Chart V5.0.6

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Strathclyde Electrophysiology Software

Chart V5.0.6

Digital Chart Recorder Software

Introduction

Chart is a digital chart recorder program for making recordings of analogue signals from physiological experiments. It emulates many of the properties of the conventional paper chart recorder but stores the results in digitised form in computer memory.

Chart's main features are :

- Records from up to 8 analogue input channels
- Continuous recording with signal traces displayed on screen and stored on data file.
- Measurement of signal traces using mouse.
- Printing of hard copies of stored recordings on printers.
- Built-in stimulator for producing groups of stimulus pulses during the recording.
- Control of CED 1902 programmable amplifier.
- Computation of heart rate from ECG and RMS from EMG.

Signal connections

In order to record signals from an experiment you will need:

1. A **transducer** to convert the physiological signal into a voltage signal.

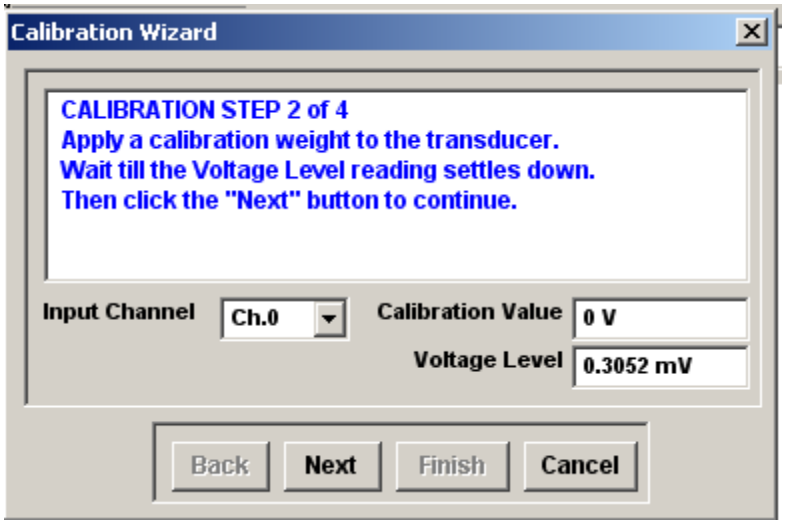
2. An **amplifier** to magnify this signal so that it is big enough to be measured accurately.

Chart supports a variety of different transducers and two types of amplifier (CED 1902, Intracel TSA1). The output of the amplifier is fed into the laboratory interface unit via one of 4 BNC connectors (ADC0, ADC1, ADC2, ADC3) on the Input/Output box.

1. Connect the transducer (or electrode leads if making an electrical recording) to the amplifier.
2. Connect the output of the amplifier to Input ADC0 of the I/O box.
3. If not already connected, connect the ribbon cable of the I/O box to the 50 way signal connector on the A/D converter card installed in the computer.
4. If you plan to record from more than one channel, connect the transducers and amplifiers for the additional channels as in steps (1)..(3). (For 2 channels use ADC0, ADC1, 3 channels - ADC0, ADC1, ADC2; 4 channels - ADC0, ADC1, ADC2; ADC3)

Calibrating Signal Channels

Select **Calibrate** to calibrate a Chart recording using Chart's "Calibration Wizard".



Calibration is a four step process for each analogue channel within the signal record. Each stage is guided by instructions from the "wizard".

1. Select the channel to be calibrated by selecting one from the **Channels** list box. (If there is only one channel this stage is omitted). Then click the **Next** button to go to the next stage. Note that you can go back to repeat a previous stage using the **Back** button.)
2. Apply the calibration signal to the input of the selected channel. (The nature of this signal depends on the transducer attached to the channel. A typical example is a 1 gram weight attached to a tension transducer). Once the signal has settle down (as indicated by the **Voltage Level** display) click the **Next** button to continue.
3. Remove the calibration signal. Wait till the signal settles down. Then click the **Next** button. (This stage is used to determine the signal zero level.)
4. Enter the magnitude of the calibration signal into the **Calibration Value** box. Then click **Finish**.

