Aerodynamics Research Center

Mechanical and Aerospace Engineering

University of Texas, Arlington

DSP TRAQ-I DAQ System

Operating Guide

Version 1.1

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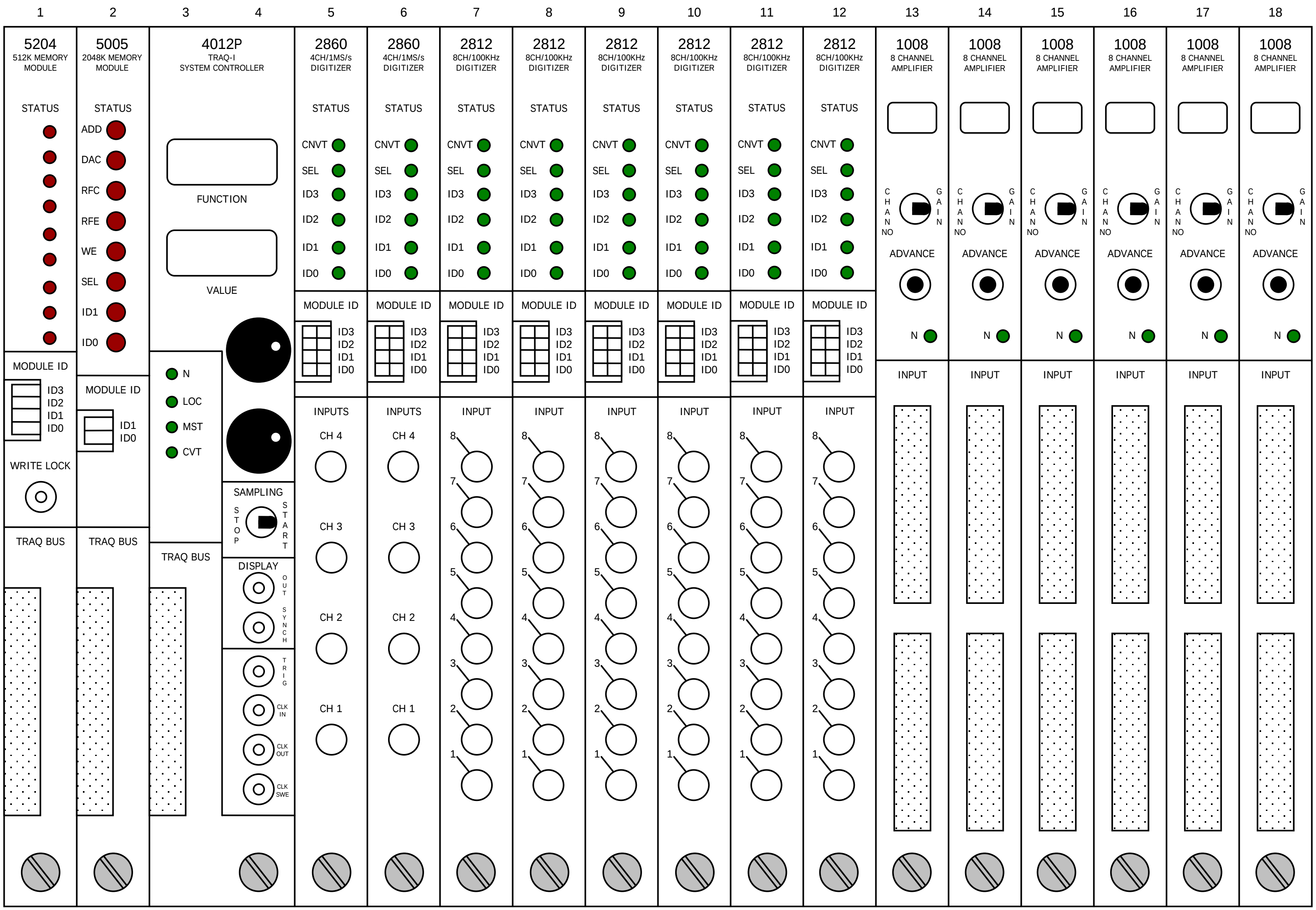
A. Introduction

The DSP TRAQ-1 DAQ System was designed to be a high-end analogue/digital input and output data acquisition system, capable of handling up to a maximum of 256 data channels (although the present machine has only 64 inputs). Supporting a maximum of 16-bit sampling bit-rate with simultaneous-sampling data acquisition ability, it remains a formidable DAQ system till today. It consists of modular components such as system controllers, digitizers, amplifiers and memory buffers, which allow flexible configurations to the hardware. Specially customized software is required to configure and run the data acquisition successfully.

