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II. AG501 Diagnostics Software

cs5diag serves the purpose to run diagnostics on the AG501-system to identify potential problems, e.g. broken sensors, external interference frequencies or corrupt transmitter coils.

The basic approach comprises a system check to validate some environmental variables, a real-time display to identify broken sensors, connections etc., and a long-term measurement to assure stable data recording.

A. The AG501-Diagnostics Tab

When starting cs5diag from the menu (Applications → AG501 → cs5diag), the program runs a system check validating the available disk space, the eBox connection and the circal zero- and HWZBase-configuration values (Figure 1).

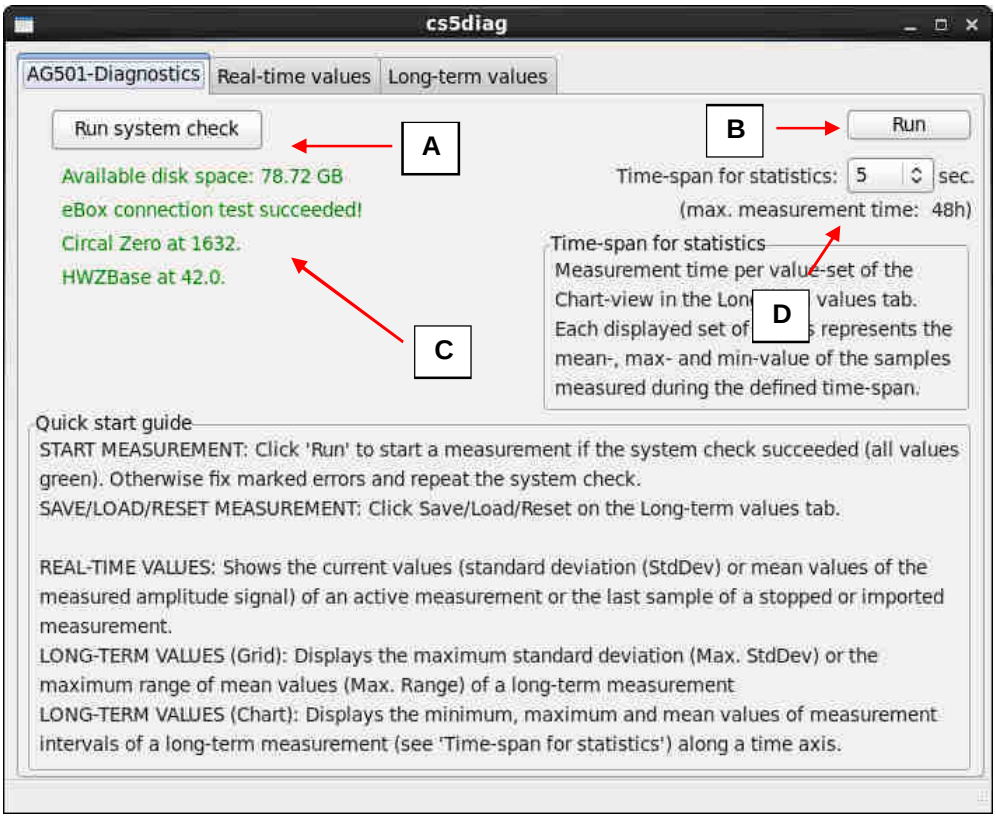


Figure 1: The AG501-Diagnostics Tab

The system check can be initialized manually by clicking the corresponding button (Figure 1 A). After passing the system check successfully the measurement can be started by toggling the *Run*-button (Figure 1 B). The time-span for each dedicated measurement of the long-term measurement can be selected via a drop-down box (Figure 1 D). The resulting maximum time of the long-term measurement is displayed beneath the selector.

An active measurement is indicated by the green color of the *Run*-button and a message in the status bar showing the starting time as well as the elapsed time of the measurement (Figure 2).

When encountering problems during the system check the incorrect values are displayed in red and the *Run*-button gets disabled until the system check is passed without errors (Figure 3).

To stop an active measurement the *Run*-button (Figure 2: colored green when active) has to be toggled again.

<u>Please note:</u> A stopped measurement cannot be continued. Clicking the *Run*-button to start a long-term measurement will always start a new long-term measurement.

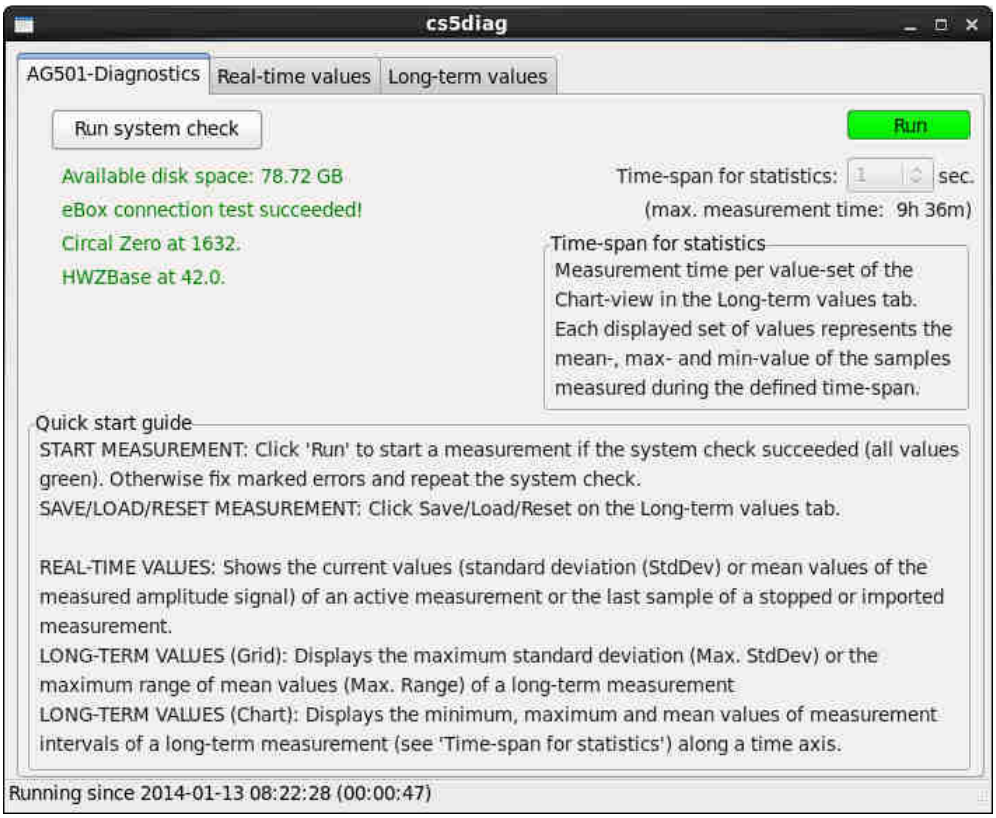


Figure 2: The *Run*-button and status text indicate an active measurement

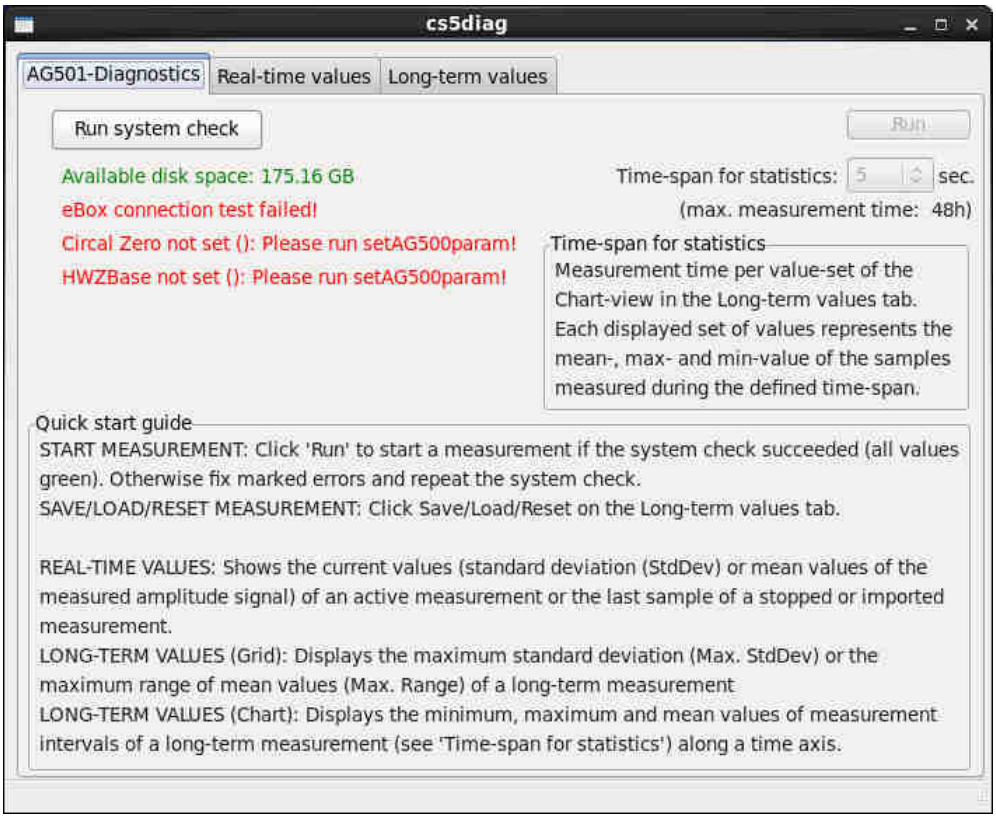


Figure 3: The *Run*-button is disabled after failing a system check

B. The Real-time values Tab

The data grid of the Real-time-Tab (Figure 4) displays the current values of an active measurement or the values of the last sample of a stopped or imported measurement respectively. Each column (tx) represents the values of one transmitter whereas each row (ch_) corresponds to one channel of the system.