This process should be repeated for each channel that needs to be calibrated.

Making a recording

1. Open a new data file to hold your recording session, by selecting **New File** from the **File..** menu. (Note. If you want to append data to the end of an existing file, using the **Open File..** command.)
2. If you need change the number of input channels being recorded, sampling rate or other recording setting, select **Recording..**. from the **Setup** menu.
3. Select a suitable duration for the chart display window by entering a time in the **Window Size** box.
4. Click on the **Record** button to begin recording signals.
5. Click on the **Stop** button to stop recording.

Displaying recorded signals

When Chart is not recording you can view the signals stored in the data file using the display controls. By changing the duration of the display window you can obtain either a compressed view of the whole recording in the file or alternatively magnify a small section.

The width (period of time displayed) of the display window can be adjusted by entering a value into the **Window Size** box and pressing the return key.

The location of the display window within the recording can be set using the scroll bar at the bottom of the chart display, or by entering a starting time into the **Start Time** box.

Making measurements

Measurements can be made from the display signals by placing the vertical readout cursor over the point on the signal to be read out. Measurements appear in the display readout box.

Measurements table

Series of measurements can be accumulated in Chart's measurements table and then transferred to other programs via the Windows clipboard.

The currently displayed cursor measurements is saved into the table by clicking the **Add to Table** button.

The measurements table can be displayed by clicking the **Show Table** button.

Clicking the **Copy Table** button copies the measurements to the Windows clipboard. The table can be cleared of data by clicking the **Clear Table** button.

Zero levels

Amplitude measurements are made relative to preset zero levels for each channel in the record. These are indicated by red horizontal dashed lines. To change the position of these levels :

1. Move the mouse cursor over them until the icon changes to Up/Down arrows.
2. Press and hold down the **left** mouse button.
3. Then drag the cursor up or down.

Time measurements are made relative to a zero time cursor, indicated by a vertical cursor with the letters "t=0" at the bottom. This cursor is initially set at the start of the recording. To move the zero time cursor :

1. Move the mouse cursor over them until the icon changes to Left/Right arrows.
2. Press and hold down the **left** mouse button.
3. Then drag the cursor left or right.

(Note. If the t=0 cursor is off- screen, click the **Fetch t=0 Cursor** button to bring it on to the display.)

Heart Rate

Chart's heart rate processor computes the beat-by-beat heart rate from an electrocardiogram (ECG) signal in real time and stores it in another channel along with the ECG.

To enable heart rate processing :

1. Configure Chart to have two inputs channels - one will be used to record the ECG, the other to store the heart rate. (Recording.. (Setup))
2. Make the appropriate connections to record an ECG signal on input channel ADC0. Set the units of Ch.0 to "mV" and the appropriate amplifier gain factors in the channel settings table as used by your amplifier.
3. Enable and configure the heart rate function using Computed channels.. (Setup)
4. Select **Ch.0** as the **Get From** Channel and **Ch.1** as the **Store In** channel.
5. The largest component of the ECG waveform is the R-Wave. Chart uses this as a reference point to detect heart beats. Set the **R-Wave detection threshold** to about 25-50% of the peak amplitude of the R-Wave. (Values should be around 0.5-1.0 mV)
6. Set the **Max H.R. Scale** value to define the upper limit of the computed heart rate range. (Default is 200.).
7. Check the **In Use** box to activate the heart rate function.

RMS (Root mean square EMG)

Chart's RMS function computes the averaged root mean square of an electromyogram (EMG) signal in real time and stores it in another channel. The averaged RMS provides a signal whose amplitude is proportional to the amount of muscular activity.

