

USBDAQ - SOFTWARE DESCRIPTION

Introduction

This guide describes how to set up, install, and operate the USBDAQ software. To follow the information and instructions contained in this manual, you must be familiar with the operation of an IBM PC AT, or equivalent computer in the Windows XP environment. You must also be familiar with USB2AD data acquisition module, principles and requirements of your applications.

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1.0 Software Installation

Combination of Hall probes connected to the USB2AD module and USBDAQ software makes a virtual instrument for magnetic field measurements. The combination can perform like an eight channels Teslammeter programmable by the software with the advantage of flexibility of logging the data that are being measured. The supporting program USBDAQ enables comfortable selection of input ranges, numbers of inputs, storage of measured data on the disk, and so on. It offers direct control of all hardware in the USB module.

It is recommended to read the **README** file before installation, which contains latest information about the last changes. In case you own the CD version of the software, run the **SETUP.EXE** program to start the installation. Follow the installation procedure.

After successful installation the **Setup.exe** program creates the USBDAQ group with the USBDAQ icon. You can run the program by clicking its icon on the Windows **Start** menu or double clicking the icon on your desktop.

To install a new version of USBDAQ, please first uninstall the current version from your PC with the UNINSTALL program located in the USBDAQ directory.

2.0 Running the USBDAQ Program

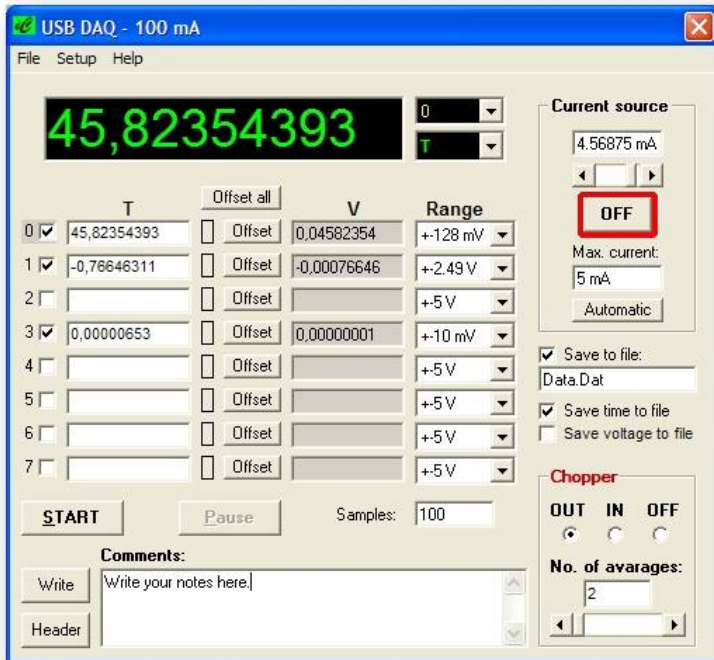
It is recommended to have connected the USB2AD module to your computer before the first time executing the USBDAQ program.

After executing the USBDAQ program will check the serial number of your USB2AD module as well as type and resolution of the current source. Then the standard configuration files **Default.Sav** and **Save.Def** are loaded and the main window appears on the screen.

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3.0 The USBDAQ Main Window

The USBDAQ utilizes the Microsoft Windows User Interface. If you are familiar with using the interface in any one of Windows software program you already know how to use the USBDAQ user interface.



All functions of the USB module can be selected from the menu either by a mouse or by cursor. The menu function can be activated by a mouse button click or by pressing **Alt** key together with a marked letter of the function (hot key). Navigation inside the menu windows is possible either by a mouse or by a hot key or a **Tab** key. Individual functions of the main window interface are described in following chapters.

Main Display

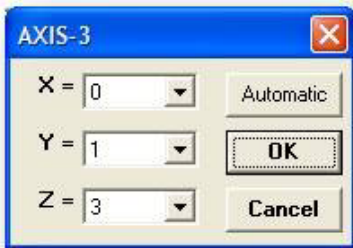
The Main Display shows measured value of the selected channel. The measured value can be displayed in *Tesla* or in *Gauss* units. The required unit must be selected in the **Unit ComboBox** before pressing the **Start** button.

