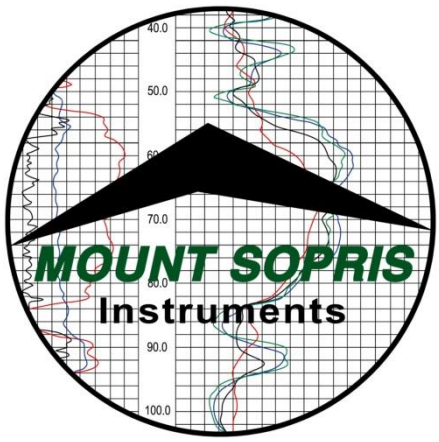
MatrixHeat v.3.3

Operator Manual



Advanced Logic Technology s.à,

Mount Sopris Instrument Co., Inc.

License Information

March 21, 2013

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1. System Overview

I. Introduction

MatrixHeat software was developed to allow operation of the Mount Sopris heat-pulse flowmeter probe using the MATRIX Logger. Please refer to the Logger Software Operator Manual for details on the Matrix logger and its associated software.

The software takes advantage of the Microsoft Windows ™ family of operating systems. These multi-tasking software platforms can accommodate all the tasks necessary for maximum data security and ease of operation.

New features have been added to the MatrixHeat logging software:

- New binary data format with .MH file extension
- Probe firing via on-screen button; replaces thumb controlled hardware button
- Ability to scroll through data samples and re-pick heat pulse events
- Simplified user controls for calibrations and picking parameters
- On screen tabulation of each tool firing, with interactive viewing capability
- Export pick times and flow values
- Export traces
- Time stamped data
- No maximum time limit in the acquisition window

II. Required Components

To operate the heat-pulse flowmeter with the Matrix logger, the following items are required:

- Mount Sopris HFP-2293 or 4293 heat pulse flowmeter probe
- Calibration data for the heat pulse flowmeter probe
- Current **.tol** for the heat-pulse probe
- Matrix Logger with firmware numbers equal to or greater than:
    - System controller 112
    - Modem controller 115
    - PSU controller 100
- LoggerSuite operating software installed to provide USB drivers

III. Installation

Run the MatrixHeat setup program provided.

The default location for the installation is C:\MatrixHeat, you can accept this location or change it but make note of any changed location.

A desktop icon and Start Menu folder are created for MatrixHeat.

2. Software Architecture

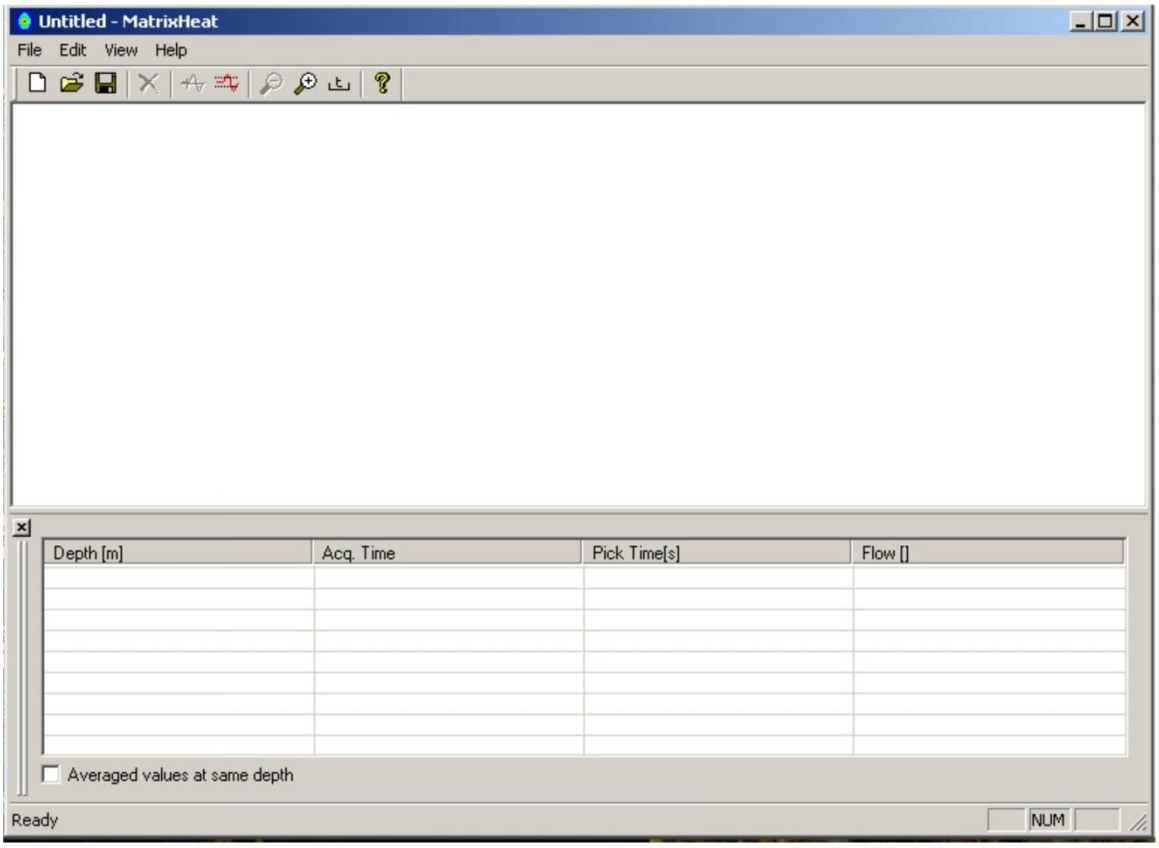
I. Introduction

The MatrixHeat software is a stand-alone product. It is required when operating the Mount Sopris Heat Pulse flowmeter on the Matrix logger.

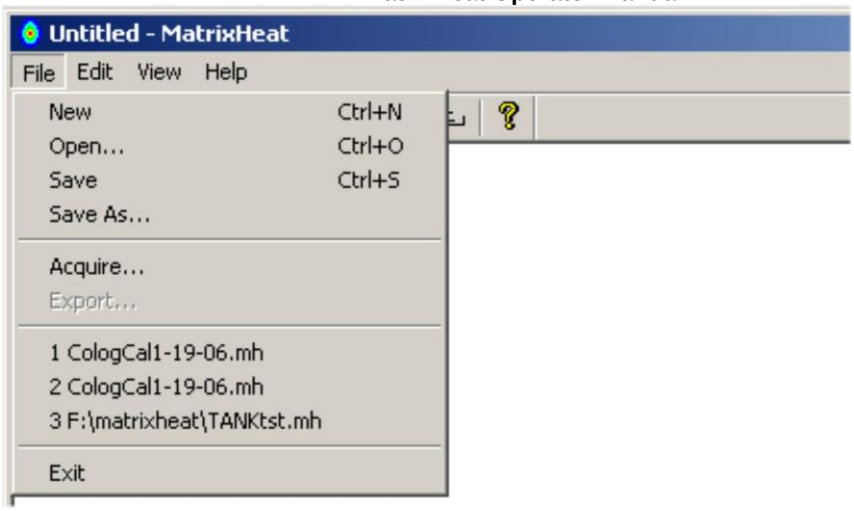
MatrixHeat version 3.2.67 or later is required for operation on Windows 7 and Windows 8.

The Matrix Operating Software, Logger, is not used for this purpose. Clicking on the MatrixHeat shortcut or executable file in the MatrixHeat directory starts the software.