To enable the RMS function:

1. Configure Chart to have two inputs channels - one will be used to record the EMG, the other to store the RMS signal (Recording.. (Setup))
2. Make the appropriate connections to record an EMG signal on input channel ADC0. Set the units of Ch.0 to "mV" and the appropriate amplifier gain factors in the channel settings table as used by your amplifier.
3. Enable and configure the RMS function using Computed channels.. (Setup)
4. Select **Ch.0** as the **Get From** Channel and **Ch.1** as the **Store In** channel.
5. Set the number of sample points to be used in computing the running average of the RMS signal. The larger the number of points the smoother the signal. (The default is 10 and the maximum is 100).
6. Check the **In Use** box to activate the RMS function.

Main Menu > **File** > **New File..**

Select **New file..** from the **File** menu to create an empty Chart data file for storing digitised recordings. Chart data files have the file extension <*.cht*>.

The name of the file, disk drive, and the directory into which the file is to be placed can be specified by selecting from the appropriate list in the New File dialog box.

Main Menu > **File** > **Open File..**

Select **Open File..** from the **File** menu to open a previously created Chart data file allowing the recording within it to be viewed.

Select the desired file from the list of names presented in the dialog box, by clicking on it, then clicking the **OK** button.

You can select other directories or disk drives using the **Drives** and **Directories** list boxes .

(Note. Chart data files are signified by the file extension ".CHT".)

Main Menu > **File** > **Save File**

Select **Save File..** from the **File** menu to update the currently open data file with any changes made after recording.

Main Menu > **File** > **Save File As**

Select **Save File..** from the **File** menu to make a copy of the currently open Chart data file in another file or folder.

Select the desired file from the list of names presented in the dialog box, by clicking on it, then clicking the **OK** button. You can select other directories or disk drives using the **Drives** and **Directories** list boxes .

Main Menu > **File** > **Save to Tab-text File..**

Select **Save to Tab-Text File..** from the **File** menu to save the recorded signals in the currently open Chart data file to a tab-text format file which can be imported into Microsoft Excel or other graph plotting software or spreadsheet software.

Select the desired file from the list of names presented in the dialog box, by clicking on it, then clicking the **OK** button. You can select other directories or disk drives using the **Drives** and **Directories** list boxes .

Main Menu > **File** > **Load Settings..**

Select **Load Settings..** from the **File** menu to load the a previously saved set of amplifier and recording settings into Chart.

Main Menu > **File** > **Save Settings..**

Select **Save Settings..** from the **File** menu to save the current set of Chart amplifier and recording settings to a (*.set) settings file.

Main Menu > **File** > **Print..**

Select **Print..** from the **File** menu to print out the signals currently displayed on the Chart screen.

Calibration bars

Calibration bars are added adjacent to the plotted traces indicating the magnitude and units of the signal level for each channel, and time. The bars are initially set to 10% of the displayed range. You can alter the size of these bars by entering new values in the **Calibration Bars** table. Note that if a bar value is set to zero (or a blank entry), the bar is not displayed.

Page Size and Typeface

The size of the printing area on the page can be specified by setting the Page Margins (**Left, Right Top, Bottom**).

The type face and size of the text used to label the plot can be set using **Font Name** and **Font Size**.

The **Line Thickness** box sets the thickness of the lines used to draw the traces.

The **Show Zero Levels** check box determines whether the signal zero levels are indicated by horizontal dotted lines (on by default).

Print Range

Select **Window** to print out the part of the recording currently displayed in the chart window on the screen. Select **Whole File** to print out the complete recording stored in the file on a series of pages.

Once the desired settings have been made, select **Print** to output the recording to the printer.

Main Menu > File > Print Setup..

Select Print **Print setup..** from the **File** menu to select the printer to be used to be used and to change the size and orientation of the printed page.

Orientation: Portrait vs. Landscape

In **Portrait** orientation the traces are printed upright as is normal on a page of text. In **Landscape** mode the printed records are rotated 90 degrees before being printed on the page.

Paper Size and Source

Indicates the type of paper in the selected printer and means by which it is being fed into the printer. Note that the options available here depend on the type of printer, its features, and the size of paper loaded into it.

