Installation Guide & User Manual

The Acoustic Level Detection Module (ALDM)

for

Two and Three Phase Separators

Part Numbers:

NERAS-2000-ELEC / NERAS-3000-ELEC

Serial Numbers:

NERAS10XX

Rev.: 1041_2007-02-27

NEW ENGLAND RESEARCH

1 Table of Contents

2 Table of Figures

3 General Information

3.1 Introduction

The NER **Acoustic Level Detection Module** (ALDM), part number : NERAS-2000-ELEC / NERAS-3000-ELEC, is a precision ultrasonic level monitor. The ALDM measures the level of two fluids in a gravity-based 2-phase high-pressure separator. It provides output signals (serial ASCII characters) proportional to either absolute level or relative to a user-selectable set-point.

This manual contains installation and operating instructions for the ALDM used in both 2-Phase and 3-Phase separator configurations. Instrument specifications and procedures for verifying proper operation are included

Block diagrams, theory of operation, and separator disassembling / assembling information are provided for use in maintaining the instrument, as well as a spare parts list.

3.2 Specifications

This section of the manual contains performance specifications for the ALDM instrument. It also lists the accessories supplied, and includes instrument and manual identification information. Table 1 Transducer Specifications and Table 2 Electronics Specifications, provides a complete list of the ALDM critical specifications.

Parameter	Value	Units
Working Pressure	1-700	Bar
Temperature	15-150	Celsius
Fluids	Reservoir Oil and Brine	
Maximum change of water volume	999	ml
Maximum change of oil volume	999	ml
Typical volume resolution (25.4 mm bores, water-paraffin)	0.08	ml
Hysteresis*	0.3 ml	ml
Transducer construction	PZT-5A, plastics, viton and epoxy	
Transducer wetted parts	Plastics, viton o-ring	
Transducer resonance frequency	1.5	MHz
Typical A2D Sample Period (User adjustable 2.5e-7 to 2.5e-8);	1e-7	Second
Maximum trace length	125,000	Samples
Required Vertical Positioning	± 2.5 deg. from true vertical	

Table 1 Transducer Specifications

Property	Value	Units
Warm-up time	30	minutes
PC interface	EIA RS-232C, ASCII, Quizix PumpWorks™ compatible	
Transmission speed	9600	Baud
Data bits	8	
Parity	No parity	
Stop bit(s)	1 stop bit (Hi)	
Mains supply	100/120, 220/240 Auto-switching	VAC

Table 2 Electronics Specifications

* Due to fluid surface mechanics, i.e. reversal of the meniscus surface when changing from rising to falling liquid levels or vice versa, a hysteresis effect occurs in the measurements. To minimize this, the user should prepare the inner surfaces of the separator in accordance with the cleaning and preparation instructions from separator vessel manufacturer.

3.3 Accessories Supplied

The following accessories are supplied with the ALDM for two and three phase separators:

- US style power cords, three conductor, length: 2.5 m.
- One coaxial transducer cable, length: 6 m. per active transducer.
- One ultrasonic transducer (two phase separators) or two ultrasonic transducers (three phase separator).
- An additional spare ultrasonic transducer.
- Spare Viton O-ring transducer seals.
- Hastelloy reference target.
- Reference target stand.
- BNC connector block.
- Serial cross-over cable (for a host computer link or diagnostics)
- User's Manual.

4 Installation, Interfacing and Safety

This section contains information and instructions for installing and interfacing the ALDM, as well as safety precautions. It includes initial inspection procedures, power and grounding requirements, and installation instructions.

The electronics console must be located within 20 feet of the separator vessels (20 feet is the length of the special high-temperature coaxial cables that connect the electronics console to the separators). The electronics may be mounted in a standard 19 inch rack if desired.

The console may come with an optional 2-port video-keyboard-mouse (KVM) switch. The KVM switch allows the embedded CPU's to utilize a single monitor, mouse and keyboard without taking up any additional desk space.

All of the required cables are included.

Please inspect all of the ALDM parts carefully, and read all of the manuals included. In addition to this set of instructions, there may be other manuals provided which describe the components of the ALDM in greater detail.

4.1 Initial Inspection

This instrument was carefully inspected both mechanically and electrically before shipment. It should be in perfect order upon receipt. To confirm this, inspect the instrument for damage that may have occurred in transit.

4.2 Safety

- **Ground the instrument**. To avoid shock hazard, the instrument chassis must be connected to an electrical ground. The instrument is equipped with a three-conductor AC power cable.
- Do not operate in an explosive atmosphere.
- Keep away from live circuits.
- Dangerous voltages are present in this instrument.
- The ALDM separator is designed to be used with high-pressure, high-temperature equipment. Damage to the device under operation or improper assembly may lead to leakage, which can cause serious injury to personnel.

4.3 Power Selection:

The instrument can be operated from 110 or 220 Volts AC single-phase power supplies, according to the fuse setting on rear panel of the ALDM unit.

- Confirm that the electronics console has the correct fuses installed for the power at your location.
- The proper fusing for the electronics is selected by adjusting the "Power Entry Module" located on the back of the electronics console.

- Be certain to use 250V fuses in all locations.

Fuse Installation Instructions:

1. Remove power cord.
2. Pry door open at socket.
3. Lift and swing door into socket.
4. Lift fuse holder out of housing.
5. Install one (1) AG fuse or two (2) metric fuses*.
6. Replace fuse holder into housing.
7. Swing and snap door back in place.

*Install fuses on one side only. Do not install both AG and metric fuses at the same time.

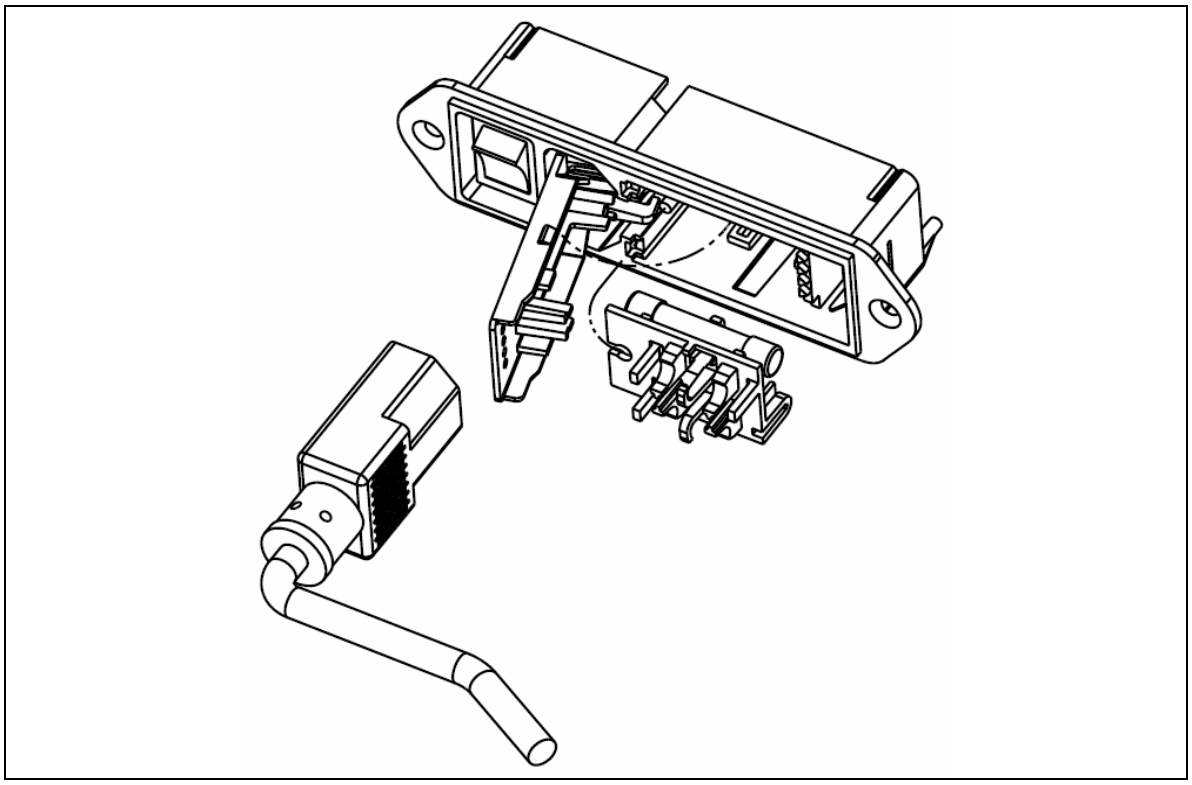


Figure 1 Removing the fuse holder

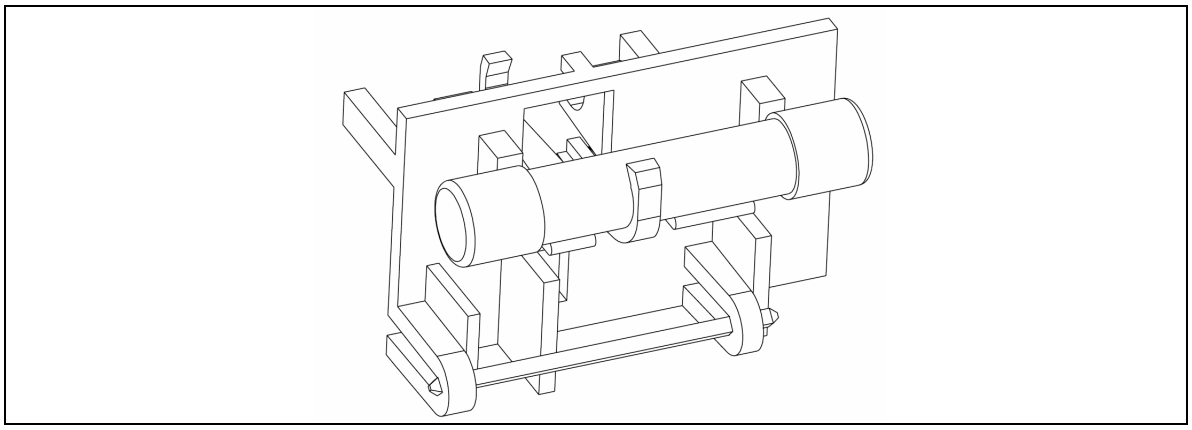


Figure 2 North American fuse arrangement

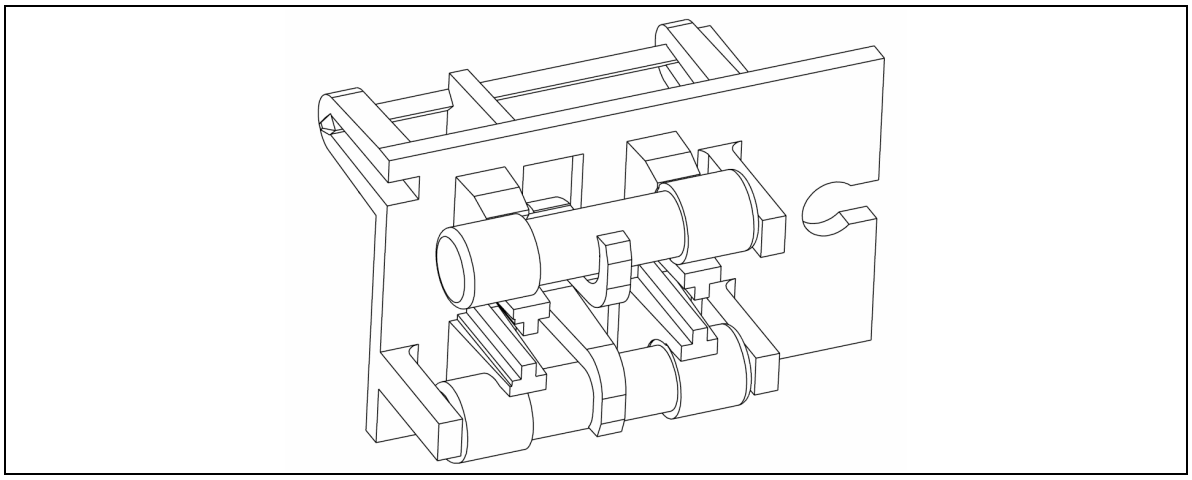


Figure 3 European fuse arrangement

Fuse Selection Chart		
Location	**Qty**	**Fuse (Maximum Rating)**
North America	1	3 Amp / 250V 3AG, ¼ x 1¼ Time Delay
Europe	2	3 Amp / 250V, 5mm x 20mm, Time Delay

