
Ariel Dynamics, Inc.

ANALOG MODULE

Revision 1.0



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ARIEL ANALOG PROGRAM

INTRODUCTION

The **ARIEL ANALOG** software is used as a general-purpose laboratory data measurement and analysis sub-system. The module is designed to sample, save and present analog signals from many independent channels. A fast measurement rate is possible, with high-resolution and programmable input voltage ranges. Data signals are measured to a 12 bit (1 in 4096) resolution. A number of triggering options are provided to assist in the capture of transient data and to allow the synchronization of the analog module with external events. The analog module also includes a set of specialized electromyogram (EMG) signal processing options. EMG data samples can be analyzed using a number of sophisticated techniques including spike analysis, signal rectification and integration, envelope processing and spectral analysis.

WHAT'S NEW IN ANALOG 1.0

A few of the new features you will see in ANALOG version 1.0

1. **High Sampling Rates.** Data can be sampled at rates up to 330 kHz.
2. **APAS Tool Bar.** A toolbar has been added to allow the user to activate individual APAS modules from within the main programs.
3. **Real-Time COP.** Software support for real time center-of-pressure using a force platform has been added.

SYSTEM REQUIREMENTS

The following table provides the basic guidelines for minimum and recommended hardware to provide the best possible performance. The software requires a minimum of Microsoft Windows 95/98 and APAS-2000 Revision 1.0 or later.

Component	Minimum	Recommended
Pentium Computer	Pentium 233	Pentium II 333 MHz or higher
RAM	32 MB	64 MB or more
Analog Board	CES#3 (Retrieve Only)	Industry Standard A/D

TO START THE ANALOG PROGRAM

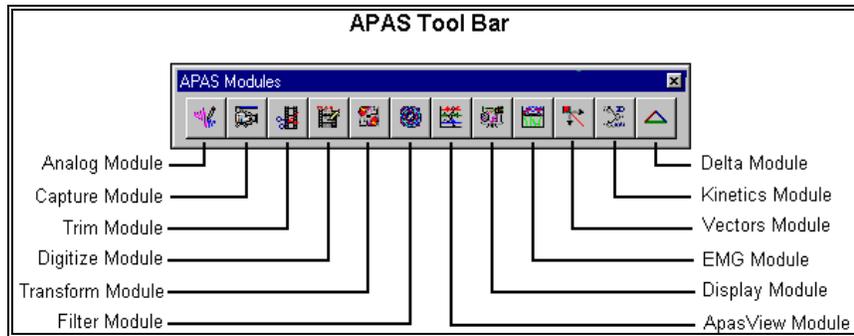
1. Double-click the **ANALOG** icon located in the **APAS System** window group. The main ANALOG window will appear.

SCREEN LAYOUT

Prior to performing the **ANALOG** module, you should take the time to familiarize yourself with the format and contents of the various screens listed below:

THE APAS TOOL BAR

You can activate any of the APAS software modules from within the current program by selecting the icons located on the APAS tool bar. The tool bar is toggled on/off using the APAS Toolbar command in the VIEW menu. A check mark in the left column of the menu indicates that the toolbar is currently active. The toolbar can be re-located anywhere in the main program window by dragging it with the mouse. Clicking the appropriate icon can activate the following program modules. Icons are pictorial representations of programs, commands or functions.

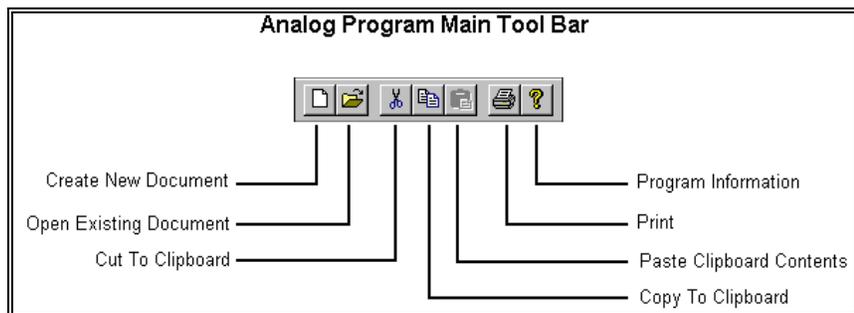


THE TOOL BAR

You can activate many functions by selecting the icons located on the **ANALOG** program tool bar. The tool bar is located near the top of the window. The icons in the Analog Tool Bar can be divided into three sections. Icons are pictorial representations of commands or functions. You can access the following commands by clicking the appropriate icon.

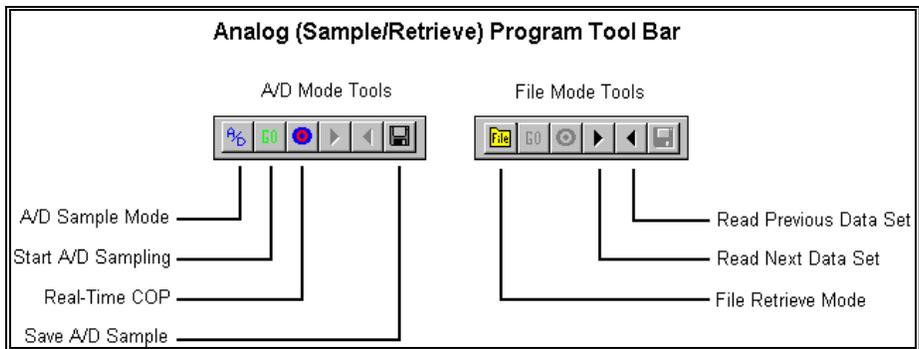
MAIN ANALOG TOOL BAR

The Main Tool Bar icons can be used to activate general file commands.



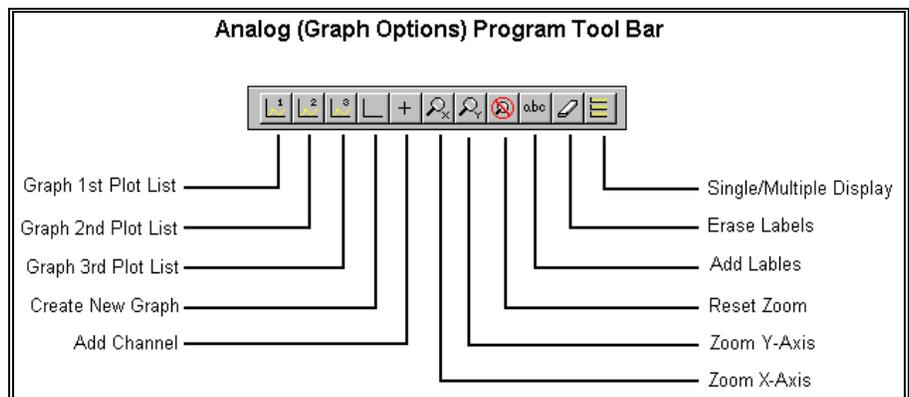
SAMPLE/RETRIEVE TOOL BAR

The icons in the Sample/Retrieve tool bar will change depending on the current file MODE. The Tool Bar for the A/D mode is shown on the left while the Tool Bar for the FILE mode is displayed on the right.



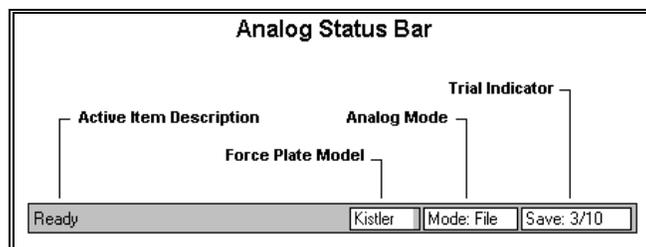
GRAPHING TOOL BAR

Sampled data can be displayed using the icons in the Graphing Tool Bar.