WARNING: If these settings do not match the actual paper size and configuration of the printer unpredictable results may occur when printing.

Options.

Clicking the Options button allows to you change details aspects of the operation of your printer. Changing these from their default settings may have unpredictable results. Consult the documentation with your printer if you need to make changes.

Main Menu > **File** > **Exit**

Select **Exit** from the **File** menu to stop the Chart program.

Main Menu > **Edit** > **Copy data**

Select **Copy data..** from the **Edit** menu to copy the sample data points of the signal currently on Chart's display screen to the Windows clipboard. The data is copied as a table of times and values for each sample within the digitised record.

Main Menu > **Edit** > **Copy Image..**

Select **Copy Image..** from the **Edit** menu to open the Copy Image dialog box and copy an image of the displayed signal to the Windows clipboard. Images can be pasted in Microsoft Word, other word processors or drawing programs.

Main Menu > **Edit** > **Edit Markers..**

Select **Edit Markers..** from the **Edit** menu to open the Edit Markers dialog box, allowing the chart annotation markers to be changed or deleted.

Main Menu > **View** > **Zoom in**

Select **Zoom in..** from the **View** menu to increase the vertical magnification of the displayed region of a selected signal channel.

Main Menu > **View** > **New Item**

Select **Zoom out..** from the **View** menu to decrease the vertical magnification of the displayed region of a selected signal channel.

Main Menu > **View** > **Zoom out (All)**

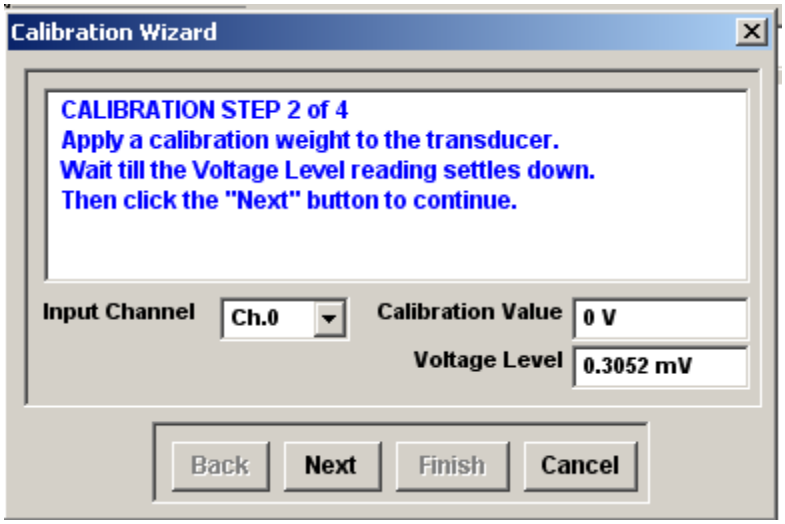
Select **Zoom out (all)** from the **View** menu to restore the vertical magnification of the displayed region of each data channel to its minimum settings.

Main Menu > **View** > **Show Grid**

Select **Show Grid** from the **View** menu to turn on or off grid lines on the chart display.

Calibrating Signal Channels

Select **Calibrate** to calibrate a Chart recording using Chart's "Calibration Wizard".



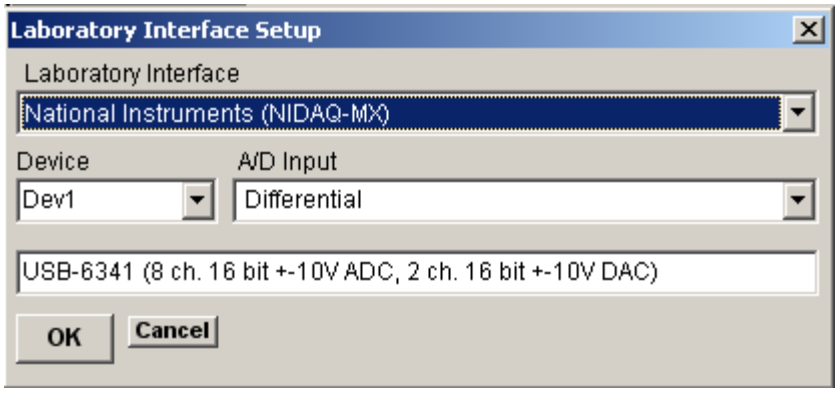
Calibration is a four step process for each analogue channel within the signal record. Each stage is guided by instructions from the "wizard".