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Channel number displayed on the Main display can be selected in the **Channel ComboBox**. Note, number of the selected channel must be enabled for measurement. You can select one of the channel no. **0 – 7** or the **AXIS-3**. The **AXIS-3** channel allows showing the resultant magnitude of two or three orthogonal vectors in the main display.

$$\text{Resultant_Value} = \sqrt{x^2 + y^2 + z^2}$$



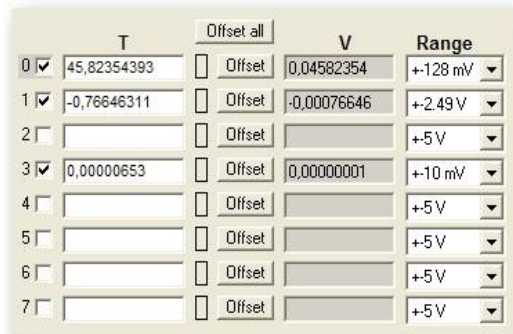
After selecting the **AXIS-3** channel a new window will be displayed. You can select channel **0 – 7** or **NONE** for each axis manually or automatically. Before automatic assigning channel numbers to XYZ axis, the **AXIS-3** type Hall probe must be selected in **Setup...Hall probe...** menu for the selected channels.

Active Channels Selection

You can use the USB2AD module to acquire data from any single analog input channel or from a range of on-board analog input channels using automatic channel scanning. These two methods of channel selection are described as follows:

- **Single channel** — check the box to specify a single channel only. All other boxes remain unchecked.
- **Multi channels** — check boxes to specify the required numbers of selected channels. The channels are sampled in order from the lower number to the last.

When the last address is reached, the multiplexer returns to the start channel and the channels are sampled again. For example, assume that the channel no. 0, 1 and 3 are selected, and you want to acquire fifty samples.



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Your program reads data first from channel 0, then from channels 1 and 3, and again will go to the channel 0. The operation will be repeated 50 times. All unselected channels are skipped. It is recommended to deselect (switch off) channels which are not connected to analogue inputs of the module. Alike, deselect all channels which will not be used for measuring. Deselected channels have shadowed color and are skipped during the USBDAQ program operation. Selected channels have checked box and show measured values in *Tesla* or *Gauss* units (it depends on the *Unit ComboBox* selection in the *Main Display*).

The magnetic field value displayed in the selected channel use measured voltage recalculated with parameters set in the **Hall Probe** window (see the **Hall probe** section). The **Offset** button provides offsetting (subtraction) the displayed value in the moment when it is pressed. The offset can be set **ON** before pressing the **START** button or during the measurement, too. When the measurement has been completed or stopped by pressing the **STOP** button, the offset is set **OFF** automatically. The button **Offset all** provides offsetting of all channels in the same time.

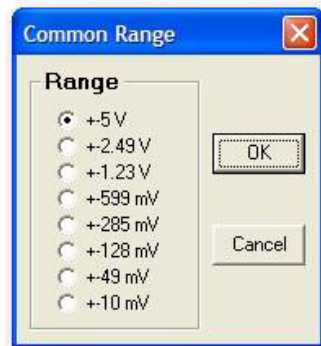
Voltage Display

It can be useful to see not only the magnetic field values but also the measured voltages corresponding to these values. Therefore, the *Voltage display* shows the measured voltage of each selected channel.

Range Selection

From the **Setup...Range...** menu can be activated one of two modes for the range selection. Selecting the **Individual ranges** menu will activate all **Range ComboBoxes** located on the *Main Display*. Now, you can select one of the eight bipolar ranges for each channel individually.

Selecting the **Common range** menu will deactivate the **Range ComboBoxes** on the *Main Display* and opens new **Common Range** window. There can be selected one of the eight ranges which will be common for all channels. For measurement in **Common range** mode you must select the range according to the highest voltage of selected channels.



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For example, if you have selected channels no. **0**, **1** and **3** in bipolar mode and maximum voltage of $Channel_0 = -0.2\text{ V}$, $Channel_1 = 0.5\text{ V}$ and $Channel_3 = 20\text{ mV}$, you must use the $\pm 599\text{ mV}$ range (or higher). For the above mentioned example in the **Individual ranges** mode you can use the $\pm 285\text{ mV}$ range for the $Channel_0$, the $\pm 599\text{ mV}$ for the $Channel_1$ and $\pm 49\text{ mV}$ for the $Channel_3$. Generally, more precise measurement will be obtained if the nearest higher range will be selected like is the maximum measured voltage. If you do not know the maximum measured voltage use the highest range of $\pm 5\text{ V}$. Start a test measurement to see the maximum voltage and then change the range to the nearest higher value.