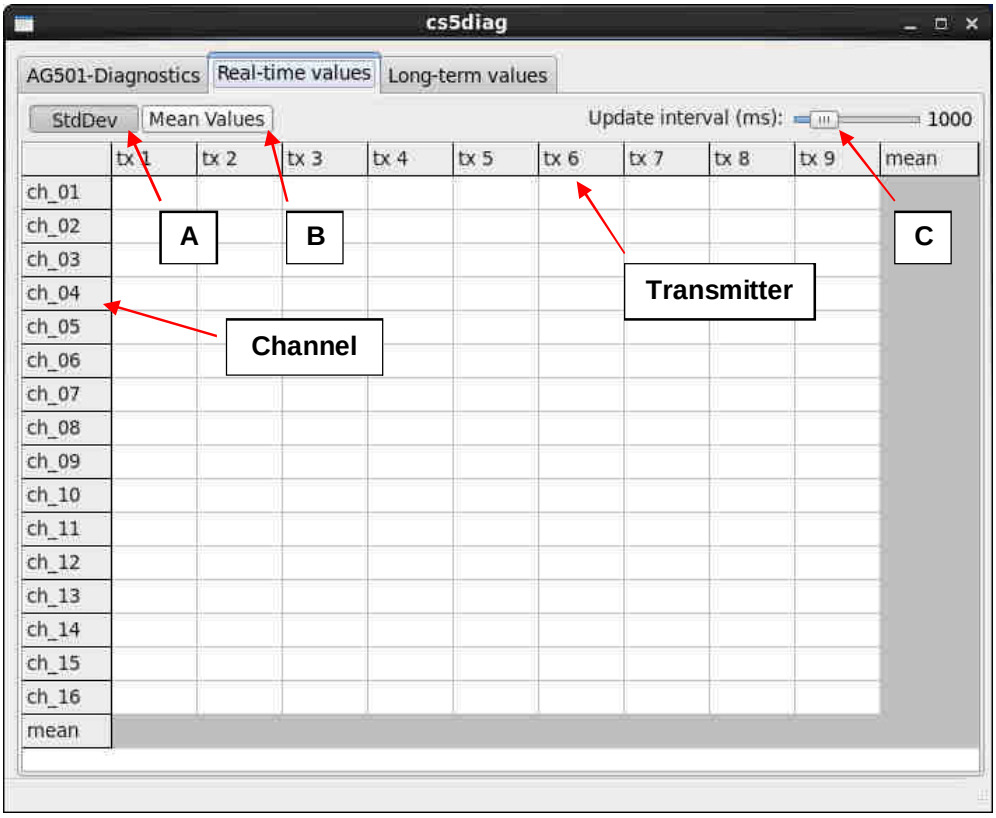


Figure 4: The Real-time values Tab

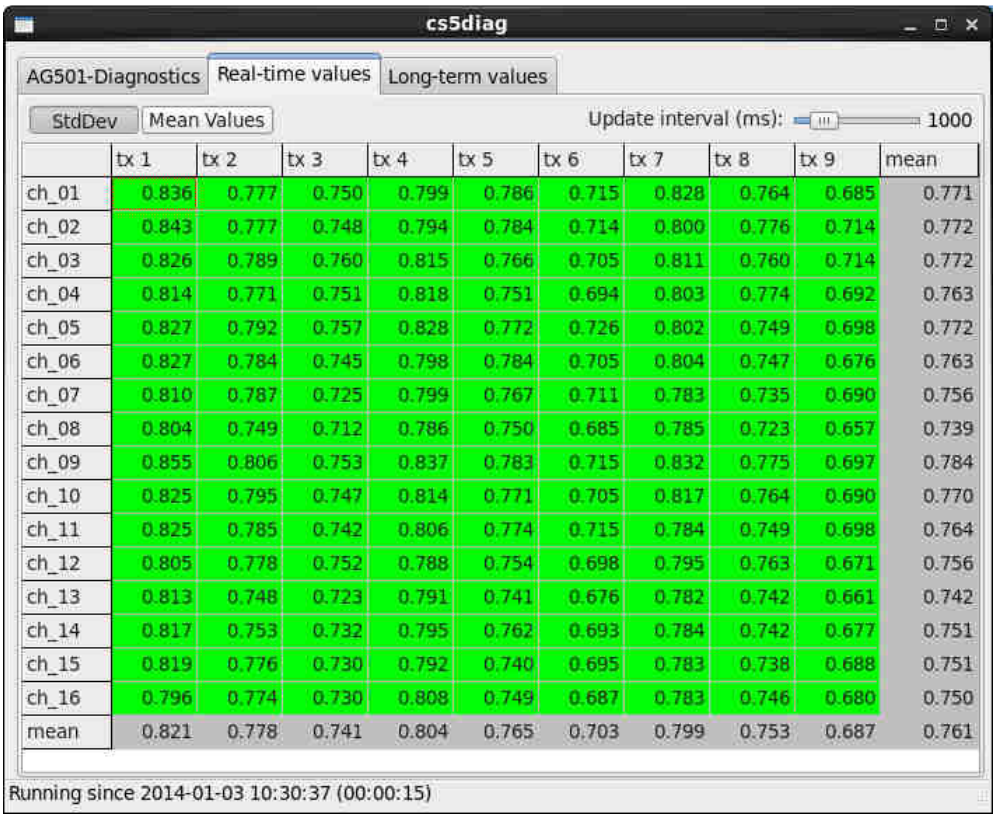
By toggling the *StdDev*- (Figure 4 A) and the *Mean Values*-button (Figure 4 B) the values displayed can be switched between the standard deviation and the mean values of the measured amplitude signal.
Per default the standard deviation of the measured amplitude signal is displayed.

The update interval of the real-time display can be adjusted via slider (Figure 4 C).

In **StdDev-mode** (Figure 5) the last column and last row labeled *mean* display the mean-StdDev-values of each row or column respectively. Standard deviation-values of the measured amplitude signal below 2 are considered within range for precise measurements and colored green. Values exceeding this limit are colored red (Figure 6).

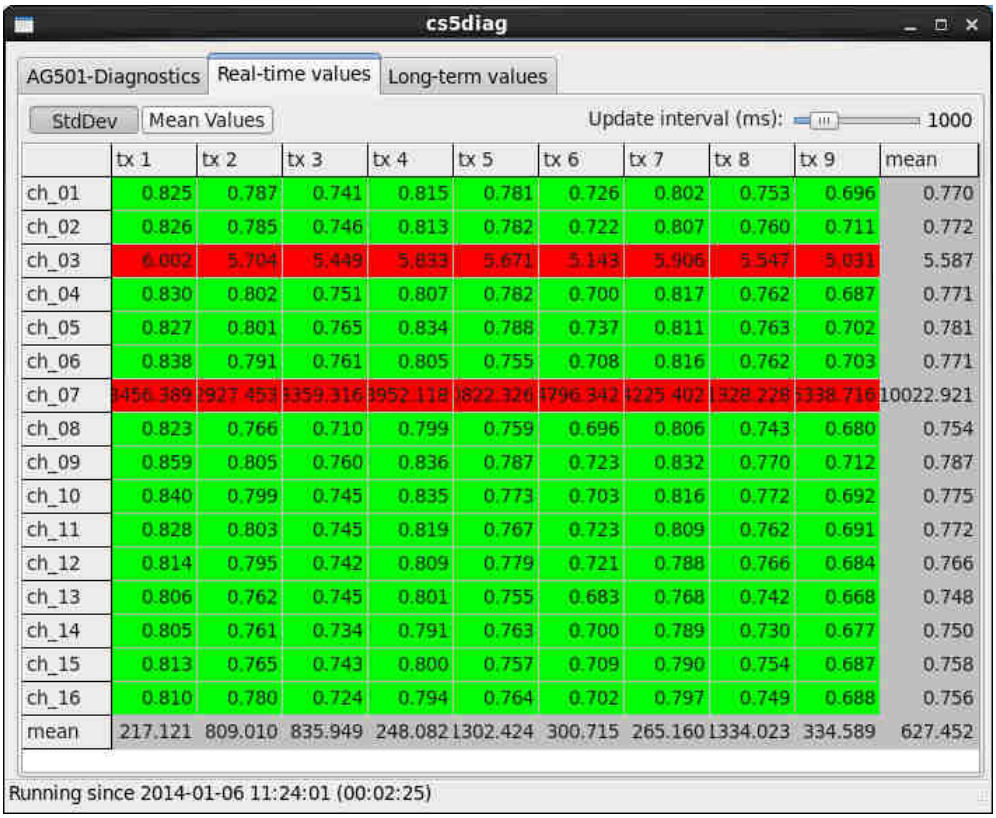
In **Mean-mode** (Figure 7) the last column and last row labeled *sum* display the sum of the absolute values of each row or column respectively. Row totals below 1000 indicate defect or missing sensors (channels 9 to 16 in Figure 7) whereas column totals below 1000 indicate transmitter problems (transmitter 4 in Figure 8). Rows or columns in question are colored red.

Grid-values can be **copied to the clipboard** by selecting the grid-cells with the mouse and pressing `Ctrl+C`. Subsequently the values can be inserted to your favorite editor or spreadsheet program by pressing `Ctrl+V`.