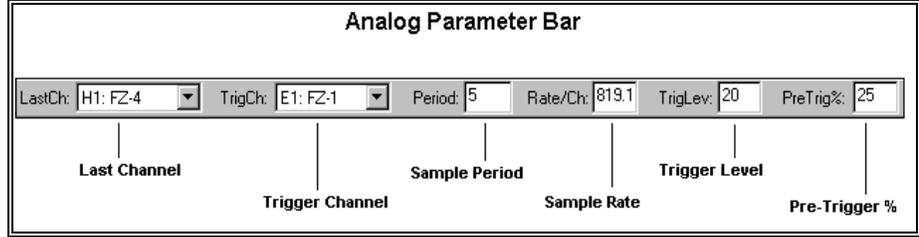
THE STATUS BAR

The status bar provides useful information about the current status of the file during the Analog process. The status bar is located at the bottom of the Analog window. The far-right side of the status bar is divided into three separate fields. The left field indicates the make (if any) of the force platform. The **ANALOG MODE** field indicates the current mode. The A/D mode is used for data sampling while the FILE mode is used for retrieving previously saved data. The third field is the **TRIAL INDICATOR**. The first number indicates the current data trial within the analog file while the second number indicates the total number of saved data trials.



THE PARAMETERS BAR

You can specify most analog functions by selecting the desired option located on the **ANALOG** Parameter bar.



Last Channel - The Last A/D field is used to select the number of active analog channels. Since the active channels always begin with channel A, the number of channels is set by specifying the last active channel. The active analog channels appear in the channel table in the main Analog window. The number of entries in this table is determined by the value of the Last A/D channel. One should not specify more channels than the actual number of analog input signals, as any additional empty channels will waste input buffer space and possibly cause the sampling rate to be reduced.

Trigger Channel - The Trigger Channel is used to select the channel used for triggering. It may be any of the active analog channels shown in the Channel Table. The current trigger channel is displayed in the Analog Parameters Bar.

Period - The Period is selected to set the duration of analog measurement. The sampling period is the length of an analog sample in seconds. All the active analog channels are measured continuously over the sampling period. The sampling rate or Rate/Chan determines the number of analog measurements that are performed for each channel during the sampling period. The sampling rate is the number of data measurements per second for each analog channel. The total number of data values sampled and saved is the sampling period times the rate/channel times the number of channels. Thus, if 1000 is entered in Rate/Chan and 2 is entered as the Period, then 2000 data values are collected for each channel during the sampling period. If there are eight active channels, then a total of 16,000 data values would be collected each time analog sampling is performed.

Rate/Channel - The Rate/Chan is used to set the sampling rate for analog data collection. All active channels are sampled at the specified rate.

Trigger Level - The Level is used to set the signal level on that channel that will cause triggering. The trigger level is entered in the units defined for that channel. Since analog input signals may be positive or negative, this value may also be positive or negative. Triggering will occur at the first measurement on this channel that is at or above the trigger level. Thus the

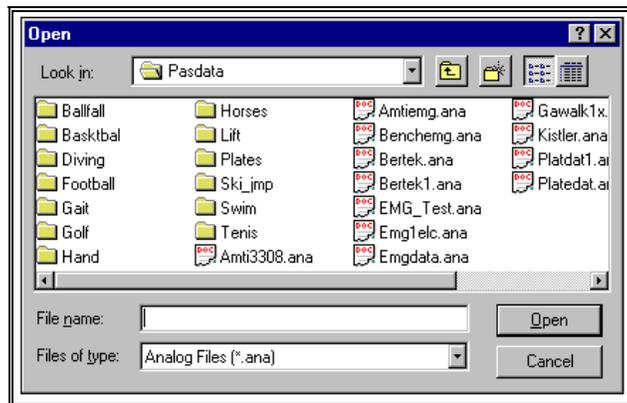
trigger is not used to start actual sampling, but rather to determine when the period of saved sample values is to start.

Pre-Trigger % - The Pre-Trigger% is used to select the percent of the total sampling period that will occur before the triggering event. Pretriggering is accomplished by continuously sampling and saving data values in a circular buffer. That is, only a limited number of samples are waved with new samples replacing the oldest ones. This parameter can be set to any value between) (no pretrigger) and 99. It is possible that less than the desired number of pretrigger samples may be collected. This occurs when the triggering event is detected after analog input is armed or started, but before the full pretrigger period has elapsed. In this event, the sampling period will be shortened by the amount that the pretrigger period is shortened. The pretrigger option allows the trigger level to be set high enough to eliminate false triggering due to noise, while still capturing significant data signals that occur before the trigger.

CREATING A NEW ANALOG FILE

Unless analog measurements are to be immediately processed and then discarded, they must be saved in data files on the computer. Data files can be created using the following procedure.

1. Choose the **NEW** command from the **FILE** menu. The **OPEN File** Dialog box will appear.

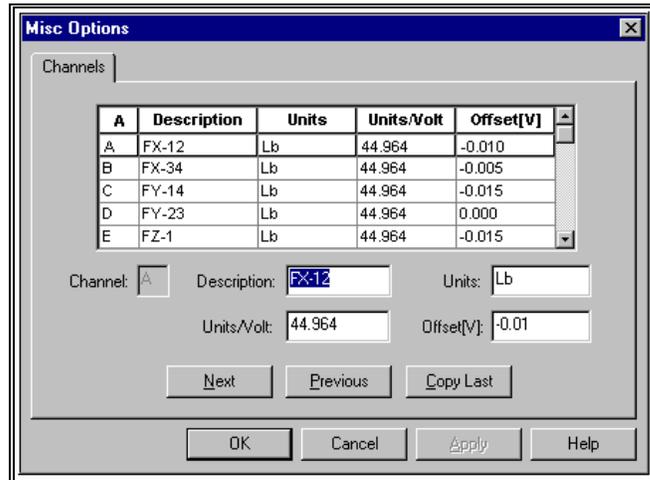


The OPEN File Dialog box looks for a particular type of file (files that have the extension of **(*.ANA)**). The OPEN File Dialog box can be used to specify the Drive, Directory, and Name of the sequence file to be created.

2. Analog input is controlled by the analog sampling parameters that are displayed in the Parameter Bar. These parameters must be set before the Analog Module may process the analog measurements. Please refer to the Parameter Bar section for additional information. Specify the following parameters to match the data collection requirements:
 - Last Channel (**LastCh**)
 - Trigger Channel (**TrigCh**)
 - Period**
 - Sample Rate (**Rate/Ch**)

Trigger Level (**TrigLev**)
Pre-Trigger Percent (**PreTrig%**)

3. Select the **CHANNELS** command from the **OPTIONS** menu to specify the Channel Information for the active analog channels. The Channels command is used to set or change the individual analog channel definitions in the analog channel table.



Any channel description (name), units, conversion factor (units/volt of analog signal), and offset (signal level in volts corresponding to zero in the units of that channel) may be entered. The current channel settings are saved each time the analog module is exited so they do not have to be reset the next time the module is run.

4. Select the **PLATES** command from the **OPTIONS** menu to activate/de-activate the force plate software. The Plate command is used to define special force platform (force plate) processing by assigning a block of analog input channels to predefine force platform signals. Typical biomechanical force platforms have six to eight analog outputs representing forces and moments measured directly by the platform. These outputs are frequently combined or used to compute additional quantities such as composite forces, moments, and point of application of force. Rather than require a user to set up numerous input channels, the Plate command automatically defines a consecutive group of channels as standard force platform input for the type of platform configured with this system (various platform definitions supporting most commercially available force platforms can be configured when the system is ordered). In addition, since the channel definitions are predefined, the computed quantities are also automatically defined and displayed as additional analog channels.
5. Set the desired channels on **Plot Lists** 1 through 3 by clicking in the desired column.
6. You are now ready to sample the analog data

CREATING AN EMG FILE (EXAMPLE)

This example illustrates the procedure for creating a two-channel EMG file using electrodes with a gain of 1000.