4.4 Basic Cable Connections:

First, familiarize yourself with the ALDM components and some typical separator pressure vessels:

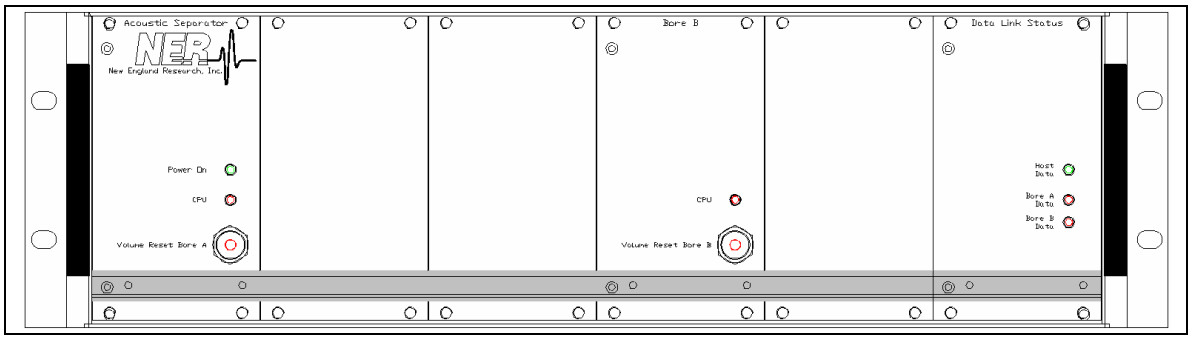


Figure 4 Electronics console front view (three phase separator version)

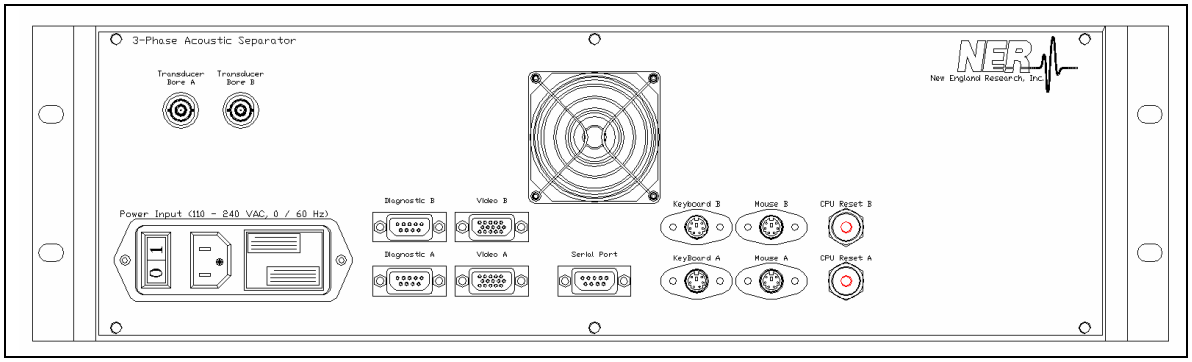


Figure 5 Electronics console rear view (three phase separator version)