1. Select the channel to be calibrated by selecting one from the **Channels** list box. (If there is only one channel this stage is omitted). Then click the **Next** button to go to the next stage. Note that you can go back to repeat a previous stage using the **Back** button.)
2. Apply the calibration signal to the input of the selected channel. (The nature of this signal depends on the transducer attached to the channel. A typical example is a 1 gram weight attached to a tension transducer). Once the signal has settle down (as indicated by the **Voltage Level** display) click the **Next** button to continue.
3. Remove the calibration signal. Wait till the signal settles down. Then click the **Next** button. (This stage is used to determine the signal zero level.)
4. Enter the magnitude of the calibration signal into the **Calibration Value** box. Then click **Finish**.

This process should be repeated for each channel that needs to be calibrated.

Main Menu > Setup > Laboratory Interface

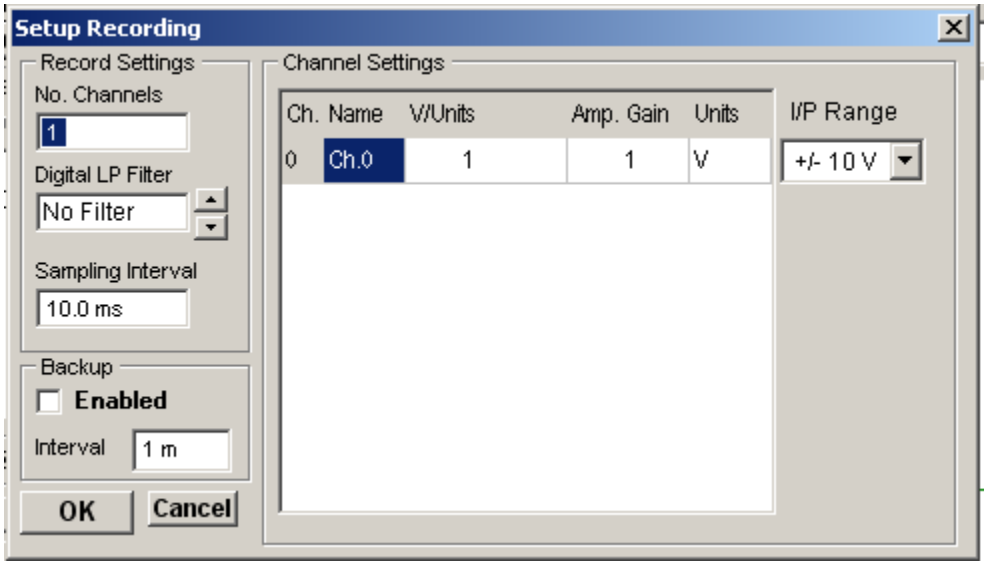
Select **Laboratory Interface..** from the **Setup** menu to select and/or configure the laboratory interface unit used by Chart to digitise analog signals.



1. Select the type of laboratory interface unit in use from the **Laboratory Interface** list.
2. If there is more than one device available, select the device number from the **Device** list.
3. Select the analog input mode from **A/D Input** list.

Main Menu > Setup > Recording..

Select **Recording..** from the **Setup** menu to set up the input channels, scaling factors and sampling rate.



Record Settings

No. Channels

Sets the number of input channels to be recorded, up to a maximum of 4.