1. Select **FILE, NEW** to create a new *.ANA file.
2. Use the **Parameter Bar** to set the following parameters:
Last Channel (**LastCh**): B1 (Two channels will be sampled)
Trigger Channel (**TrigCh**): A1
Period: 5 seconds
Sample Rate (**Rate/Ch**): 1000 samples/sec/chan
Trigger Level (**TrigLev**): 0.2 mv
Pre-Trigger Percent (**PreTrig%**): 10%
3. Select **OPTIONS, CHANNELS** to specify the Channel Information for the active analog channels.

Channel A:

Description: Channel 1
Units: mv
Units/volt: 1 (Since gain=1000 and 1000mv=1volt) Offset:
0 Calculated during the ZERO process

Channel B:

Description: Channel 2
Units: mv
Units/volt: 1
Offset: 0

4. Select **OPTIONS, PLATES** and select **NONE** to de-activate the force plate software.
5. Set the desired channels on **Plot Lists** 1 through 3 by clicking in the desired column.
Click in the 1st column for Channel A1 and 2nd column for Channel B1.
6. You are now ready to sample the analog data.

CREATING A FORCE PLATFORM FILE (EXAMPLE)

This example illustrates the procedure for creating an analog file for a single AMTI force platform (Gain = 2000 and Excitation voltage = 5)

1. Select **FILE, NEW** to create a new *.ANA file.
2. Use the **Parameter Bar** to set the following parameters:
Last Channel (**LastCh**): F1 (6 channels total)
Trigger Channel (**TrigCh**): C1 (Vertical force channel)
Period: 5 seconds

Sample Rate (**Rate/Ch**): 1000 samples/second/channel
Trigger Level (**TrigLev**): 10 lbs
Pre-Trigger Percent (**PreTrig%**):10%

3. Select **OPTIONS, CHANNELS** to specify the Channel Information for the active analog channels.

4. Select **OPTIONS, PLATES, AMTI** to activate the software drivers for the AMTI force platform.

Select the **INFO** tab and enter the following:

Length Units: Inches
Force Units: Lbs
#Plates: One
1st Plate Channel: A1

Select the **PLATE#1** tab and enter the following:

Transducer Depth: 1.36
Length: 20.00
Width: 18.25

Select the **CAL#1** tab and enter the following:

Force Plate Constants: FX = 2.883 uV/Vo/Lb
FY = 2.864
FZ = 0.725

Moment Calibration Constants: MX = 1.770 uV/Vo/ft-lb
MY = 1.770
MZ = 3.423

Select the **ELECTRONICS** tab and enter the following:

Excitation: 5.00 Volts
Gain: 2000

5. Select **OK** to Calculate Plate Conversion Factors. This will automatically update the Units/Volt entry in the Channel Information Table.

6. Set the desired channels on **Plot Lists** 1 through 3 by clicking in the desired column.

Click in the 1st column for Channel C1 (Z direction force)

Click in the 2nd column for Channels A1 and B1 (X and Y direction Forces)

Click in the 3rd column for Channels D1, E1 and F1 (X, Y, Z Moments)

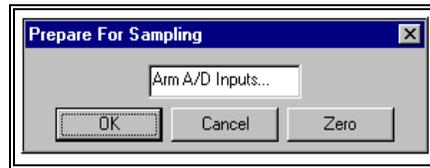
7. You are now ready to sample the analog data.

ANALOG MEASUREMENT PROCESS

Once the analog sampling parameters have been set to accommodate the signals being measured, actual analog sampling may begin. The most recent

values of the sampling parameters are saved and are reset when the module is run again. Thus sampling parameters do not need to be set each time analog processing is begun unless sampling values must be changed.

1. Choose the **START** command from the **SAMPLE** menu (or select the **GO** icon from the tool bar) to initiate Analog sampling. When Start is selected, the analog module displays a reminder message to prepare for analog measurement.



At this point actual sampling has not begun and three options are available. The first option is to begin analog sampling by selecting the **OK** button. The second option is to abort by selecting the **Cancel** button to return to the main Analog window. The purpose of this additional step is to allow a final check of the analog signal source, force platform, EMG equipment, etc., and make sure that the subject is prepared to perform the activity being measured. The third option is to zero any voltage offsets on the active analog channels.

2. Select the **ZERO** button to compute the offsets for the active analog channels.
3. Select the **OK** button to begin the sampling process. As soon as analog input is "armed," the analog module begins measuring each of the input signals and monitoring the trigger channel for the triggering event. A message will appear on the screen to indicate that analog sampling is in progress.



Sampling may be aborted at this time by selecting the **Cancel** button. The **Cancel** option is provided in the event the subject is not able to perform the activity, equipment malfunction, or there is an interruption in the normal sampling process. Selecting **Cancel** will return the screen to the main Analog window.

Assuming that sampling has occurred normally and that the triggering event has been detected, analog sampling will end when all of the post trigger measurements have been collected. The Analog Module will sound an audible "beep" to mark the end of data collection and the active analog signals in Plot List #1 will appear on the color graphic display. The display is in graph format with the horizontal axis corresponding to the sampling period (time), and the vertical axis corresponding to the units of measurement of the analog signals. The signal from each channel is displayed as a curve with different colors being used to distinguish different channels.

After sampling has been completed the graphed data is displayed in the Analog window. This is the primary menu used for the display and

analysis of data in the Analog Module. Some of the listed options are used to display analog data measurements in different ways, while other options provide various types of data analysis functions from simple measurement of values and intervals to sophisticated signal processing. Included in these analysis functions are a number of specialized EMG processing applications. A discussion of these display and analysis options will be the subject of the following sub-sections.

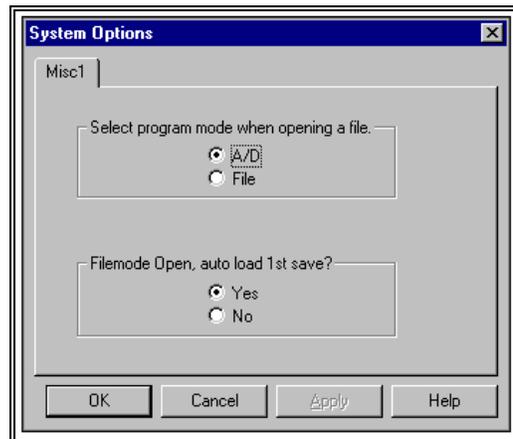
4. Select **FILE, EXIT** to exit the ANALOG program.

OPTIONS

The **ARIEL ANALOG** software contains many options designed to enhance the analog process. Selecting the **OPTIONS** menu accesses these options. Available options allow for selecting the setting system parameters, specifying channel information and specifying force platform parameters.

SYSTEM OPTIONS

The **System** command is selected from the **OPTIONS** menu when the default program mode or autoload option is to be changed. When this command is selected, the System Options menu will be displayed indicating the current program mode and autoload option when opening an analog file.



PROGRAM MODE

The System Options menu is used to set the default program mode when opening a file. The A/D mode is used for measuring and saving analog data values. It is called A/D mode because actual analog-to-digital conversion is performed.

In the File mode, analog sampling cannot be performed using the analog-to-digital interface. This option allows previously sampled and saved

data to be read or retrieved from a data file. In the File mode, one may advance to the next saved sample in the file or backup to the previous saved sample. When a sample is read, the information is displayed in the same manner as when analog sampling has been performed.