The program opens a screen like the one below:

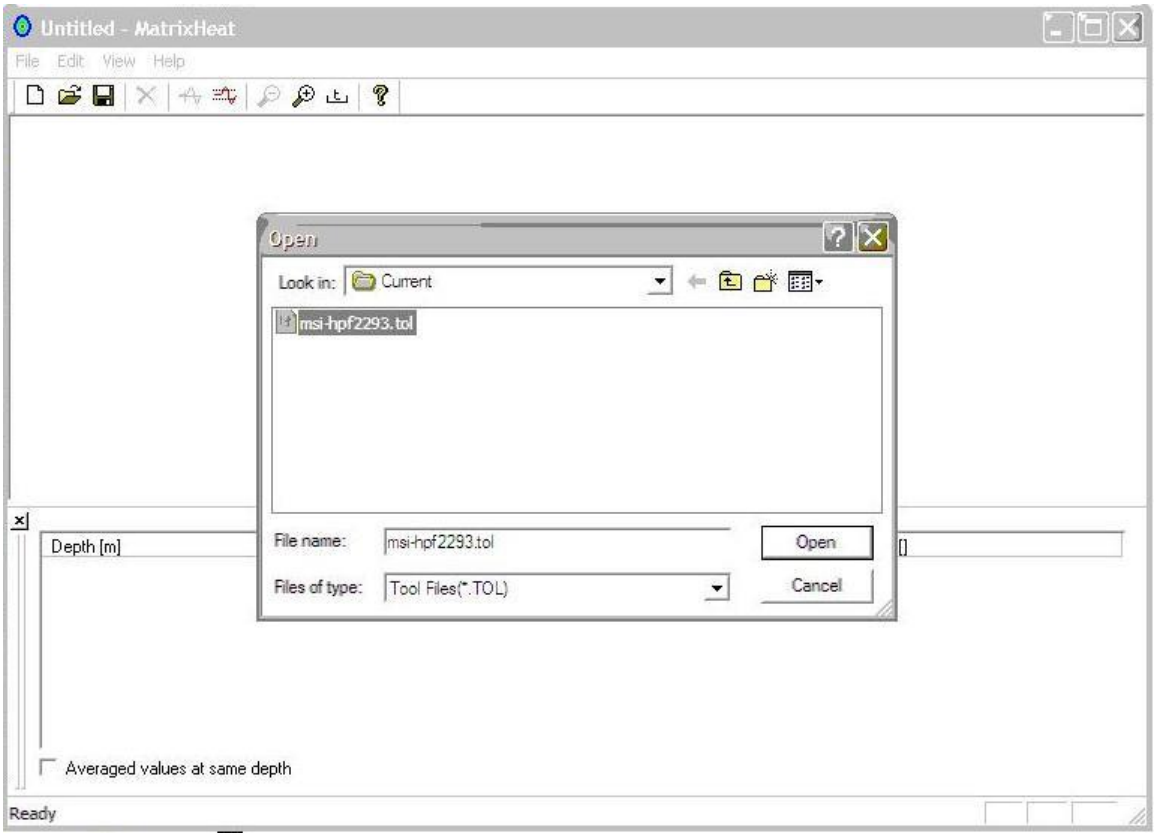


To begin, click on File on the top menu bar:



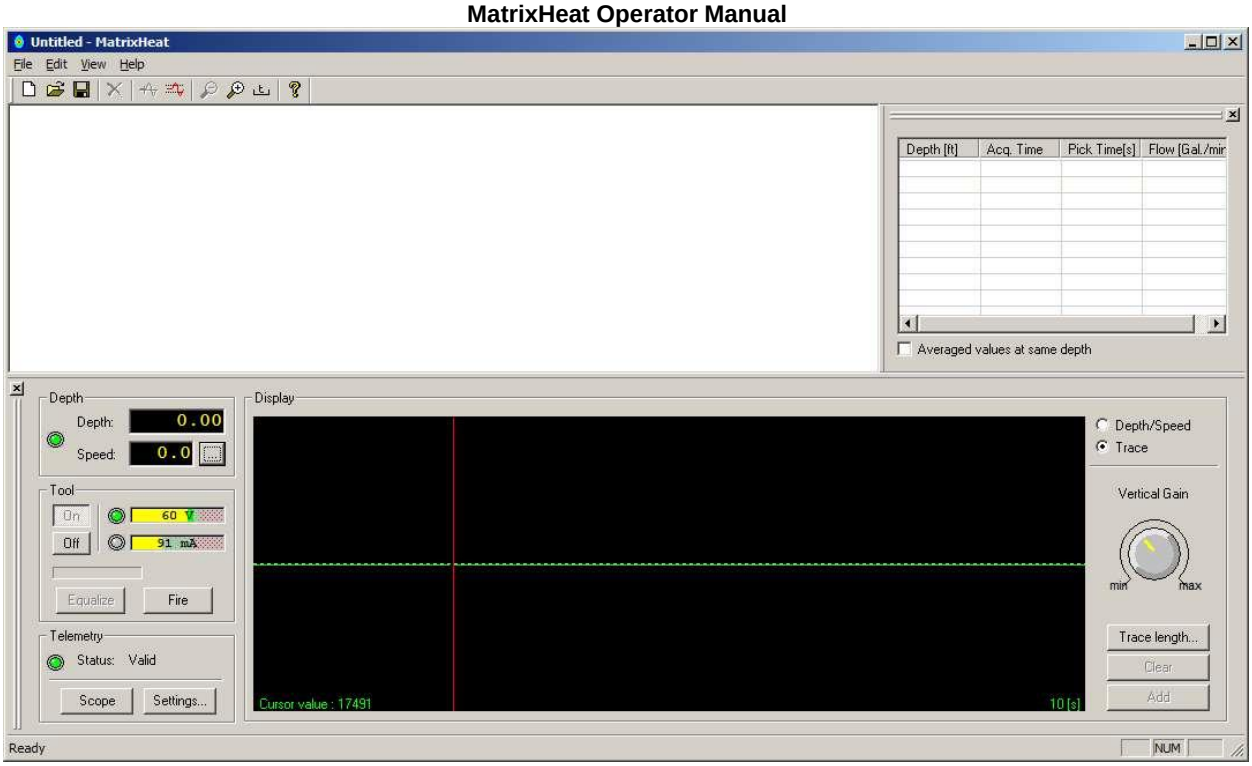
To connect with the Matrix logger, select **Acquire**.

You will be asked to provide a tol file; you should see the HFP2293_mtx.tol TOL file listed. If not you will need to navigate to /MatrixHeat/Tol/Current. This tol file is specific to MatrixHeat software, and should only be installed in the /MatrixHeat/Tol/Current directory. Do not install any other non Heat Pulse tol files in this directory. It is possible to have more than one Heat Pulse tol file in the directory, if you have more than one probe, with more than one calibration. If the Matrix logger is detected by the USB routine on the PC, the tol file will be loaded, and the current depth value in the Matrix logger will be loaded.



NOTE: If the logger has been used with a different winch model, it may be necessary to exit the program and verify (with LoggerSettings.exe) that the proper depth encoder settings are programmed into the logger. Refer to the Logger Operating software manual for more details.

After the tol file has been selected, a screen like the one below will appear:



II. Powering the Probe

Once all winch settings have been confirmed, the probe may be powered up using the Tool On/Off button on the left side of the screen. The correct power settings are read from the Tol file, and are automatically adjusted depending on the wireline type and length. In general, the probe operates on 60 VDC and 180 mA of current. Operating current is lower than charging current. Charging current is applied when the probe is first powered up, or immediately after the probe is fired. New in version 3 are current and Voltage displays. New in version 3.3.22.8 is an option to change the Display to Depth/Speed mode which is useful when operating the winch.

