

Troika



Off-line Data Analyser



User Manual

110720

Revision 1.03

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Revision History

- 1.01 - 101105 Initial Release
- 1.02 - 110709 Updated Screenshots
- 1.03 - 110720 Added 3D Mapping & Tilt feature

Rationale

This application was spawned from the frustration and tedium of converting raw data files to a CSV format for display in Excel. A considerable amount of formatting must then be applied to allow a meaningful inspection of the data. Charting is also time-consuming and after preparing one file, the thought of repeating the exercise is totally discouraging.

Troika attempts to address these issues by employing intuitive and innovative display and selection methods. Data files are loaded from disk and held in memory to allow fast access without disk thrashing. Two complementary graphical displays are provided, with linear and circular plots. Anomalous data points may be clicked on either graphical display, which forces a jump to the relevant record in the Table and View windows. Similarly, clicking on an Event entry will force the linear display, View and Table windows to update.

Features

- Fast memory-based, 10,000 record capacity
- Drag & Drop data files onto the Console window for rapid scanning
- Full event log reconstitution.
- Detailed Status information for each record
- Cross-linked windows, allowing synchronised display of selected record.
- Reselection of channel display in linear plot.
- Auto display of windows.
- Save and restore user configuration choices.
- Snapshot inspection
- A Graphical Overview depicting the currently selected data record
- Date-Time and Value labels for each data point in all plots.
- Statistical data for each channel's data, raw and normalised
- Tool attitude and depth

Operation

Upon application start-up, the Console window is presented; the "Load" button must be pressed to allow selection and loading of a disk-based data file. At this point, any subsidiary windows that have their auto-display checkboxes ticked will be placed on the desktop.

Alternatively single data files may be dragged to the Console and dropped to initiate the loading process.

Console

Display

The main console has pixel dimensions of 751x589. The application requires a screen with greater dimensions, in order to display as intended.

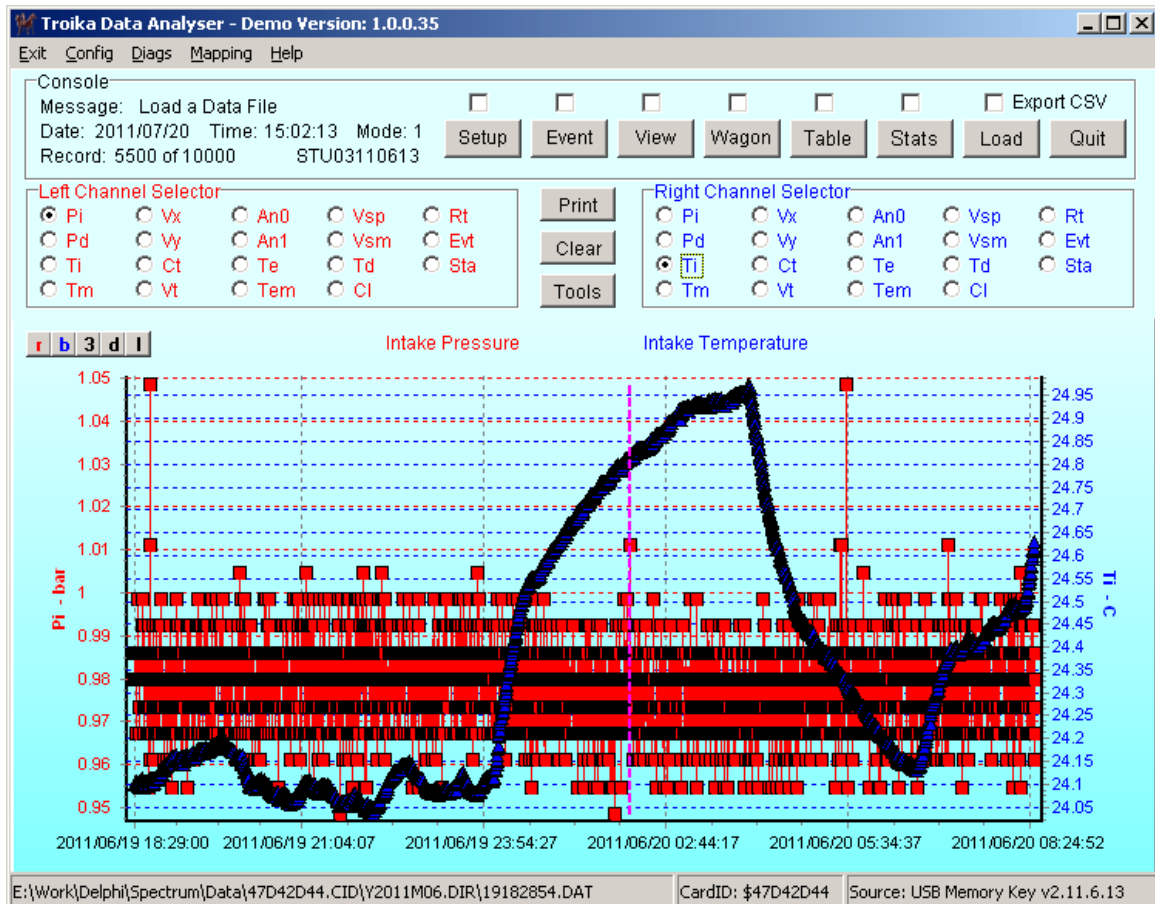


Figure 1 – Troika Console

Configuration

All settings appropriate for restoration are saved in the configuration INI file, "Troika.INI". Use the pull-down menu to select the Save/Load configuration file. Other configuration names may be used, but "Troika.INI" is auto-loaded upon start-up.