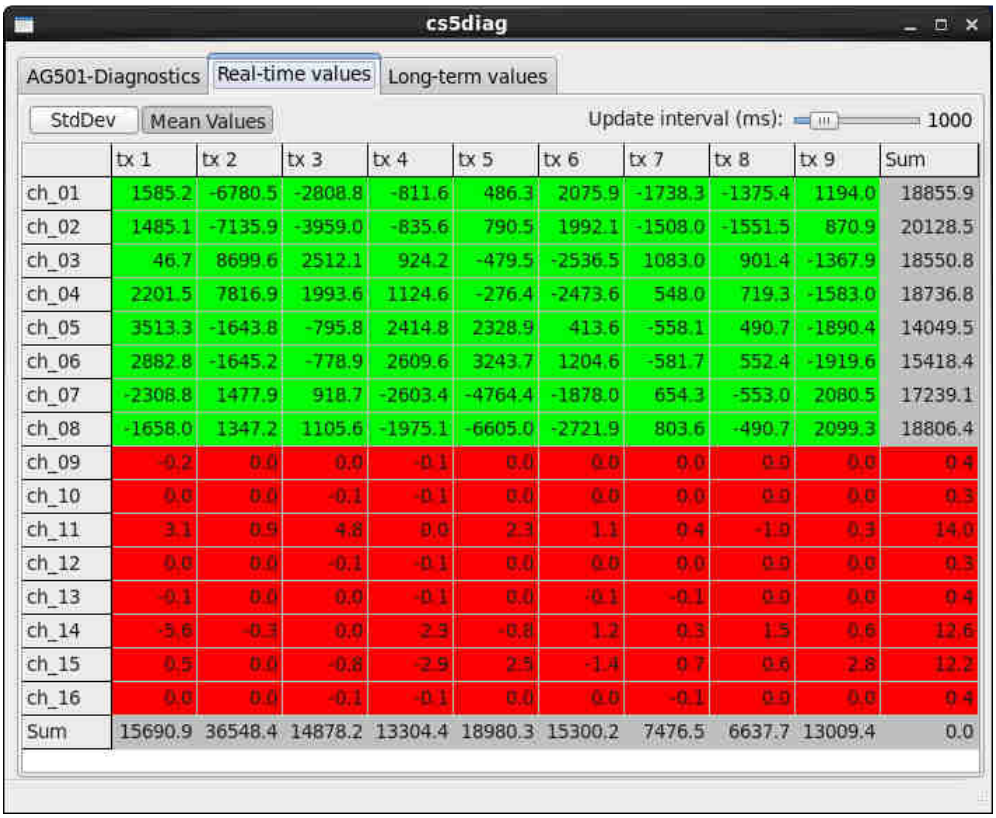
	tx 1	tx 2	tx 3	tx 4	tx 5	tx 6	tx 7	tx 8	tx 9	mean
ch_01	0.836	0.777	0.750	0.799	0.786	0.715	0.828	0.764	0.685	0.771
ch_02	0.843	0.777	0.748	0.794	0.784	0.714	0.800	0.776	0.714	0.772
ch_03	0.826	0.789	0.760	0.815	0.766	0.705	0.811	0.760	0.714	0.772
ch_04	0.814	0.771	0.751	0.818	0.751	0.694	0.803	0.774	0.692	0.763
ch_05	0.827	0.792	0.757	0.828	0.772	0.726	0.802	0.749	0.698	0.772
ch_06	0.827	0.784	0.745	0.798	0.784	0.705	0.804	0.747	0.676	0.763
ch_07	0.810	0.787	0.725	0.799	0.767	0.711	0.783	0.735	0.690	0.756
ch_08	0.804	0.749	0.712	0.786	0.750	0.685	0.785	0.723	0.657	0.739
ch_09	0.855	0.806	0.753	0.837	0.783	0.715	0.832	0.775	0.697	0.784
ch_10	0.825	0.795	0.747	0.814	0.771	0.705	0.817	0.764	0.690	0.770
ch_11	0.825	0.785	0.742	0.806	0.774	0.715	0.784	0.749	0.698	0.764
ch_12	0.805	0.778	0.752	0.788	0.754	0.698	0.795	0.763	0.671	0.756
ch_13	0.813	0.748	0.723	0.791	0.741	0.676	0.782	0.742	0.661	0.742
ch_14	0.817	0.753	0.732	0.795	0.762	0.693	0.784	0.742	0.677	0.751
ch_15	0.819	0.776	0.730	0.792	0.740	0.695	0.783	0.738	0.688	0.751
ch_16	0.796	0.774	0.730	0.808	0.749	0.687	0.783	0.746	0.680	0.750
mean	0.821	0.778	0.741	0.804	0.765	0.703	0.799	0.753	0.687	0.761

Figure 5: Real-time standard deviation values (example)



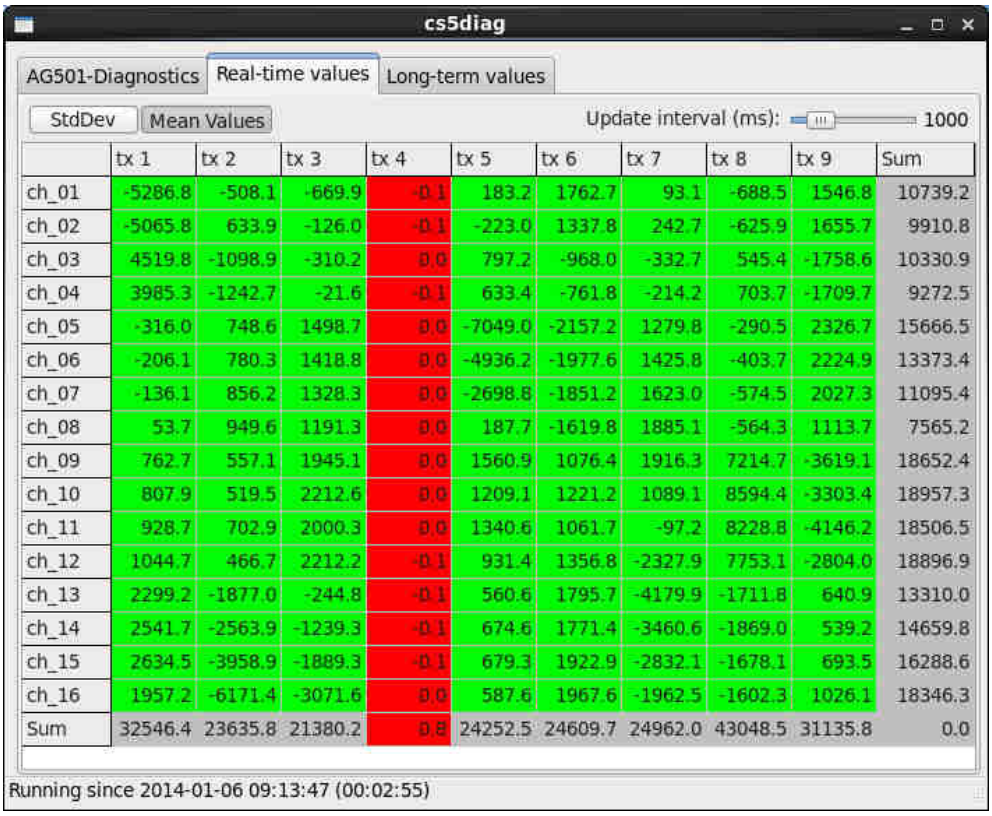
	tx 1	tx 2	tx 3	tx 4	tx 5	tx 6	tx 7	tx 8	tx 9	mean
ch_01	0.825	0.787	0.741	0.815	0.781	0.726	0.802	0.753	0.696	0.770
ch_02	0.826	0.785	0.746	0.813	0.782	0.722	0.807	0.760	0.711	0.772
ch_03	6.002	5.704	5.449	5.833	5.671	5.143	5.906	5.547	5.031	5.587
ch_04	0.830	0.802	0.751	0.807	0.782	0.700	0.817	0.762	0.687	0.771
ch_05	0.827	0.801	0.765	0.834	0.788	0.737	0.811	0.763	0.702	0.781
ch_06	0.838	0.791	0.761	0.805	0.755	0.708	0.816	0.762	0.703	0.771
ch_07	8456.389	7927.453	8359.316	8952.118	8822.326	11796.342	14225.402	11328.228	13338.716	10022.921
ch_08	0.823	0.766	0.710	0.799	0.759	0.696	0.806	0.743	0.680	0.754
ch_09	0.859	0.805	0.760	0.836	0.787	0.723	0.832	0.770	0.712	0.787
ch_10	0.840	0.799	0.745	0.835	0.773	0.703	0.816	0.772	0.692	0.775
ch_11	0.828	0.803	0.745	0.819	0.767	0.723	0.809	0.762	0.691	0.772
ch_12	0.814	0.795	0.742	0.809	0.779	0.721	0.788	0.766	0.684	0.766
ch_13	0.806	0.762	0.745	0.801	0.755	0.683	0.768	0.742	0.668	0.748
ch_14	0.805	0.761	0.734	0.791	0.763	0.700	0.789	0.730	0.677	0.750
ch_15	0.813	0.765	0.743	0.800	0.757	0.709	0.790	0.754	0.687	0.758
ch_16	0.810	0.780	0.724	0.794	0.764	0.702	0.797	0.749	0.688	0.756
mean	217.121	809.010	835.949	248.082	1302.424	300.715	265.160	1334.023	334.589	627.452

Figure 6: Real-time standard deviation values exceeding 2 are colored red



	tx 1	tx 2	tx 3	tx 4	tx 5	tx 6	tx 7	tx 8	tx 9	Sum
ch_01	1585.2	-6780.5	-2808.8	-811.6	486.3	2075.9	-1738.3	-1375.4	1194.0	18855.9
ch_02	1485.1	-7135.9	-3959.0	-835.6	790.5	1992.1	-1508.0	-1551.5	870.9	20128.5
ch_03	46.7	8699.6	2512.1	924.2	-479.5	-2536.5	1083.0	901.4	-1367.9	18550.8
ch_04	2201.5	7816.9	1993.6	1124.6	-276.4	-2473.6	548.0	719.3	-1583.0	18736.8
ch_05	3513.3	-1643.8	-795.8	2414.8	2328.9	413.6	-558.1	490.7	-1890.4	14049.5
ch_06	2882.8	-1645.2	-778.9	2609.6	3243.7	1204.6	-581.7	552.4	-1919.6	15418.4
ch_07	-2308.8	1477.9	918.7	-2603.4	-4764.4	-1878.0	654.3	-553.0	2080.5	17239.1
ch_08	-1658.0	1347.2	1105.6	-1975.1	-6605.0	-2721.9	803.6	-490.7	2099.3	18806.4
ch_09	-0.2	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.4
ch_10	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.3
ch_11	3.1	0.9	4.8	0.0	2.3	1.1	0.4	-1.0	0.3	14.0
ch_12	0.0	0.0	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0	0.3
ch_13	-0.1	0.0	0.0	-0.1	0.0	-0.1	-0.1	0.0	0.0	0.4
ch_14	-5.6	-0.3	0.0	2.3	-0.8	1.2	0.3	1.5	0.6	12.6
ch_15	0.5	0.0	-0.8	-2.9	2.5	-1.4	0.7	0.6	2.8	12.2
ch_16	0.0	0.0	-0.1	-0.1	0.0	0.0	-0.1	0.0	0.0	0.4
Sum	15690.9	36548.4	14878.2	13304.4	18980.3	15300.2	7476.5	6637.7	13009.4	0.0