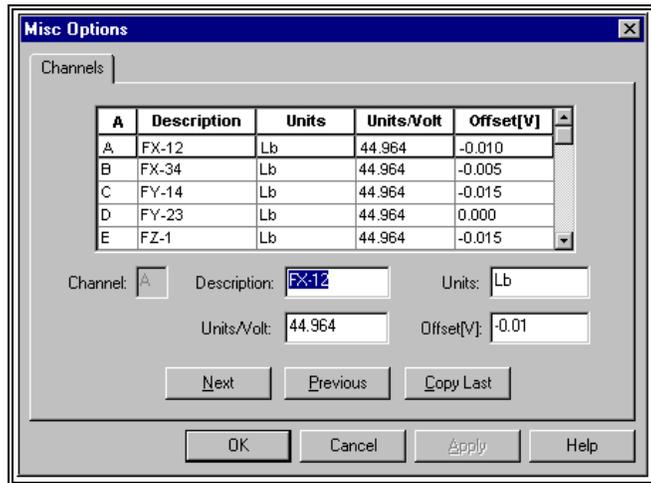
It is possible to change between A/D mode and File mode at any time using the icons in the Analog Sample/Retrieve Tool Bar. (**NOTE:** Changing the mode using the Tool Bar does not affect the default setting.) For example, if data is being sampled and saved in a file, the A/D mode, it is possible to review previous samples by selecting FILE mode and reading the desired sample. Similarly, if previously sampled data is being examined, in the FILE mode, it is possible to add new data to this file by selecting A/D mode and performing additional sampling of analog signals. New data is always saved at the end of a file so that previously saved data is retained.

AUTOLOAD 1ST SAVE

The System Options menu can also be used to set the auto-load option. When this option is activated (YES), the channels listed in Plot List #1 of the first trial in the analog file will automatically be graphed. If this option is inactive (NO), no data will be plotted.

CHANNELS

The Channels command is used to set or change the individual analog channel definitions in the analog channel table. When this option is selected, the Misc. Options menu is displayed.



Any channel description (name), units, conversion factor (units/volt of analog signal), and offset (signal level in volts corresponding to zero in the units of that channel) may be entered. The current channel settings are saved each time the analog module is exited so they do not have to be reset the next time the module is run. In addition, each time an existing analog data file is accessed, the channel definitions are copied from that file. In this manner, different sets of channel definitions corresponding to different types of input (force platforms, EMG equipment, etc.) can be quickly accessed from a predefined data set.

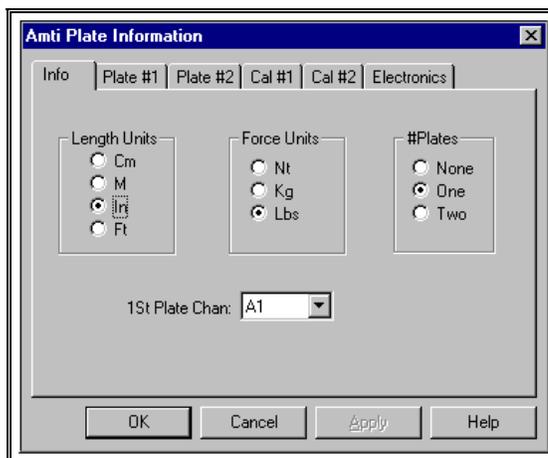
The rest of this option discussion has been deferred to the section on Analog Sampling And Channel Definition, to allow the specific features of the analog module to be presented without having to be concerned with the actual source of the analog signals. In practice, the first item to be considered in the data collection process is the source, type, and magnitude of the individual analog signals along with the corresponding definition of the analog channel table.

PLATES

The Plate command is used to define special force platform (force plate) processing by assigning a block of analog input channels to predefined force platform signals. When this option is selected, the Plate Information menu is displayed. Typical biomechanical force platforms have six to eight analog outputs representing forces and moments measured directly by the platform. These outputs are frequently combined or used to compute additional quantities such as composite forces, moments, and point of application of force. Rather than require a user to set up numerous input channels, the Plate option automatically defines a consecutive group of channels as standard force platform input for the type of platform specified. In addition, since the channel definitions are predefined, the computed quantities are also automatically defined and displayed as additional analog channels.

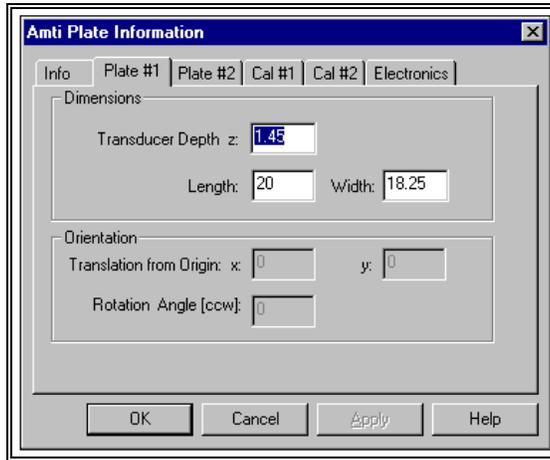
When Plate is selected, the Plate Information menu will be displayed. The information required by the software depends upon the make of force platform selected. The AMTI plate has been used for this discussion. Select each of the following tabs to enter the required information.

The **Info** tab is selected to specify the desired units for length and force, the number of plates being used and the first platform channel. The units selected for length and force will be used for reporting data results and can be changed at any time. Outputs from the force platform must be connected sequentially therefore, only the first channel must be specified. The analog module will then show the expected force plate inputs and channel assignments for the type of plate configured to the system. Once configured, all measured and computed force plate quantities are available for graphing and analysis.

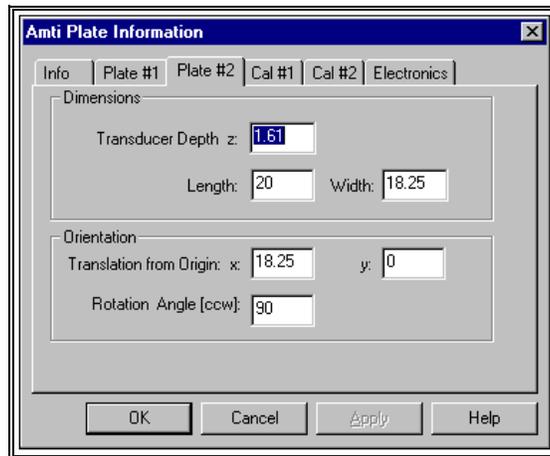


The **Plate #1** tab is selected to enter dimensions for the first force platform. The Transducer Depth is obtained from the force platform calibration

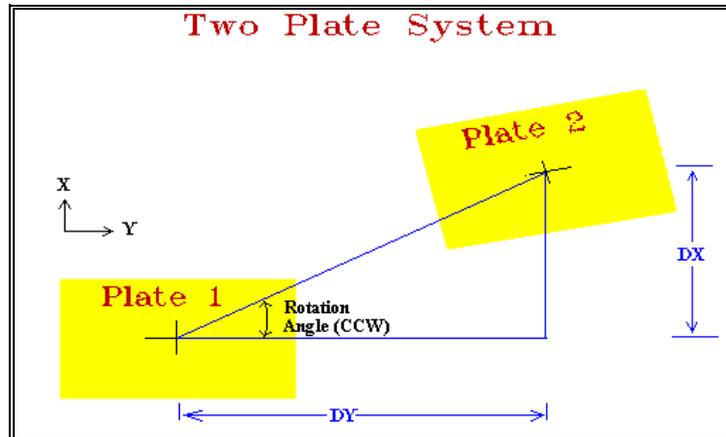
information and is equal to the vertical distance from the top of the force platform to the top of the transducer. The Length and Width are also obtained from the force platform manual. All Dimension values must be entered in the user specified units.



The **Plate #2** tab is selected to enter dimensions for the second force platform as well as the orientation of the first force platform to the second force platform.



Refer to the following diagram for the orientation of two force platforms.