Help

The "Help|Read the Manual" pull-down menu will load this document into an Acrobat reader, providing that the file "TroikaManual.pdf" resides at the same location as the executable Troika.exe itself. Most items have hint-help, evoked by hovering the mouse cursor over the relevant item.

Buttons

The row of buttons allow individual windows to be toggled on or off. The small checkboxes, located just above the buttons, allows those associated windows to be opened automatically, when a data file is loaded.

Load

Nothing happens until this button is pressed. When a data file has been selected and loaded, the whole application comes alive.

Additionally, ticking the “Export CSV” box will write a CSV disk file of the chosen DAT file.

Messages

Status messages are displayed when salient events occur.

Linear Plotter

The two channels may be selected on the fly and will cause an immediate repainting of the graph. Data points will yield their Date-Time stamp and value, if the mouse cursor is hovered over the point of interest. Clicking on the point will place a dashed magenta marker line and update the other displays with the data associated with this point. A set of small buttons at the top-left corner of the plot allow one or both of the plotted channels to be hidden. Dots and or line graphs can be hidden or shown according to the user’s preference. Finally, a 3D view may be portrayed. The desired settings may be saved as the default in the INI configuration file.

Table

The main display presents a row of data values for each data record. The selected row is hot-linked from the linear and circular plots.

Navigation

- A single mouse-click on any of the visible rows selects that record.
- The mouse wheel, or arrow keys will also change the row selected.
- Page-Up and Page-Down keys advance or retard the selected record by increments of five records.

RECORD NUMBER	Date-Time	Pi	Pd	Ti	Tm	Vx	Vy	Ct	Vt	An0	An1	Te
	YYYY/MM/DD-HH:MM:SS	bar	bar	C	C	g	g	mA	V	mA	mA	C
5125	2011/06/20 01:39:45	0.98	0.95	24.74	27.56	0.02	0.02	14.98	120.14	0.000	0.000	-20
5126	2011/06/20 01:39:51	0.97	0.95	24.74	27.50	0.02	0.02	14.97	120.10	0.000	0.000	-20
5127	2011/06/20 01:39:56	0.97	0.95	24.74	27.50	0.02	0.01	14.98	119.95	0.000	0.000	-20
5128	2011/06/20 01:40:00	0.97	0.95	24.74	27.50	0.02	0.01	14.98	120.21	0.000	0.000	-20
5129	2011/06/20 01:40:05	0.98	0.95	24.74	27.50	0.02	0.01	14.97	119.83	0.000	0.000	-20
5130	2011/06/20 01:40:10	0.97	0.95	24.74	27.50	0.02	0.01	14.95	119.83	0.000	0.000	-20
5131	2011/06/20 01:40:15	0.99	0.95	24.74	27.50	0.02	0.02	14.96	119.91	0.000	0.000	-20
5132	2011/06/20 01:40:20	0.99	0.95	24.74	27.50	0.02	0.02	14.97	120.14	0.000	0.000	-20
5133	2011/06/20 01:40:25	0.97	0.97	24.74	27.50	0.02	0.02	14.97	119.87	0.000	0.000	-20
5134	2011/06/20 01:40:30	0.99	0.97	24.74	27.49	0.02	0.02	14.97	119.91	0.000	0.000	-20
5135	2011/06/20 01:40:35	0.99	0.97	24.74	27.49	0.02	0.02	14.96	120.18	0.000	0.000	-20

Selected Record Details: #5130		
Surface Card Interface: %00000111	Downhole Status: %00010001	System: \$0B15
Version: STU:03-110613	Gauge Type: Dual 2P2T2V 5P: 4.98V	Memory: 18,243,400 bytes
Card Address: A	Sensor-1: OK Locked: YES	Mode: 1
AutoReset: OFF	Sensor-2: OK Lo Fuse: INTACT	Initial Leakage Current: 15.00mA
FastLog: OFF	Modulation: OK Hi Fuse: INTACT	Event: #01 - Lo-Trip Set
Averaging: OFF		
<input type="radio"/> Alarm <input type="radio"/> Trip <input type="radio"/> Log		<input type="button" value="Clear"/> <input type="button" value="Size"/> <input type="button" value="Update"/> <input type="button" value="First"/> <input type="button" value="Last"/>

Figure 2 – Data Record Table

Selected Record Details

Surface Card Interface

Version

The source SCI's revision and firmware date is extracted from the Snapshot.

Card Address

This is the SCI's address for packet communications, also obtained from the Snapshot.

LEDs

Individual LEDs depict the Logging, Alarm and Trip states prevailing at the instant of the selected data record.

Status

The status field of the selected row allows a detailed display of the SCI's Status information.

- AutoReset ON/OFF – Shows whether Alarm/Trip condition will be automatically reset.
- FastLog ON/OFF – After a Trip condition is registered, the logging rate is increased to allow better determination of the fault.
- Averaging ON/OFF – Indicates that the SCI data is subjected to a specified degree of filtering.

Downhole Status

The following information is derived from the transferred bit-field.

- Gauge Type VARIOUS - Depicts the Gauge's capabilities
- Sensor-1 OK/BAD - Sensor-1 communication quality
- Sensor-2 OK/BAD - Sensor-2 communication quality
- Modulation OK/BAD - Gauge<>SCI communication quality
- Locked YES/NO - SCI communication link is locked
- Lo Fuse INTACT/BLOWN - Low temperature fuse integrity
- Hi Fuse INTACT/BLOWN - High temperature fuse integrity

System

Memory

This display shows Troika's total memory requirement. It is a programming aid to detect possible memory leaks.

Mode

This was the Mode in operation at the instant of the currently selected data record.