Figure 7: Real-time mean values - the low total values of channel 9 to 16 indicate incorrect values for these channels (defective or missing sensors)



	tx 1	tx 2	tx 3	tx 4	tx 5	tx 6	tx 7	tx 8	tx 9	Sum
ch_01	-5286.8	-508.1	-669.9	-0.1	183.2	1762.7	93.1	-688.5	1546.8	10739.2
ch_02	-5065.8	633.9	-126.0	-0.1	-223.0	1337.8	242.7	-625.9	1655.7	9910.8
ch_03	4519.8	-1098.9	-310.2	0.0	797.2	-968.0	-332.7	545.4	-1758.6	10330.9
ch_04	3985.3	-1242.7	-21.6	-0.1	633.4	-761.8	-214.2	703.7	-1709.7	9272.5
ch_05	-316.0	748.6	1498.7	0.0	-7049.0	-2157.2	1279.8	-290.5	2326.7	15666.5
ch_06	-206.1	780.3	1418.8	0.0	-4936.2	-1977.6	1425.8	-403.7	2224.9	13373.4
ch_07	-136.1	856.2	1328.3	0.0	-2698.8	-1851.2	1623.0	-574.5	2027.3	11095.4
ch_08	53.7	949.6	1191.3	0.0	187.7	-1619.8	1885.1	-564.3	1113.7	7565.2
ch_09	762.7	557.1	1945.1	0.0	1560.9	1076.4	1916.3	7214.7	-3619.1	18652.4
ch_10	807.9	519.5	2212.6	0.0	1209.1	1221.2	1089.1	8594.4	-3303.4	18957.3
ch_11	928.7	702.9	2000.3	0.0	1340.6	1061.7	-97.2	8228.8	-4146.2	18506.5
ch_12	1044.7	466.7	2212.2	-0.1	931.4	1356.8	-2327.9	7753.1	-2804.0	18896.9
ch_13	2299.2	-1877.0	-244.8	-0.1	560.6	1795.7	-4179.9	-1711.8	640.9	13310.0
ch_14	2541.7	-2563.9	-1239.3	-0.1	674.6	1771.4	-3460.6	-1869.0	539.2	14659.8
ch_15	2634.5	-3958.9	-1889.3	-0.1	679.3	1922.9	-2832.1	-1678.1	693.5	16288.6
ch_16	1957.2	-6171.4	-3071.6	0.0	587.6	1967.6	-1962.5	-1602.3	1026.1	18346.3
Sum	32546.4	23635.8	21380.2	0.8	24252.5	24609.7	24962.0	43048.5	31135.8	0.0

Figure 8: Real-time mean values - the low total of tx 4 indicates a disconnected transmitter

C. The Long-term values Tab

The Long-term values tab (Figure 9) contains the controls to administer and evaluate long-term measurements. Beside the controls to save/load long-term measurements to/from files (Figure 9 A), to crop data to a data section (Figure 9 E) or to start a new long-term measurement (*reset*), it includes a grid- and a chart display-mode that can be toggled by clicking the corresponding *Grid*- and *Chart*-button (Figure 9 B).

While measuring, the statistics of the long-term measurement are updated every 5 seconds. The values of the data grid and chart are updated automatically as long as the *Refresh*-button is toggled down (Figure 9 C).

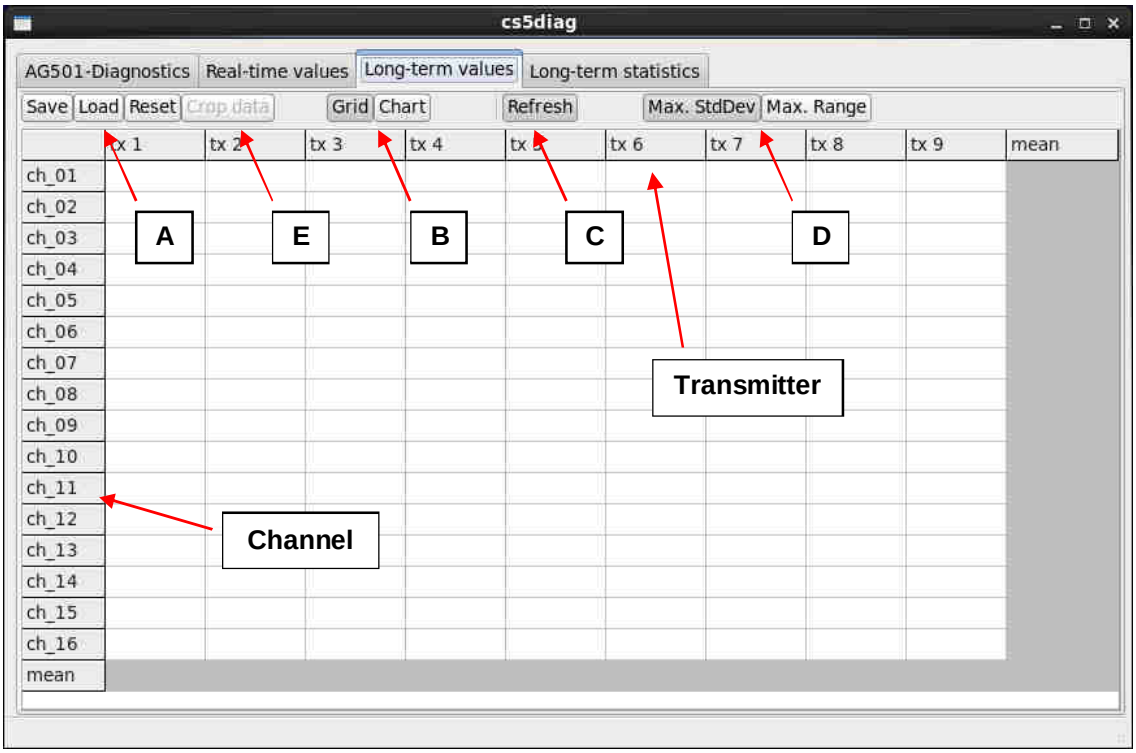


Figure 9: The Long-term values Tab

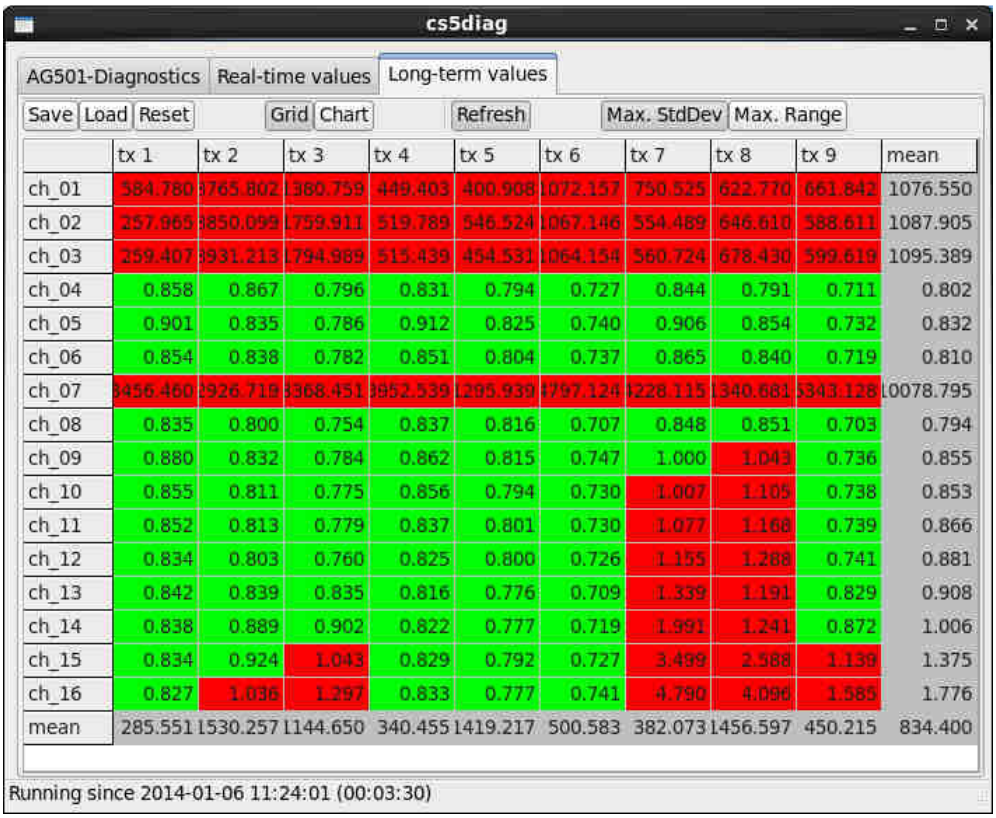
1. The Grid-mode

In **grid-mode** the data grid displays the maximum standard deviation (default) or the maximum range of the mean values of the long-term measurement depending on the setting of the *Max. StdDev*- and *Max. Range*-buttons (Figure 9 D).

In **Max. StdDev-mode** (Figure 10) the last column and last row labeled *mean* display the mean-maximum-StdDev-values of each row or column respectively. Maximum standard deviation-values of the measured amplitude signal below 1 are considered within range for precise measurements and colored green. Values exceeding this limit are colored red (Figure 10).