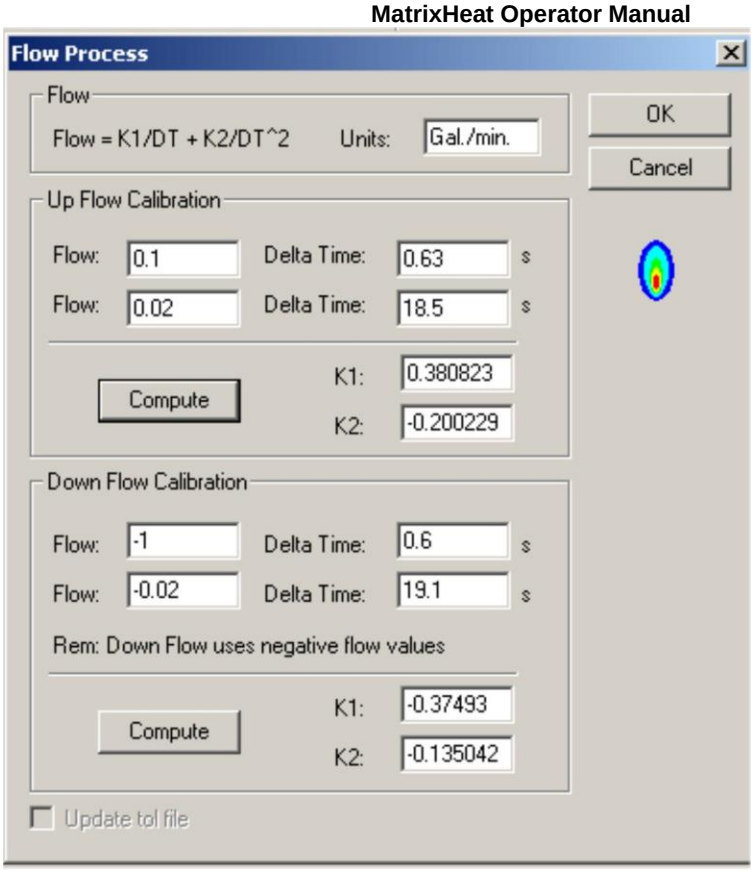
a) Checking calibrations

After the probe is powered up, it will take several minutes for the probe measuring array to stabilize and for the firing capacitors to charge up. This is a good time to confirm that the proper calibrations for the probe have been entered in the Tol file and saved.

ai Note: Calibration Settings

For the Flow Calibration button to be active the probe must be fired at least one time and the data added (click the **Add** button in the lower right side of the Acquisition screen). To access the calibrations screen, select Edit on the top task bar, and then select Flow Calibration as seen below:

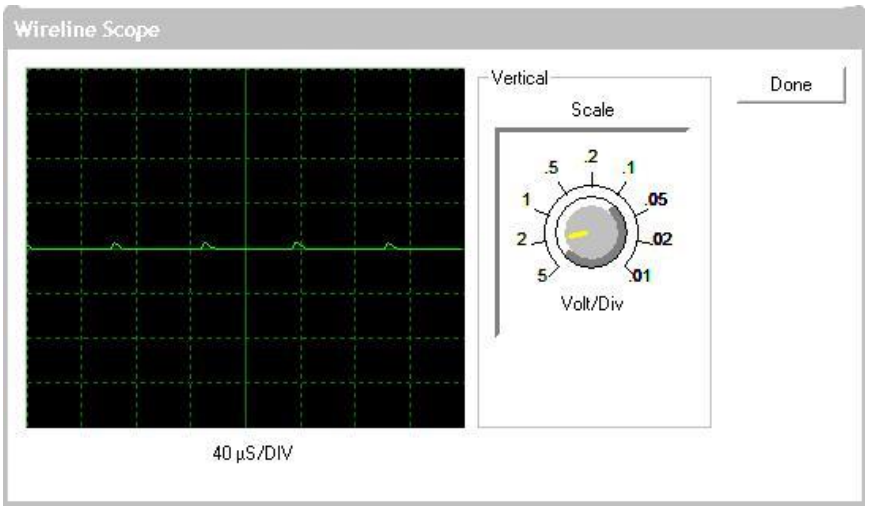
Check the calibration values for the probe being used against the values on the calibration screen. An example follows:



Please note that **Down Flow** values are considered to be ***Negative*** numbers.

b) Checking proper probe operation

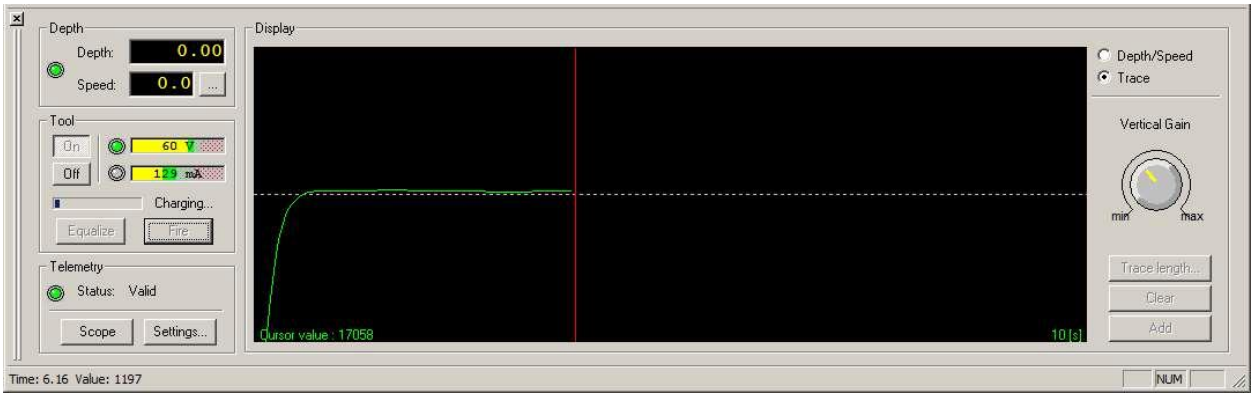
After entering the calibration numbers, it is recommended that the user check the probe data to confirm that it is operating properly, and is ready to begin a logging operation. The best way to see if the probe is sending data is by clicking on the Scope button. A screen like the one below will appear:



Probe data consists of a ~20 kHz positive pulse stream on the wireline, which will vary with the response of the sensor pairs to presence of a heat pulse moving past. If you don't see this kind of data on the wireline scope screen, the probe is not sending data.

After confirming that the probe is sending data, the user should check the main data display

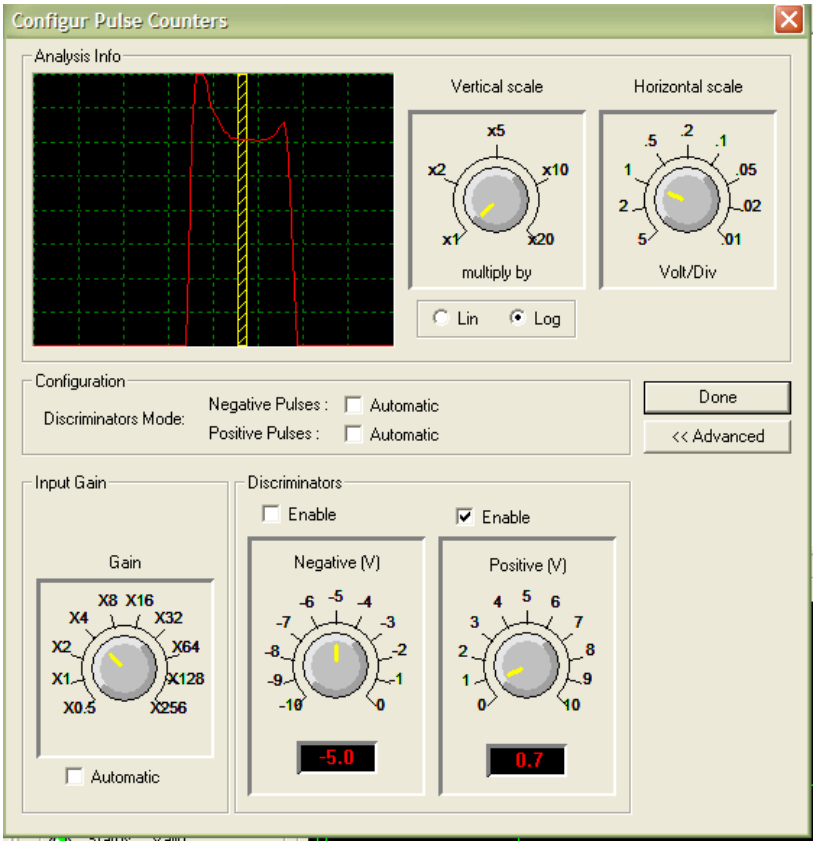
screen to verify that the pulse detection modem is in fact detecting the ~20 kHz signals. The following screen shows a properly functioning probe and modem, with a baseline frequency of around ~19 kHz. If a zero value is indicated on the lower portion of this screen, the modem needs to be adjusted. This might be the case for a long wireline.



c) Adjusting the modem

If a normal (18-20 kHz) value is not indicated on the heat-pulse real time acquisition screen (shown above), modem adjustment may be required. To access the modem controls, click on the Settings... button, and then on "Advanced" to show the modem settings:

The advanced modem settings are embedded in the tol file, depending on the wireline type and



length. In general, the gain of the modem should be left in **manua**l mode, and the positive discriminator should also be left in **manual** mode, such that it is centered in the middle of the modem display screen. The screen pictured above shows proper position and settings for the heat-pulse flowmeter operating on a 500 meter winch with 1/8" single conductor cable.