Events

The applicable event is specified along with the associated subsystem.

Update

A green Update LED briefly lights when a new record is selected, either from a plot data-point, or else from mouse/key actions performed on the table itself.

Commands

Clear

Clears whole table; useful for confirmation of a new file loading.

Size

The Table format necessitates a wide display. Whilst unused channels have their field widths minimised to use space efficiently, the latter channels may be hidden without using the horizontal scrollbar. On systems with a generous screen area, the size button may be employed to view all the available fields, thus allowing vertical scrolling, without the screen reverting to the default view.

First

This pushbutton forces the table to the first record in the data set

Last

This forces the table row selector to the last record in the data set

Wagon Wheels

The Wagon display provides a suite of six polar graphs, analogous to the display of a continuous circular chart recorder.

Features

- Displays ALL six major downhole parameters simultaneously
- Colour-coded Pressure | Temperature | Vibration pairs
- Maximum and Minimum values for each parameter
- Continuous spiral showing total duration
- Spot anomalies immediately
- Filter start-up values at Zero/Full-scale limits.
- Hover over data-points to read Date-time and Value
- Zoom individual Wheels for greater clarity
- Expand to full-screen for utmost detail
- Full Printing
- Image copy for pasting into reports etc.
- Information pane showing strategic file data

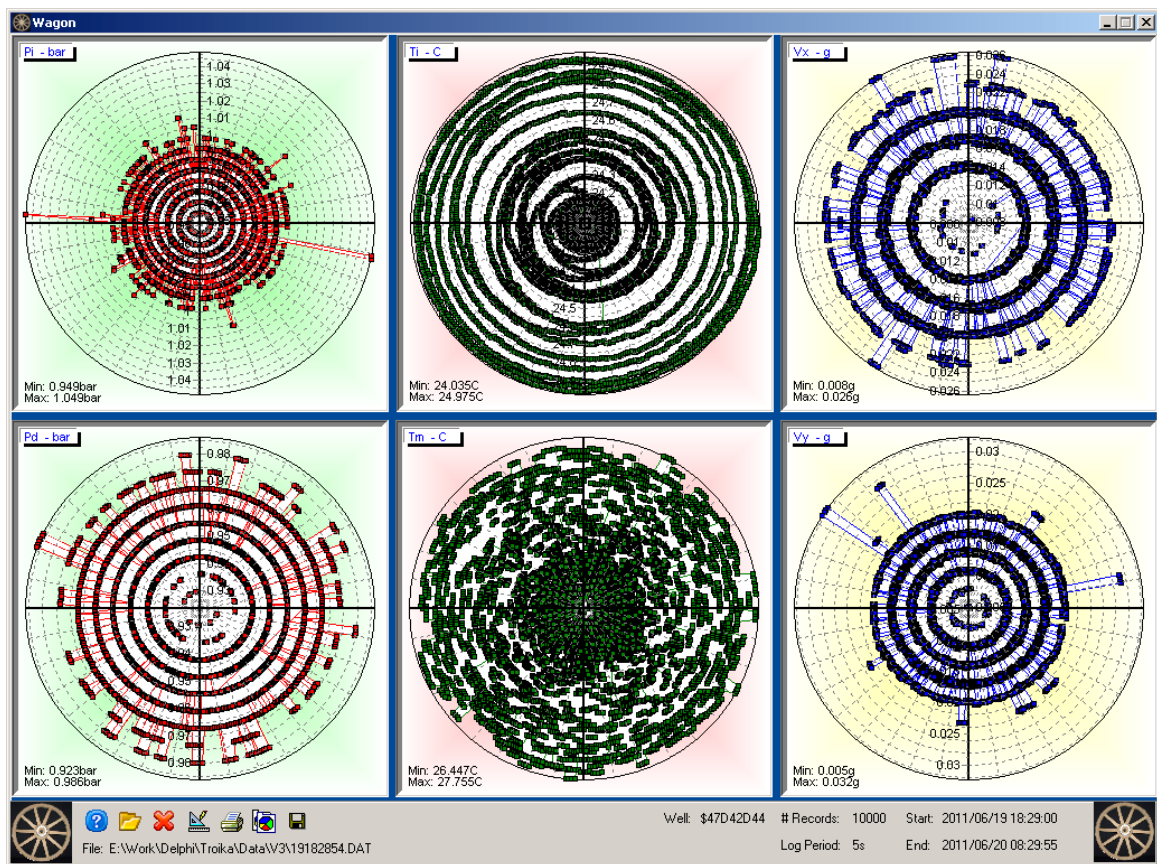


Figure 3 - The Wagon Display

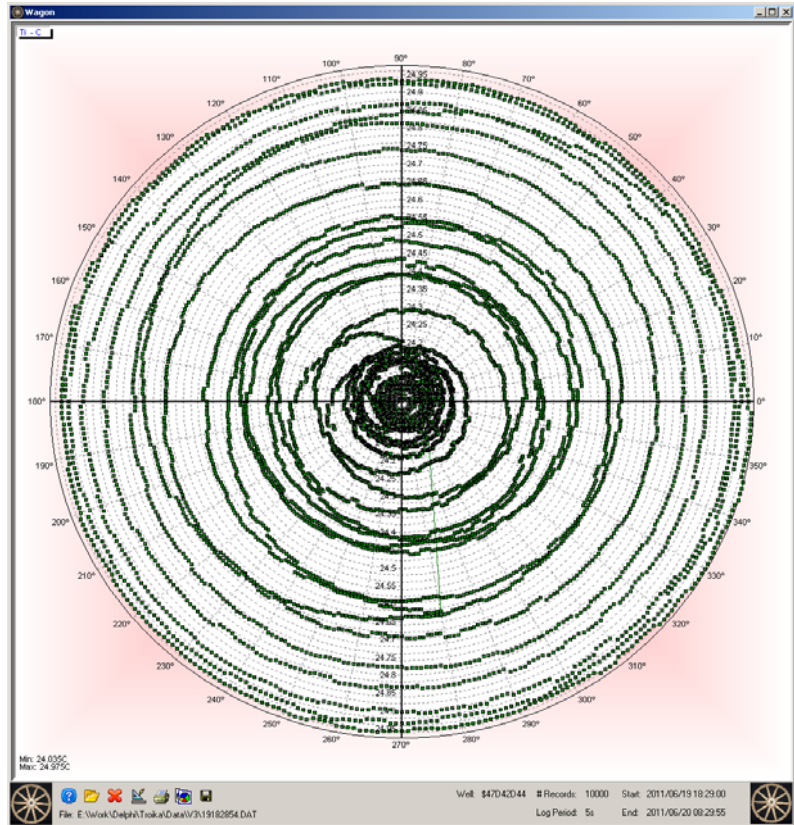
Data Labels

Data labels are available for every data-point. Hovering the mouse over the requisite point will display that point's data label for 1 second; however, it is not possible to capture the screen in that state.

The date-time information is presented in the ISO 8601:2004 Calendar-Date format.

Zoomed Wheels

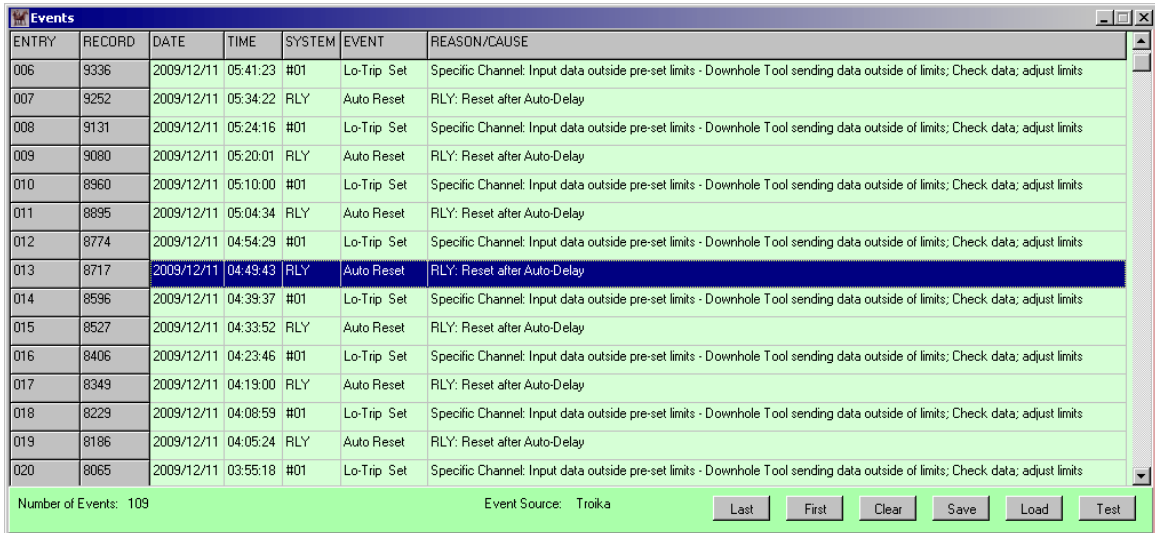
Double-clicking a specific wheel will cause the display to expand to maximally show that wheel. Additionally, compass points are added to indicate the anti-clockwise plot direction.



Events