During a typical data acquisition, data signals are transmitted into the 5-pin Amphenol connectors located at the system front panel which are subsequently channeled into Model 1008 amplifiers. After imposing the gain upon the data signals, the latter are transmitted into the digitizers which discretize the analogue signal into digital signals through Analog-to-Digital Converters (or ADCs). There are two types of digitizers available on the system: (a) Model 2860 which allows 10-bit sampling bit-rate at 1MHz sampling frequency, and (b) Model 2812 which allows 12-bit sampling bit-rate at 100KHz sampling frequency. Model 2860 supports up to 4 channels per module (for a total of 8 channels), whereas Model 2812 supports up to 8 channels per module (for a total of 48 channels). Usually, Model 2812 digitizers are used as their maximum sampling rates are sufficiently high for most experiments. These digitizers are at the heart of the high-speed simultaneously-sampling capability of the DAQ system. The high-speed Model 5005 memory modules in turn store the sampled data signals until retrieved by the operator using a PC.

This guide reports on the configurations required for a successful data acquisition, saving and reviewing data files, as well as post-processing them using modern software.



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5204
512K MEMORY MODULE
STATUS
MODULE ID
ID3
ID2
ID1
ID0
WRITE LOCK
TRAQ BUS
5005
2048K MEMORY MODULE
STATUS
ADD
DAC
RFC
RFE
WE
SEL
ID1
ID0
MODULE ID
ID1
ID0
TRAQ BUS
4012P
TRAQ-I SYSTEM CONTROLLER
FUNCTION
VALUE
N
LOC
MST
CVT
TRAQ BUS
SAMPLING
STOP
START
DISPLAY
OUT
SYNCH
TRIG
CLK IN
CLK OUT
CLK SWE
2860
4CH/1MS/s DIGITIZER
STATUS
CNVT
SEL
ID3
ID2
ID1
ID0
MODULE ID
ID3
ID2
ID1
ID0
INPUTS
CH 4
CH 3
CH 2
CH 1
2812
8CH/100KHz DIGITIZER
STATUS
CNVT
SEL
ID3
ID2
ID1
ID0
MODULE ID
ID3
ID2
ID1
ID0
INPUT
8
7
6
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4
3
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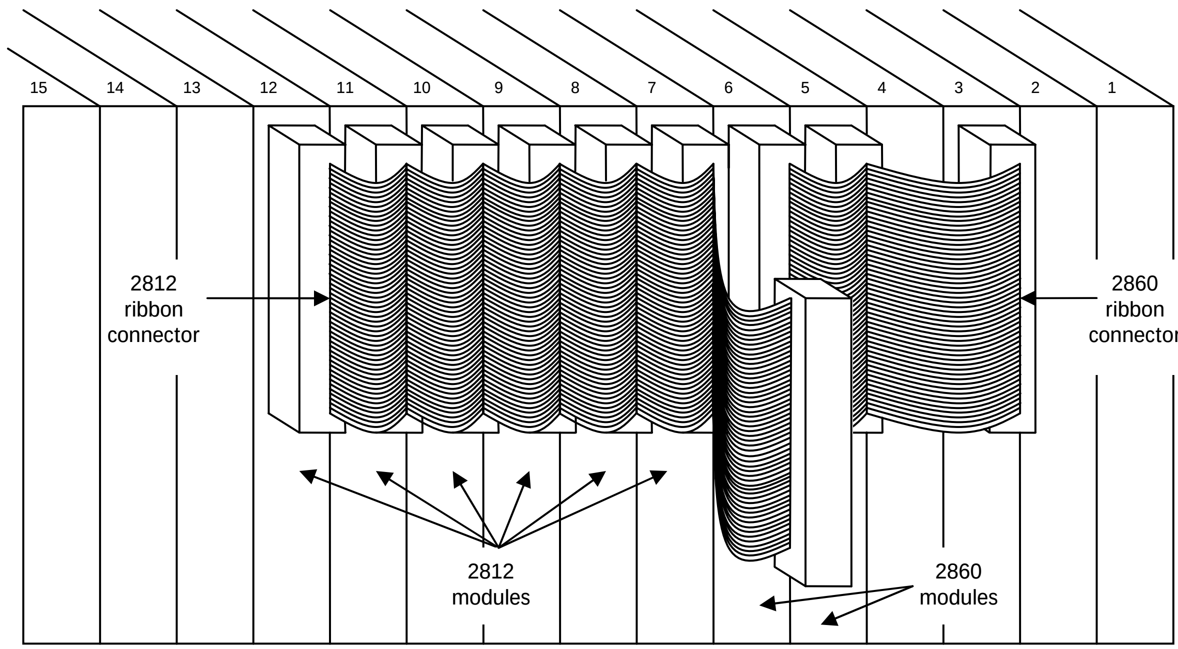
1
1008
8 CHANNEL AMPLIFIER
CHAN NO
GAIN
ADVANCE
N
INPUT