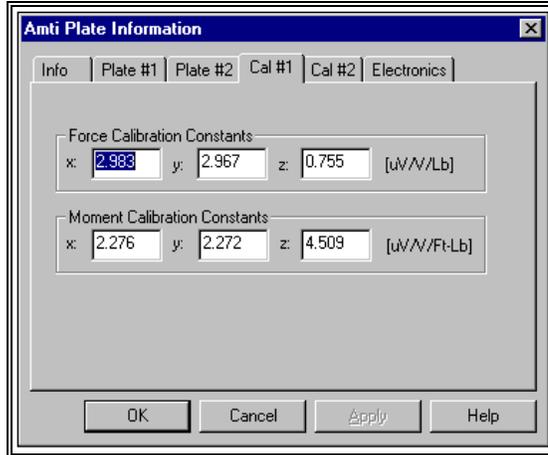


Required information for two force platforms includes:

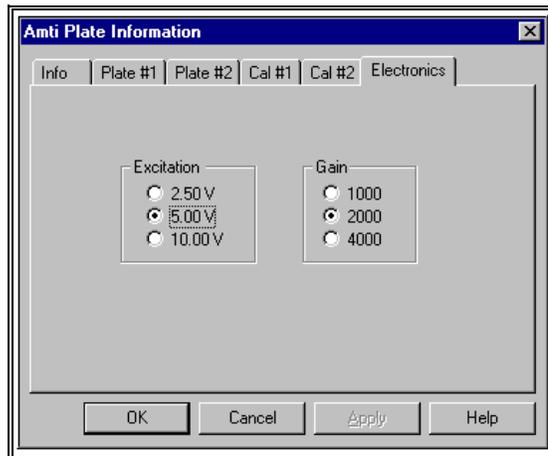
Translation from Origin on both the **X** and **Y** directions

Rotation Angle - Measured Counter-Clockwise, this number represents the angle from force platform #1 to platform #2.

The **CAL #1** and **#2** tabs are selected to enter the Force and Moment Calibration Constants. These values are obtained from the calibration values supplied in the force platform documentation.



Electronics is selected to enter the force plate amplifier information. The required information is dependent upon the type of force plate being used. This information can be obtained by reading the current settings on the force plate amplifier hardware.

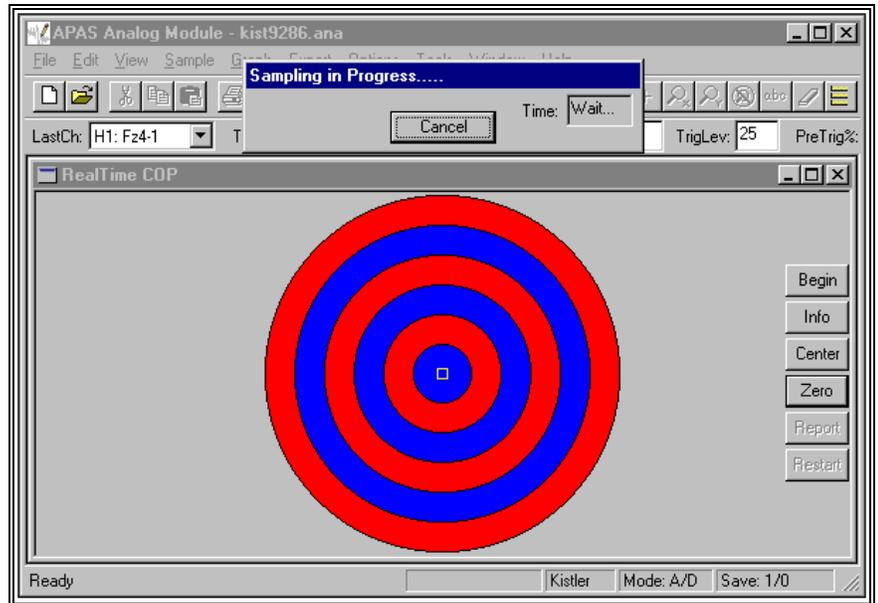


REAL TIME CENTER-OF-PRESSURE (COP)

The Real Time Center-of-Pressure (COP) mode provides a method to measure and analyze balance and stability parameters. This type of analysis can be used for testing the effects of orthotics and prosthetics, evaluating sports performance requiring stability, and examining orthopedic or

neurological dysfunction. Suggested steps for using the COP option are listed below.

1. Configure force plate setup as described in the section titled Creating A Force Platform File.
2. Select the **COP** command from the **SAMPLE** menu (or the **COP** icon in the toolbar). This will open the main COP menu.



Begin is selected to initiate COP sampling.

Info is selected to specify COP options.

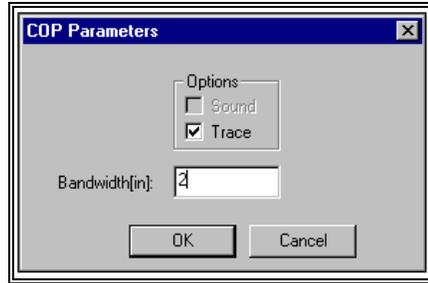
Center is selected to center the cursor on the target. This works even if the applied force is not centered on the force platform.

Zero is selected to zero the offsets on the analog data channels.

Report is selected to display the results of the COP data.

Restart is selected to initialize the COP mode for another sample.

3. Select the **INFO** button to set the COP options.

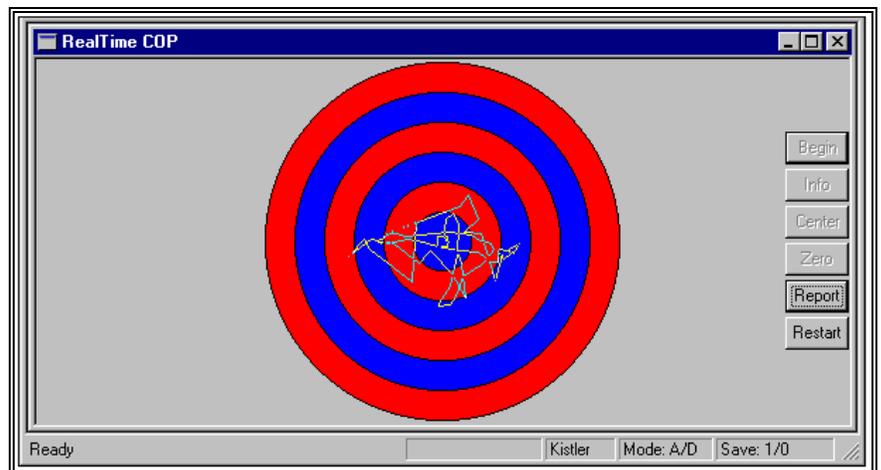


Sound is used for biofeedback with the tone increasing in pitch as the distance from the center of the target to the COP increases. A checkmark next to the Sound box indicates the sound option is turned on.

Trace is used to display the linear path of the COP. When the Trace mode is turned on, a white line superimposed on the target displays the path taken by the COP. When the trace is turned off, no path is displayed.

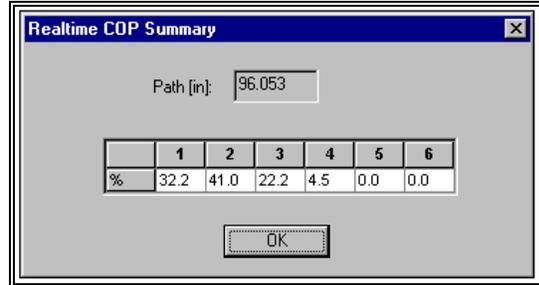
Bandwidth specifies the width of the each colored ring displayed on the target. The display becomes more sensitive as the size of the bandwidth (target) decreases. Changing the bandwidth simply scales the size of the target. It has no effect on the values of the collected data.

4. Select the **ZERO** button. This will zero any offsets present on the analog data channels.
5. Have subject stand on force platform with minimal movement
6. Select the **CENTER** button to center the cursor on the target
7. Select the **BEGIN** button to initiate data sampling in the COP mode.



The plot above shows the results with the Trace mode turned on.

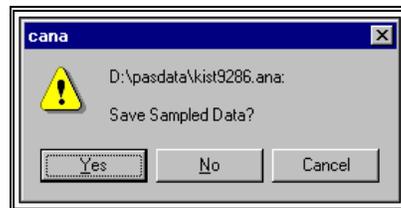
8. Select **REPORT** to display the COP summary.