The Event Log holds a maximum of 1000 entries, which may be scrolled through, using the side scroll-bar. The most recent event is posted in position "000". A new event will cause the preceding events to be shuffled downward.

When a data file is loaded, records are processed in chronological order, a change of event between the current record and the previous will automatically add an entry to the Event log. In this way the event log is rebuilt to mirror that available at the logging time.



ENTRY	RECORD	DATE	TIME	SYSTEM	EVENT	REASON/CAUSE
006	9336	2009/12/11	05:41:23	#01	Lo-Trip Set	Specific Channel: Input data outside pre-set limits - Downhole Tool sending data outside of limits; Check data; adjust limits
007	9252	2009/12/11	05:34:22	RLY	Auto Reset	RLY: Reset after Auto-Delay
008	9131	2009/12/11	05:24:16	#01	Lo-Trip Set	Specific Channel: Input data outside pre-set limits - Downhole Tool sending data outside of limits; Check data; adjust limits
009	9080	2009/12/11	05:20:01	RLY	Auto Reset	RLY: Reset after Auto-Delay
010	8960	2009/12/11	05:10:00	#01	Lo-Trip Set	Specific Channel: Input data outside pre-set limits - Downhole Tool sending data outside of limits; Check data; adjust limits
011	8895	2009/12/11	05:04:34	RLY	Auto Reset	RLY: Reset after Auto-Delay
012	8774	2009/12/11	04:54:29	#01	Lo-Trip Set	Specific Channel: Input data outside pre-set limits - Downhole Tool sending data outside of limits; Check data; adjust limits
013	8717	2009/12/11	04:49:43	RLY	Auto Reset	RLY: Reset after Auto-Delay
014	8596	2009/12/11	04:39:37	#01	Lo-Trip Set	Specific Channel: Input data outside pre-set limits - Downhole Tool sending data outside of limits; Check data; adjust limits
015	8527	2009/12/11	04:33:52	RLY	Auto Reset	RLY: Reset after Auto-Delay
016	8406	2009/12/11	04:23:46	#01	Lo-Trip Set	Specific Channel: Input data outside pre-set limits - Downhole Tool sending data outside of limits; Check data; adjust limits
017	8349	2009/12/11	04:19:00	RLY	Auto Reset	RLY: Reset after Auto-Delay
018	8229	2009/12/11	04:08:59	#01	Lo-Trip Set	Specific Channel: Input data outside pre-set limits - Downhole Tool sending data outside of limits; Check data; adjust limits
019	8186	2009/12/11	04:05:24	RLY	Auto Reset	RLY: Reset after Auto-Delay
020	8065	2009/12/11	03:55:18	#01	Lo-Trip Set	Specific Channel: Input data outside pre-set limits - Downhole Tool sending data outside of limits; Check data; adjust limits