Current Source

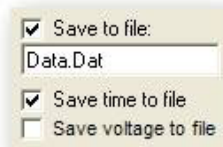
From the **Current source** window you can control the current source of the USB2AD module. The output current can be set by *horizontal slider* or you can write the required value in the *display* located above the slider. The **Max. current** display is proposed for a safe biasing of your Hall probes. Write here the maximum value of the current which can be used for Hall probes biasing. This value will limit the *horizontal slider* to set the maximum output current. You can do it automatically pressing the **Automatic** button. When you will press this button, the program will look for a lowest value of the max. current set in the **Setup... Hall probe...** menu and write it in the *Max. current* display. It is possible to switch ON/OFF the current source before as well as during the measurement. Alike the output current value can be changed during the measurement.

NOTE - to make the new value valid, you have to shortly switch OFF and ON the current source by the **ON/OFF** button. Switch ON position of the current source is marked by red color around the **ON/OFF** button.



Save to File

Checking the **Save to file** box will enable the dialog box where you can write the name of the saved file. The file will be saved in ...\\DATA subdirectory which is located in your USB2AD application directory. You can use the same file for more measurements. Next measurement will not redraw the file, but the data will be appended below the last line of the file. Should you need to have a time stamp on each row of the data file check the **Save time to file** box. Enabling the **Save voltage to file** box will save the voltage and magnetic field values abreast.



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An example shows you two rows of the data file where the **Save time to file** and **Save voltage to file** are enabled:

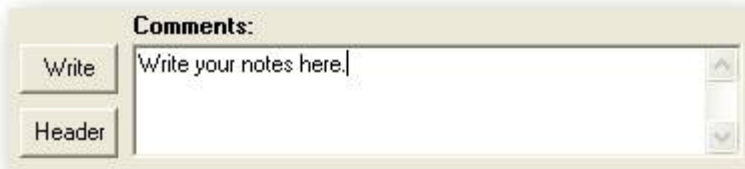
```
0.00    6.247329    0.2498932    12.24867    0.2499728
0.28    6.247329    0.2498932    12.24665    0.2499317
```

In the first column is time stamp, in the 2nd and 4th columns are magnetic field values of the *Channels_0* and *1*. In the 3rd and 5th columns are saved voltage values corresponding to these channels.

In the **Samples** box you have to write the number of samples to be acquired (and saved, respectively) after pressing the **START** button. The maximum number is 2'147'483'646 samples.

Comments

The **Comments** window allows you to write your own notes in the current data file. Type any notes in the window and press the **Write** button. Your notes will be added to the file.



Pressing the **Header** button will display header in the Comments window. Pressing the **Write** button will save the displayed header in your current data file. Header contains the following information about settings of your measurements:

- Date and time of the header creation
- Numbers of selected (active) channels
- Offset voltage and sensitivity values of the Hall probe for each channel
- Resolution
- Filter mode and its coefficient
- Output current of the current source
- Units of measured data (Tesla or Gauss)

Following section shows you an example of the header:

```
-----
9.07.2010    20:42:12
```

```
CHANNEL 0: Offset voltage:0.003 V; Sensitivity:0.049 V/T
CHANNEL 1: Offset voltage:0.002 V; Sensitivity:0.011 V/T
```

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Resolution: 22 bits [20 ms]

Filter: NO

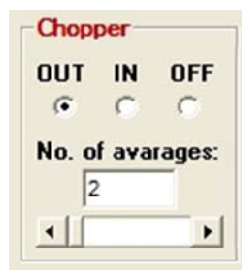
Current: 20 mA

Values in Tesla

Chopper

Chopping is a technique that can be used to cancel offset voltages errors that can arise at many points within a signal processing, e.g., the temperature dependent thermocouple voltages that arise when two dissimilar metals are joined. In the **Chopper** window can be activated output or input chopping.