A little information on the hardware

The figure shown in the previous page shows the front panel of the DAQ system. The DAQ system is essentially a rack mount system which means that the modules are slide into the rack mount. The first number at the top of each module is the module series number and the function/role of the module is abbreviated right below the module series number. Two high-speed memory modules, 5204 and 5005 are available in Rack 1 and 2, followed by the 4012P TRAQ-I system controller taking up both Rack 3 and 4. Rack 5 and 6 consist of the 2860 10-bit 1MHz high-speed data acquisition modules, while Rack 7 to 12 contain the lower-speed 2812 12-bit 100KHz data acquisition modules. 1008 amplifier modules sit in Racks 13 to 18.

These modules can be located anywhere in the rack mount system, the only condition being that **the module ID must be unique**. The module ID can be set using the dip switches located on the module front panel. Due to the configuration of the ribbon connector located behind the modules, the usage of the high-speed 2810 modules usually excludes the use of the 2812 modules. The figure below illustrates the high-speed data acquisition configuration. As can be seen, the high-speed configuration makes use of a relatively short ribbon connector connecting from the two daisy-chained output ports behind the 2860 modules to the input port behind the 4012P TRAQ-I system controller. In this case, the low-speed modules are not used at all. Note that the six 2812 modules are daisy-chained using another ribbon connector, albeit longer to accommodate the six modules. Similarly, there is an output connector meant to be connected to the 4012P but not used in this configuration. To use the 2812 modules, the 2860 modules can be removed to make room for two 2812 modules OR; remove the 2860 modules and relocate 4012P TRAQ-I system controller to rack location 5 and 6. In the second configuration, all 48 channels (6 modules x 8 channels/module) on the 2812 modules can be utilized. Remember to update the new rack location of the 4012P TRAQ-I system controller in the workstation software if this is done.


15
14
13
12
11
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5
4
3
2
1
2812 ribbon connector
2860 ribbon connector
2812 modules
2860 modules

B. Starting the data acquisition program

1. Power up the DSP DAQ system and ensures that the DAQ bus extender is properly power up. The DAQ bus extender needs to communicate to the PC bus extender to get a hardware handshake, which allows for the PC to configure and control the DAQ system successfully.

2. Switch on the computer system. It's an Intel 486 machine so you have to wait awhile.

3. After booting up, you will see the C drive prompt.

```
C:\
```

4. Go to D drive by entering "**d:**" and hit **ENTER** key.

```
C:\d:
```

5. Get into the DAQ operating directory by entering "**cd psp**" and hit **ENTER** key.

```
C:\d:
D:\cd psp
```

6. To run the data acquisition program, enter "**psprun**" and hit **ENTER** key.

```
C:\d:
D:\cd psp
D:\PSP\psprun
```

7. The program will start and you will see the **MAIN MENU** with the corresponding function key listing the various operating tools.

MAIN MENU

F1	Configure system
F2	Session control
F3	Data acquisition
F4	Data review
F5	Environment
F6	DOS command
F10	Exit

C. Configuring the channels

1. Hit **F1** to go into the **SYSTEM CONFIGURATION** screen.

2. You will see a listing of all the physical rack locations (**N**) which are available in the DAQ SYSTEM. These rack locations are where the DAQ hardware modules are located. Hence before anything else, you have to tell the program what kind of DAQ hardware modules (for example, a digitizer or amplifier) is located at which rack location.

SYSTEM CONFIGURATION

Crate: 1

N	ch	Device	s/n	Signal Name	Device Status	Device Access	Acquisition Enabled
1	0		....			local	disabled
2	0		....			local	disabled
3	0		....			local	disabled
4	0		....			local	disabled
5	0		....			local	disabled
6	0		....			local	disabled
7	0		....			local	disabled
8	0		....			local	disabled
9	0		....			local	disabled
10	0		....			local	disabled
11	0		....			local	disabled
12	0		....			local	disabled
13	0		....			local	disabled
14	0		....			local	disabled
15	0		....			local	disabled
16	0		....			local	disabled

Ins: ↑↓

F3:setup F4:init F5:load F6:save F7:auto F10:exit

3. For typical data acquisitions, only the relevant amplifiers (**1008** 8-channel amplifier) and TRAQ-I system controller (**4012P** system controller) locations need to be specified. The 4012P is currently located at rack 4 location (N=4).