Figure 6 - Event Log

Navigation

Mouse or key selection of a specific log event will synchronise the Table and View displays to the associated record number. This provides a rapid determination of the conditions prevailing at the time of the event. Whilst every event has a record number, only a small amount of records have event changes, therefore it is inappropriate to update the Event row indicator when the current record is changed via the Table and Plots. First and Last button jump to the first and last records, (NOT event numbers), respectively.

Save/Load

Event logs may be stored and subsequently retrieved for examination, allowing inspection of logs received from the field. It is advisable to press the Console's STOP button whilst loading and viewing a stored log. Upon loading from disk, the existing entries are erased and the stored contents are placed at the bottom of the log. Unused locations are filled with "Invalid Event" messages. This is to differentiate between an active log and that loaded from a disk-file.

Test

A Test function allows Events to be generated, with a "SYSTEM" identification of "TST".

View

This shows the whole system's status in one window, for the selected record. All channels are normalised to 100%. This allows the Alarm & Trip regions to be displayed in proportion with their valid range.

Channels that have their Display Mask set will be hidden from view. The cyan-coloured blocks denote current data. This display is most effective in 3D. Channels that have Alarms/Trips enabled will appear in highlighted colours, (see Pi Channel, in Figure 7).

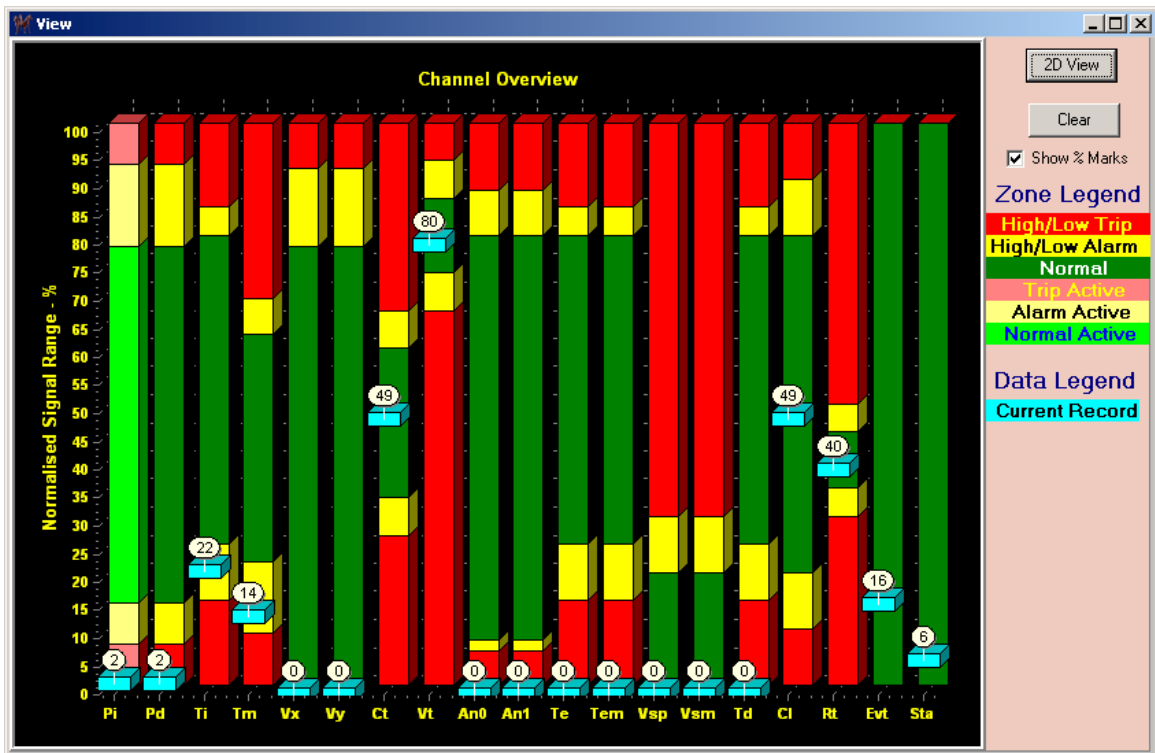


Figure 7 - Graphical Overview

Setup

This window presents the prevailing Snapshot in the SCI, or the application that logged the data file. Without the Snapshot, or at least knowledge of its contents, the scaled values produced from the data file may not be fathomable. It is imperative to check the Snapshot to ascertain that the data is as expected.

The “Save” button allows the snapshot to be written to disk and subsequently used by LumberJack.

The screenshot shows a window titled "Setup" with a sub-header "Embedded Snapshot". It displays Modbus Address: 1 and Modbus Baud: 38400bps. A "Save" button is visible in the top right. The main content is a table with 19 rows and 16 columns. The columns are: CHAN, TYPE, UNITS, ZSV, FSV, DP, LO-TRIP, LO-ALARM, HI-ALARM, HI-TRIP, DC, TRIPMASK, ALRMASK, DSPMASK, FILT, and AVG. The rows contain numerical and categorical data for each channel.