Moving the discriminator slightly closer to the center peak and away from the center of the signal valley may reduce spikey noise on the data trace particularly on coax wireline.

d) Zeroing the depth

Using the winch controls, lower the probe to the zero point. The probe zero point is the junction between the probe top and the cable head. Once the probe is placed at this point, referenced to the zero depth location, click on the "**…**" button on the depth window and a dialog box like the one below will appear:

Depth and Speed can be shown in the Display panel by selecting the **Depth/Speed** menu item located on the right side of the Display panel (v3.3.22.8 and later only). Select the **Trace** menu item to return to data display mode. Units for depth and speed will be those set in the Matrix Logger using LoggerSettings.

Select Zero Tool, and the depth should automatically be set to 0.97 meters (or 3.18 feet), which is the mid-point of the sensor array. Keep in mind that the probe is actually 1.22 meters (4 feet) long.

Once the probe has been zeroed, it can be lowered to the first firing depth. In general, the first depth depends on user preference. It is sometimes preferred to begin measurements at the top of the borehole, so as not to disturb the fluid flow patterns in the lower sections. Movement of the probe (and the close fitting flow diverters) can temporarily influence the borehole flow regime.

To avoid interference from eddy currents that might be induced by lowering or raising the probe, the operator should wait a few minutes at each shot depth before firing the probe. This will provide the most accurate data, and avoid erroneous readings.

Note that the Depth/Speed colors are controlled within the Matrix.ini file located in the C:/MatrixHeat folder. The default color is red characters on black background.

III. Firing the probe

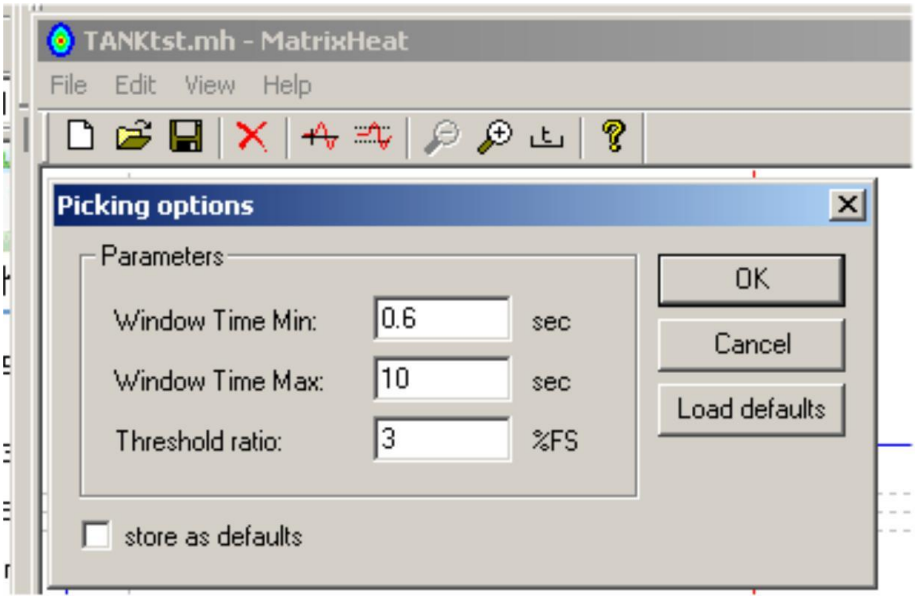
a) Picking Options

Before firing the probe, the operator should set the picking options to match the estimated heat pulse arrival time. In a new well, with no information, it is best to set the parameters so that a long time interval is available. Two Time Sample settings are required. One is in the Flow Pick window, and the other is in the Shot Window display. The Time Sampling for the Shot Window controls the actual length of the record. The Time Setting in the Flow Pick Window only controls the display of the saved flow trace. As the logging proceeds, the operator can "fine tune" these parameters to make the best use of time available. For faster flow rates, the time window can be decreased to save time. However, even for faster flows, the probe must recharge between shots, and this time is fixed.

To set picking options, click on the Pick Options icon on the top selection bar. The various selections on this are shown below:

Picking options can also be accessed by clicking on Edit, Picking Options.

The picking options window is shown below:

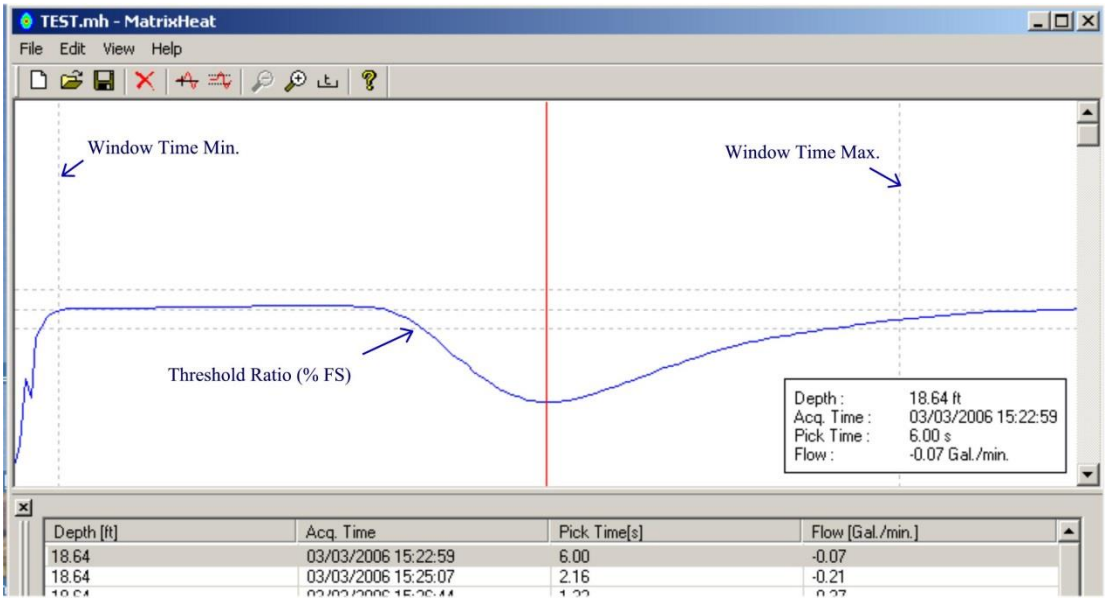


The **Window Time Min** value should be kept low, in general. It is the minimum time after which a pick will be allowed. Normally, there is no measurable flow before 0.6 seconds, as the flow is so fast that the sensors cannot see the heat pulse.