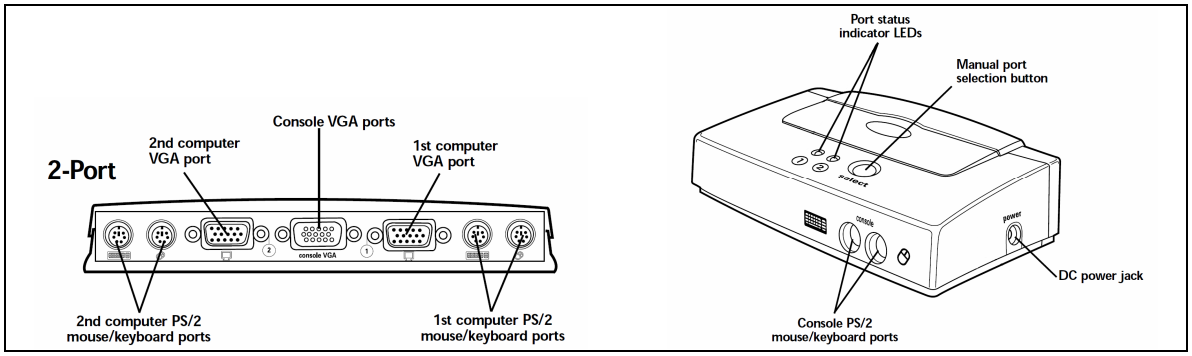


Figure 6 KVM connections

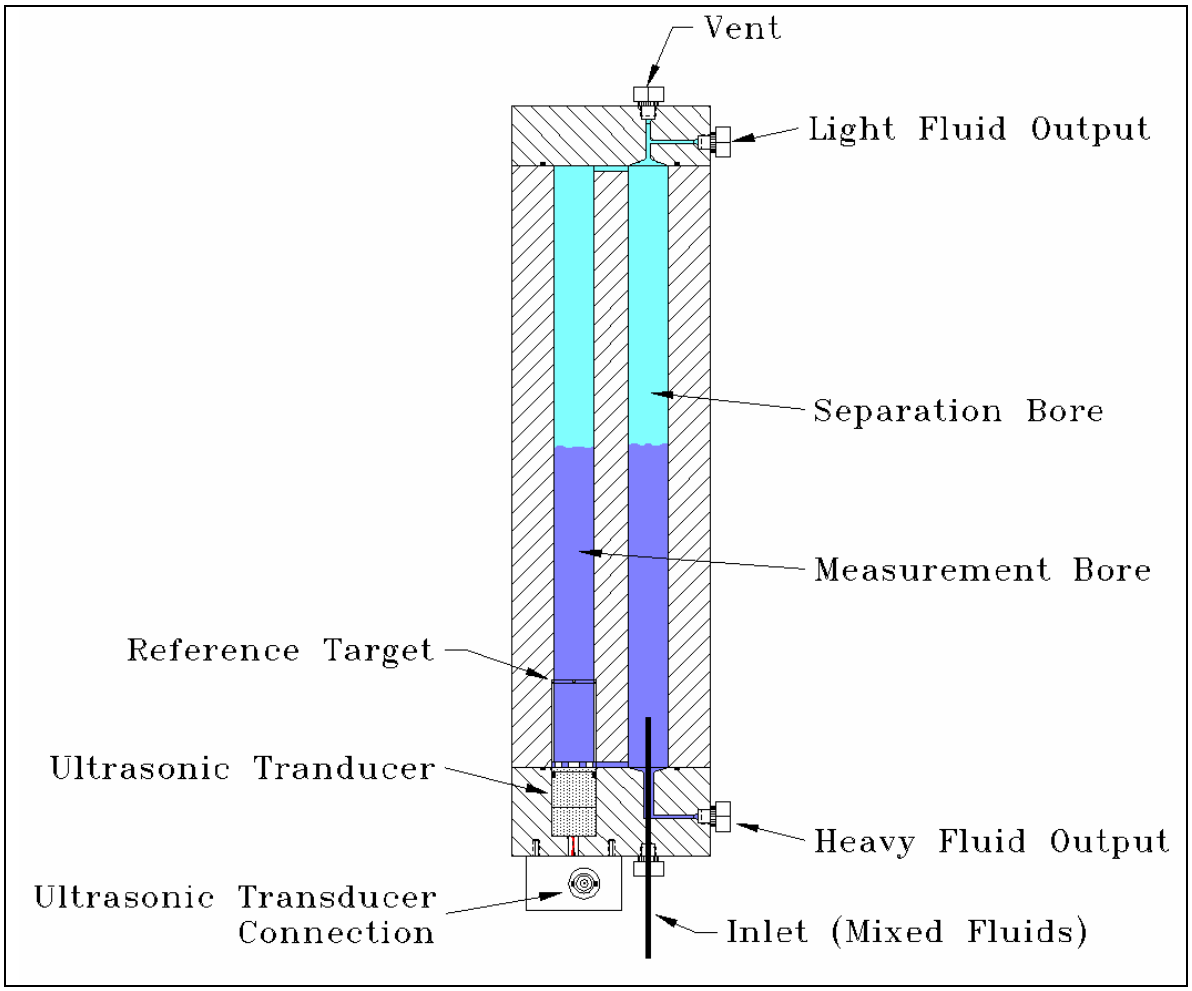


Figure 7 Typical two-phase separator vessel

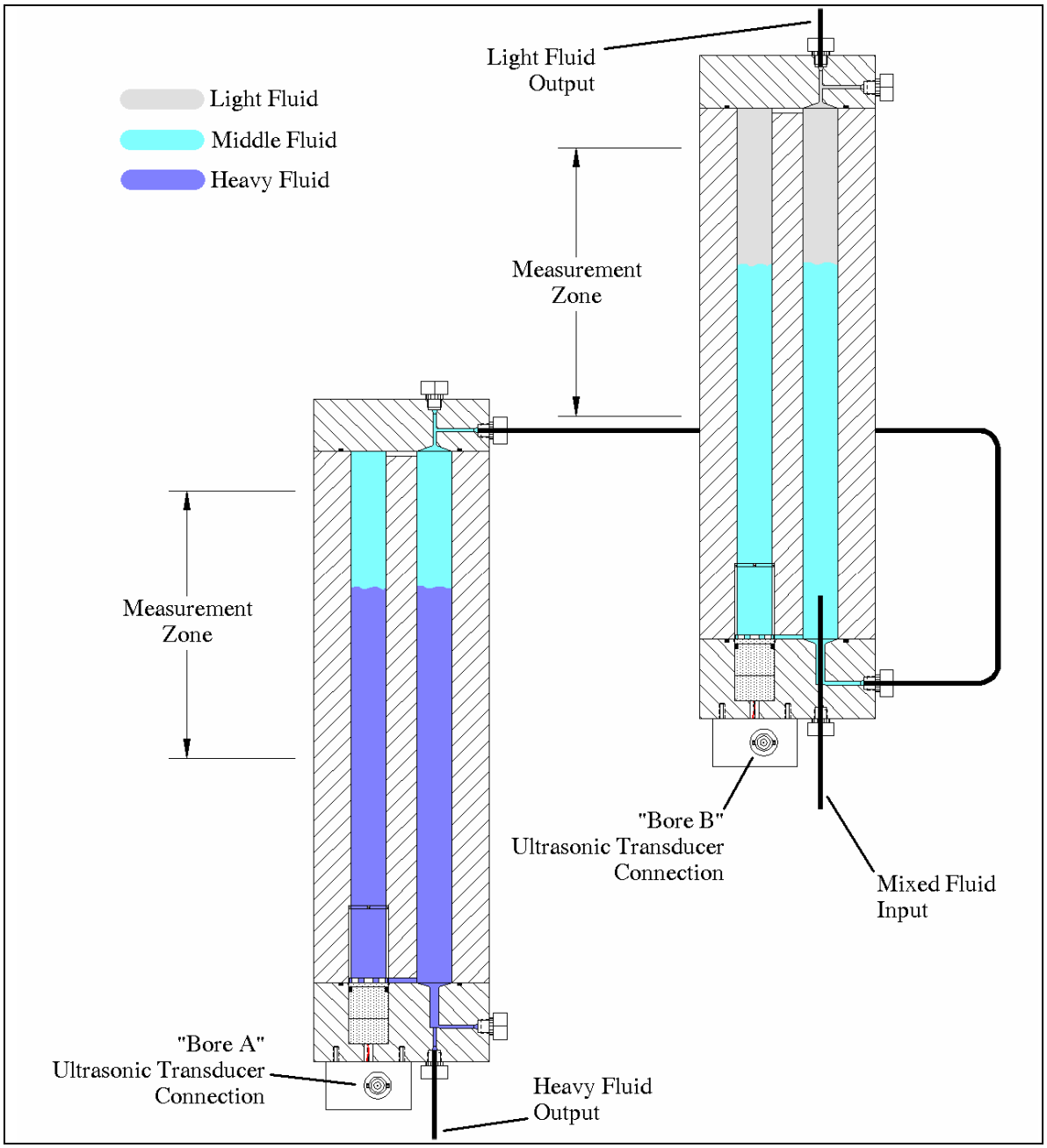


Figure 8 A hybrid three-phase separator vessel

Cables supplied with this system:

- **[A]** (2) VGA Video cables for use with the KVM switch
- **[B]** (2) PS2 Keyboard cables for use with the KVM switch
- **[C]** (2) PS2 Mouse cables (not required for operation) for use with the KVM switch.
- **[D]** (2) Teflon coaxial "separator" signal cables.
- **[E]** (1) Electronics console power cord.
- **[F]** (1) 9-pin, serial cross-over cable.

Connections required for standalone operation:

Electronics Console	**To**	**Use Cable Type**
Video A	KVM 1st VGA Port	**[A]** VGA video cable
Video B	KVM 2nd VGA Port	**[A]** VGA video cable
Transducer Bore A	"Separator 1" Ultrasonic Transducer (Pressure Vessel)	**[D]** Teflon coaxial cable
Transducer Bore B	"Separator 2" Ultrasonic Transducer (Pressure Vessel)	**[D]** Teflon coaxial cable
AC Power Source	Electronics Console	**[E]** Power cord

KVM Switch		**Use Cable Type**
Console VGA	To Video Monitor VGA	Video Monitor Cable

Connections required for configuration and diagnostics only:

Electronics Console	**To**	**Use Cable Type**
Keyboard A	KVM 1st Keyboard Port	**[B]** PS2 Keyboard Cable
Keyboard B	KVM 2nd Keyboard Port	**[B]** PS2 Keyboard Cable
Diagnostics A or B	Host Computer	**[F]** Cross-Over Cable

KVM Switch		**Use Cable Type**
Console Keyboard	To Keyboard	Attached Keyboard Cable

Connections required for remote data transfer & control:

Electronics Console	**To**	**Use Cable Type**
Serial Port	Host Computer (or Quizix® Computer)	**[F]** Cross-Over Cable

4.5 Transducer Assembly

The ALDM comes supplied with a specially designed ultrasonic transducer assembly.

Transducer Assembly Components – 2 Phase Separator Systems	
Qty	**Description**
1	Ultrasonic Reference Target
1	Reference Target Stand
2	Ultrasonic Transducer Assembly (1 Spare)
1pkg	#119 Viton O-rings
1	BNC Connector Block

Transducer Assembly Components – 3 Phase Separator Systems	
Qty	**Description**
2	Ultrasonic Reference Target
2	Reference Target Stand
3	Ultrasonic Transducer Assembly (1 Spare)
1pkg	#119 Viton O-rings
2	BNC Connector Block

The Ultrasonic Transducer Assembly may arrive wrapped in black plastic tape. The tape ensures that the assembly remains intact during shipment. The tape also provides minimal strain relief for the signal wires. **The signal wires are very fragile, and can be easily broken.** Remove the shipping tape before inserting the assembly into an appropriately sized holder. Be careful handling the transducer when the shipping tape is removed.

The transducer assembly will require the attachment of the two signal wires for operation. These wires must be soldered with the supplied high-temperature solder, or a similar solder rated for your operating temperatures.

The black wire from the transducer should be connected to the shield connection of the BNC connector. The other wire may vary in color (red, white, etc.), and should be connected to the BNC center pin.

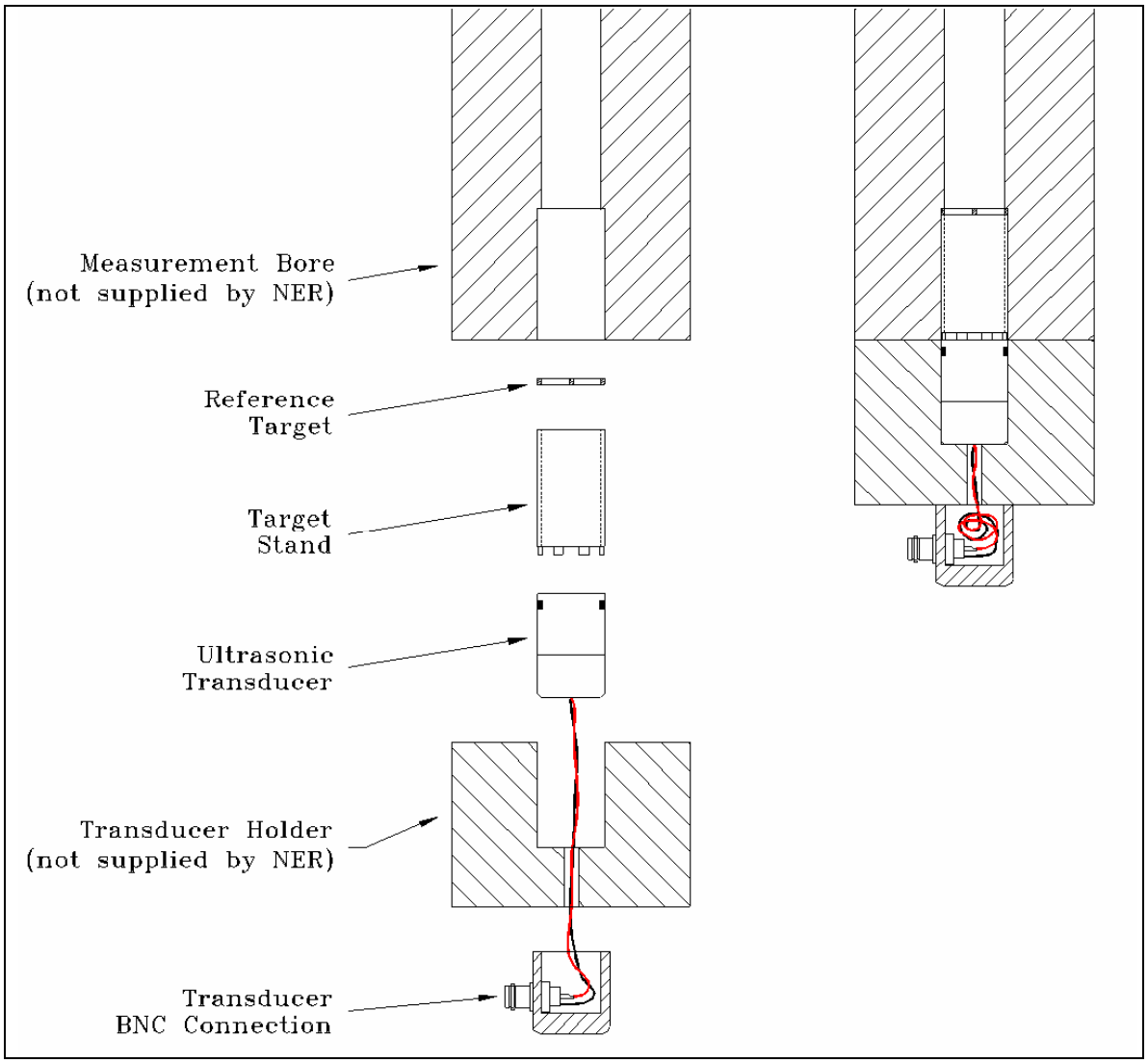


Figure 9 Ultrasonic transducer assembly

4.6 Turning the system "On"

The main system power switch is located on the back of the electronics console. Upon activation, the separator system starts the boot procedure. Progress, as well as any error or diagnostic messages will appear on the video output.

For three-phase systems, the boot procedures (as well as all other functions) are independent for both Bore A and Bore B. You may need to change the KVM selection to view the desired output.

Eventually a graphical display will appear that shows the current output of either Bore A or Bore B. You can switch the view of the current output to another bore by changing the KVM switch setting.

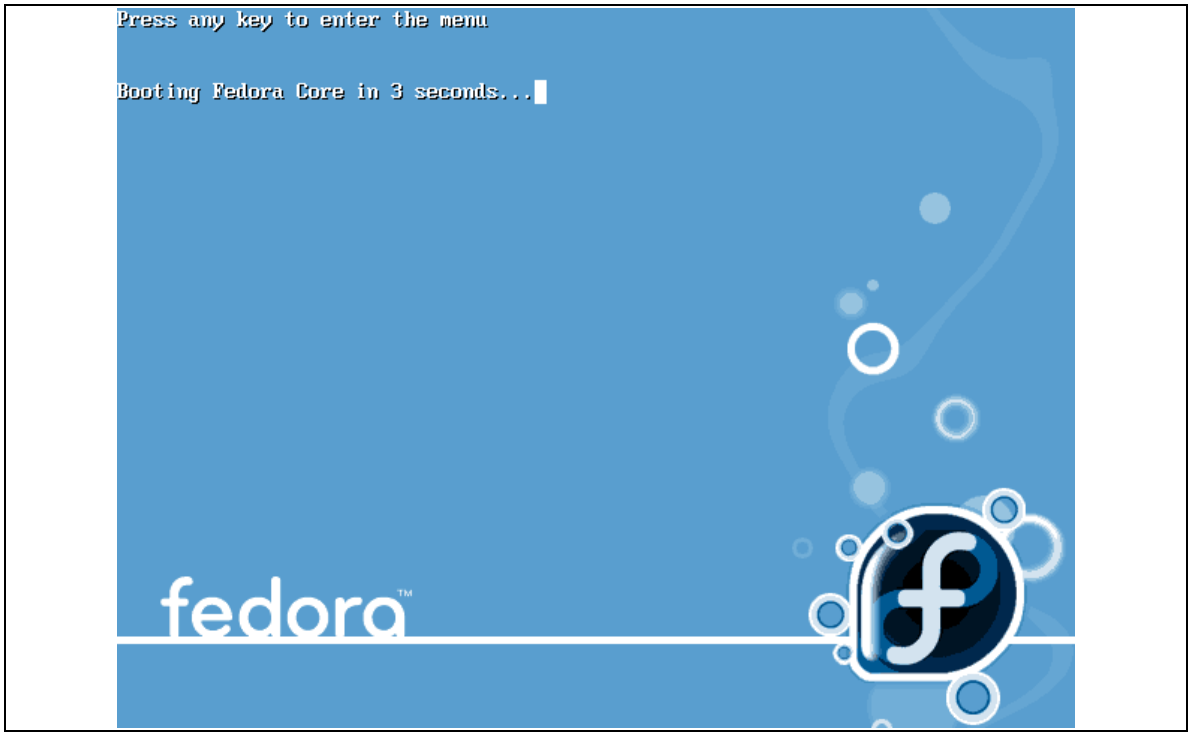
4.7 ALDM Software Configuration ("fbas.ini"):

The various software settings used by the ALDM computer are held in a configuration file titled fbas.ini.