CHAN	TYPE	UNITS	ZSV	FSV	DP	LO-TRIP	LO-ALARM	HI-ALARM	HI-TRIP	DC	TRIPMASK	ALRMASK	DSPMASK	FILT	AVG
1	Pi	bar	-10.00	400.00	2	20.01	50.00	310.00	370.00	0	No	No	No	9	0
2	Pd	bar	-10.00	400.00	2	20.01	50.00	310.00	370.00	2	Yes	Yes	No	9	0
3	Ti	C	-20.00	180.00	2	10.00	30.00	140.00	150.00	3	Yes	Yes	No	9	0
4	Tm	C	-20.00	300.00	2	10.00	50.00	180.00	200.00	4	Yes	Yes	No	9	3
5	Vx	g	0.00	10.00	2	0.00	0.02	7.80	9.20	5	Yes	Yes	No	9	0
6	Vy	g	0.00	10.00	2	0.00	0.02	7.80	9.20	6	Yes	Yes	No	9	0
7	Ct	mA	0.00	30.00	2	8.00	10.00	18.00	20.00	7	Yes	Yes	No	9	0
8	Vt	V	0.00	150.00	2	100.00	110.00	130.00	140.00	8	Yes	Yes	No	9	0
9	An0	mA	0.000	25.000	3	1.500	2.000	20.001	22.000	9	Yes	Yes	No	9	4
10	An1	mA	0.000	25.000	3	1.500	2.000	20.001	22.000	-	Yes	Yes	No	9	4
11	Te	C	-20.00	180.00	2	10.00	30.00	140.00	150.00	-	Yes	Yes	No	9	0
12	Tem	C	-20.00	180.00	2	10.00	30.00	140.00	150.00	-	Yes	Yes	No	9	0
13	Vsp	kV	-0.40	3.90	2	-0.40	-0.40	0.46	0.89	-	Yes	Yes	No	9	0
14	Vsm	kV	-0.40	3.90	2	-0.40	-0.40	0.46	0.89	-	Yes	Yes	No	9	0
15	Td	C	-20.00	180.00	2	10.00	30.00	140.00	150.00	-	Yes	Yes	No	9	0
16	Cl	mA	-20.00	20.00	2	-16.01	-12.00	12.00	16.00	-	Yes	Yes	No	9	0
17	Rt	Dhm	0	20000	0	6000	7000	9000	10000	-	Yes	Yes	No	9	0
18	Evt	Hex	0	65535	0	0	0	65535	65535	-	Yes	Yes	No	9	0
19	Sta	Hex	0	65535	0	0	0	65535	65535	-	Yes	Yes	No	9	0

Figure 8 – Setup Snapshot Display

Statistics

Graphical displays are a first port of call; imagine trying to ‘see’ the beauty of the Mandelbrot set just by gazing at numbers on a printout. However, having dragged much detail out of the graphs, perhaps there is purpose in seeing what else the numbers hide.

An overall view of each channel’s min, max, mean, sample standard distribution and variance is calculated for the complete data set and displayed on the Stats window. Whilst the two main graphical displays provide the best visualisation of the data set and immediately expose glitches, it was felt that a statistical approach might elicit additional details, which could highlight erroneous data.

Buttons

A [Clear] button erases the values and the display. The [Calculate] button recalculates and displays the data.

CHAN	TYPE	UNITS	MIN	MEAN	MAX	SSD (s)	VAR (s ²)
01	Pi	bar	0.686	0.877	1.055	0.055	0.003
02	Pd	bar	-10.000	-9.996	-9.931	0.008	0.000
03	Ti	C	22.213	77.414	123.458	29.315	859.072
04	Tm	C	24.352	81.403	126.611	29.407	864.427
05	Vx	g	0.014	0.032	0.118	0.008	0.000
06	Vy	g	0.014	0.036	0.109	0.008	0.000
07	Ct	mA	14.603	14.824	14.985	0.039	0.002
08	Vt	V	118.915	119.760	120.597	0.158	0.025
09	An0	mA	0.000	0.000	0.002	0.000	0.000
10	An1	mA	0.000	0.000	0.001	0.000	0.000
11	n/a	n/a					
12	n/a	n/a					
13	n/a	n/a					
14	n/a	n/a					
15	n/a	n/a					
16	Cl	mA	-0.400	-0.182	-0.010	0.040	0.002
17	Rt	Ohm	7968.383	8081.582	8212.836	24.154	583.200
18	Evt	Hex					
19	Sta	Hex					

Figure 9 – Basic Statistics Display

Navigation

The up/down arrow keys or the mouse wheel may select a specific row. A left mouse-button click will load that channel’s data into the left-hand display of the Console’s plot. A right mouse-button click will load into the right-hand display.

Summaries

Three standard summaries are provided, Min, Max and Arithmetic Mean.

Arithmetic Mean

The Mean is perhaps the simplest measure of central tendency, but is only meaningful for stable conditions.

$$\bar{x} = \frac{(x_1 + x_2 + \dots + x_n)}{n}$$

Sample Standard Deviation

The Sample Standard Deviation is not applicable in certain situations, especially when the examined parameter is subjected to a step-change in conditions, or in the presence of glitches.

$$s = \sqrt{\frac{\sum(X - \bar{X})^2}{n - 1}}$$

Histogram

This button widens the window to reveal a bar chart with a histogram display of the chosen channel. When a channel row is selected, an algorithm is employed to optimise the number of bins. The number of bins may be set manually with the left/right arrows, adjust to give a display free of gaps between the bars. The data is quantitised, so for a channel with minimally varying data, too many bins will cause zero counts for those bins between the quanta.