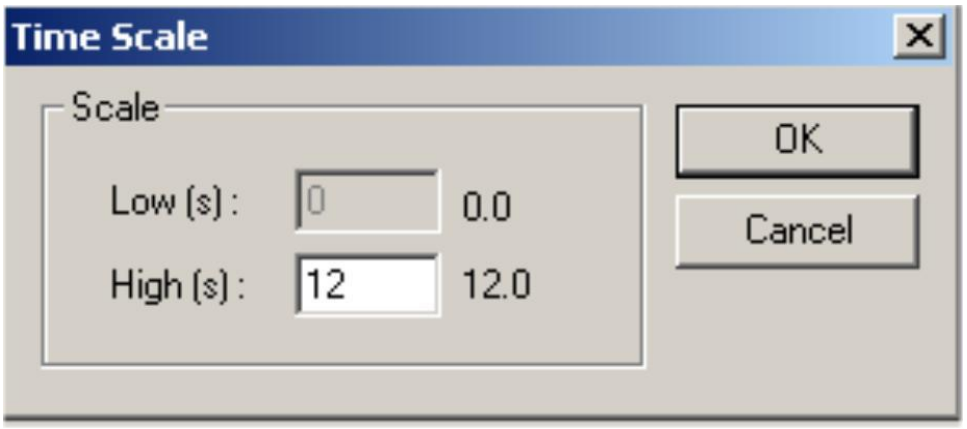
The **Window Time Max** value is the maximum time in which a pick can be allowed. Once this value is reached, the program will stop recording, and automatically make a pick on the maximum or minimum peak produced by the heater grid within these times.

The **Threshold ratio** is the “detection level” above which the software is allowed to make a pick. For low heat pulse peaks, the level may need to be decreased, and for very high peaks, the level can be raised.

These three parameters are represented on the plot record by dashed lines. The Time windows are vertical, and the Threshold ratio is indicated by a pair of dashed horizontal lines equidistant from the zero baseline. An example is shown below:



The **Time Scale** parameter is set by clicking on the time scale icon on the menu bar. It brings up a window like the one below:

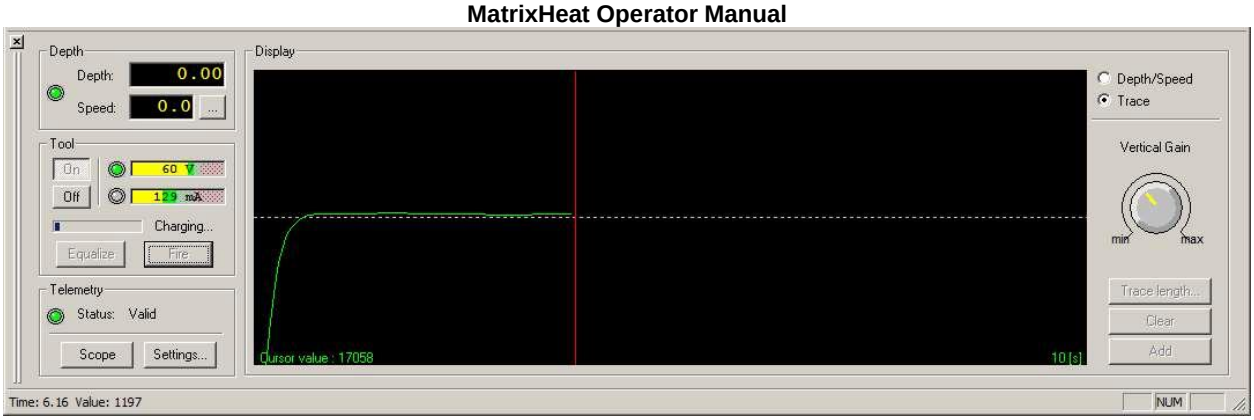


This time scale is the maximum time scale that will be displayed on the Flow Picking screen. This Time Scale is not the same time scale that is presented on the Shot Window, which is described in the following section

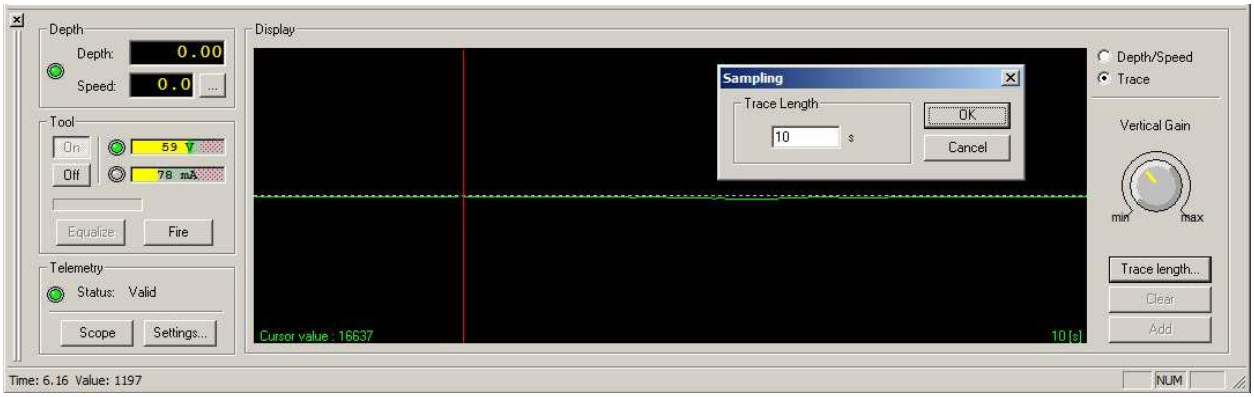
A third icon on the main menu is the **AutoPick** selection. It is used to re-pick a heat pulse event in the data records, if the operator does not believe that the first pick was correct. It is used after picking parameters are adjusted, and when pressed, will automatically select a new pick, based on the new parameters.

b) Firing

Once all parameters are set, the probe can be fired. The fire button should only be pressed if a smooth baseline, with a frequency of around 20 kHz, +/- 2 kHz, is present in the shot window. If the baseline is wavy or changing with time, this is usually caused by probe induced flows. The operator should wait until this background “noise” is gone before firing. An example of a smooth baseline is shown on the next page:



Note that the **Time Scale** on the Shot Window is set by clicking **Trace length..** button:



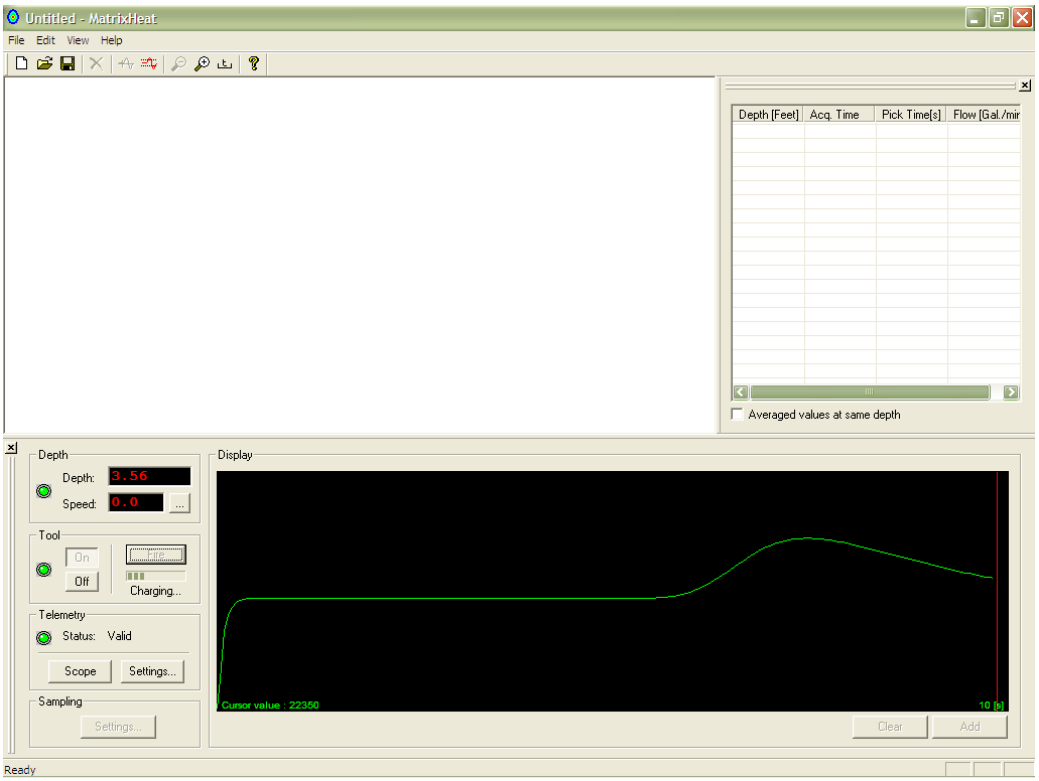
The length of the time scale on the Shot Window must be long enough to capture the heat pulse. If it is not, the operator should increase the time to make sure the pulse is detected, if one exists. Normally, there is no usable data past a time of 25 seconds. When the end of the time scale is reached, the system stops, and the probe begins its recharge cycle.

