuals or other publicly available documentation made available by Seller current at the time of shipment to Buyer when properly installed on that processor, provided however that Seller does not warrant the operation of the processor or software or firmware will be uninterrupted or error-free.

The warranty herein applies only to Products within the agreed country of original end destination. Products transferred outside the country of original end destination, either by the Seller at the direction of the Buyer or by Buyer's actions subsequent to delivery, may be subject to additional charges prior to warranty repair or replacement of such Products based on the actual location of such Products and Seller's warranty and/or service surcharges for such location(s).

**Repaired Products**
Repaired products are warranted for 90 days with the above exceptions.

**Limitation of Remedy and Liability**
IN NO EVENT SHALL SELLER BE LIABLE TO BUYER FOR ANY INDIRECT, CONSEQUENTIAL, INCIDENTAL, SPECIAL OR PUNITIVE DAMAGES, OR FOR ANY LOSS OF USE OR PRODUCTION, OR ANY LOSS OF DATA, PROFITS OR REVENUES, OR ANY CLAIMS RAISED BY CUSTOMERS OF BUYER OR ANY ENVIRONMENTAL DAMAGE OR ANY FINES IMPOSED ON BUYER BY ANY GOVERNMENTAL OR REGULATORY AUTHORITIES, WHETHER SUCH DAMAGES ARE DIRECT OR INDIRECT, AND REGARDLESS OF THE FORM OF ACTION (WHETHER FOR BREACH OF CONTRACT OR WARRANTY OR IN TORT OR STRICT LIABILITY) AND WHETHER ADVISED OF THE POSSIBILITY OF SUCH DAMAGES OR NOT.

Revision Date: June 2019