*Note: As the name suggests, each amplifier is responsible for up to eight data channels. There are six amplifiers located from rack 13 to 18 locations (N=13 to 18) for a total of forty-eight data channels. Signals to be acquired are to be connected to the five-pin female amphenol connectors on the front panel using appropriate cabling. Channels 1 to 8 are sent to the digitizer (**2812** 12-bit digitizer) before channeling into the first amplifier with every set of eight channels going into the next amplifier i.e. channels 9 to 16 are sent to the second amplifier.*

In all DAQ systems, data acquisition is carried out by sampling the source voltage signals and subjecting them to discretizations. (Optional signal conditioning such as noise filtering and amplifications are also available on most systems) Analogue voltage signals are continuous in nature and the sampling carried out by DAQ system essentially breaks down the continuous voltage signals into discrete points, albeit a large amount of them. Hence, to obtain data points which can be considered as a pseudo-continuous voltage signals, it is usually desired to sample *the signals at high sampling rate as well as high bit-rate. The default bit-rates for many modern DAQ cards from National Instruments and Data Translation are 16-bits. The bit-rate determines the number of discrete levels which the voltage signals can be divided into. For example, as a comparison, a 12-bit DAQ system can produce 2^{12} or 4096 discrete levels whereas a 16-bit DAQ system is able to generate 2^{16} or 65536 discrete levels. Hence, the 16-bit DAQ system is 16 times more sensitive than the 12-bit DAQ system and that leads to significantly better control over truncation errors during discretizations.*

4. To configure the TRAQ-I system controller, move the arrow keys until the highlighted area reaches the **Device** column along **N=4** row. Hit the **INSERT** key to enter into selection mode and use the arrow keys to scroll through the list of available DAQ hardware modules. Select **4012** since the TRAQ-I system controller is physically located at rack 4 location.

5. Hit **INSERT** key again to get out of selection mode and move the highlighted area to the **Device** column along **N=13** row. Hit the **INSERT** key to enter into selection mode and use the arrow keys to scroll through the list of available DAQ hardware modules. Select **1008** since the amplifier module is physically located at rack 4 location.

6. If the total number of channels to be sampled are less than or equals to eight, configuring one 1008 amplifier module is sufficient. For channel counts higher than that, more 1008 selections need to be made in the **Device** column along **N=14 and/or higher numbered rows**. For simplicity, this guide will explain for the case where the total number of sampling channels are less than or equals to eight as the steps for adding and configuring more 1008 amplifier modules are the same.

7. Once these selections have been made, the **SYSTEM CONFIGURATION** menu will look like this:

SYSTEM CONFIGURATION

Crate: 1

N	ch	Device	s/n	Signal Name	Device Status	Device Access	Acquisition Enabled
1	0		....			local	disabled
2	0		....			local	disabled
3	0		....			local	disabled
4	0	4012	....	1	offline	remote	enabled
5	0		....			local	disabled
6	0		....			local	disabled
7	0		....			local	disabled
8	0		....			local	disabled
9	0		....			local	disabled
10	0		....			local	disabled
11	0		....			local	disabled
12	0		....			local	disabled
13	0	1008	....	13	offline	remote	enabled
14	0		....			local	disabled
15	0		....			local	disabled
16	0		....			local	disabled

Ins: ↑↓

F3:setup F4:init F5:load F6:save F7:auto F10:exit

8. Now that the appropriate hardware modules are selected, the detailed configurations will have to be made regarding sampling rates, gains and etc.

9. Move the arrow keys until the highlighted area moves to the **4012** device. Hit **F3** to **setup** the configuration for that module. The following **MODULE CONFIGURATION** screen will be shown:

```
                           MODULE CONFIGURATION

Crate: 1       Device: TRAQ 1 multi-channel recorder sub-system
Station: 4     Signal:          1              Device Status: OFFLINE
Model: 4012    Access: LOCAL                   Acquisition: ENABLED
s/n: .........  Used:                          Updated: 09-16-04 10:39:02
--------------------------------------------------------------------------
Timebase Units  :  1.      sec           per second
         Clock1 :  20000.  samples per sec       Source  :  INTERNAL
         Clock2 :  2000.   samples per sec       Mode    :  CLOCK 1
TRIGGER  Delay  :  0.      sec                   Source  :
         Post   :  6.5536  sec                   Address: crate 1 station 4
MEMORY   per ch:   256  k  samples    Total   :   256  k   samples
CHANNEL  Active (NOC):   1            Total   :     1  Mode (4012P):  DATA
--------------------------------------------------------------------------
         Number  :   1              Memory  : 13.1072 sec
         Name    :   1              Status   : ACTIVE   Type  :
         Units   :  10.   volts          full scale      Mode  :  BIPOLAR
         Offset  :   0.   volts
--------------------------------------------------------------------------

 F1:remote   F2:controller                          F7:init      F10:exit
```