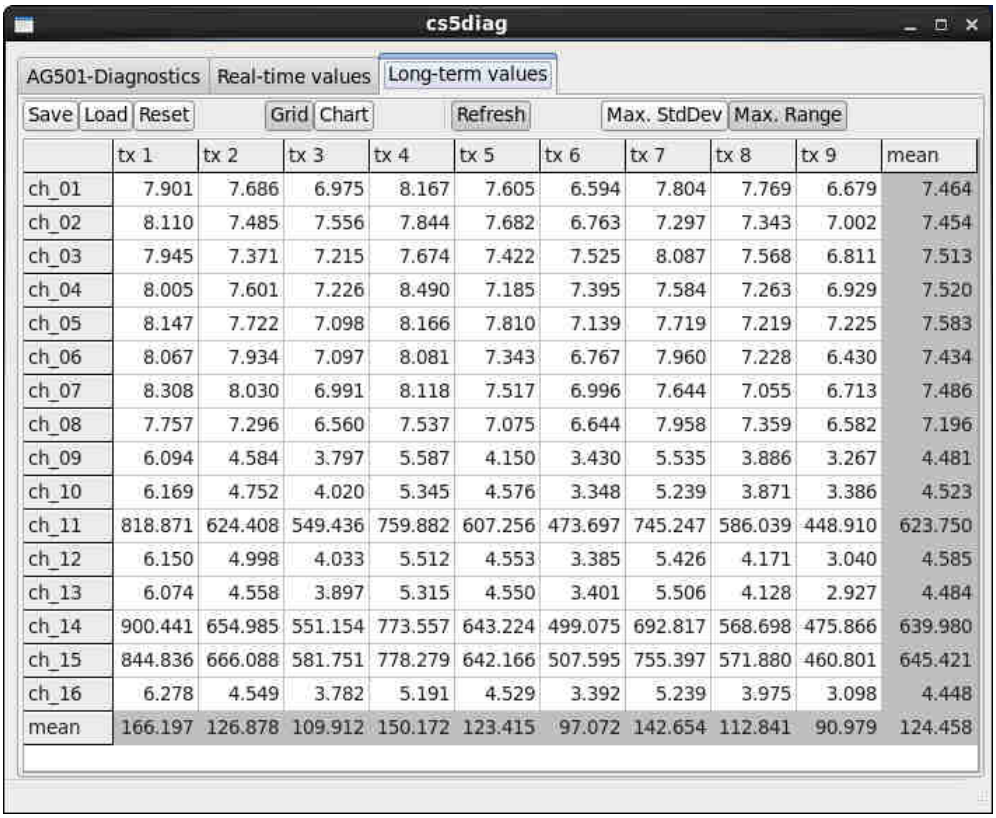
In **Max. Range-mode** (Figure 11) the maximum range of the mean values of the long-term measurement of each channel/transmitter is displayed without dividing values by color into plausible and suspicious values. By now the range serves rather as additional information (if needed) than for evaluation purposes.

Just like in the real-time tab, grid-values can be **copied to the clipboard** by selecting the grid-cells with the mouse and pressing `Ctrl+C`. Subsequently the values can be inserted to your favorite editor or spreadsheet program by pressing `Ctrl+V`.



	tx 1	tx 2	tx 3	tx 4	tx 5	tx 6	tx 7	tx 8	tx 9	mean
ch_01	584.780	4765.802	1380.759	449.403	400.908	1072.157	750.525	622.770	661.842	1076.550
ch_02	257.965	3850.099	1759.911	519.789	546.524	1067.146	554.489	646.610	588.611	1087.905
ch_03	259.407	3931.213	1794.989	515.439	454.531	1064.154	560.724	678.430	599.619	1095.389
ch_04	0.858	0.867	0.796	0.831	0.794	0.727	0.844	0.791	0.711	0.802
ch_05	0.901	0.835	0.786	0.912	0.825	0.740	0.906	0.854	0.732	0.832
ch_06	0.854	0.838	0.782	0.851	0.804	0.737	0.865	0.840	0.719	0.810
ch_07	8456.460	2926.719	4368.451	3952.539	1295.939	4797.124	4228.115	1340.681	5343.128	10078.795
ch_08	0.835	0.800	0.754	0.837	0.816	0.707	0.848	0.851	0.703	0.794
ch_09	0.880	0.832	0.784	0.862	0.815	0.747	1.000	1.043	0.736	0.855
ch_10	0.855	0.811	0.775	0.856	0.794	0.730	1.007	1.105	0.738	0.853
ch_11	0.852	0.813	0.779	0.837	0.801	0.730	1.077	1.168	0.739	0.866
ch_12	0.834	0.803	0.760	0.825	0.800	0.726	1.155	1.288	0.741	0.881
ch_13	0.842	0.839	0.835	0.816	0.776	0.709	1.339	1.191	0.829	0.908
ch_14	0.838	0.889	0.902	0.822	0.777	0.719	1.991	1.241	0.872	1.006
ch_15	0.834	0.924	1.043	0.829	0.792	0.727	3.499	2.588	1.139	1.375
ch_16	0.827	1.036	1.297	0.833	0.777	0.741	4.790	4.096	1.585	1.776
mean	285.551	1530.257	1144.650	340.455	1419.217	500.583	382.073	1456.597	450.215	834.400

Figure 10: Long-term values - maximum standard deviation



	tx 1	tx 2	tx 3	tx 4	tx 5	tx 6	tx 7	tx 8	tx 9	mean
ch_01	7.901	7.686	6.975	8.167	7.605	6.594	7.804	7.769	6.679	7.464
ch_02	8.110	7.485	7.556	7.844	7.682	6.763	7.297	7.343	7.002	7.454
ch_03	7.945	7.371	7.215	7.674	7.422	7.525	8.087	7.568	6.811	7.513
ch_04	8.005	7.601	7.226	8.490	7.185	7.395	7.584	7.263	6.929	7.520
ch_05	8.147	7.722	7.098	8.166	7.810	7.139	7.719	7.219	7.225	7.583
ch_06	8.067	7.934	7.097	8.081	7.343	6.767	7.960	7.228	6.430	7.434
ch_07	8.308	8.030	6.991	8.118	7.517	6.996	7.644	7.055	6.713	7.486
ch_08	7.757	7.296	6.560	7.537	7.075	6.644	7.958	7.359	6.582	7.196
ch_09	6.094	4.584	3.797	5.587	4.150	3.430	5.535	3.886	3.267	4.481
ch_10	6.169	4.752	4.020	5.345	4.576	3.348	5.239	3.871	3.386	4.523
ch_11	818.871	624.408	549.436	759.882	607.256	473.697	745.247	586.039	448.910	623.750
ch_12	6.150	4.998	4.033	5.512	4.553	3.385	5.426	4.171	3.040	4.585
ch_13	6.074	4.558	3.897	5.315	4.550	3.401	5.506	4.128	2.927	4.484
ch_14	900.441	654.985	551.154	773.557	643.224	499.075	692.817	568.698	475.866	639.980
ch_15	844.836	666.088	581.751	778.279	642.166	507.595	755.397	571.880	460.801	645.421
ch_16	6.278	4.549	3.782	5.191	4.529	3.392	5.239	3.975	3.098	4.448
mean	166.197	126.878	109.912	150.172	123.415	97.072	142.654	112.841	90.979	124.458

Figure 11: Long-term values - the maximum range of the mean values

2. The Chart-mode

In chart-mode (Figure 12) the chart displays long-term data for each channel/transmitter along a time/measurement-axis. The minimum-, the maximum- as well as the mean-value for each measurement is plotted as y-values along the x-axis. The time-span for each measurement is indicated in the upper right corner (Figure 12 C). Each displayed set of values represents the mean-, max- and min-value of the samples measured during the defined time-span.

The channels and transmitters can be switched by the corresponding selectors (Figure 12 A). By checking the *Measurement index*-checkbox (Figure 12 B) the unit of the x-axis changes from time (hours, minutes and seconds) to measurement index (Figure 13).

For easy comparison of different channel/transmitter-combinations all values are shown in relation to the average of the mean values of the corresponding channel/transmitter-combination. The real value of the displayed y-axis-0 is shown in the legend beneath the chart. This also allows easy identification of value-shifts over time (Figure 14).

The default chart view displays all values of a measurement scaled to the canvas of the chart.

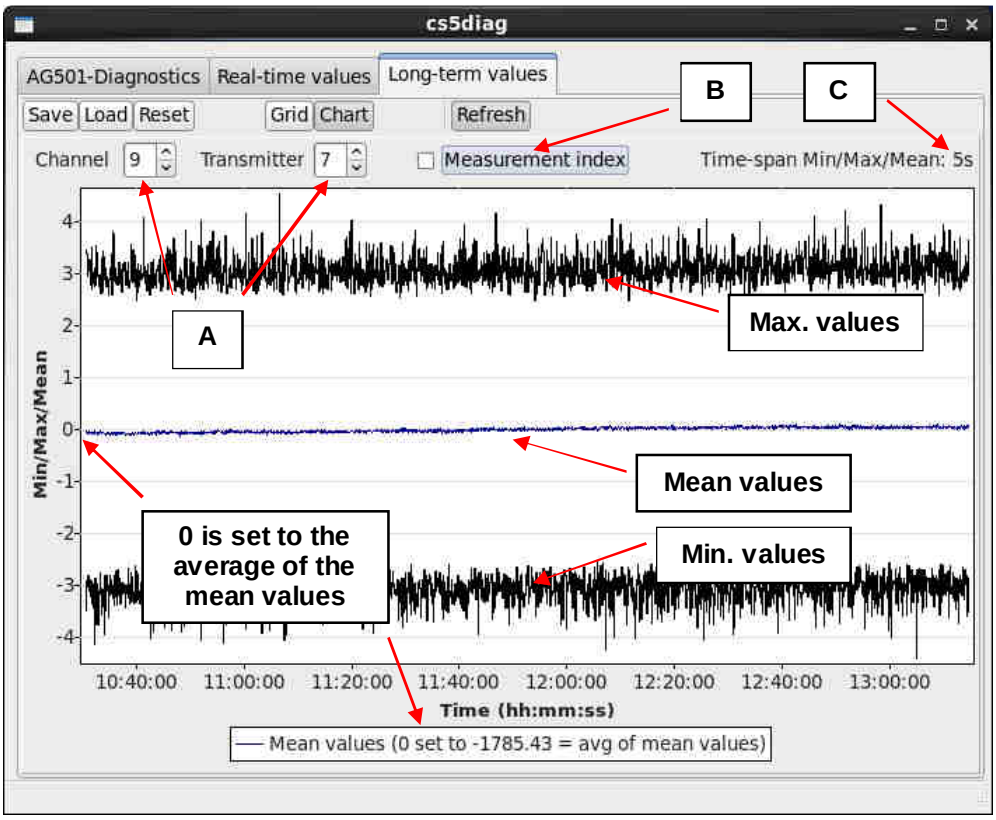


Figure 12: Long-term values - Chart mode

The chart-mode allows some basic display adjustment using the computer mouse:

Moving: Dragging the mouse cursor across the chart while holding the right mouse button moves the displayed part of the chart.