Sampling Interval

Sets the time interval (msecs) between samples for each channel (The minumum interval is 1 x No. of Channels msecs.) The sampling interval should be chosen to ensure that there are a sufficient number of samples taken to allows accurate measurement of the fastest changing part of the signals being studied. (A sampling interval of 10 msec is usually sufficient for most purposes).

Digital LP Filter

Chart has a low pass digital filter algorithm which can be used to smooth the the stored recordings. The cut-off frequency (Hz) can be set using this entry. The lower the cut-off frequency the greater the smoothing.

Back-up

If the backup **Enabled** option is ticked, CHART makes a back-up copy (same name as the data file but with a .BAK file extension) of the data file at intervals defined by the **Interval** setting during recording. (Note. Use of this option is advisable when very long duration recordings (e.g. hours) are being acquired)

Channel Settings Table

The channel settings table indicates the input channels which are in use and defines the names, units, amplification and scaling factors for each channel.

Ch. : The I/O panel **channel number** (0, 1, 2, 3.).

Name : The **channel name**. which is displayed along side each trace on the screen and on hard copies.

Names can be up to 4 letters.

Volts / Unit : The channel **calibration factor (Volts per Unit)** which scales the signal from volts to the units defined below.

Amp. Gain : The **gain factor** for any external amplifier that might be used to amplify the transducer signal before it is digitised.

Units : The physical **units** of the signal being measured by the transducer. (E.g. in the case of muscle tension units this might be grams). The units names can have up to 4 letters.

I/P Range

Sets the input voltage range of the A/D converter for each signal channel. (Ranging over a 100-fold from 5V to 50mV.)

Notes.

(a) The default table settings are to display signals in terms of millivolts (mV) with no amplification (i.e. an amplifier gain of X1). The calibration factor is thus set to 0.001 (i.e. 0.001 Volts / mV)

(b) The Calibrate menu option sets the calibration factor column automatically, calculating it from the measured calibration signal and the calibration value entered at that stage. If you alter the value in that column you will have to re-calibrate.

Main Menu > Setup > CED 1902 Amplifier..

Select **CED 1902 Amplifier..** from the **Setup** menu to set the amplifier inputs, gain, low and high pass filters.

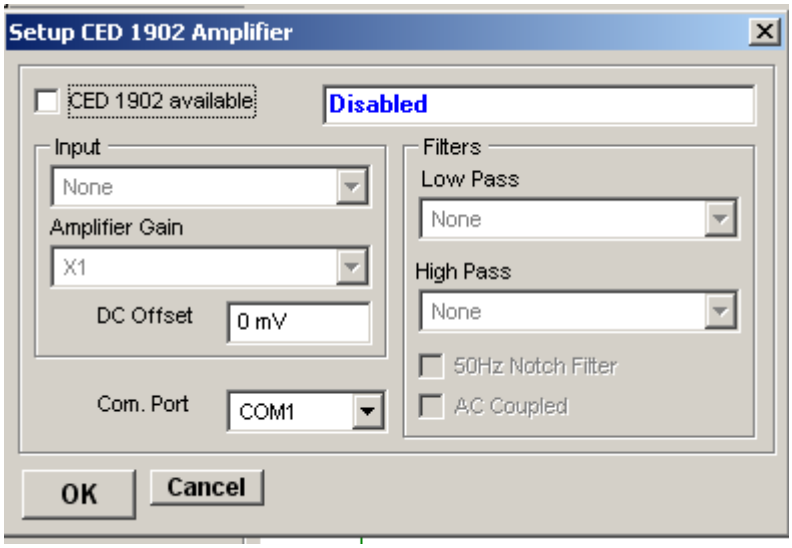


Chart supports the use of the Cambridge Electronic Design 1902 programmable amplifier. If you have this amplifier attached to your computer you can control its inputs, gain and filter settings from within the Chart program. The CED 1902 output should always be attached to analog input channel 0 and may be controlled via either the computer's COM1 or COM2 serial port.