10. The **MODULE CONFIGURATION** by default goes into **LOCAL** access mode. It allows you to make changes to the units i.e. sec, samples per sec, but not the actual number. **LOCAL** access makes changes to the configuration where no communication is required with the DAQ system, such as the **Timebase**.

11. The configuration defaults to second timebase. To change the **Timebase** or fundamental time unit, move the arrow keys until it reaches the "**sec**" area along the **Timebase** row. Hit **INSERT** key and type in "**millisec**" if millisecond timebase is desired. Do the same to replace "samples per sec" with "samples per millisec" for the **Clock1** sampling rate if desired. It is recommended to keep consistent timebase units to avoid confusion.

12. Once the units for the timebase have been adjusted as desired. Hit **F1** to enter **REMOTE** access. **REMOTE** access allows changes to be made which require communication with the DAQ system during initialization stage, such as sampling rate. Use the arrow keys to move to the desired areas.

13. As indicated by the **Source**, the timing for the data acquisition is internal-based. That is, the timing for data sampling is decided by the onboard oscillator or clock. This DAQ system has two onboard clocks, **CLOCK 1** and **CLOCK 2**. **CLOCK 1** is already selected under **Mode**.

14. Therefore, the sampling rate should be adjusted under **Clock1**. To adjust **Clock1**, move the arrow keys until it reaches the "**20000.**" area along the **Clock1** row. Hit **INSERT** key and use the up/down arrow keys to select the desired sampling rate.

15. If the **TRIGGER** signal comes from an external source, it may be set under **Source**. However, if the triggering is done manually, it can be left blank. To change the setting, move the highlighted area using the arrow keys to the desired area. Hit **INSERT** and use the arrow keys to change the trigger source. In most cases, triggering signal comes through the trigger port on the 4012 system controller. Hence there is no need to set any **Source**.

16. **Delay** for the **TRIGGER** can be specified if the operator need some time delay after the trigger (external or manual trigger). For most data acquisitions, it can be set to 0sec. To change the value, move the highlighted area using the arrow keys to the desired area. Hit **INSERT** and use the arrow keys to adjust the trigger time delay.

17. **POST** for the **TRIGGER** is by default set to 50% of the total acquisition time. This represents an **about-trigger** type operation, where 50% of the pre-trigger data and 50% of the post-trigger data are captured. Depending on the needs of the data acquisition, it can be varied at 1/8th of data record length intervals. To change the value, move the highlighted area using the arrow keys to the desired area. Hit **INSERT** and use the arrow keys to adjust the post-trigger fraction.

18. The DAQ system is a **simultaneous-sampling** system which means that ALL channels are sampled together instead of "sample and hold" multiplexed sampling. Each channel has its own dedicated ADC to process the data sampling. All sampled data are channeled into a high-speed 2048K memory buffer (**5005** memory module). Hence, the maximum attainable number of samples will be 2048k samples after system initialization.

19. The allocated **MEMORY** per channel is 256k samples and the **Total** is 256k as well. This is because only one channel is currently set up. Note that 1k samples is equivalent to 1024 samples. To change the value, move the highlighted area using the arrow keys to the desired area. Hit **INSERT** and use the arrow keys to adjust the number of samples per channel. The total number of samples cannot be changed as it will be calculated automatically by the system.

20. **CHANNEL Active (NOC)** shows the number of active channels used and **Total** shows the number of channels physically attached to **4012P**. Hence, the number stated under **CHANNEL Active (NOC)** must be less than or equals to the number stated under **Total**. All memory and samples will be calculated based on the number of active channels only. To change the value, move the highlighted area using the arrow keys to the desired area. Hit **INSERT** and use the arrow keys to adjust the number of channels.

21. Further down below the separator line, the **Number** indicates the present channel number. **Memory** indicates the time length of the acquired data for this channel based on sampling rate and allocated memory. It is also the time required for the data acquisition process. To view other channel numbers, move the highlighted area using the arrow keys to the desired area. Hit **INSERT** and key in the desired channel number. All information will be refreshed to reflect on the new selected channel.