Zooming: Dragging the mouse while holding the left mouse button zooms in to the selected area (Figure 15 and Figure 16).

Reset: A simple left-mouse-click on the chart resets the display to the default chart view.

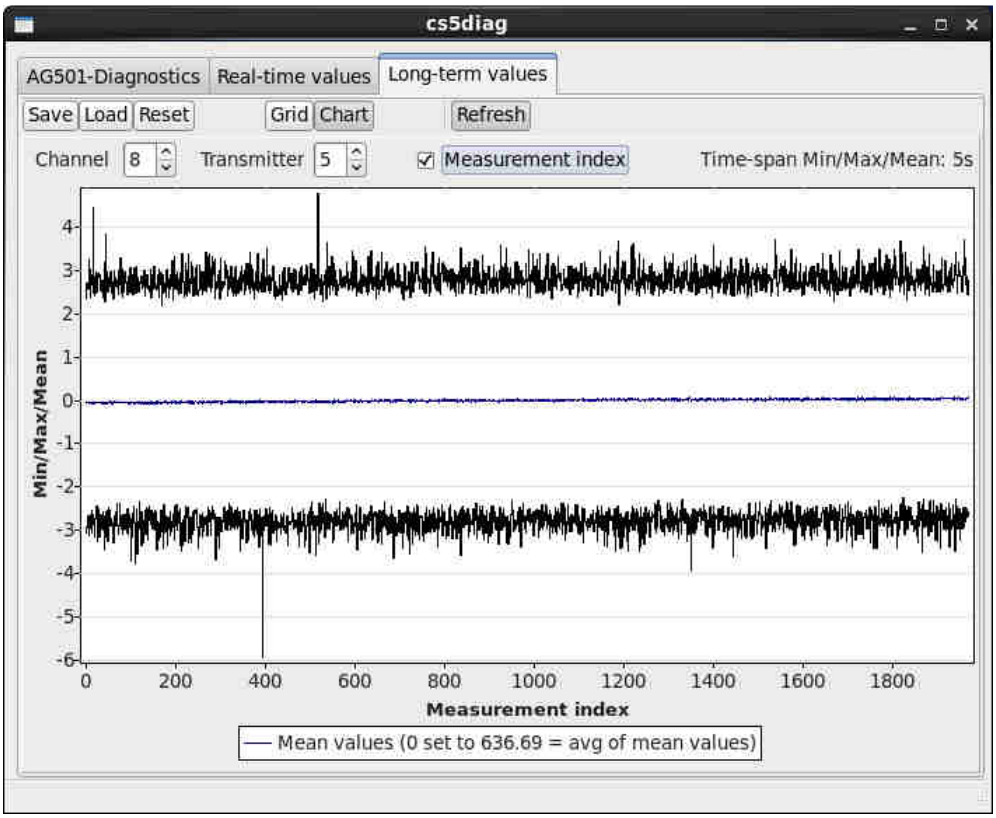


Figure 13: Long-term values - Measurement index as axis-label

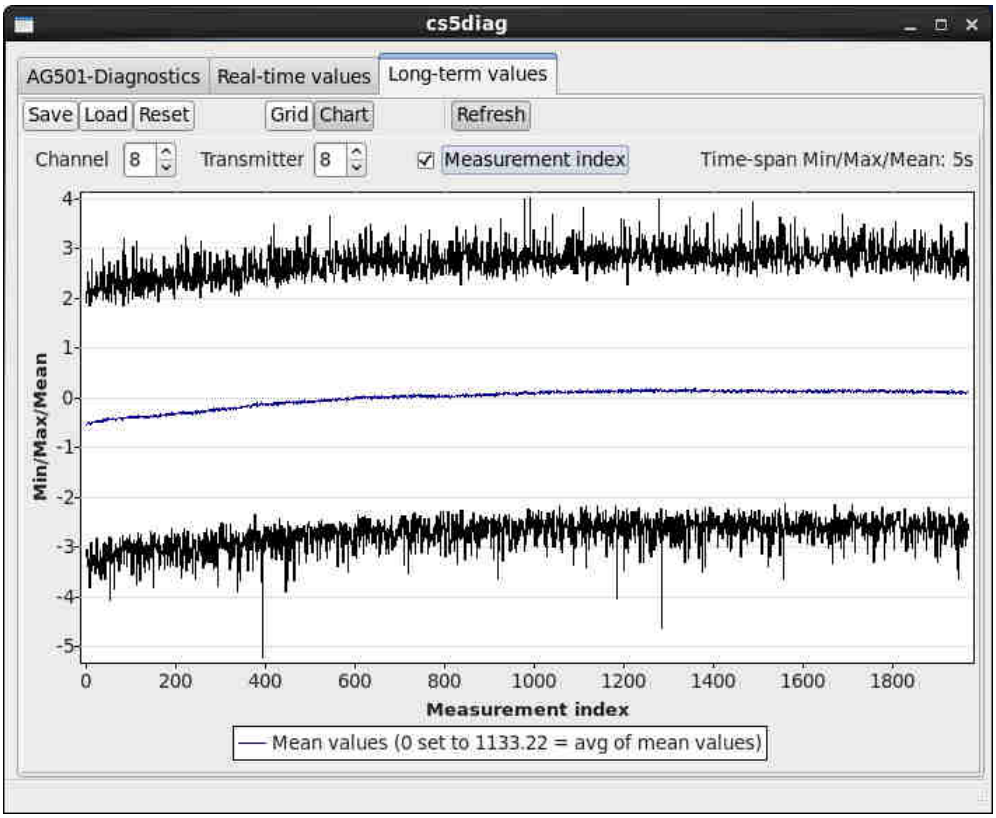


Figure 14: Long-term values – slight value shift during system warm up (0 set to 1133.22)

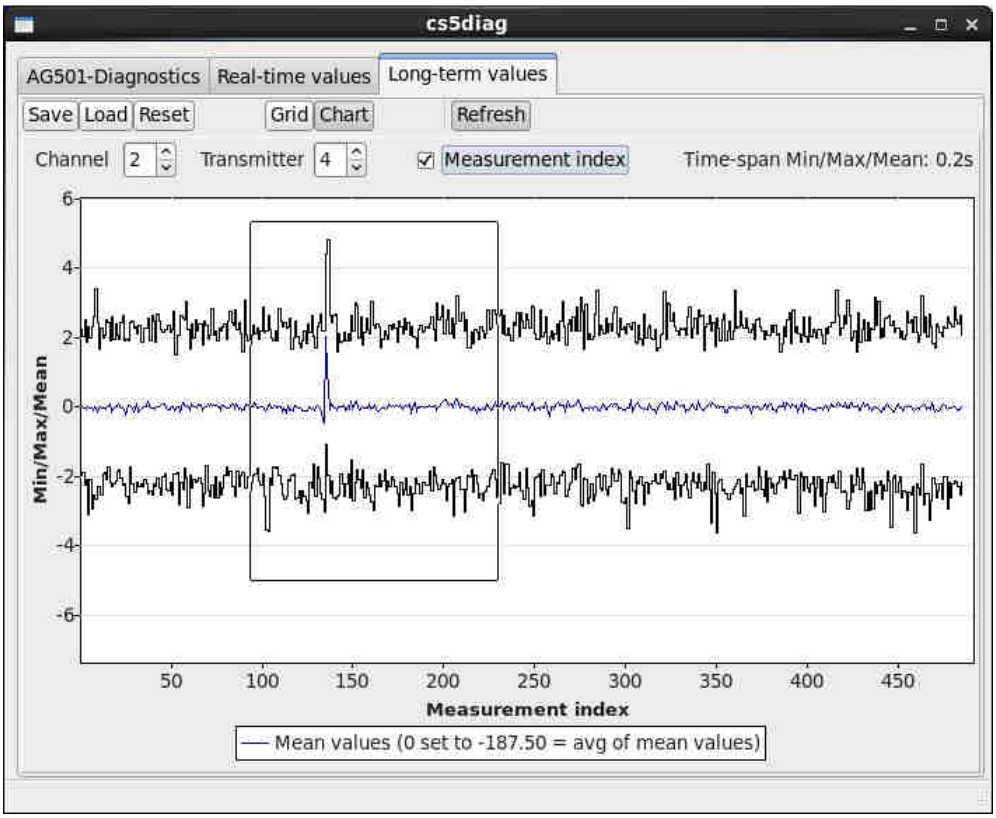


Figure 15: Long-term values - zoom in on a chart by dragging the mouse while holding the left mouse button forming a rectangle including the area to be displayed