Path displays the total distance that the COP traveled over the plate during the sample period. Think of the COP path shown above as a string. The length of this string, extended in a straight line represents the Path value. This value is displayed in the Length units selected when setting up the force platform file.

Each ring of the target is assigned a number (with 1 being the center). The **Summary Table** displays the percentage of the total sample time that the COP spent in each zone. For example, in the figure above, 32.2% of the sample period was spent in the center zone of the target.

9. Select **RESTART** button to redo the current sample or proceed to an additional sample.



If a previous sample has been taken, a confirmation menu will be displayed. Select YES to save the previous data sample. Select NO to delete the previous sample. Cancel will return to the previous menu without any changes being made.

ANALOG DATA DISPLAY

The Analog module allows for the measurement of many simultaneous analog signals. The display of many curves on a single graph would, for all practical purposes, be unreadable. In order to simplify the process of determining which channels are to be drawn on a graph, the Analog module contains a feature called the Plot List.

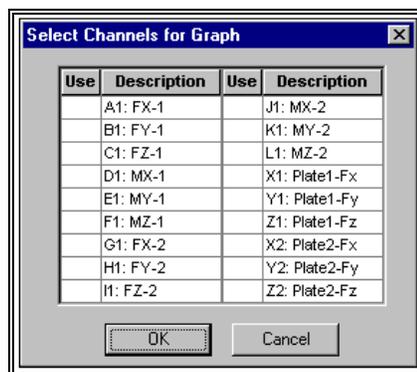
PLOT LIST

Plot Lists are merely lists of analog channels that are plotted or graphed together. By grouping channels in this manner, time is saved in the display and analysis of analog input. The first plot_list is automatically graphed after each analog sample is collected or read from a file. The other plot_lists may be graphed by selecting the "2nd" and/or "3rd" options on the analog-processing menu. The "Plot" column in the channel table shows which plot list(s) each analog channel is associated with. A channel may be on more than one plot_list, if desired. Since the first plot_list is automatically graphed when analog input is performed, it is recommended that as many of the input channels be assigned to this list as is practical. Channels with different units should be assigned to separate plot_lists, as graphs are labeled with the units of the first channel plotted.

The menu box lists all the analog channels. A channel is selected by clicking the mouse in the desired Plot List column for that channel. A channel that is currently selected may be removed from this Plot_List by clicking the column for the channel letter again. The plot_list assignments are shown in the channel table under the 1st, 2nd and 3rd column headings. An X indicator is used to activate a channel for the plot_list. A channel may be on more than one list at the same time.

NEW GRAPH

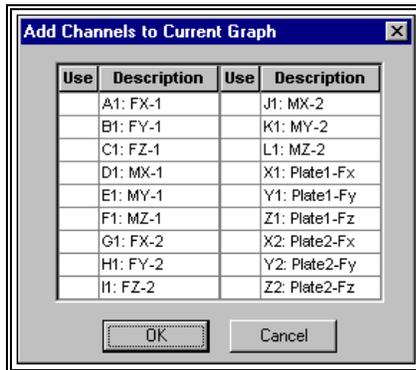
Before plotting individual analog channels, one typically creates a new (empty) graph as the current graph. To start a new graph, select the **NEW** command from the **GRAPH** menu (or the **NEW** icon). The existing graph(s) are moved to the background and an empty window is created for a new graph. Any number of curves may now be drawn on this graph using the **ADD** command from the **GRAPH** menu (or the **ADD** icon).



The active analog channels are displayed in the menu box. To select the new channel to be graphed in the new window simply click the mouse in the column corresponding to that channel. Then select OK.

ADD GRAPH

Plot lists are used to graph groups of channels. In addition, the Analog module allows any single active analog channel to be graphed using the **ADD** command from the **GRAPH** menu (or the **ADD** icon). When ADD is selected, a list of active channels is presented. Choosing a channel letter will cause the data curve for that channel to be added to the current graph. In this manner, graphs may be created with curves for one or more analog channels in different combinations than the ones defined for the three existing plot lists.



The active analog channels are displayed in the menu box. To select the channel to be added as an additional curve on the current graph simply click the mouse in the column corresponding to that channel. Then select OK.

TOOLS FOR GRAPHIC DISPLAY

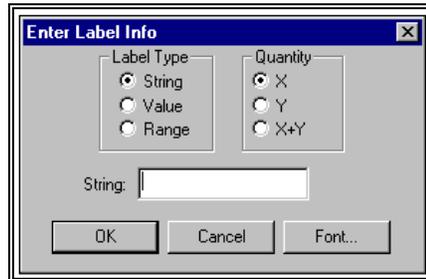
The **ZOOM X** and/or **Y** command is selected to expand the current graph so that a horizontal and/or vertical interval of the existing curves is expanded and plotted to the full scale of the graph. This zoom function allows any portion of the current graph to be examined in an enlarged format. When this option is selected the graph will be redrawn with an expanded horizontal or vertical axis. Zoom may be selected repeatedly, each time expanding an already expanded graph. In this manner even the smallest detail recorded may be zoomed in. Zoom X is selected to expand the current graph along the X or horizontal coordinate axis. Zoom Y is selected to expand the current graph along the Y or vertical coordinate axis. This option is identical to the Zoom X with the exception of expanding along the vertical axis instead of the horizontal axis.

UNZOOM is selected to remove all expansion options and return to the original graph. When this command is selected, the current graph will be redrawn with the original X and Y-axis data ranges.

LABEL - The Label command is used to select from a number of specialized labeling options available in the analog module from the Enter Label Info Menu.

In addition to providing standard text labels for annotation of analog displays, the labeling options perform various computations on the data values in

individual curves and report the results of these computations in label format. In this manner basic analysis and labeling of data curves can occur simultaneously.



Label Type - Used to specify the type of label. **String** labels are text labels entered at the keyboard. Any character string can be added to the display in user specified font, style, size, color or effect. **Value** labels report horizontal or vertical coordinate values. The mouse is used to enter the position of a point on the current graph. The specified value then appears on the screen. Labels may be positioned to any screen location using the mouse. A line will connect the beginning of the label to the indicated point. **Range** labels report horizontal or vertical graph intervals. The mouse is used to enter the endpoints of the interval to be reported by selecting the first point and clicking the mouse. Then select the endpoint and click the mouse again. At this point the mouse is used to position the label to the desired location on the screen. A line will connect the beginning of the label to the indicated point.

Quantity - The Quantity option is selected to specify which axis will be used for reporting the value indicated by the Label Type.

String - The String field is used to enter the text label when the String Label Type is specified. Type the desired text and select OK to enter the label on the current graph.

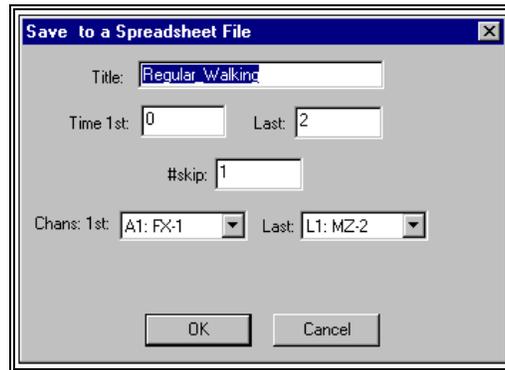
ERASE - is used to remove all labels from the graphic display. Individual labels cannot be removed once they have been fixed, however, ample opportunity is provided to change, move, or cancel labels before they are fixed on the display. Labels are automatically cleared each time a new analog sample is measured or read from a file.

SINGLE - A plot_list is normally displayed in "Multiple" mode. In this mode all channels on the list are drawn on a single graph. Alternately, a plot_list may be displayed in "Single" mode. In this mode each channel on the list is displayed on a separate graph. This option is often used for rapidly fluctuating data such as EMG signals. The mode of the current plot_list is indicated by the check mark next to the Single command (or the Single icon) and may be changed by selecting the **Single** command from the **Tools** menu (or by selecting the Single icon in the Tool Bar). Each time Single is selected the mode is toggled to the other display mode.