22. By default, the **Name** for that particular channel number is set to the same number. However, it can be changed to represent more logical naming systems i.e. PT1, OXY and etc. To change the name, move the highlighted area using the arrow keys to the desired area. Hit **INSERT** and key in the desired channel name.

23. The **Status** will be shown as **ACTIVE** if that particular channel is among the active channels. Conversely, it will be shown as **INACTIVE** if it is not.

24. The **Units** represent the maximum full-scale reading. Depending on the data acquisition, it can be set to volts, psi, amps and etc. Usually, it is either set to volts or psi. The maximum full-scale reading can be changed as well. Note that it should be higher than the anticipated maximum measured value so as not to cause voltage saturation. To change the values for both, move the highlighted area using the arrow keys to the desired area. Hit **INSERT** and key in the desired value or unit.

25. **Mode** can be changed between **UNIPOLAR** or **BIPOLAR**. For unipolar mode, the full-scale reading will be used purely from 0 to the value stated i.e. 0 to 10 volts. On the other hand, for bipolar mode, the full-scale reading will be used equally in the positive and negative domain i.e. -5 to +5 volts. Unipolar can be used to double the range of the measurement if all measurements do not have negative readings at all. However, as a precaution, **BIPOLAR** is usually used just in case the measurements actually manage to drop below 0 volts/psi.

26. For some sensors, they may have a non-zero bias voltage even when not in measuring conditions. This is usually caused by the excitation voltage which leads to slight output voltage offset. Unless the bias voltage is large, most sensors would still be considered as relatively accurate when no **OFFSET** was stated. This ultimately depends on the choice of the operator. Similarly, to change the values for the value or unit, move the highlighted area using the arrow keys to the desired area. Hit **INSERT** and key in the desired value or unit.

27. Repeat the necessary steps for each of the active channels. When finished, hit **F10** to exit the **MODULE CONFIGURATION** screen and the **SYSTEM CONFIGURATION** screen will appear.

28. Move the highlighted area using the arrow keys to row 13 where the **1008** 8-channel amplifier module is located. Hit **F3** to **setup** the configuration for that module. The following **MODULE CONFIGURATION** screen will appear:

MODULE CONFIGURATION

Crate: 1	Device: 8-channel prog. gain amplifier	
Station: 13	Signal: 13	Device Status: OFFLINE
Model: 1008	Access: LOCAL	Acquisition: ENABLED
s/n:	Used:	Updated: 09-16-04 10:39:02

Note: Gains entered here must be factored into conversion factors for transient recorder channels.

CHANNEL	GAIN V/V	INPUT FROM CRT STN CHN	OUTPUT TO CRT STN CHN
1	1024		
2	1024		
3	1024		
4	1024		
5	1024		
6	1024		
7	1024		
8	1024		

Ins: ↑↓

F1:remote F7:init F10:exit

As the name implies, the amplifier amplifies the data signal before actual data acquisition by imposing gain on it. This is useful for sensor outputs in the mV region although electrical noise will be amplified together as well. The gain has to be set such that the maximum voltage/pressure input acquired by the DAQ system will not exceed the full-scale reading stated in the 4012P MODULE CONFIGURATION for that channel, after multiplying the input by the gain factor. For example, for a bipolar input of 10volts full-scale, if the maximum anticipated voltage output by the sensor is 0.05volts, the maximum gain that should work within the -5 to +5volts will be 100. However, gain is always in 2^n *form and thus the highest gain that can be set in the above MODULE CONFIGURATION screen will be 64. The maximum acquired voltage will be 3.2V after amplification.*

29. To change the values of the **GAIN** factor, hit **F1** to enter **remote** mode. Move the highlighted area using the arrow keys to the desired area. Hit **INSERT** and use the arrow keys again to select the desired gain values for the active channels.

30. The gain can set as either input gain or output gain. The operator will have to decide which gain to use, although for data acquisition purposes alone without outputting any voltage signals, input gain is sufficient. If the channel configuration has been set up properly in the **4012P MODULE CONFIGURATION**, there is no need to enter more information under the "**INPUT FROM CRT STN CHN**" column. If not, hit **F1** to enter **local** mode. Move the highlighted area using the arrow keys to the areas under the "**INPUT TO CRT STN CHN" column**. Hit **INSERT** and key in the crate, station and channel numbers of the input channels where the gain is needed.

31. In the case where output gains need to be keyed in, hit **F1** to enter **local** mode. Move the highlighted area using the arrow keys to the areas under the "**OUTPUT TO CRT STN CHN" column**. Hit **INSERT** and key in the crate, station and channel numbers of the output channels where the gain is needed.