If the trace goes off the top or bottom edge as it draws across the screen turn the Vertical gain dial counter clockwise towards **min** to shrink the trace size. To increase the trace size, turn the dial clockwise towards **max**.

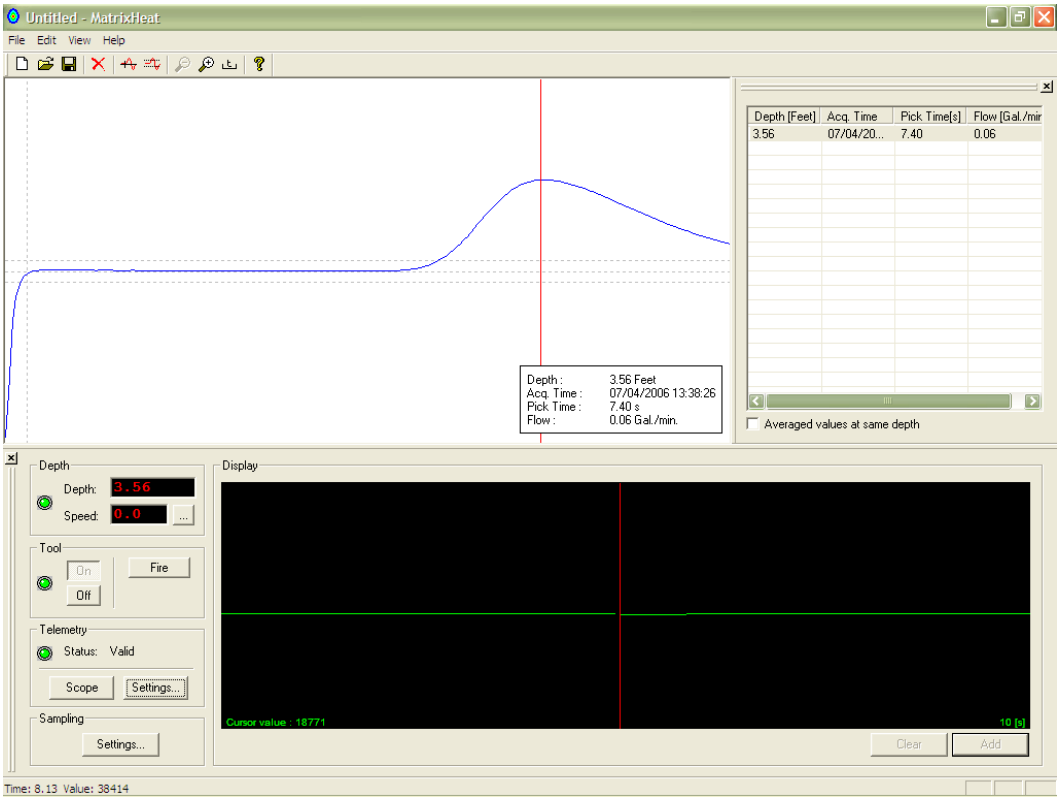
Once the probe fire button is pushed, a real time plot of frequency vs. elapsed time will appear in the shot window. This green line indicates the differential temperature being sensed between the two thermistors, which are located equidistant from the heater grid in the center of the probe. The direction of the flow is based on the net frequency response. If the frequency goes down, the flow is down. This is shown graphically on the shot window until the elapsed time passes the Time Scale setting chosen for the shot. After the firing event, the probe begins an automatic "charging cycle", in preparation for the next shot.

If the shot record appears to indicate a successful flow event, the operator should press the **Add** button at the lower right hand corner of the shot window. If the record is questionable, it can be deleted from the display with the **Clear** button.

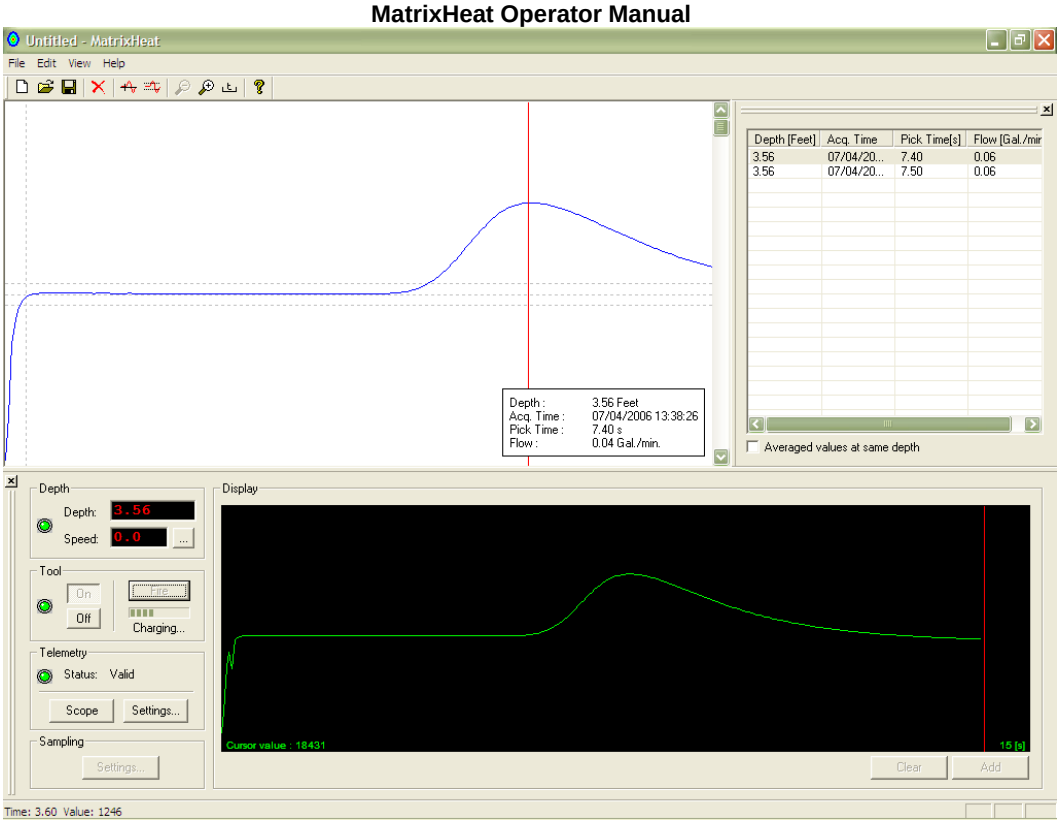
An example of a real time shot record is shown on the following page.



This sample record appears to be valid, so it is added to the Pick Window register by clicking the Add button. The record is then moved into the Pick register table, which shows the pick information and calculated flow rate for the current shot.



To fire the probe again, the user must wait until the probe capacitors are fully charged. This process is indicated in the window with the bar graph meter, right under the Fire button. It is a good idea to make at least two firings per station, to confirm the accuracy of the measurement. A second firing, in the same interval is shown below:



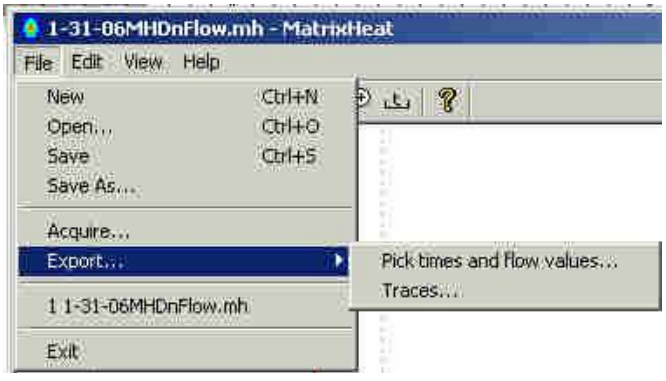
c) Re-picking

In the event that the automatic peak picking did not actually pick on the correct pulse, it is possible to adjust the Min and Max time windows to “bracket” the correct pulse, and/or change the Threshold ratio and then press the autopick button again. It will re-pick a new time within the new parameters. In general, this should only be necessary when a large change in flow magnitude occurs.