- **OUT** - activates chopping of analog output. Inverter of the analog output implemented in the USB2AD module alternately switches the bias polarity of the current source to eliminate spurious offset voltages generated in entire circuit of the sensor connection.
- **IN** - activates chopping of analog inputs. The analog signal is measured, then input is inverted and signal is measured again. The offset voltage is removed by averaging of both measured voltages.
- **OFF** - deactivates chopper



Number of chopping cycles on analog input or analog output can be set by *horizontal slider* or you can write the required value (even-number) in the **No. of averages** display located above the slider. Since signal AD conversion for each phase of the chopping is performed, the total integration time is multiplied by the number of chopping cycles.

*NOTE - the **Filter** command (see p. 13) is inactive in case the **Chopper** has been activated.*

(More information about chopping on analog input and analog output can be found on pages 14—15 of the USB2AD manual.)

START/STOP Button

To start your measurements press the **Start** button. The card will acquire the number of samples set in the **Samples** window and then will be stopped automatically. The measurements can be stopped anytime manually by pressing the **STOP** button. Pressing the **Pause** button the measurement will be paused. You can continue pressing the **Continue** button or stop your measurement pressing the **STOP** button.

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4.0 Menu Description

The main menu appears with the following choices for selection:

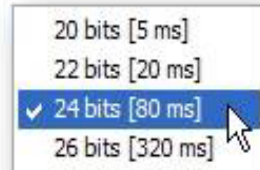


File command: **Exit** exits the USBDAQ measurement without prompt.

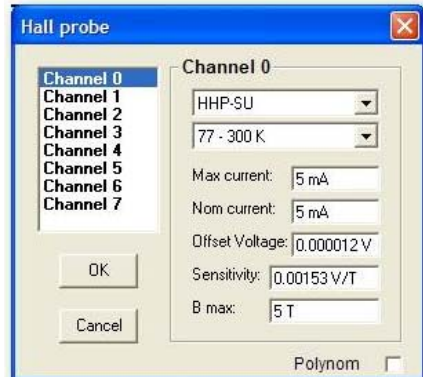
The following commands are found on the **Setup** menu:

- **Range** – opens the sub-menu for **Individual ranges** or **Common range** selection (see the **Range Selection** section)

- **Resolution** – opens the sub-menu where the resolution of the conversion can be selected in the range from 20 to 26 bits. The change of resolution is made by the change of integration time (see the table on page 13 of your USB2AD module manual). The higher resolution (longer integration time), the higher rejection of distorting alternating voltages. It means that longer integration time can be convenient even if the required resolution is not so high. Note, that unique conversion time is effective for each selected channel. Therefore, the total conversion time must be multiplied by number of selected channels in the **Main window** (see the **Active Channels** section).



- **Hall probe...** - this command opens a new **Hall probe** window where you can assign and set Hall probe parameters for each channel. Highlight the channel number in the left window where your Hall probe is connected. Once the channel is highlighted the title of the right window will be redrawn by the same channel number. Now, you can choose appropriate model of the Hall probe from the scrollbar menu. All standard Hall probes are available from AREPOC production. Once the Hall probe is selected the **Maximum current**, **Nominal current** and **B_{max}** values are set automatically.



Selecting the **Other...** command in the scrollbar menu allows to set parameters of a Hall probe (or similar device) from other suppliers. The **None** command in the Hall probe scrollbar menu will disable the selected channel in the **Main window**.

In the **Temperature** scrollbar menu (located under the Hall probe scrollbar menu) choose the temperature of the Hall probe during measurement. If you will measure in a changing temperature environment select the nearest temperature range of your measurement.

The **Maximum current** display shows the maximum current of the selected Hall probe according to its electrical specifications. The value is assigned automatically. It's possible to change the maximum current value manually. If a higher value than assigned will be used you will be prompted to adjust (restore) this value. Press **NO** to keep the new higher value or press **YES** to adjust the value automatically. *NOTE - the higher value of the maximum current can damage the Hall probe!*

The **Nominal current** display shows the nominal current of the selected Hall probe according to its electrical specifications. The value is assigned automatically and has informative character only. If you use different value of the nominal current you can retype it manually.