EXPORTING ANALOG DATA

The **EXPORT** menu provides an additional graph related option. This function is used to produce a worksheet file of numerical curve values from the current graph(s). This feature can be utilized for performing custom analysis on the Analog data.

1. Select the **EXPORT** menu. When this option is first selected you will be asked to specify either a **NEW** or **OLD** worksheet file for data export. Specify the drive, directory and file name.
2. Select the **SAVE** command from the **EXPORT** to save data to the worksheet file. The Save To Spreadsheet File menu will be displayed.



Title - The Title is used as a short description of the exported data. This title will be entered as a column label in the worksheet file.

Time 1st and **Last** - Since typical analog sampling contains hundred and perhaps thousands of measurements, the 1st and Last time can be specified to reduce the number of values printed by selecting smaller intervals of the data curves

#Skip - Since the Analog Module may measure thousands of values for each channel, it is normally not practical to export all values in a table. The Skip factor is used to specify the frequency of values to be exported. A factor of 1 would cause every value to be exported. A factor of 2 would result in every other value being exported. A factor of 10 would result in every tenth value being exported, and so on.

Chans 1st and **Last** - The Export option normally lists all active analog channels. Select the first and last channels to print a fewer number of channels. Channels must be displayed sequentially. This option does not allow channels between the first and last channel to be skipped.

3. Select **OK** to save the specified data to the worksheet file. Select **CANCEL** to abort the menu without saving data.

ANALOG SIGNALS AND CHANNEL DEFINITION

This discussion has been deferred to allow the specific features of the analog module to be presented without having to be concerned with the actual source of the analog signals. In practice, the first item to be considered in the data

collection process is the source, type, and magnitude of the individual analog signals along with the corresponding definition of the analog channel table.

The analog to digital conversion hardware supplied with the analog module measures all analog input signals in volts. The default input range is ± 5 volts. Input should not exceed 5 volts for proper operation (this may require the addition of over voltage protection circuitry on some signal sources). The limit of resolution for signals in this voltage range is approximately 5 millivolts.

All analog inputs being measured must use the same input voltage range. The inputs to the analog converter feature high impedance and a low capacitance to minimize the effect of the measurement process on the signal itself. Most types of analog signals can be directly measured by the analog hardware, however, certain signal sources such as strain gauges and transducers with frequency or current outputs will require external signal conditioners and/or conversion prior to measurement by the analog module.

Once the analog signals are properly established, they are connected to the converter module using standard BNC type connectors. Sources with different types of connectors will require adapters that are readily available. Signals should be connected to consecutive channels starting with channel A1, then channel B1, and so on. If channels are skipped for any reason, the input to that channel must be connected to ground. Floating or unterminated input channels may result in inaccurate data measurements.

The individual input signals must now be defined in the analog module. Select the CHANNELS command from the Options Menu. A table of the possible analog channels will be displayed in the analog window. This is called the channel Definition Table. For each channel, this table contains:

- a. channel designator (A1 through P1 for 16 channels, A2 through P2 for 32 channels),
- b. channel description (up to 10 characters),
- c. units of measurement (for reporting purposes),
- d. conversion factor in units/volt,
- e. an offset value, in volts, corresponding to the zero value in the selected units of measure for that channel.

Below this table is a menu that is used to enter or change the table entries on the individual channel basis.

Entry of an accurate conversion factor and offset for each channel is critical if measurements are to be reported correctly. For example, if force platform input is being measured, and it is desired to report results in pounds, the output of each force platform channel in pound/volts must be known and entered in the channel table. If the conversion factor is not known, use volts for Units and enter 1 for Units/V. Most laboratory measuring devices can be adjusted for a zero offset (i.e. zero volts of output signal equals zero

measurement units). If analog signals do not have a zero volt offset, measure the actual offset corresponding to zero measurement units (this can be done using an analog channel with 1 unit/volt and a zero offset), and enter this value in the Channel Table. The measured signal will then be adjusted by this offset prior to being graphed or analyzed.

Whenever a new data file is created in the analog module, the contents of the channel definition table, as well as the analog input parameters, are saved in that file. If there are several standard input configurations that will be used for sampling (e.g. force platform, EMG equipment, etc.) each channel and parameter configuration can be saved in a separate file. In this manner, one only needs to access an existing file in order to configure the analog module for a given type of data collection. In addition, the current configuration is saved on exit from the analog module and is restored when the module is run again.

This completes the discussion of analog channel setup. In practice, one typically connects the input signals and then performs a series of trial measurements to establish signal levels, sampling times, and adjustment of signal sources to achieve proper calibration. A discussion of specific laboratory and clinical data measurement techniques is, however, beyond the scope of this manual.

ANALOG QUICK REFERENCE

CREATING A NEW ANALOG FILE

1. Select **FILE, NEW** to create a new *.ANA file.
2. Set the Last Channel (LastCh), Trigger Channel (TrigCh), Period, Sample Rate (Rate/Ch), Trigger Level (TrigLev) and Pre-Trigger Percent (PreTrig%) using the parameter bar.
3. Select **OPTIONS, CHANNELS** to specify the Channel Information for the active analog channels.
4. Select **OPTIONS, PLATES** to activate/de-activate the force plate software.
5. Set the desired channels on Plot lists 1 through 3 by clicking in the desired column.
6. You are now ready to sample the analog data.

CREATING AN EMG FILE (EXAMPLE)

This example illustrates the procedure for creating a two channel EMG file using electrodes with a gain of 1000.

1. Select **FILE, NEW** to create a new *.ANA file.
2. Use the **Parameter Bar** to set the following parameters:

Last Channel (LastCh):	B1 (Channels A1 and B1)
Trigger Channel (TrigCh):	A1
Period:	5 seconds
Sample Rate (Rate/Ch):	1000
samples/second/channel	
Trigger Level (TrigLev):	0.2 mv
Pre-Trigger Percent (PreTrig%):	10%
3. Select **OPTIONS, CHANNELS** to specify the Channel Information for the active analog channels.

Channel A:

Description:	Channel 1
Units:	mv
Units/volt:	1 (Gain=1000 and 1000mv=1volt)
Offset:	0 (Calculated during the ZERO process)

Channel B:

Description:	Channel 2
Units:	mv
Units/volt:	1
Offset:	0

4. Select **OPTIONS, PLATES** and select **NONE** to de-activate the force plate software.
5. Set the desired channels on Plot lists 1 through 3 by clicking in the desired column.

Click the 1st column for Channel A1
Click the 2nd column for Channel B1.
6. You are now ready to sample the analog data.

CREATING A FORCE PLATFORM FILE

This example illustrates the procedure for creating an analog file for a single AMTI force platform in English units (Force = Pounds, Length = inches, Gain = 2000 and Excitation voltage = 5)

1. Select **FILE, NEW** to create a new *.ANA file.
2. Use the **Parameter Bar** to set the following parameters:

Last Channel (LastCh):	F1 (6 channels total)
Trigger Channel (TrigCh):	C1 (Trigger from the Z force)

Period: 5 seconds
Sample Rate (Rate/Ch): 1000
 samples/second/channel
Trigger Level (TrigLev): 10 lbs
Pre-Trigger Percent (PreTrig%): 10%

3. Select **OPTIONS, CHANNELS** to specify the Channel Information for the active analog channels.
4. Select **OPTIONS, PLATES, AMTI** to activate the software drivers for the AMTI force platform.

Select the **INFO** tab and enter the following:

Length Units: Inches
Force Units: Lbs
#Plates: One
1st Plate Channel: A1

Select the **PLATE#1** tab and enter the following:

Transducer Depth:
Length: 20.00 inches
Width: 18.25 inches

Select the **CAL#1** tab and enter the following information. The calibration information is obtained from the force platform user manual.