If the hardware setup is altered, it may become necessary to adjust the settings in the fbas.ini file. This can be accomplished using the following procedure. Keep in mind that you can change the configuration settings for only one bore at a time. For three phase separators, any changes that are applied to "Bore A" may also have to be applied to "Bore B".

To modify the ALDM configuration file:

1. Start with the ALDM electronics turned off.
2. Make sure the monitor and keyboard are plugged into the ALDM electronics console or KVM switch.
3. Turn the power to the ALDM electronics console to "On".



4. When a blue screen with the text "Press any key to enter the menu" appears, quickly press any key on the keyboard. If you do not press a key within time, the ALDM will boot normally. If this happens, power cycle the electronics console, or press the "CPU Reset" button on the back of the ALDM electronics to try again.

5. By default, the 'embedded linux' entry is selected. Using the arrow keys, select 'maintenance' option, then press enter.
6. The ALDM will now boot into maintenance mode. Eventually a login prompt will appear. Type 'root' (without quotes), and press enter. For the password type 'root*" (without quotes), as shown below in red.

```
NER embedded linux development and maintenance system
Fedora Core 2 2.6.5-1.358 on an i386
Use field root login:
Midge login: root
Password: root*
```

7. Now type "./sepcfg" to start the configuration editor:

```
NER embedded linux development and maintenance system
Fedora Core 2 2.6.5-1.358 on an i386
Use field root login:
Midge login: root
Password: root*
Last login: Saturday August 18 on tty1
NER embedded linux development and maintenance system

Midge: ./sepcfg
```

8. The configuration editor, "jed", appears. Using the arrow keys, edit the configuration file as necessary (see the next section).

9. When complete, press <Ctrl>-x, then <Ctrl>-c to save the file and exit the text editor. If you made any changes that you wish to make permanent, then press 'y' at the confirmation prompt.
10. At the prompt, type 'reboot' to restart the ALDM system.

```
Midge: reboot
```

Please note: When the ALDM is running in 'Normal' mode, the system is operating from a read-only file system. The system may be shut down without damage by simply turning off the power switch.

When the system is in 'maintenance mode', the computer is running with "read – write' disk access. It is very important not to power down the system by using the power switch. Use the 'reboot' command to restart the separator system. After the system successfully restarts, you can then power–down using the main power switch.

ALDM Software Configuration variables:

The syntax for values in the "fbas.ini" configuration file is:

```
set <variablename> <value>
```

- One entry per line.
- **All variables are case sensitive!**
- If 'value' is a string with spaces, use quotation marks (") around the value.

Variables in "fbas.ini" that may be modified:		
Variable	**Function**	**Typical Value**
borediam	Bore diameter in inches.(Measurement Bore)	Actual Bore diameter[1]
borediam2	Bore diameter in inches. (Separation Bore)	Actual Bore diameter[1]
cmax	Max allowable 'Heavy Fluid' speed (KM/s)	2.0
cmin	Min allowable 'Heavy Fluid' speed (KM/s)	0.8
h2htime	Head-to-head (transducer) time in 10^(-6) seconds	14.88

[1] Separator vessels with unexpected geometries can be accommodated by adjusting the bore diameters as needed to allow the ALDM to report correct volume measurements.

heavyname	String label for heavy fluid (normal text characters only, no square brackets)	Brine
lightname	String label for light fluid (normal text characters only, no square brackets).	Oil
maxrange	... in inches (Bore length minus safety margin). Typical value: (Bore length – 1 inch)	14
minrange	... in inches (Closest possible acquisition - be wary of making this too small, the ultrasonic shadow from the target will interfere with the acquired signal).	4
titlestring	User configurable string that is displayed on the NERAS monitor. If not specified, defaults to “Acoustic Separator - ”. This string cannot be more than 34 characters long.	NER ALDM

Default contents of the "fbas.ini" configuration file

```
#-------------------------------------------------------------
#
# stuff you might (BUT NEED NOT NECESSARILY) change
#
#-------------------------------------------------------------
# text labels: MUST be in double qoutes
set titlestring "Acoustic Level Detector"
set heavyname "brine"
set lightname "oil"

# bore sizes in inches
set borediam  1.00
set borediam2 1.00

#-------------------------------------------------------------
#
# stuff that may need field changes but that's really tricky and
# can break the whole system in hard-to-detect ways.
#
# CONSULT THE VENDOR before you change any of these.
#
#-------------------------------------------------------------
set maxrange 14.00
set minrange 5.00
set cmin 0.8
set cmax 2.0
set dt 1e-7

#-------------------------------------------------------------
#
# STUFF YOU SHOULD NOT NEED TO CHANGE EVER EVER EVER without a
# special license.
#
#-------------------------------------------------------------
set serialnumber 1027
set default_boxcol hotpink
set bgcol "azure"
set plotfont hersheyserif-bold
set resultfont courier-bold
set usel2 0
set useenv 1
set agamma 0.01
set etasim 0.1
set amplpwr 2.0
set h2htime 14.88
set refrange 2.00
set refreflead 2e-6
set intreflead 2e-6
set xpixels 1024
set ypixels 768
set bitsperplane 16
```

4.8 EIA RS-232C Communication Port

Communication is performed via standard asynchronous RS-232C interface operating at **9600 baud, 8 bits, 1 stop bit, no parity, no flow control**. Key parameters for the RS-232C link are given in Table 4 and in section 8, Serial Commands. The pin-out of the 9-pin RS-232C socket is as given in Table 3 RS-232C Connector Pinout.

Pin Number	Function
1	no connection
2	This pin outputs data to the PC
3	Data from the PC is to be applied to this pin
4	no connection
5	Ground
6-9	no connection

Table 3 RS-232C Connector Pinout

Communication consists of:

1. Data request, which is always results in a transfer of measured values and error codes to the PC.
2. Reset of relative volume reading.

A data request cycle is initiated when the code "ENQ" (ASCII 0x05) or the ASCII character “?”, is received followed by a carriage return "CR" (ASCII 0x0D). ALDM responds by sequencing through a measurement cycle and returning the newly measured data, together with an error message. The data string is formatted as shown in Table 4 RS-232 Data Format.

Reset of relative volume reading is carried out on receipt of "R": or "r" (ASCII 52h or 72h) followed by a "CR". ALDM responds by resetting both relative volume readings to zero. No confirmation code is returned.

Serial Output	Two-Phase ALDM Output	Three-Phase ALDM Output
Bytes 1-8	Error Codes	Error Codes
Bytes 9-13	Absolute Volume of the Light Fluid	Absolute Volume (Upper Phase Bore B), Light Fluid
Bytes 14-19	Relative Volume of the Light Fluid	Relative Volume of the Light Fluid
Bytes 20-23	Heavy fluid velocity (meters/second)	Fluid Velocity (Bore B), Middle Fluid
Byte 24-28	Absolute Volume of the Heavy Fluid	Absolute Volume of the Heavy Fluid (Lower Phase Bore A)
Byte 29-34	Relative Volume of the Heavy Fluid	Relative Volume of the Heavy Fluid
Byte 35-38	Heavy fluid velocity (meters/second)	Fluid Velocity (Bore A), Heavy Fluid
Byte 39	Carriage Return (0Dh)	Carriage Return (0Dh)

Table 4 RS-232 Data Format

- Absolute volume = 5 characters. NNN.NN in ml
- Relative volume = 6 characters. ±NNN.NN in ml
- Sound velocity = 4 characters NNNN in m/s.

All characters are numeric (ASCII 30h to 39h). Leading zeros are used when number is less than full scale. Relative volumes use "+" (ASCII 2Bh) and "-" (ASCII 2Dh) to indicate whether the volumes are higher or lower than when last reset. Decimal points are implied and not sent.

A response to a status query is listed blow for both two and three phase systems. Please note that the list may include commands that are not compatible with earlier versions of the ALDM, or other manufacturer's control-systems.

ALDM Response to a Host Computer '?' Command:

The Command:	?<Carriage Return>
The Response:	STATS OK26839+21278167411129-212781674

bytes:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	S	T	A	T	S		O	K	2	6	8	3	9	+	2	1	2	7	8	1	6	7	4	1	1	1	2	9	-	2	1	2	7	8	1	6	7	4	<CR>
ALDM Serial Output	Error Code								Light-Fluid Volume NNN.NN [ml]					delta-Light Fluid Volume +/-NNN.NN [ml]						Speed Heavy Fluid NNNN [m/s]				Heavy-Fluid Volume NNN.NN [ml]					delta-Heavy Fluid Volume +/-NNN.NN [ml]						Speed Heavy Fluid NNNN [m/s]				CR

Where:

Error Code:	= Anything other than "STATS OK" indicates a software or hardware problem
Light Fluid Volume	= the absolute volume of the light fluid
delta-Light Fluid Volume	= running delta, reset to zero if a "r" is received
Speed Heavy Fluid	= The speed of the heavy fluid in meters/second
Heavy Fluid Volume	= the absolute volume of the heavy fluid
delta-Heavy Fluid Volume	= running delta, reset to zero if a "r" is received
Speed Heavy Fluid	= The speed of the heavy fluid in meters/second (repeated)

Command Name	**Command (from Host)**	**Action by the ALDM**
Request Data	ASCII ENQ (05h) followed by ASCII character CR (0Dh) OR a ? followed by ASCII character CR (0Dh)	Distribute this string to all embedded CPU's. Wait for responses. Modify returned Absolute Volumes as necessary. Reply to Host with modified values.
Volume Reset	'R'(52h) or ASCII 'r'(72h), followed by ASCII character CR (0Dh)	Send same command (R or r) out to all embedded CPU's. No response expected. Reset internal delta-volume values to 0.

Decimal points are implied and not sent.
Leading zeros or spaces are present when number is less than full scale.
Relative Volume uses '+' (ASCII 2Bh) and '-' (ASCII 2Dh) to indicate whether volumes are higher or lower than when last reset.