In the **Offset voltage** display enter the value supplied with the Hall probe's electrical specifications. This value will be subtracted from the measured input voltage. It is also possible to use the following procedure to set more precise the offset voltage:

1. Set the offset voltage to 0 V
2. Set the sensitivity to 1 V/T
3. Press OK and set the current source to 0 mA (switch OFF)
4. Switch ON the selected channel only and press START and STOP button.
5. Read the voltage value in the *Voltage display* and set the nearest *range* for the measured voltage.
6. Press START and STOP button again.
7. Select the measured voltage value in the *Voltage display* and copy the value to clipboard <Ctrl-C>.
8. Go to the *Hall probe* window; select the channel number and past <Ctrl-V> the value from clipboard to the *Offset Voltage* display.

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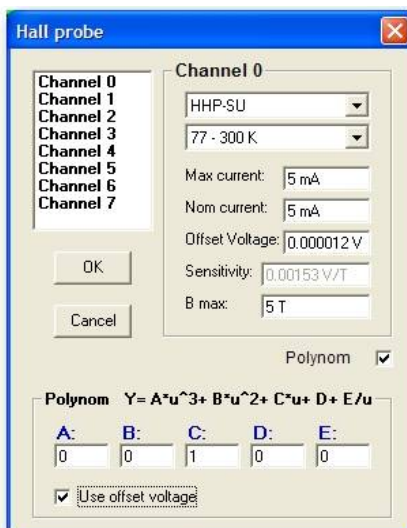
In the **Sensitivity** display enter the value supplied with the Hall probe electrical specifications. This value will be used for magnetic field calculations.

The **B_{max}** display shows you the maximum magnetic field measured by your Hall probe. The value is assigned automatically. It can be modified manually – just enter a new value of maximum magnetic field applied during your measurement.

Checking the **Polynom** check box will change the appearance of the Hall probe window. If the **Use offset voltage** check box is checked the **Sensitivity** display become disabled and the **Polynom** window will be enabled. Formula of the polynomial function is:

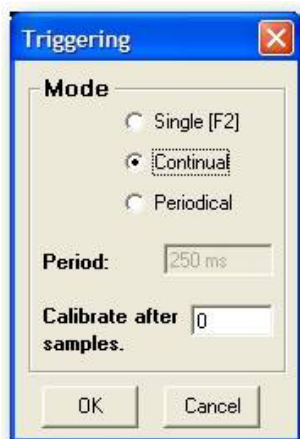
$$Y = Au^3 + Bu^2 + Cu + D + \frac{E}{u}$$

where A , B , C , D and E are regression parameters and u represents the measured voltage value subtracted by offset voltage ($u = U_H - U_{offset}$). If the **Use offset voltage** check box is not checked the **Offset Voltage** display become disabled. Then the u parameter represents the measured voltage value ($u = U_H$) only. The polynomial function can be used for custom re-calculation of the measured voltage value. For example, for calibrated Hall probes you can make a polynomial function from your calibration data and attach values to the appropriate parameters. A reciprocal value of *Sensitivity* (1/mV/T) should be assigned to the C coefficient. To disable the polynomial function, just uncheck the **Polynom** check box.



- Triggering** – this command opens new window where you can set the data transfer modes from the USB module to computer. When you will press the **Start** button (or <F2> key) in a **Single** mode operation the data acquisition module acquires a single sample from each selected channel.

In the **Continual** mode the USB module acquires one or more samples from selected channels. The number of acquired samples must be selected in the **Samples** box of the *Main window* (see **Save to file** section). Reading time interval depends on selected conversion rate and number of selected channels.



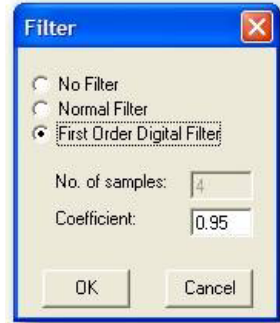
The USB2AD module has factory preset voltage constants of all voltage ranges which are used for internal calibration of the A/D converter. This is suitable for a long term measurements when a voltage drift caused by changing temperature inside the USB module will occur. **Calibrate after xxx samples** means internal calibration of the A/D converter after number of selected samples. The zero input voltage and the internal calibration voltage are measured and the correcting constants are calculated from both values. By this way the error of the zero drift and the gain are suppressed.