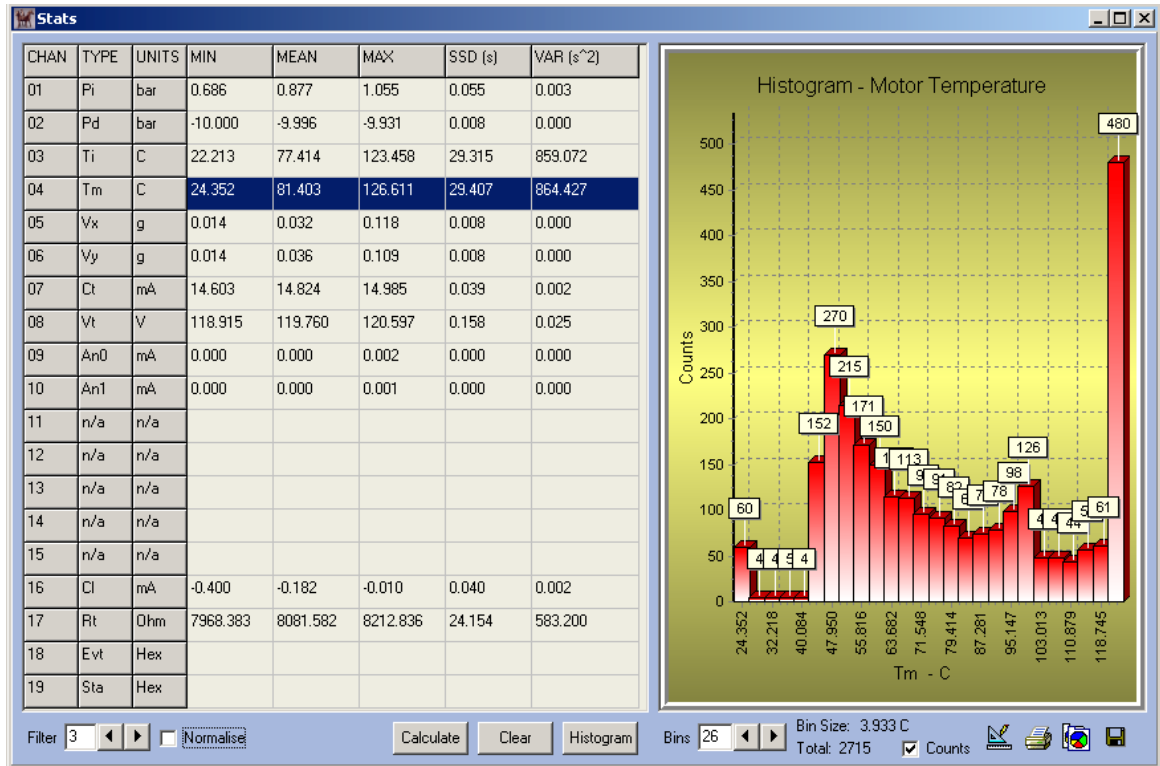


Figure 10 – Histogram of Raw Data

Normalisation

The next step is to normalise the data set using a moving, (local), average, which will effectively straighten the curves, by removing the real-world value of the selected parameter. The filtering strength is adjustable from 1 to 10 and any change to the filter strength will force a recalculation.

Due to the iterative algorithm employed, calculation times are extended for the normalised display. A message is deployed whilst calculating.

The resultant display now portrays the underlying mensuration and transmission quality; a single high peak with symmetrical skirts indicates ideal performance.