Re-picking can be done at any time, simply by highlighting the shot on the list of data in the Pick Flow table. It is even possible to “re-process” picks later, using the program without the logger connected. Simply start the program, open the data file, and proceed as above.

IV. Exporting Data

After a data file has been created, it should be saved as ***.mh** file, by clicking on the task bar File selection, and on Save or Save As. This the data in a binary file that then be displayed or re-processed using MatrixHeat.



To obtain a text version of the results, for use in other programs such as WellCAD, Excel, select File, Export…Pick times and flow values, as shown in the image below:

Example of exported ***.txt** flle

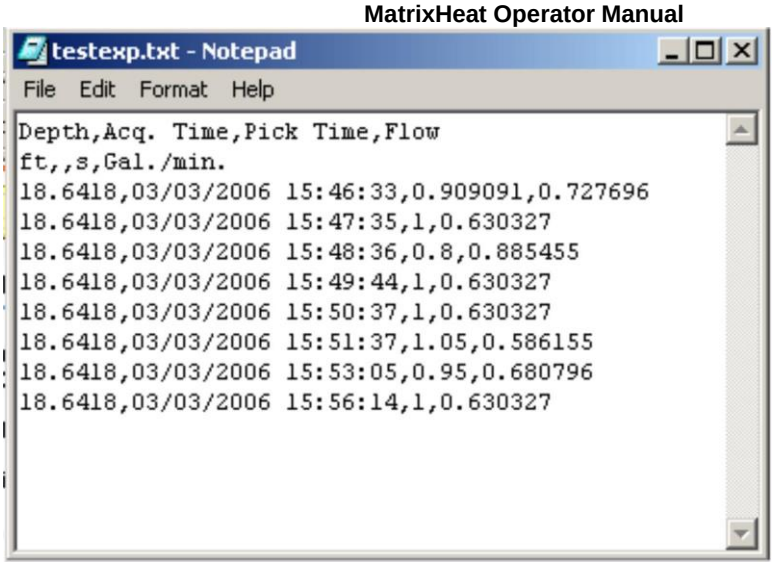


Figure 1 Export Pick times and flow values .txt file

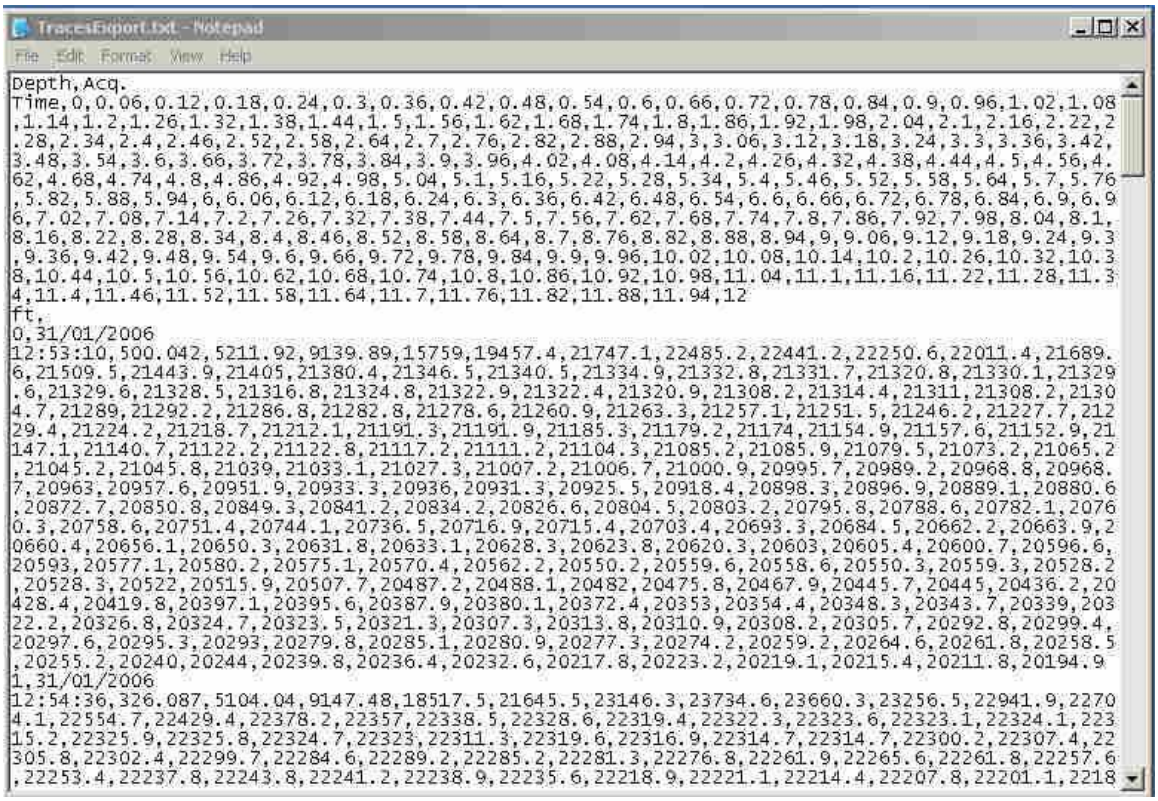


Figure 2 Export Traces .txt file

In the traces export file above, the first and second line Depth,Acq.Time is a label followed by the acquisition time digitization sequence which beginning with 0 and ends with 12(seconds) on line 12. Note the trace amplitude values are sampled every 0.06 seconds with trace length time equal to the longest used during the acquisition.

Line 13 is ft. label, which depends on the Software Depth/Speed Units; see MatrixSettings.

Line 14 begins: 0,31/01/2006; which is depth, date

Line 15 begins: 12:53:10, 500.042; which is time stamp, first amplitude data point additional amplitude data points per time slice follow.

The next amplitude trace record is at line 32 the sequence of Line 14 and 15 is repeated on this and subsequent records. Traces may vary in length depending on the trace length used.