Write a number of samples into the box after the internal calibration will be provided. The range of measured samples can be set to 0 – 999 999 999 samples. The default value for the internal calibration is 0.

Interval between conversions in **Periodical** mode can be set in range of 1 ms to 9 000 ms (by step of 1 ms). The real time is derived from onboard timer on the USB module. The selected period must be higher than the total conversion time of all selected channels at given resolution. For example, if you have selected *Channel_0* and *1*, the resolution is set to 24 bits (integration time 80 ms) and conversion time of your PC is 10 ms, the period must be set higher as $2 \times 90 = 180$ ms.

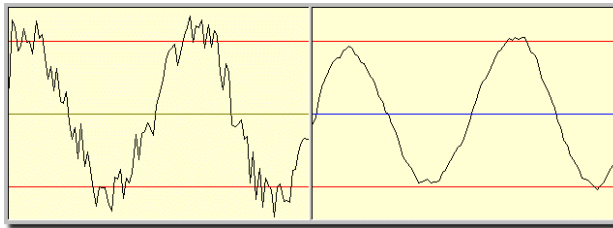
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- **Filter** – this command makes possible additional filtration of measured values. If the option **Normal filter** is active, the number of samples for the average calculation can be selected. The average value from the number of selected samples is calculated and displayed. It results in additional suppression of distorting signals but also in slowing down of measurement. This option should be used when even the longest integration time is insufficient.

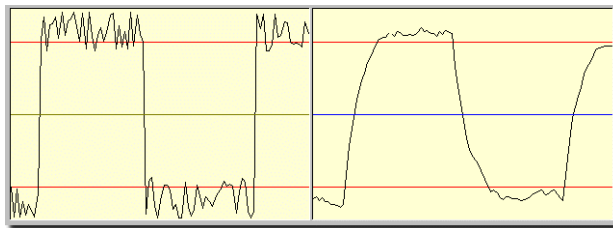


The **First Order Digital Filter** option allows you to use more rapid filtering of your measured data like the **Normal filter**. Coefficient of the digital filter can be set in the range of 0 – 0.99. The higher coefficient's number the higher filtering efficiency and higher signal distortion.

For example the following pictures show both the unfiltered and filtered sinus, rectangle and noise signals:

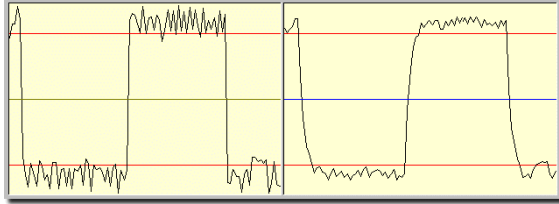


Unfiltered and filtered sinus signal using 0.82 coefficient

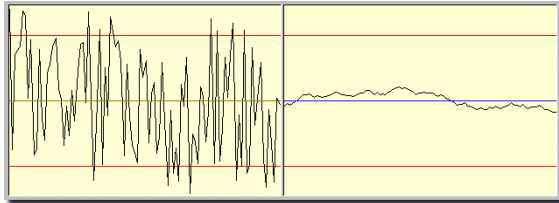


Unfiltered and filtered rectangle signal using 0.82 coefficient

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Unfiltered and filtered rectangle signal using 0.58 coefficient



Unfiltered and filtered noise signal using 0.97 coefficient

Disadvantage of the simple digital filter (when a higher filter coefficient is selected) is the signal distortion. Therefore, it is recommended to use lower filter coefficient for rapidly changing signals (e.g. rectangle characteristics) and higher coefficient for a stable noise signal. Make your own experiment with various filter coefficients and plot measured characteristics to see the influence of the coefficient on the signal distortion.

*NOTE - to activate the **Filter** command, **Chopper** must be set **OFF!***

- **Save settings now...** command allows you to save settings of the current session so you can return to the same settings in a future USBDAQ session choosing the **Load settings...** command.
- Check the **Save settings on Exit...** command if you would like to save settings of the current session when exiting the program. The session will be saved to the currently opened [*.Sav] file.

The following is a list of the **Help** command:

- **Help topic...** this command opens this help file.
- **AREPOC on the Web...** link to the Arepoc's web site.
- **About...** information window about the USBDAQ program version, serial number of your USB2AD module and e-mail address of the Arepoc's technical support.

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