Figure 10 Two-Phase Separator Serial Protocol Example

Data Link Card Response to a Host Computer '?' Command:

The Command:	?<Carriage Return>
The Response:	STATS OK26839+21278167411129-212781674

bytes:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	S	T	A	T	S			O	K	2	6	8	3	9	+	2	1	2	7	8	1	6	7	4	1	1	1	2	9	-	2	1	2	7	8	1	6	7	4	<CR>

Data Link Output	Error Code	Light-Fluid Volume NNN.NN [ml]	delta-Light Fluid Volume +/-NNN.NN [ml]	Speed Middle Fluid NNNN [m/s]	Heavy-Fluid Volume NNN.NN [ml]	delta-Heavy Fluid Volume +/-NNN.NN [ml]	Speed Heavy Fluid NNNN [m/s]	CR

Where:

Error Code:	= the "OR" of error codes of Bore A / B
Light Fluid Volume	= volume reported from Bore B
delta-Light Fluid Volume	= running delta, reset to zero if a "r" is received
Speed Middle Fluid	= Middle fluid speed as reported from Bore B
Heavy Fluid Volume	= (Heavy Fluid Volume from Bore A) - (Volume Adjustment Constant)
delta-Heavy Fluid Volume	= running delta, reset to zero if a "r" is received
Speed Heavy Fluid	= Heavy fluid speed as reported from Bore A

Command Name	**Command (from Host)**	**Action by the Data Link Card**
Request Data	ASCII ENQ (05h) followed by ASCII character CR (0Dh) OR a ? followed by ASCII character CR (0Dh)	Distribute this string to all embedded CPU's. Wait for responses. Modify returned Absolute Volumes as necessary. Reply to Host with modified values.
Volume Reset	'R'(52h) or ASCII 'r'(72h), followed by ASCII character CR (0Dh)	Send same command (R or r) out to all embedded CPU's. No response expected. Reset internal delta-volume values to 0.
Config Data Link Card*	'C' or 'c' <optional value>, followed by ASCII character CR (0Dh)	Returns the value of the 'Volume Adjustment Constant'. If the command is followed by a number, set the constant to the new value and save to flash memory.
Return Version Number*	'V' or 'v', followed by ASCII character CR (0Dh)	Returns the current firmware version-code.

(Commands with * are NER diagnostic commands. Not required for Quizix® compatibility.)

Decimal points are implied and not sent.
Leading zeros or spaces are present when number is less than full scale.
Relative Volume uses '+' (ASCII 2Bh) and '-' (ASCII 2Dh) to indicate whether volumes are higher or lower than when last reset.

Figure 11 Three-Phase Separator Serial Protocol Example

4.9 Integration with Quizix PumpWorks™

The ALDM for two and three-phase separators from New England Research, Inc. are fully compatible with the current "PumpWorks™" software release from Quizix (V 5.35 – B5). Quizix supplies pumps that are commonly used in separator systems. Please note that New England Research, Inc. makes every effort to ensure that our Acoustic Level Detection Modules will function seamlessly with PumpWorks™. However, we cannot guarantee this functionality for different versions of PumpWorks™ or hardware changes that are beyond our control.

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*Quizix product and company names (Quizix, PumpWorks, …) are trademarks or trade names of Quizix Incorporated.

The ALDM console may be detected automatically[2] upon starting PumpWorks™. If this is not the case, you can manually configure PumpWorks™ to recognize and control the two or three phase separator ALDM as shown below:

1. Select "Communications" ⇒ "Separator Communications" ⇒ "Separator 3" (select "Separator 3" even if you are using a two phase separator).

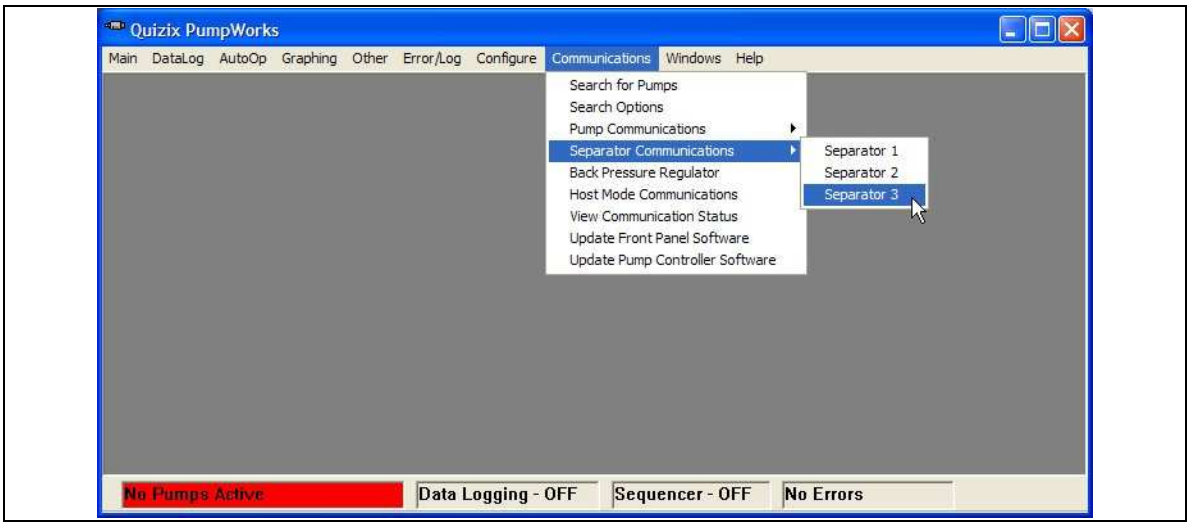

Figure 12 PumpWorks separator communications step #1

[2] PumpWorks sends out a query to available hardware. In some case, this query can leave unwanted characters on the communication bus. These characters may cause a communications "timeout" when you try to initialize the separator setup. Simply retry the separator setup until communications are established with the ALDM.

2. Apply the settings shown below. The "Com Port" setting, Com8, may be different for your system. Select "Enable Separator" when finished.

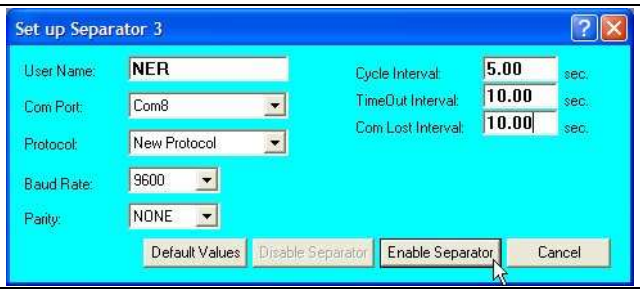

Figure 13 PumpWorks separator communications step #2

3. You can view the current separator data by selecting "Other" ⇒ "Separator Data" from the main menu.

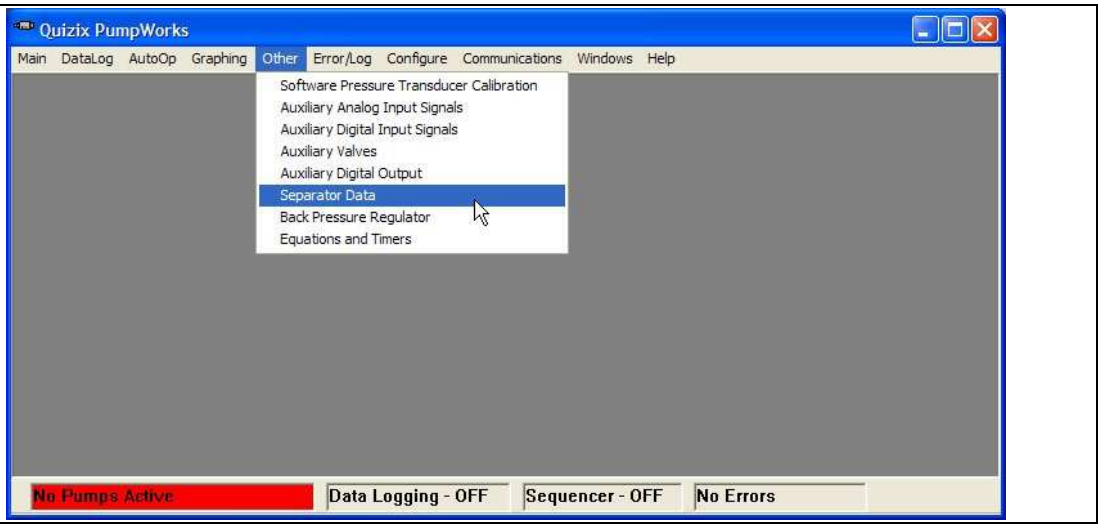

Figure 14 View separator data

Please see the PumpWorks™ documentation for more information on the operation and setup of the PumpWorks™ software.

5 The ALDM Console

This section provides general operating information and functional identification of all controls and connectors on the ALDM unit.

5.1 Front Panel Description

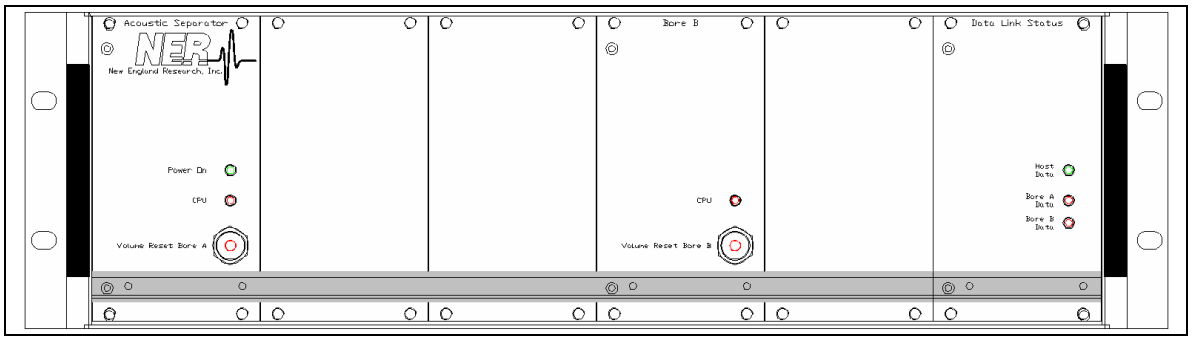

Figure 15 ALDM Electronics Console Front Panel (Three Phase Separator)

"Power ON" Indicator

This green indicator signifies that the Electronics Console's power switch is in the "On" position and the unit is receiving AC power.

"CPU" Bore-A and "CPU" Bore-B (Three Phase Separator)

This red indicator flashes when the embedded CPU is active. A program or hardware error is indicated by this LED remaining constantly on or off.

"Volume Reset Bore A" and "Volume Reset Bore B" (Three Phase Separator)

When this red switch is pushed, the relative reading of liquid level is set to zero.

"Host Data", "Bore A Data" and "Bore B Data" (Three Phase Separator)

These panel mounted LED's indicate serial communication activity with an external host.