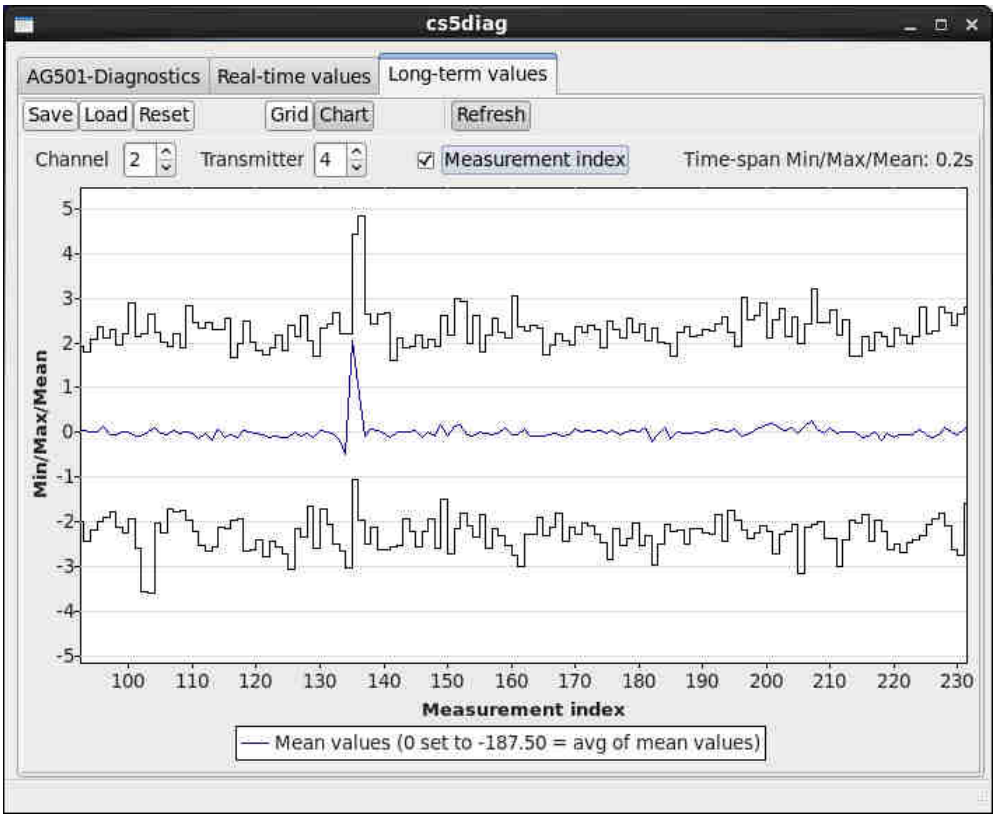


Figure 16: Long-term values - zoomed in selection of the chart

3. Saving / Loading / Resetting

a) Save

Clicking the *Save*-button (Figure 17 A) opens a file-dialog to save the long-term measurement as an agd-file (Figure 18). The default file-name proposed is the starting date and time of the long-term measurement with the agd-file-extension (i.e. `2014-01-03-153733.agd` for a long-term measurement started on January 3rd, 2014 at 03:37 and 33 seconds p.m.).
Please note: An active measurement will be stopped when saved and cannot be continued. Clicking the *Run*-button (Figure 1 B) will always start a new long-term measurement.

b) Load

Archived long-term measurements (agd-files) can be opened by clicking the *Load*-button (Figure 17 B). An *Open existing file*-dialog will guide you through the process.

c) Reset

The *Reset*-button (Figure 17 C) will reset an active, stopped or imported (loaded) long-term measurement. If the measurement time exceeds 30 minutes and the measurement has not been saved, a dialog will allow you to save the data prior to resetting (Figure 17).

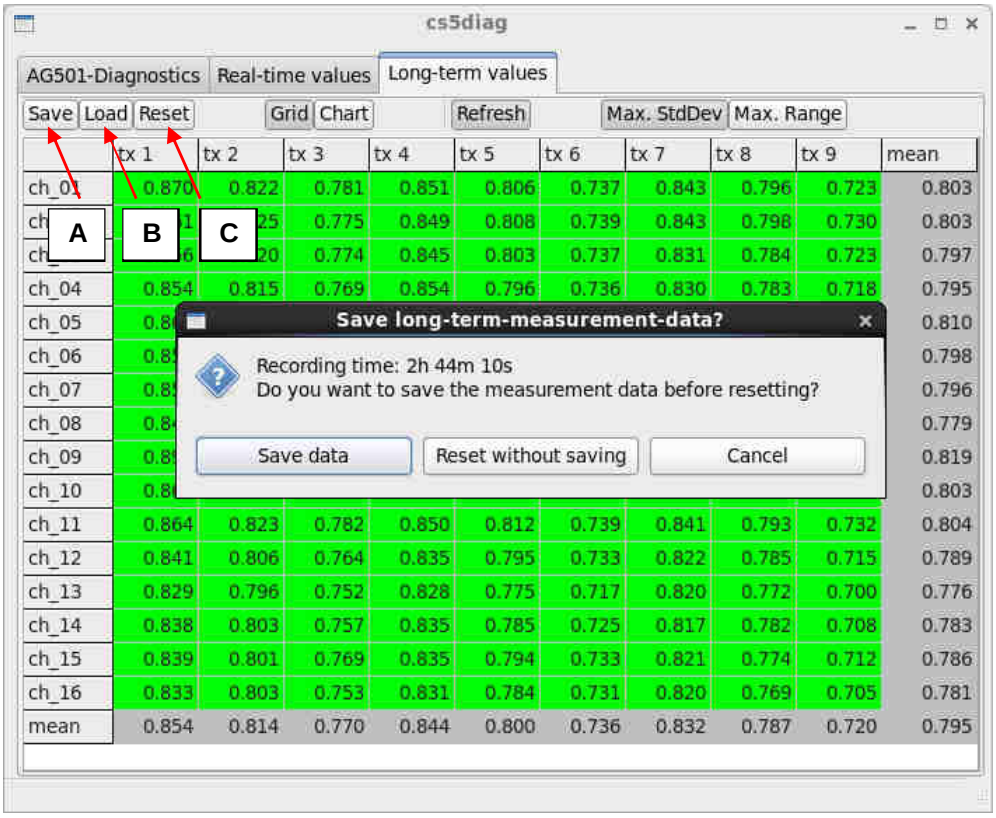


Figure 17: Resetting an unsaved long term measurement (> 30 minutes) requires confirmation

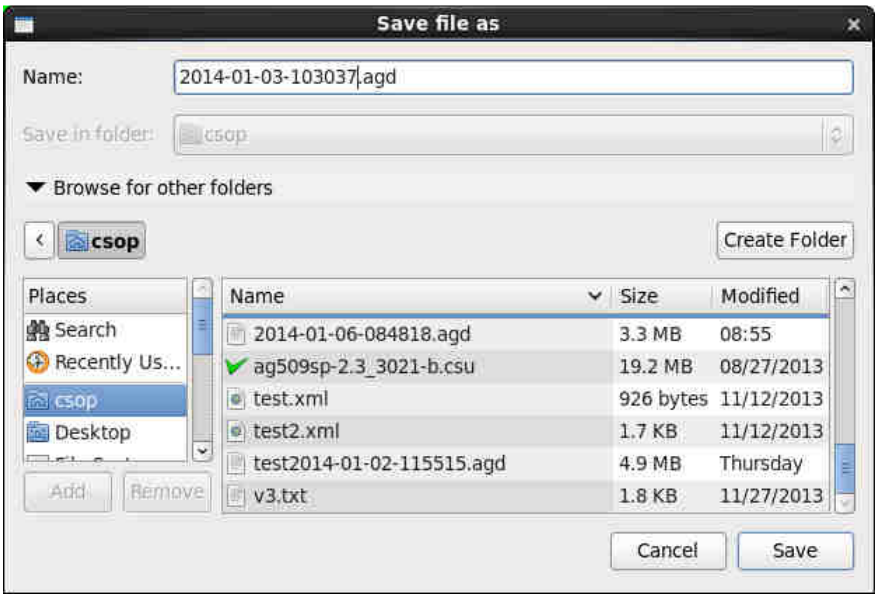


Figure 18: The *Save File As*-dialog

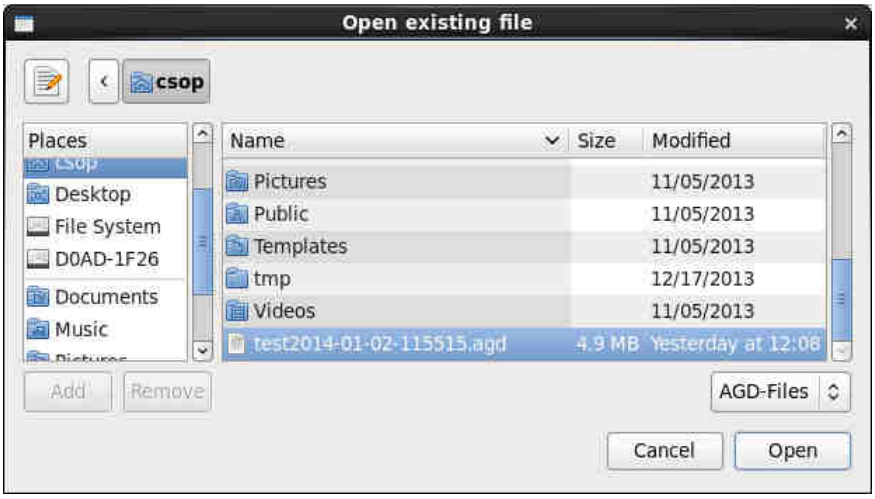


Figure 19: The *Open Existing File*-dialog

4. Cropping data to data section

The data of a terminated long-term measurement can be cropped to the data section of interest by clicking the *Crop data*-button (Figure 20 A).

This can be useful for analyzing long-term data that has been accidentally ruined by some interference (Figure 20 C) to see if the undisturbed part (Figure 20 D) shows good data or to focus on the disturbed data (Figure 20 E).

It is recommended to switch the unit of the x-axis to *measurement index* (Figure 20 B) to identify the data section of interest. In the *Crop data*-dialog (Figure 21) you can define the section of interest by selecting the range of samples you want keep.

Please note: Cropping data cannot be undone. It is highly recommended to save your original long-term measurement prior to cropping to a data section. This gives you the opportunity to always go back to the original data by loading the original file.