32. Once all the gain values have been selected for all active channels, hit **F10** to **exit**. The **SYSTEM CONFIGURATION** screen will appear. Hit **F4** to **initialize** all configurations. The screen will refresh and the following screen will appear.

SYSTEM CONFIGURATION

Crate: 1

N	ch	Device	s/n	Signal Name	Device Status	Device Access	Acquisition Enabled
1	0		....			local	disabled
2	0		....			local	disabled
3	0		....			local	disabled
4	0	4012	....	1	configured	local	enabled
5	0		....			local	disabled
6	0		....			local	disabled
7	0		....			local	disabled
8	0		....			local	disabled
9	0		....			local	disabled
10	0		....			local	disabled
11	0		....			local	disabled
12	0		....			local	disabled
13	0	1008	....	13	configured	local	enabled
14	0		....			local	disabled
15	0		....			local	disabled
16	0		....			local	disabled

Ins: ↑↓

F3:setup F4:init F5:load F6:save F7:auto F10:exit

33. It is always better to hit **F3** to enter **setup** mode and go through all the settings again to make sure all are correct before running the actual data acquisition. Once every setting has been verified, the operator can proceed to create a session for the data acquisition.

34. If these settings remained the same for most or all of the future data acquisitions, the operator may hit **F6**, name and **save** the configuration file. Hence, the next time the **SYSTEM CONFIGURATION** is loaded; the operator can hit **F5**, type in the configuration file name and **load** it.

35. Hit **F10** to exit to the **MAIN MENU**.

D. Configuring session control

1. Before running the data acquisition, the program needs to know which file it should write the data to should the operator choose to save the data after the run. It allows the operator to enter some header information in the title portion of the data file to help to understand the data acquisition.

2. At the **MAIN MENU**, hit **F2** to enter **SESSION CONTROL**. The following screen will appear:

```
                SESSION CONTROL

        LU    STATUS    SESSION

   =>   0     closed                 <=
        1     closed
        2     closed




                                            Ins: ↑↓
                                            F10:exit
```

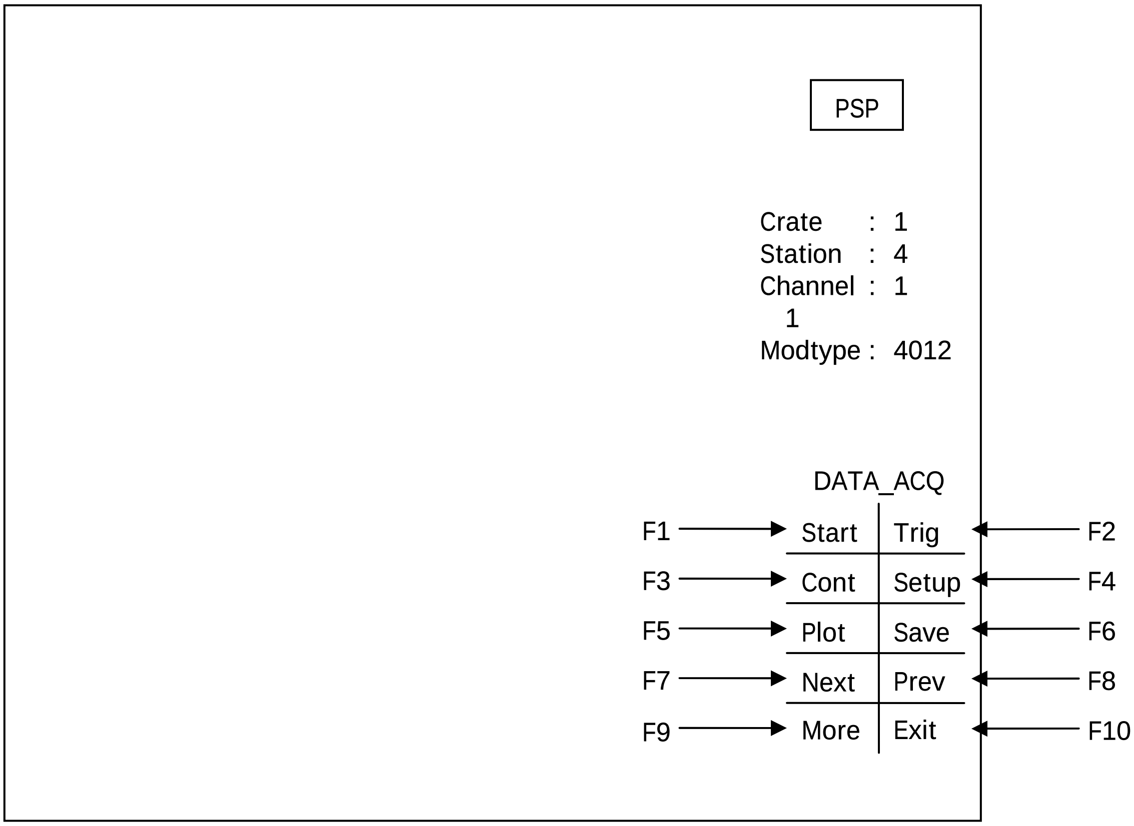
3. Move the highlighted area to the **LU=0** line under **STATUS** column. Hit **INSERT** key and use the arrow keys until the **STATUS** is set to "**write**" mode. Hit **ENTER** key and the highlighted area will move to the **SESSION** column. Key in the relevant binary file name (Note: without the TDT file extension) and hit **ENTER** key again. Two files with the names, given_name.TDT and given_name.TCF, will be created. The first file will be data file (DT) while the second file will be the configuration file (CF). The following screen will appear:

```
                SESSION CONTROL

      LU    STATUS    SESSION

  =>   0     write       test     <=
       1     closed
       2     closed
-----------------------------------------------------
 Title :
 Start Time  :      @     Mode     :
 Stop Time   :      @     Records  :      Format :


                                                text
                                             F10:exit
```