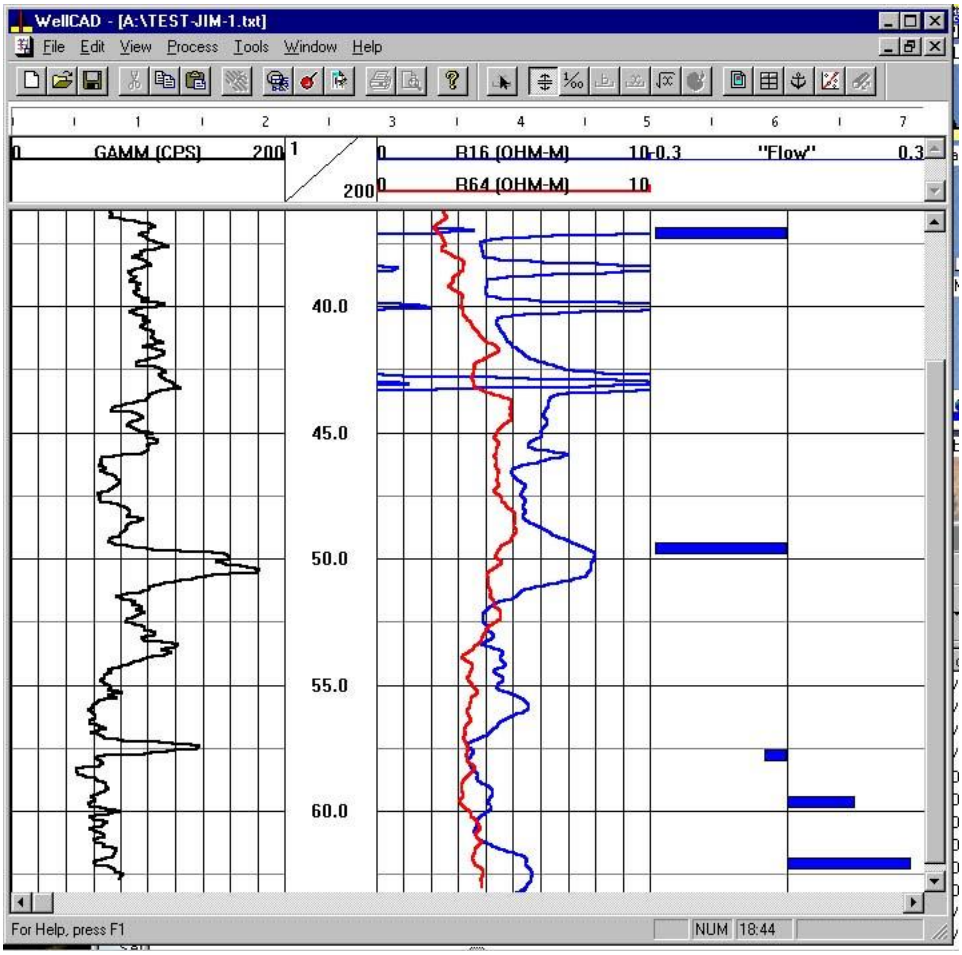
V. Appendix

a) Import to WellCad

1. Locate the Pick-times **.txt** file that was exported from MatrixHeat and rename it with **.waf** extension instead of .txt.
2. Start WellCad and select the 'Import' command from the 'File' menu. Next select 'Single File'.
3. Answer the import wizard questions when prompted. Note that the first line contains titles and the second line contains units. Make sure that these boxes are checked in the import wizard. When the wizard asks what type of log to import select **Mud-log**.
4. After importing the text file, double click the scale header of the time or flow log. Under style, chose **'fixed w/ polarity**". Also, change the plotting scale the necessary negative to positive range.

Delete the unnecessary logs (time, speed) if desired. Set the depth scale and track positions as usual. Save the resultant **.wcl** file and plot as usual.

b) Example of WellCAD presentation of Heat Pulse Flow data as mud log



c) Example of Excel presentation of exported traces

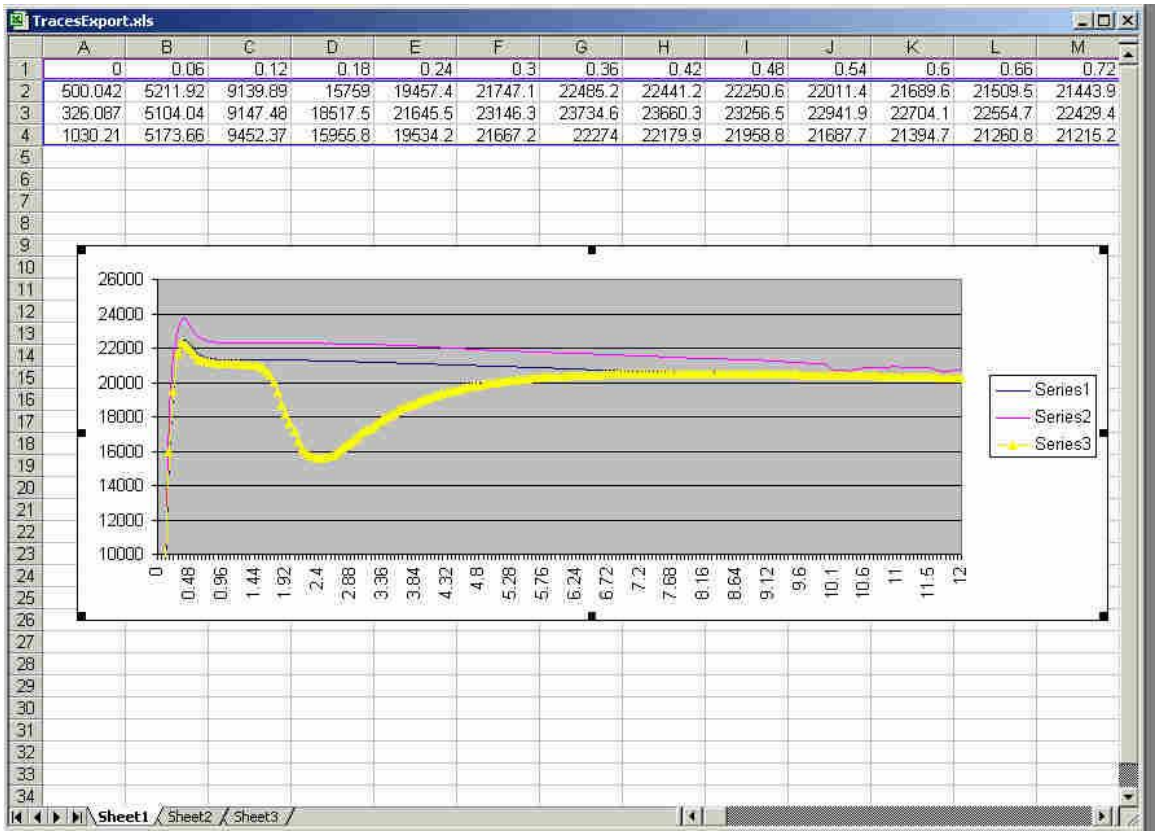


Figure 3 Excel plot of exported traces

To start this spreadsheet the time data from the exported traces, line two was copied into the spreadsheet at line one. After using the Data, Text to Columns tool to format the first line, three data sets from the exported traces file were copied and pasted into the following lines two through four.
A graph was created from the data with the x-axis representing the time axis.

Note that depth and time stamp were not included although they could have been.

d) MatrixHeat ".ini" files

Two ".ini" configuration files are used with MatrixHeat, matrixheat.ini and matrix.ini. These files are in the same folder as MatrixHeat.ini. There can be some crossover in their functionality but the following examples are normal.

Matrixheat.ini

[Tol Files]

RootDir=C:\MatrixHeat\TOL\Current

[FirstArrival]

; The following values are managed by the MatrixHeat dialogs

Threshold=3

TimeMin=0.6

TimeMax=10

[Recent File List]

Matrix.ini

[Dashboard Panels]

; The following values are described below

LedDisplayBkgColor=0

LedDisplayFontColor=ffff

e) Font and background color of numerical displays

The color of the background and characters in the Depth display can be controlled in the Matrix.ini file, which can be found in \MatrixHeat installation folder. Yellow characters on a black background seem to give the best contrast the settings for which are shown below.

Use the following keys in matrix.ini

[Dashboard Panels]
LedDisplayBkgColor=0
LedDisplayFontColor=ffff

The table below shows some common color codes:

Color	Color HEX	Color
	#000000	Black
	#0000FF	Red
	#00FF00	Green
	#FF0000	Blue
	#00FFFF	Yellow
	#FFFF00	Bright Blue
	#FF00FF	Violet
	#C0C0C0	Grey
	#FFFFFF	White

There are many other hues of colors available by adjusting the Hex numbers. If you use another resource that describes standard HTML font colors for browsers note that *the order of the HEX numbers shown above are reversed* from those standards.

f) Robertson Geologging Heat Pulse tool operation notes

MatrixHeat supports the operation of the Robertson Geologging Heat Pulse Flowmeter on a Matrix in which the associated, optional modem has been enabled. Contact Mount Sopris Instruments for further information.

The tol file for the RG HFP tool is in the \MatrixHeat\tol\ folder; copy it to the \MatrixHeat\Tol\Current folder.

Warning: Do not turn the HFP-2293 on with the RG HPF tol file selected for acquisition as damage to the HFP-2293 tool will result due to the higher operating voltages for the RG HPF.

As the RG HPF tool isn't as stable as the Mount Sopris HFP-2293 it takes a little practice to figure out when the best time to fire it is depending on the values from the tool.

It is a two-step process; first the Stabilize button is pressed then perhaps pressed again about 5 seconds before firing the tool.

It should probably be stabilized and fired a couple more times to verify the flow signature.