Force Plate Constants: FX = 2.883
 uV/Vo/Lb

FY = 2.864
 FZ = 0.725

Moment Calibration Constants: MX = 1.770
 uV/Vo/ft-lb

MY = 1.770
 MZ = 3.423

Select the **ELECTRONICS** tab and enter the following:

Excitation: 5.00 Volts
Gain: 2000

5. Select **OK** to Calculate Plate Conversion Factors.

This will automatically update the Units/Volt entry in the Channel Information Table.

6. Set the desired channels on Plot lists 1 through 3 by clicking in the desired column.

Click in the 1st column for Channel C1 (Z direction force)
 Click in the 2nd column for Channels A1 and B1 (X and Y direction Forces)

Click in the 3rd column for Channels D1, E1 and F1 (X, Y, Z Moments)

7. You are now ready to sample the analog data.

EXPORTING ANALOG DATA

1. Sample desired data
2. Select **EXPORT, NEW** to name and open a worksheet file.
3. Select **EXPORT, SAVE** to export the current data set to the active worksheet file.

SAVING AN ANALOG FILE

1. Parameters associated with an analog file are saved to the *.ANA file when data has been sampled and saved.

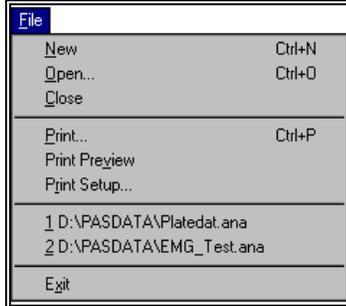
SAVING ANALOG DATA IN AN ANALOG FILE

1. Create or Open an Analog file.
2. Select **SAMPLE, START** (or select the **GO** icon) to sample the analog data.
3. Select **SAMPLE, SAVEDATA** to save the data. A Save menu will appear to enter a caption for the sampled data. The time period and saved channels can also be specified.
4. You are now ready to analyze the current sample, collect another sample, or exit the program.

ANALOG MENUS

Listed below are the various menus for the ANALOG program. Select the desired menu to see a description of the available commands for each menu.

FILE COMMAND MENU



New

Selected to create a new document file for analog processing.

Open

Selected to open an existing document for analog processing.

Close

Selected to close the active analog file.

Print

Selected to PRINT the active analog document.

Print Preview

Selected to preview the active document prior to issuing the PRINT command.

Print Setup

Selected to adjust the printer settings prior to issuing the PRINT command.

Recent File

Provides a list of the most recent sequences accessed by the ANALOG program. These files can be recalled by selecting the desired sequence using the mouse.

Exit

Selected to EXIT the ANALOG program.

EDIT COMMAND MENU



Undo

Select the Undo command to undo the last change and restore the text that you deleted, replaced or changed. This command restores your text to the way it was before the last edit.

Cut

Select the CUT command to remove the selected item and temporarily copy it to the Windows Clipboard. The items are placed in the clipboard so that it can be Pasted into another area of the same application or into another Windows application. To avoid losing this item, you should Paste it before performing any additional editing.

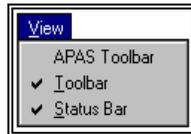
Copy

Select the COPY command to make a COPY of the selected item and temporarily copy it to the Windows Clipboard. The items are placed in the clipboard so that it can be Pasted into another area of the same application or into another Windows application. To avoid losing this item, you should Paste it before performing any additional editing.

Paste

Select the PASTE command to insert a copy of the item currently in the Windows clipboard. This item could have been cut or copied from almost any Windows application.

VIEW COMMAND MENU



APAS Toolbar

Selected to toggle on/off the APAS toolbar. When this option is active, the APAS toolbar will be displayed and allow the user to select additional APAS modules while keeping the current program open. The toolbar can be positioned to the desired position by dragging it with the mouse.

Toolbar

Selected to alternately either display or hide the Toolbar located at the top of the ANALOG window. The check mark to the left indicates that the Toolbar will be visible.

Status Bar

Selected to alternately display the status bar located at the bottom of the ANALOG window. The check mark indicates that the Status Bar will be visible.

SAMPLE COMMAND MENU



A/D

Selected to set the mode to analog sampling. It is called A/D mode because actual analog-to-digital conversion is performed. The current mode is indicated in the status bar.

File

Selected to set the mode to file. This option allows previously sampled and saved data to be read or retrieved from a data file. The current mode is indicated in the status bar.

Start

The Start command is selected to initiate sampling of the analog data channels. The analog input is controlled by the analog sampling parameters that are displayed in the parameter bar.

COP

The COP command is selected to begin force platform analog sampling in the real time center-of-pressure (COP) mode.

Next

The Next command is selected to read the Next sequential data set in the analog file.

Prev

The Prev command is selected to read the previous sequential data set in the analog file.

Select

The Select command is used to display a list of all data sets in the active analog file. The desired set can then be Selected from the available list.

Save Data

Selected to Save the current data set to the active analog file.

GRAPH COMMAND MENU



1st Group

Selected to display graph of 1st Group of channels.

2nd Group

Selected to display graph of 2nd Group of channels.

3rd Group

Selected to display graph of 3rd Group of channels.

New

Selected to create a new graph of channels.

Add

The Add command can be selected to add channels to the current graph.

EXPORT COMMAND MENU



New

Selected to create a new spreadsheet file for storing the analog data.

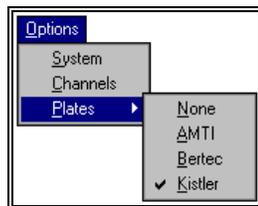
Old

Selected to open an existing spreadsheet file.

Save

The Save command is selected to save the current analog data set to the active spreadsheet file.

OPTIONS COMMAND MENU



System

The System command is selected to specify system options when opening the Analog module.

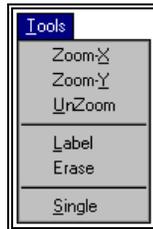
Channels

The Channels command is used to set or change the individual analog channel definitions in the analog channel table.

Plates

The Plate command is used to define special force platform processing by assigning a block of analog input channels to predefined force platform signals. When this command is selected, an additional menu will be displayed for various makes of force platforms.

TOOLS COMMAND MENU



Zoom X

The Zoom X command is selected to zoom the X-axis of the currently displayed graph. The Zoom command can be selected numerous times to maximize the resolution of the graph.

Zoom Y

The Zoom Y command is selected to zoom the Y-axis of the currently displayed graph. The Zoom command can be selected numerous times to maximize the resolution of the graph.

Unzoom

The Unzoom command is selected to remove all zooming commands on the currently displayed graph.

Label

The Label command is used to select from a number of specialized labeling options.

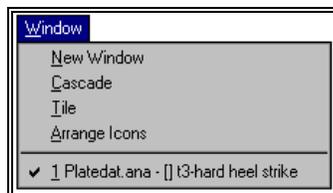
Erase

The Erase command is used to remove all labels from the currently active graph.

Single

The Multiple/Single command is selected to toggle between multiple and single display modes. In the "Multiple" mode, all channels on the list are drawn on a single graph. Alternately, in the "Single" mode, each channel is displayed on a single graph.

WINDOW COMMAND MENU



New Window

Selected to open a new window for the active document.

Cascade

Selected to arrange all programs that are window sized in an overlapping CASCADE. This will not arrange a program that has been minimized to an icon.

Tile

Selected to re-size the program windows to fit side-by-side on the screen. Since Windows will include all programs that are window-sized in the tile setup, it is best to minimize all programs that are not currently being used so it will not take up space on the screen.

Arrange Icons

Selected to automatically ARRANGE ICONS in a straight row. The user has no control over where the icons are placed.

HELP COMMAND MENU



Index

Selected to provide an INDEX of Help related topics.

Using Help

Selected to provide instructions on using the Help Windows.

About ANALOG

Provides program information, version number and copyright for the ANALOG program.