5.2 Rear Panel Description

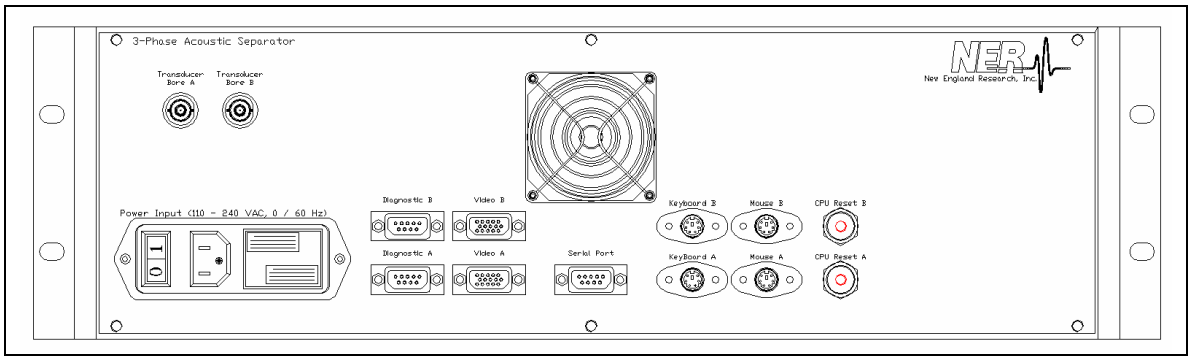

Figure 16 ALDM Electronics Console Rear Panel (3 Phase)

Power Input

Main AC supply connection and fuse location. Connect 110 – 240VAC at 50/60 Hz. Maximum current is 4 amps.

Transducer Bore A

This is the ultrasonic transducer connection for Bore A. Connect the transducer using the supplied high-temperature coaxial cable.

Transducer Bore B (Three Phase Separator)

This is the ultrasonic transducer connection for Bore B. Connect the transducer using the supplied high-temperature coaxial cable.

Diagnostic A / Diagnostic B (Three Phase Separator)

These are the diagnostic serial ports for the Bore A and B CPU's. Protocol settings are: 9600 baud, 8-n-1. No connection is required for normal use.

Video A / Video B (Three Phase Separator)

Video output for each bore. These outputs may be connected to an external KVM switch to allow the use of one video monitor.

Serial Port

Data acquisition and control port. This port is commonly connected to Quizix® control systems. It may also be connected to any computer using a serial terminal program. See section 4.8, EIA RS-232C Communication Port for configuration information and available commands.

Keyboard A / Keyboard B (Three Phase Separator)

Connect an external keyboard adjust the configuration settings. These ports may be connected to an external KVM switch to allow the use of only one keyboard.

Mouse A / Mouse B (Three Phase Separator)

These connectors currently have no function.

CPU Reset A / CPU Reset B (Three Phase Separator)

When pushed, these buttons reset the corresponding embedded CPU. Effectively restarts the system without disconnection the power. Each bore ha an independent CPU Reset button.

6 Principle of Operation

This section contains functional descriptions keyed to overall, simplified mechanical drawings or block diagrams of electronic circuits.

A typical two-phase separator vessel is shown below. Notice how the measurement bore is isolated from the separation bore, preserving a high quality liquid interface. The ultrasonic transducer, reference target and electrical connections supplied by NER can be seen near the bottom of the measurement bore. The bore diameters are user specified and may be unequal diameters. The bore length is also user specified and is limited only by signal quality.

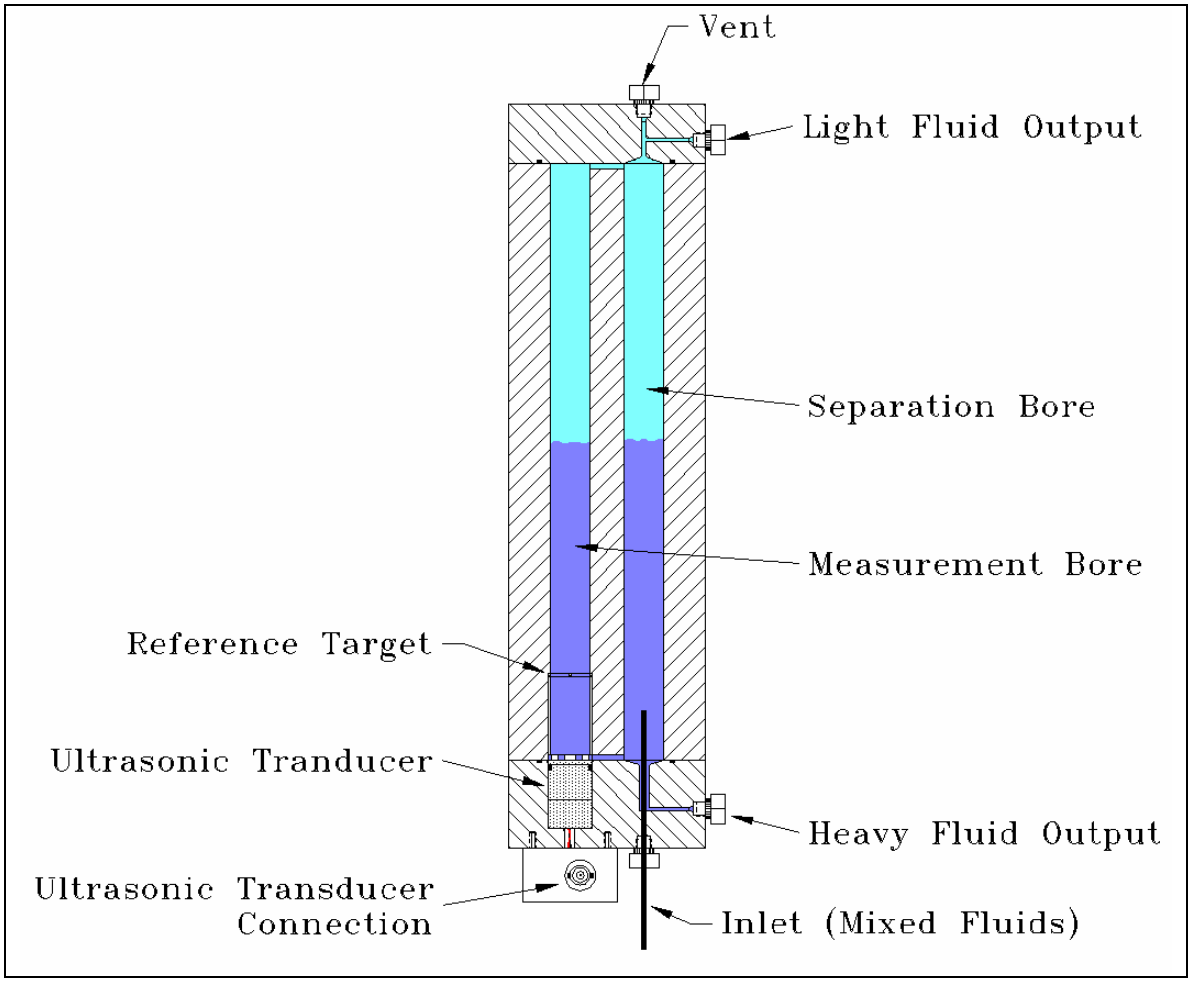

Figure 17 A typical two-phase separator vessel.

A hybrid three-phase separator vessel is shown below. In this configuration, two two-phase systems are connected together. This configuration enables the measurement of three different volumes while also recording the wave velocity in the two heaviest fluids. The light fluid may be a gas.

The ultrasonic transducer, reference target and electrical connections supplied by NER can be seen near the bottom of each measurement bore.

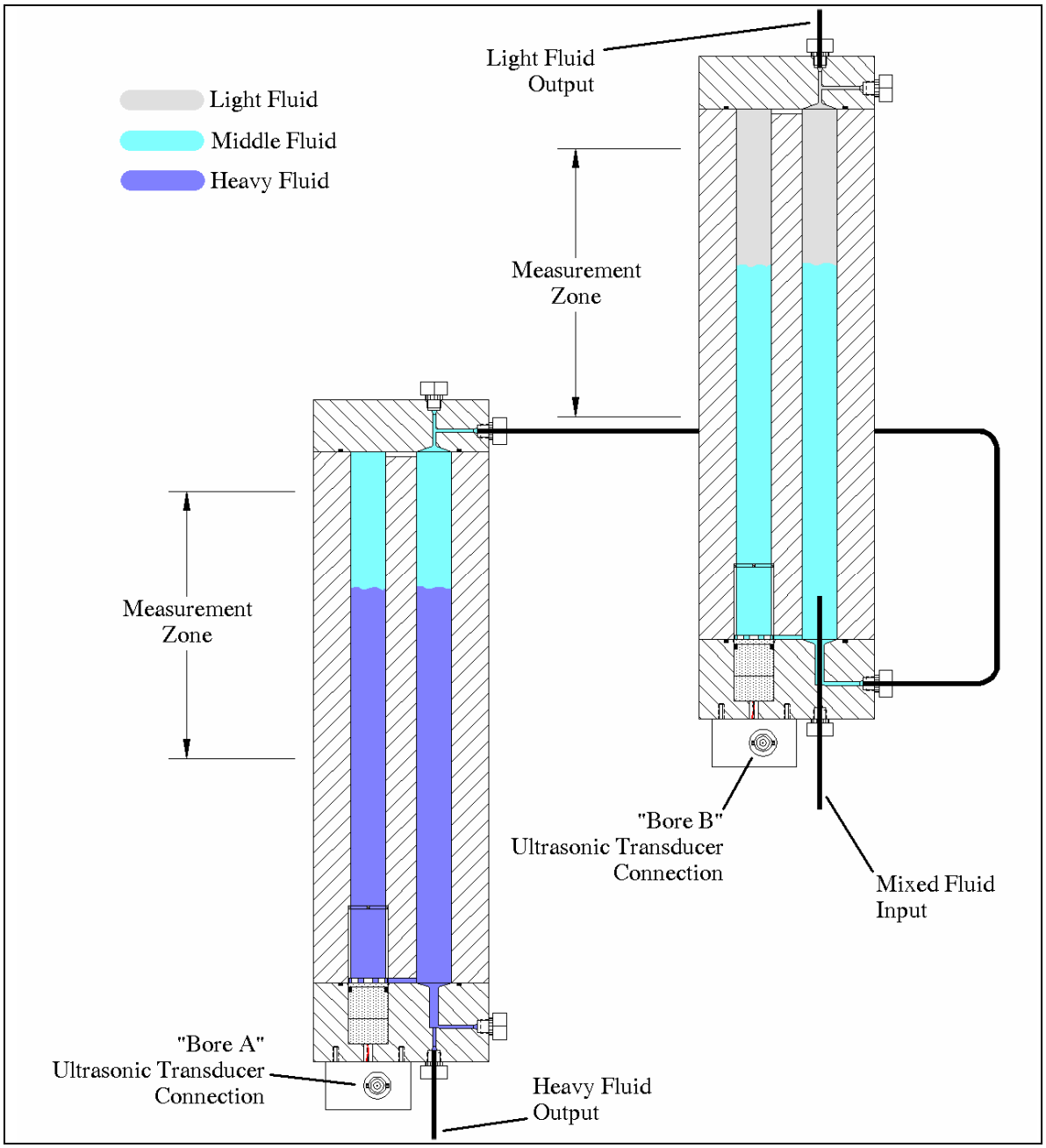

Figure 18 A hybrid three-phase separator

A specific purpose, staggered three-phase separator vessel is shown below. In this configuration, the separation bore is in the center and the measurement bores are isolated on either side, still preserving the high quality liquid interfaces.