CED 1902 Available

Indicates whether the CED 1902 is in use. If you do not have a CED 1902 (or if you do not want to use it) un-check this box.

Input

The **Electrodes** input is an electrically isolated differential amplifier input used to record ECG, EMG and similar signals. Isolation makes it safe to attach recording leads to human subjects.

The **Transducer** input is a differential amplifier input used to record from transducers such as force and pressure transducers. It is not isolated.

The following input modes can be selected :

Grounded. The input is connected to ground, i.e. there is no signal.

Single Ended The transducer input in singled ended (i.e. non-differential mode).

Normal Diff. The Transducer input in differential amplifier mode.

Inverted Diff. The transducer input in differential mode with the signal inverted.

Grounded EEG The input is connected to ground, i.e. there is no signal.

Isolated EEG The electrically isolated differential input.

Note. **Normal Diff.** mode is used when recording from a force or pressure transducer and **Electrodes** used when making EMG, ECG recordings. When using non-standard transducer consult your experimental notes.

Amplifier Gain

Sets the gain of the CED 1902 amplifier. The range of gain settings depends on which input is in use. When using the Transducer input there are 11 gain settings **(X1, X3, X10, X30, X100, X300, X1000, X3000, X10000, X30000, X10000).** When using the Electrodes input **(X1000, X3000, X10000, X30000, X100000, X300000, X1000000, X3000000, X10000000, X30000000, X10000000).**

Note. When the CED 1902 is in use, the gain setting is automatically entered into the Amp. Gain column of analog input channel 0 in the Channel Settings table .

Low Pass Filter

Sets the cut-off frequency of the CED 1902's built-in low pass filter. The filter can be set to **None** (out of use), **1000Hz, 500Hz, 100Hz**. The low pass filter removes signal frequencies signal higher than the cut-off, smoothing the signal.

High Pass Filter

Sets the cut-off frequency of the CED 1902's built-in high pass filter. The filter can be set to **None** (out of use), **50Hz, 100Hz, 200Hz**. The high pass filter removes signal frequencies signal lower than the cut-off, removing steady and slowly changed components of the signal.

AC Coupled

AC / DC coupling. Check this box to make the CED 1902 input AC (alternating current) coupled. In this mode only variations in the signal are allowed through to the amplifier, constant (DC) levels are blocked. (AC coupling should be used with EMG and ECG recordings but not with force or pressure transducer recordings.)

50 Hz Filter

A notch filter which selectively removes frequencies around 50Hz. (Used to remove 50Hz interference from mains power lines).

DC Offset

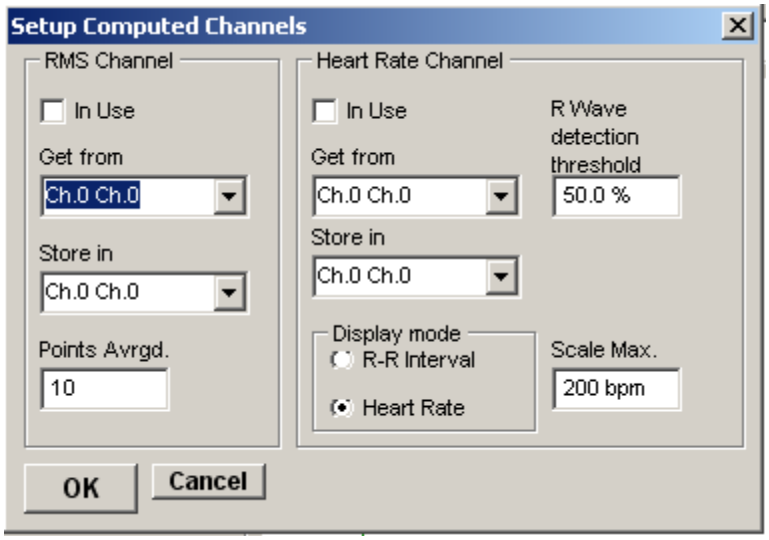
The DC Offset facility adds or subtracts a DC voltage level from the input. The offset range depends upon the input mode (Normal and Inverted Diff.- = +/-0.5mV, Single Ended =+/-500mV, Electrodes = +/-0.1mV). The offset facility is often used to cancel out the standing DC voltage signal from tension transducers.