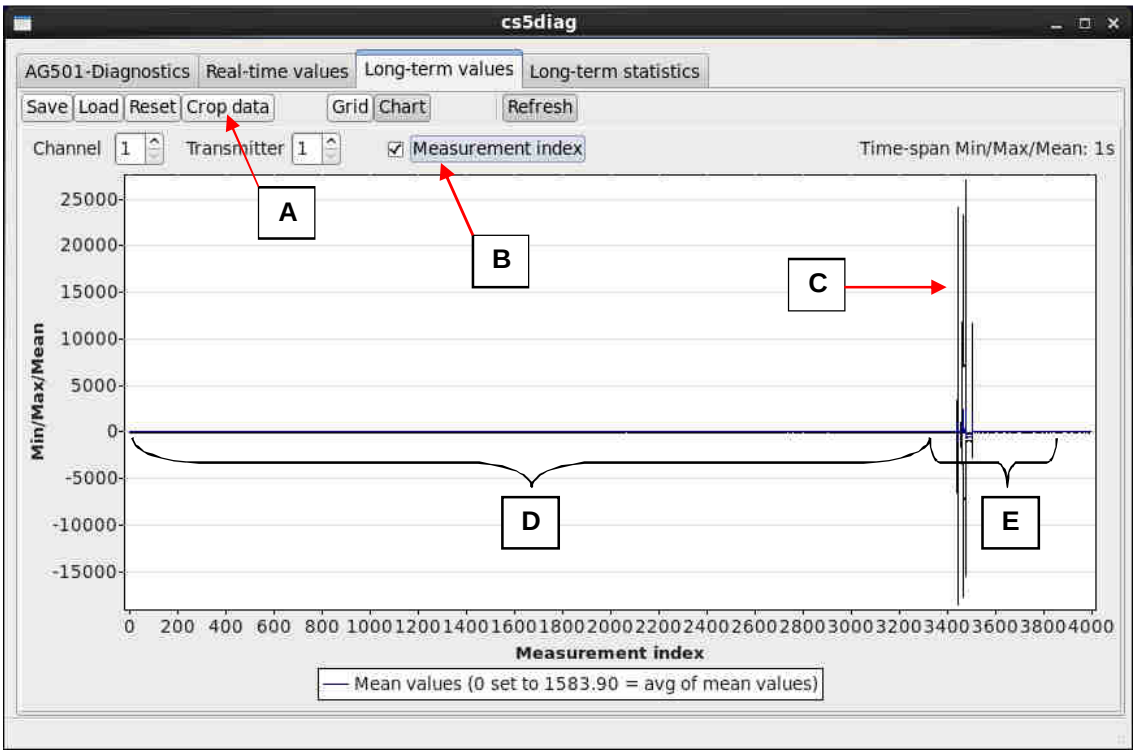


Figure 20: Cropping long-term data to a data section

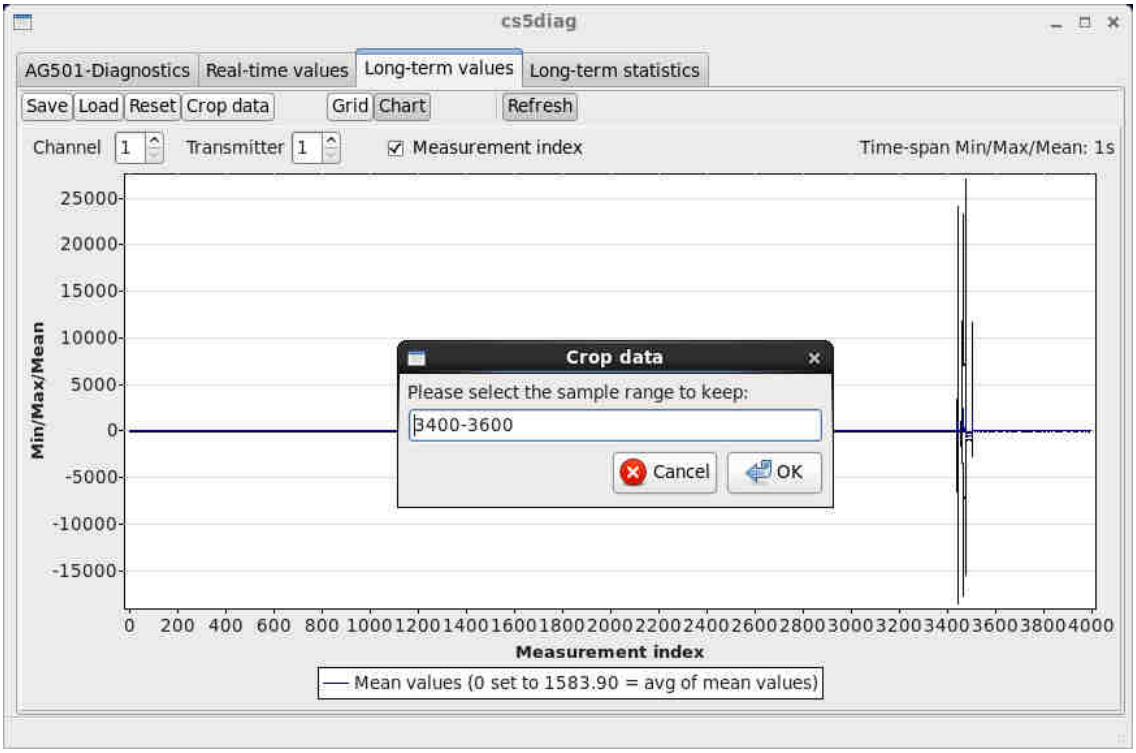


Figure 21: Selecting samples of the data section of interest

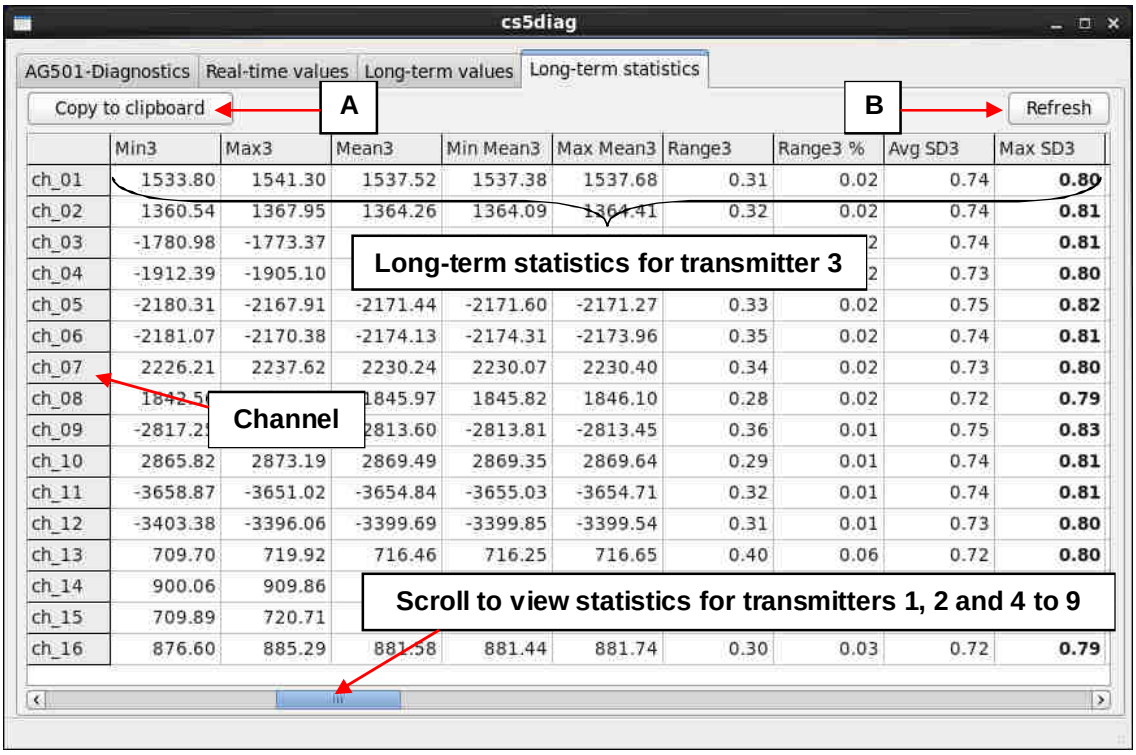
D. The Long-term statistics Tab

The Long-term statistics tab (Figure 22) contains the statistic values for the current long-term measurement for each transmitter and channel.

- MinX: the minimum value of transmitter X for the corresponding channel
- MaxX: the maximum value of transmitter X for the corresponding channel
- MeanX: the average of all measured mean values of transmitter X
- Min MeanX: the maximum of all measured mean values of transmitter X
- Max MeanX: the minimum of all measured mean values of transmitter X
- RangeX: the difference between the Max and Min Mean values
- RangeX %: the percental deviation of the RangeX from the MeanX value
- Avg SDX: the average standard deviation of all measurement intervals
- Max SDX: the maximum standard deviation of all measurement intervals

The values for the different transmitters (X) can be viewed by moving the scrollbar at the bottom of the table. During an active long-term measurement auto-refresh of the values can be toggled using the *Refresh*-button (Figure 22 B).

For further processing the statistic values can be copied to any spreadsheet program using the the *Copy to clipboard*-button (Figure 22 A).



	Min3	Max3	Mean3	Min Mean3	Max Mean3	Range3	Range3 %	Avg SD3	Max SD3
ch_01	1533.80	1541.30	1537.52	1537.38	1537.68	0.31	0.02	0.74	**0.80**
ch_02	1360.54	1367.95	1364.26	1364.09	1364.41	0.32	0.02	0.74	**0.81**
ch_03	-1780.98	-1773.37					2	0.74	**0.81**
ch_04	-1912.39	-1905.10					2	0.73	**0.80**
ch_05	-2180.31	-2167.91	-2171.44	-2171.60	-2171.27	0.33	0.02	0.75	**0.82**
ch_06	-2181.07	-2170.38	-2174.13	-2174.31	-2173.96	0.35	0.02	0.74	**0.81**
ch_07	2226.21	2237.62	2230.24	2230.07	2230.40	0.34	0.02	0.73	**0.80**
ch_08	1842.5		1845.97	1845.82	1846.10	0.28	0.02	0.72	**0.79**
ch_09	-2817.2		2813.60	-2813.81	-2813.45	0.36	0.01	0.75	**0.83**
ch_10	2865.82	2873.19	2869.49	2869.35	2869.64	0.29	0.01	0.74	**0.81**
ch_11	-3658.87	-3651.02	-3654.84	-3655.03	-3654.71	0.32	0.01	0.74	**0.81**
ch_12	-3403.38	-3396.06	-3399.69	-3399.85	-3399.54	0.31	0.01	0.73	**0.80**
ch_13	709.70	719.92	716.46	716.25	716.65	0.40	0.06	0.72	**0.80**
ch_14	900.06	909.86							
ch_15	709.89	720.71							
ch_16	876.60	885.29	881.58	881.44	881.74	0.30	0.03	0.72	**0.79**

Figure 22: The Long-term statistics Tab

III. Revision history - AG501 Diagnostics Software

Date	Revision	Annotation
January 13th, 2014	1	Ulrich Szagun
April 2nd, 2014	2	Added cropping data and long-term statistics