This setup preserves the same resolution as the hybrid separator, however material and machining cost is reduced. The three-phase separator communication interface allows the implementation of a volume offset to the measurements. This coupled with user specified bore diameters, allows the ALDM to be configured for nearly any conceivable hardware setup. See section 4.7, “ALDM Software Configuration (“fbas.ini”):” for more details.

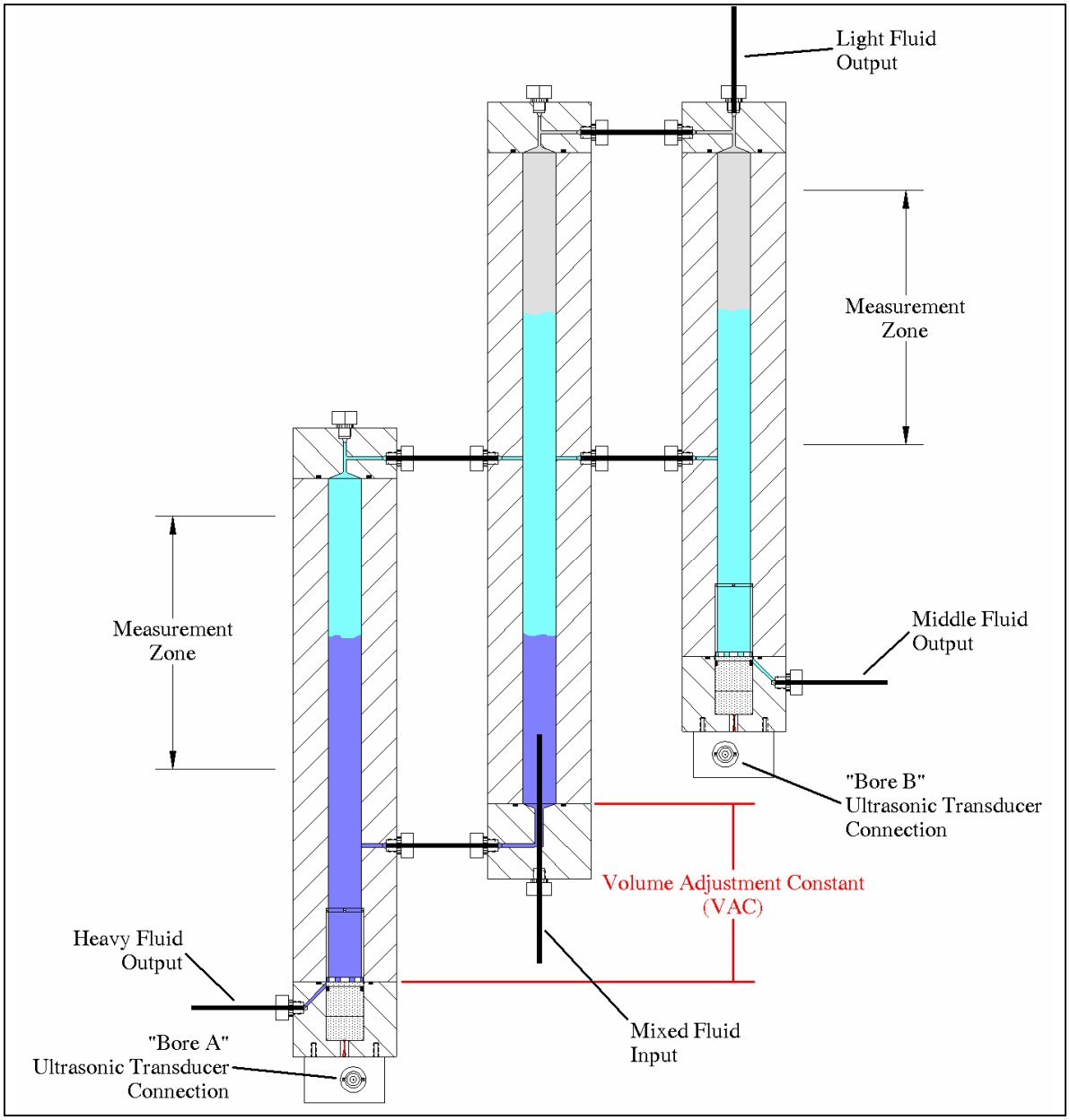

Figure 19 Staggered three-phase separator

6.1 Three Phase Separators - The Data Link Status Panel

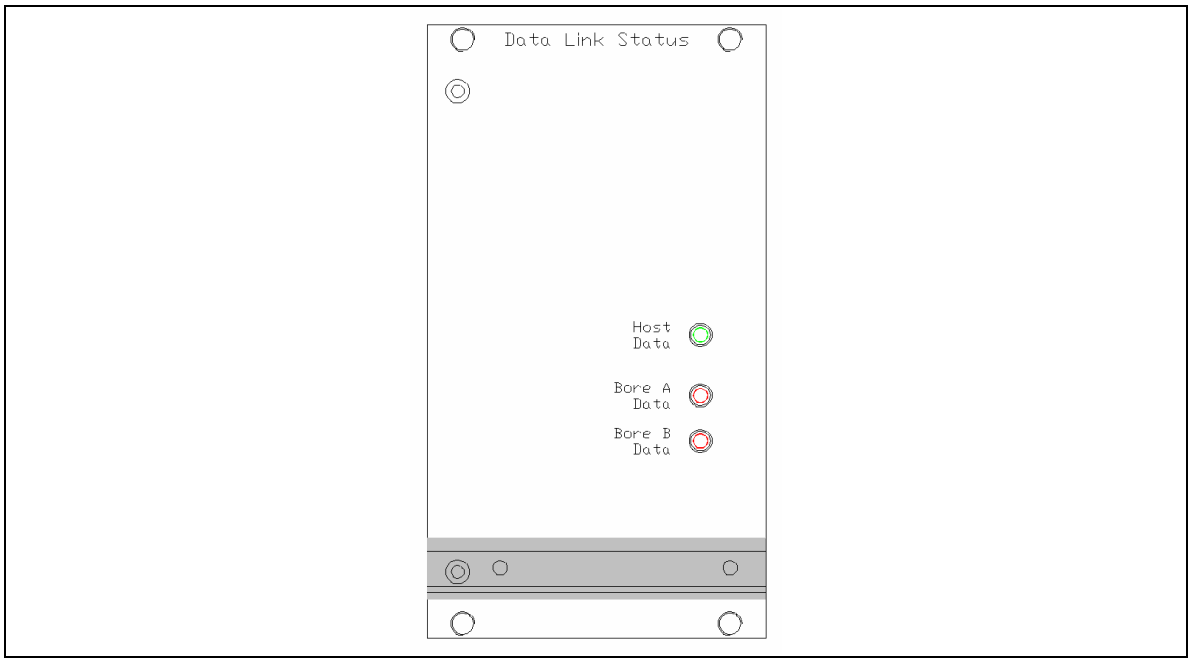

Figure 20 Data Link front panel

The Data Link feature allows the two data streams from each bore (A & B) to be merged and sent out the serial port on the back of the electronics console. The “Host Data” indicator will illuminate when a command from a host computer is pending and waiting for a response. The “Bore A Data” and “Bore B Data” indicators will illuminate when there is a measurement being acquired from the respective subsystems.

An indicator that remains lit informs the user that communication with a subsystem could not be established. Please check the condition of the communications cable.

The Data Link card is connected directly to the serial port connector on the back of the ALDM console.

You may configure and test the operation of the data link by using a general purpose serial terminal program (like “HyperTerminal”, which is installed by default on most Windows computers).

The serial port configuration is described in section 4.8, EIA RS-232C Communication Port on page 20.

Data Link Card Response to a Host Computer '?' Command:

The Command:	?<Carriage Return>
The Response:	STATS OK26839+21278167411129-212781674

bytes:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
	S	T	A	T	S			O	K	2	6	8	3	9	+	2	1	2	7	8	1	6	7	4	1	1	1	2	9	-	2	1	2	7	8	1	6	7	4	<CR>
Data Link Output	Error Code								Light-Fluid Volume NNN.NN [ml]					delta-Light Fluid Volume +/-NNN.NN [ml]						Speed Middle Fluid NNNN [m/s]				Heavy-Fluid Volume NNN.NN [ml]					delta-Heavy Fluid Volume +/-NNN.NN [ml]						Speed Heavy Fluid NNNN [m/s]				CR

Where:

Error Code:	= the "OR" of error codes of Bore A / B
Light Fluid Volume	= volume reported from Bore B
delta-Light Fluid Volume	= running delta, reset to zero if a "r" is received
Speed Middle Fluid	= Middle fluid speed as reported from Bore B
Heavy Fluid Volume	= (Heavy Fluid Volume from Bore A) - (Volume Adjustment Constant)
delta-Heavy Fluid Volume	= running delta, reset to zero if a "r" is received
Speed Heavy Fluid	= Heavy fluid speed as reported from Bore A

Command Name	**Command (from Host)**	**Action by the Data Link Card**
Request Data	ASCII ENQ (05h) followed by ASCII character CR (0Dh) OR a ? followed by ASCII character CR (0Dh)	Distribute this string to all embedded CPU's. Wait for responses. Modify returned Absolute Volumes as necessary. Reply to Host with modified values.
Volume Reset	'R'(52h) or ASCII 'r'(72h), followed by ASCII character CR (0Dh)	Send same command (R or r) out to all embedded CPU's. No response expected. Reset internal delta-volume values to 0.
Config Data Link Card*	'C' or 'c' <optional value>, followed by ASCII character CR (0Dh)	Returns the value of the 'Volume Adjustment Constant'. If the command is followed by a number, set the constant to the new value and save to flash memory.
Return Version Number*	'V' or 'v', followed by ASCII character CR (0Dh)	Returns the current firmware version-code.

(Commands with * are NER diagnostic commands. Not required for Quizix® compatibility.)

Decimal points are implied and not sent.
Leading zeros or spaces are present when number is less than full scale.
Relative Volume uses '+' (ASCII 2Bh) and '-' (ASCII 2Dh) to indicate whether volumes are higher or lower than when last reset.

Figure 21 Data Link serial protocol

The “Volume Adjustment Constant” (see Figure 22 A (conceptual) three-phase separator) is a constant value in [ml] that is subtracted from the Heavy Fluid volume. This is required for a staggered 3-Phase vessel setup where the separation and measurement bores for the heavy fluid are not the same length.