COM Port

The serial communications port to used to control the CED 1902. Can be set to either COM1 or COM2.

Main Menu > Setup > Computed channels..

Select **Computed channels..** from the **Setup** menu to set up the heart rate and EMG computed channels.



Heart Rate

The heart rate function computes the instantaneous beat-by-beat heart rate from the interval between R-waves of the ECG waveforms. To enable heart rate processing :

1. Specify the channel which contains the ECG signal by selecting its name from the **Get From** list.
2. Specify the channel into which the heart rate is to be stored by selecting its name from the **Store In** list. (Note **Get From** and **Store In** should be set to different channels. Thus there should be at least 2 channels being recorded.)
3. Set a value for the **R-wave detection threshold**. This should be around 25% - 50% of amplitude of the R-Wave, e.g. around 0.5mV.
4. The **Display Mode** determines how the heart rate data is to be displayed. Select **R-R Intervals** if the heart rate data is to be displayed as R-R time intervals. Select **Heart Rate** if the data is to be displayed as heart beats per minute.
5. Set a value for the upper limit of the display range in **Max Scale**. (Default values are 200 bpm when in Heart rate mode and 2 s when in R-R Interval mode.)
6. Check the **In Use** box to enable heart rate processing.

RMS

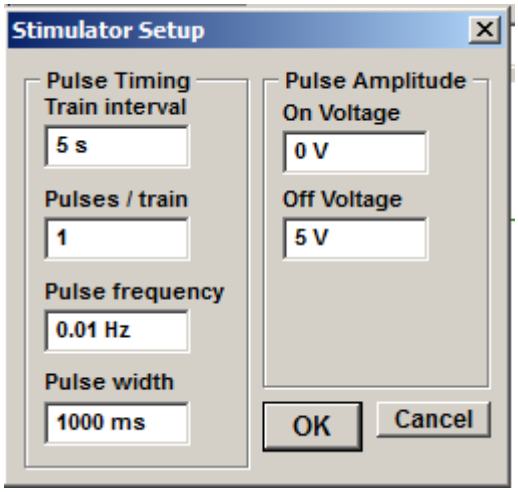
The RMS function computes the averaged root mean square (RMS) from an EMG signal. The amplitude of the RMS signal provides a quantitative estimate of the amplitude of EMG activity. The RMS is computed by squaring the EMG signal samples and calculating a running average over a series of adjacent sample points. To enable RMS processing :

Specify the channel which contains the EMG signal by selecting its name from the **Get From** list.

1. Specify the channel into computed RMS(EMG) is to be stored by selecting its name from the **Store In** list.
   (Note **Get From** and **Store In** should be set to different channels. Thus there should be at least 2 channels being recorded.)
2. Set the number of sequential points to be averaged in **Points Avrgd**.
3. Check the **In Use** box to enable RMS processing.

Main Menu > Setup > Stimulator..

Select **Stimulator..** from the **Setup** menu to set up Chart's built-in pulse generator.



The interval at which trains of stimuli are produced, the number of pulses per train, and frequency of stimulus pulses within the train are set by this option.

Pulse Timing

Train interval: The time (seconds) between successive trains of stimulus pulses.

Pulses / train: The number of stimulus pulses contained within a train.

Pulse frequency: The frequency (Hz) at which the stimuli are produced (assuming more than one stimulus pulse per train has been selected).

Pulse width: The width of each stimulus pulse (ms).

Pulse Amplitude

On Voltage : The voltage applied during a stimulus pulse (V).

Off Voltage : The voltage applied between stimulus pulses and when the stimulator is off (V).

Stimulus pulses are turned on and off by clicking on the Stimulus **On / Off** button.