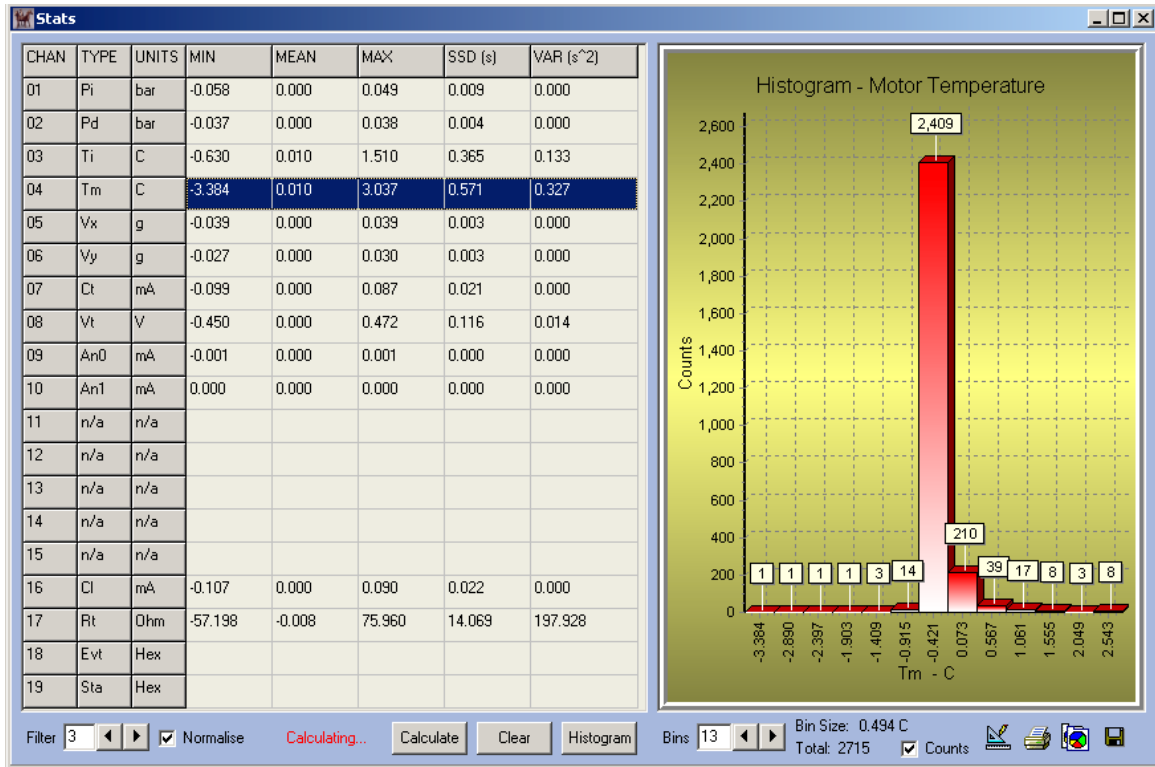


Figure 11 – Histogram of Normalised Data

References

Two useful sources of information on statistical matters are given below.

Stats4Students

<http://stats4students.com/measures-of-spread-3.php>

Laerd Statistics

<http://statistics.laerd.com/statistical-guides/>

This site has excellent tutorials and worked examples using your data.

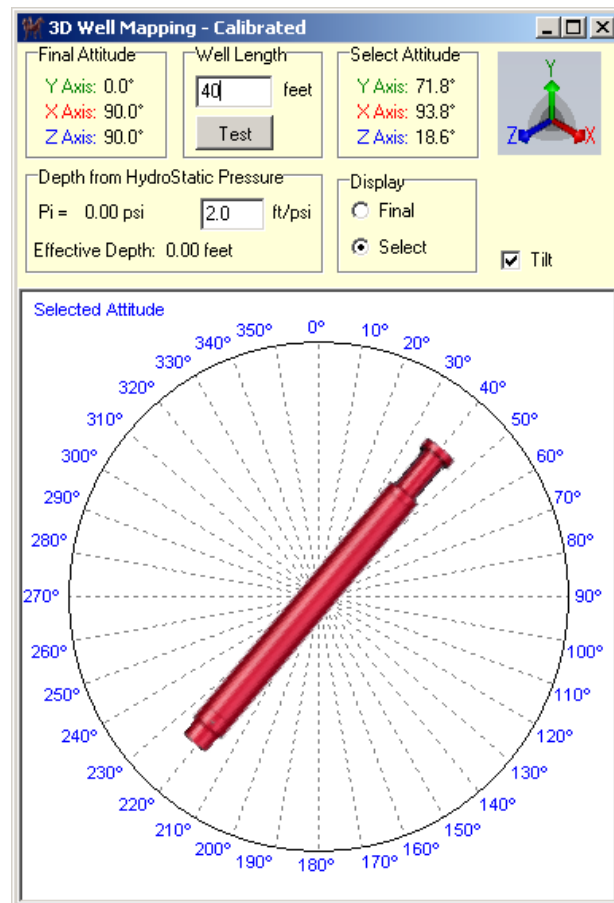
3D Well Mapping & Tilt

During the ESP string's run-in, the operator is keen to position the motor in a region of the well shaft that is substantially straight, (<2 degrees curvature over a distance of 100 feet) and as near to vertical as possible. These considerations ensure that the motor and ESP pump's thrust bearings are correctly loaded, thus providing maximal system lifetime.

The Inclinometer Mode, (Mode-3), provides a means of recording the Tool's attitude, (tilt). A companion application may be used to calibrate the Tool's axes in a known orientation. The calibration data is stored in the Snapshot of the associated SCI and is embedded in the binary data files subsequently produced. This allows Troika to recreate the path followed by the Tool during the Run-in and to display its final resting-place.

The "Mapping" menu option evokes the Tiltometer display shown in Figure 12. An idealised image of the Tool is used as a clock pointer.

Figure 12 - Tiltometer



Final Attitude

At the end of the Run-In, the Tool's final position may be stored alongside the Calibration data. Troika extracts these values and after applying the calibration, is able to display the Tool's resting place.

Select Attitude

This is the Tool's attitude at the record selected via the Console's plot, or the Table entry.

Well Length

The Well length may be readily determined by one of two methods, by counting the number of "Stands" used to deploy the string, or by measuring the length of ESP cable used.

It is preferable to use both methods, if possible. The accepted value is committed to the Snapshot at the end of the Run-In procedure.

Depth from Hydrostatic Pressure

The weight of the specific well fluid creates a hydrostatic pressure that if logged by the SCI during the Run-In process. The ft/psi value may be determined with either an analysis of the fluid, or an empirical measurement of the pressure change due to the immersion of a stand. A reasonable default value of 2.0ft/psi is offered. The Effective Depth value is committed to the Snapshot at the end of the

Run-In procedure. This reading gives a true depth of the Tool, as opposed to the deployed length, measured by either the number of stands, or else the ESP cable length.

Display

The radio-buttons switch the Tiltometer's focus from the Final attitude, to that of the selected record's.

Well Mapping (a future feature)

This topic is "work-in-progress"; the aim is to provide a reasonable map of the well's trajectory. However, without real Mode-3 data from a Run-In event, this feature can not be progressed.

Figure 13 - Well Mapping in 3D

The magenta cross indicates the currently selected record in the data file. The 3D display may be rotated/zoomed by means of the manipulation tools on the lower bar. An alternative display using the OpenGL library is available if desired.

Reset

This button attempts to fit the display in the available space. This is especially welcome after use of the manipulation tools has rendered the view unusable.