The Volume Adjustment Constant (VAC) can be calculated by:

$$VAC[ml] = \frac{HeightDifference[mm] \times \pi \times BoreRadius[mm]^2}{1000}$$

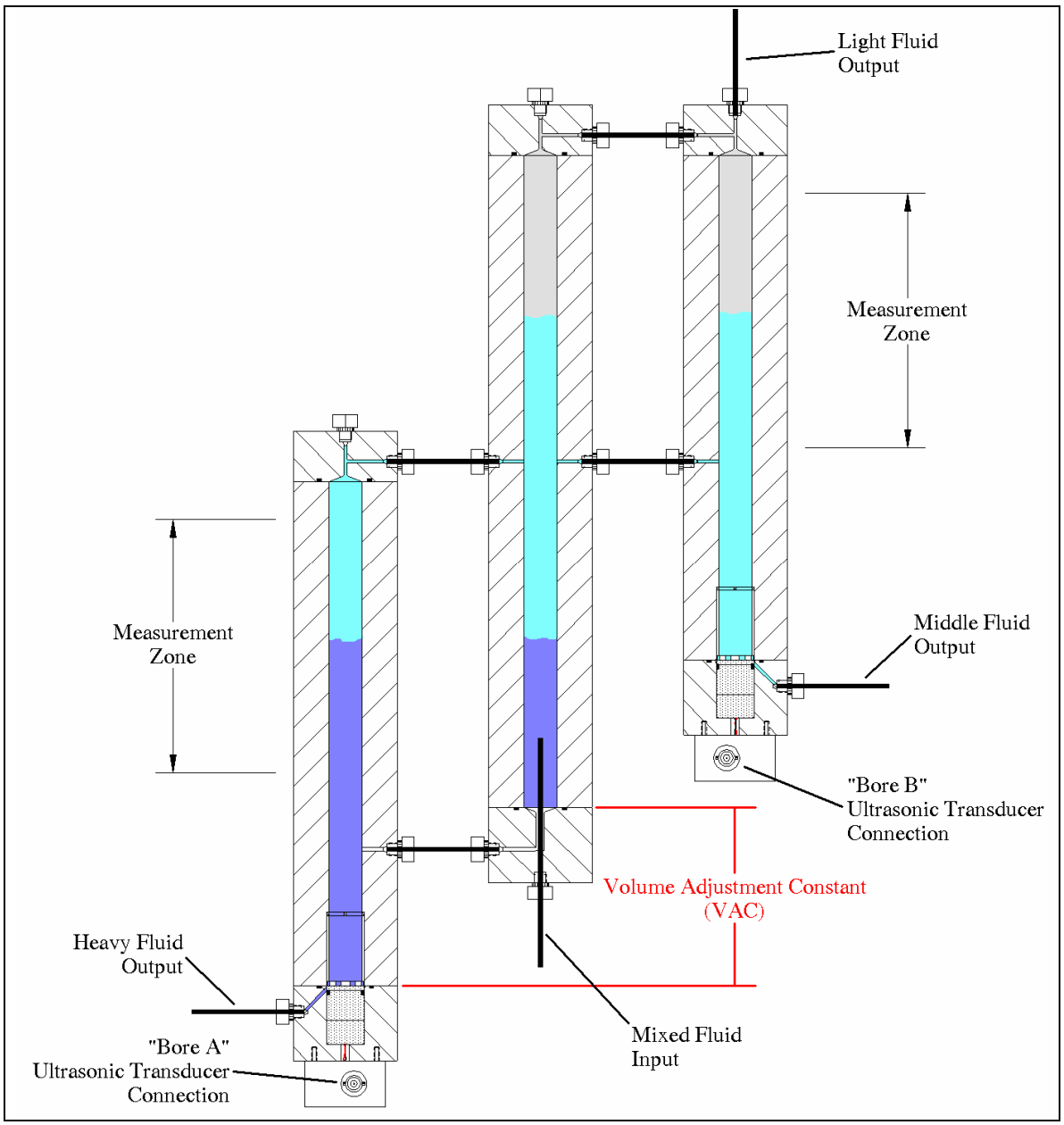

Figure 22 A (conceptual) three-phase separator that requires a VAC constant.

The default value is 64.61[ml]. This value can be set (and is reported) as 6461 by the Data Link card (the last two digits are always assumed to be right of the decimal point).

For example, if a new VAC value is determined to be 50.33 [ml], you would send the command ‘c5033’ to the Data Link card.

All other commands not listed in the graphic above are forwarded to the individual bores, and each response is forwarded back. The response from Bore A is preceded by an ‘A’ and the response from Bore B preceded by a ‘B’.

The “Host Data” LED illuminates Data Link card receives a command from a host. The LED is turned off when the entire transaction is completed. The “Bore A Data” LED blinks when the processor is waiting for a response from Bore A, and the “Bore B LED” blinks when the processor is waiting for a response from Bore B.

A problem with a bore's data stream can result in a non-responsive Data Link card, and one of the Data LED’s remaining continuously lit.

6.2 Description of Electronic Functions

ALDM measurements are carried out under the control of one or more embedded computers in the electronics console.

The acquisition process starts when the control system initiates an ultrasonic pulse transmitted from the transducer. The ultrasonic energy is transmitted into the fluid in the vessel. This energy wave first encounters the reference target that is placed a known distance away from the transducer face. Some of the transmitted energy is then reflected back to the ultrasonic transducer. This reflection from the target is then received by an ultrasonic amplifier and routed to the data acquisition subsystem and stored in memory.

However, most of the ultrasonic energy passes by the reference target and continues past. When a fluid interface is reached, again some of the energy is reflected back toward the ultrasonic transducer. This reflected signal is also acquired and saved to be processed.

The embedded computer then processes this information, automatically matching the acquired waveforms with a stored library of reference waveforms. From this match an accurate and stable “pick time” can be calculated.

The system automatically calibrates out any pressure and temperature effects on the fluid by using the information from the reference target waveform. The speed of the heavy fluid is then calculated. Next the arrival of the fluid interface is processed, and along with the stored vessel geometry information, the fluid volumes can be calculated.

This information is then displayed on the video output, and is made available to the digital serial link, if present.

This entire process is automatic and does not require any user intervention or threshold adjustments. In addition, the raw waveforms and a plot of the match quality is displayed on the video output. This makes the NER ALDM one of the easiest and most reliable ultrasonic level measuring systems available.

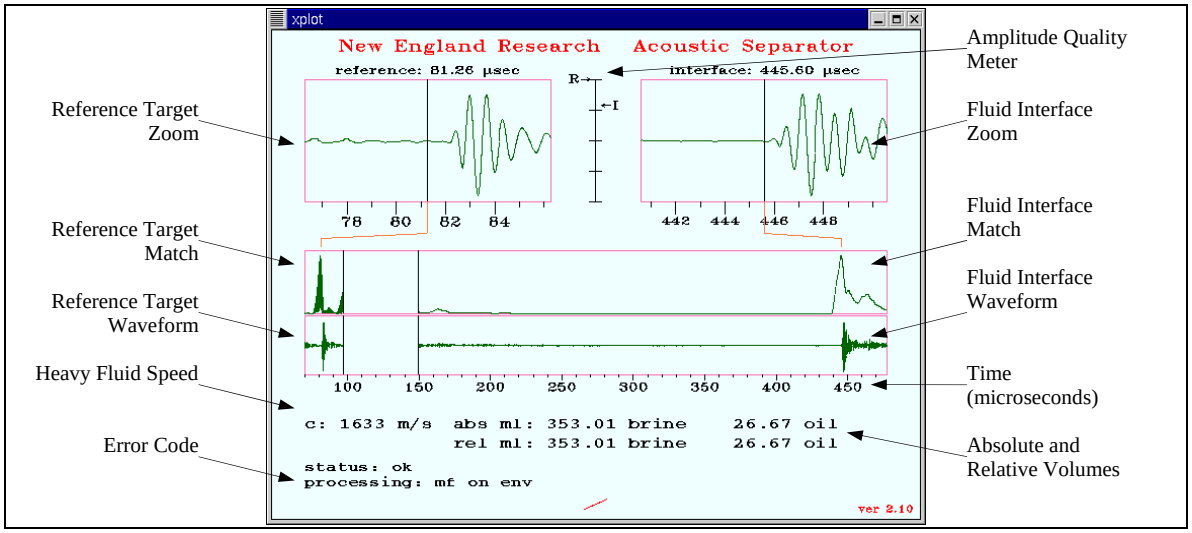

Figure 23 ALDM Video Screen

Once the computer has located the interface signal, the relative volumes are calculated, and the results displayed on the screen.

6.3 Error Messages

If an error information code is present in the data packet, then all other data in the packet are to be regarded as invalid. If valid data has been acquired, then the data packet should start with "STATUS OK" message, and a “Status: OK” indication should appear on the video output:

Table 5 is a complete list of the error codes and the necessary corrective actions for Two-Phase Separators.

DISPLAY TEXT	RS-232 CODE	Cause/action
STATUS OK	STATS OK	System is operating normally.
ERR1, SOUND VEL COUNT LOW!	ERROR1	Oil-water interface is too close to the transducer. Add water. Noise level exceeds threshold when the detector is enabled, causing erroneous reference and echo detection.
ERR2, SOUND VEL COUNT HIGH!	ERROR2	Too weak reference signal. Reference target is out of adjustment.
ERR3, WAT-OIL INT COUNT LOW!	ERROR3	The oil-water interface is too low. Add water.
ERR4,WAT-OIL INT COUNT HIGH!	ERROR4	The oil-water interface is above upper limit. Drain water.

Table 5 Two-Phase Separator Error Codes

In addition to the errors codes listed above, Table 6 is a list of the additional error codes and the necessary corrective actions for Three-Phase Separators.

DISPLAY TEXT	RS-232 CODE	Cause/action
STATUS OK	ERROR0	This bore is operating normally.
ERROR8	ERROR8	Communication timeout. There is a problem with the embedded communication bus. Contact NER.
ERROR9	ERROR9	Garbled data received. Try removing any sources of electrical interference from the proximity of the ALDM system. Contact NER.

Table 6 Three-Phase Separator Error Codes

The Error Codes for a three-phase system are concatenated into a single result like so:

Error<**Bore A Error Code**><**Bore B Error Code**><Recovered Data>

- For example, a result like:

```
"Error02 26839+21278167411129-212781674"
```

Indicates that Bore A is operating correctly and Bore B has encountered an "ERROR2" as described in the table above. The data included in this response may not be reliable.

- Similarly the result below:

```
"Error20 26839+21278167411129-212781674"
```

Indicates that Bore B is operating correctly and Bore A has encountered an "ERROR2" as described in the table above. The data included in this response may not be reliable.

7 Ultrasonic Transducer

The ultrasonic transducer should not require any maintenance.

It is suggested that the unit be returned to New England Research, Inc. if the ultrasonic transducer needs servicing.

It may be necessary to cut and replace the electrical connections to the coaxial connector in order to service this component. Repair of electrical connections on the ultrasonic transducer requires the use of high-temperature solder.

8 Serial Commands

The **ALDM** listens for commands on /dev/ttyS0, configured for 9600 Baud, 8 bits, 1 stop bit, no parity, and no flow control. It responds to certain command characters, when followed by a new-line or carriage return, as detailed below. Each response is terminated by a new-line.

Two-Phase and Three-Phase Commands:

? or 0x05

The ALDM will return the standard status information and data.

See Figure 10 Two-Phase Separator Serial Protocol Example or Figure 11 Three-Phase Separator Serial Protocol Example.

r or R

Send a reset command to the ALDM. This will reset the relative volume counters.

Additional Three-Phase Separator Commands:

c or C

Set or report the internal “volume adjustment constant” calibration.

See Figure 11 Three-Phase Separator Serial Protocol Example.

v or V

Return the version number of the data-link card firmware.

End of document.