4. The cursor will be located in the highlighted area under **Title**. Key in the working parameters of the data acquisition in this area and hit **F10** to **exit**. The **MAIN MENU** will appear again and that concludes that **SESSION CONTROL**.

E. Running the data acquisition and saving the data

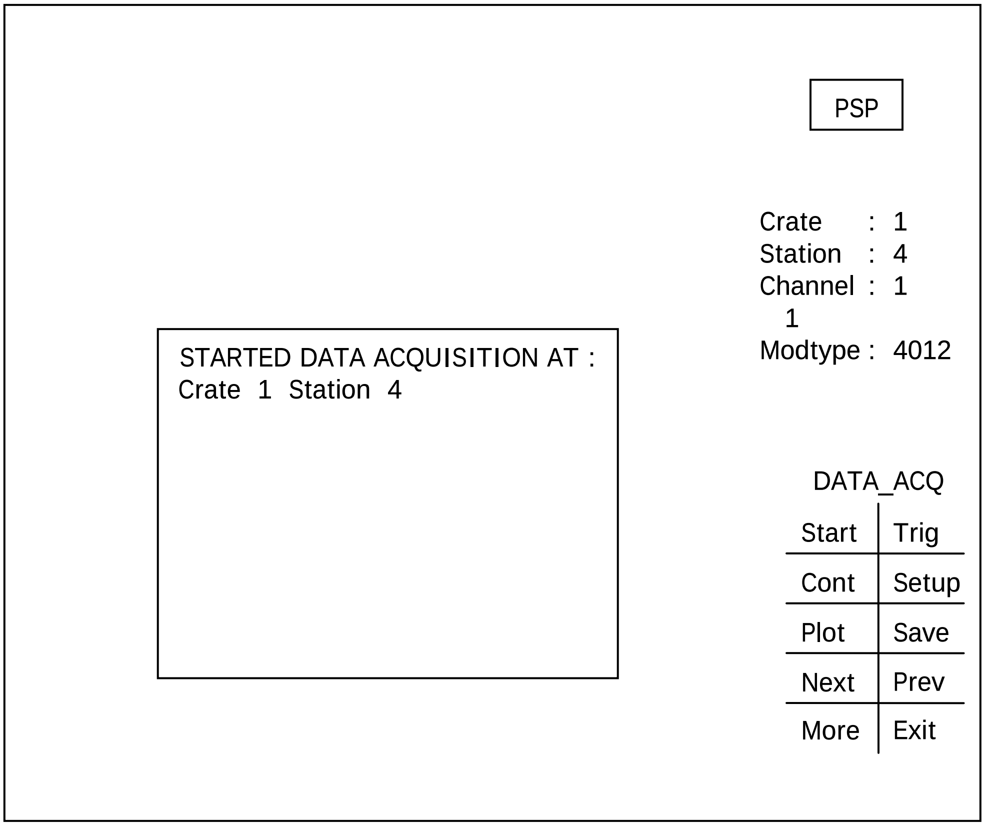
1. To begin data acquisition, hit **F3** in the **MAIN MENU** to enter **Data Acquisition** mode. The following screen will appear:



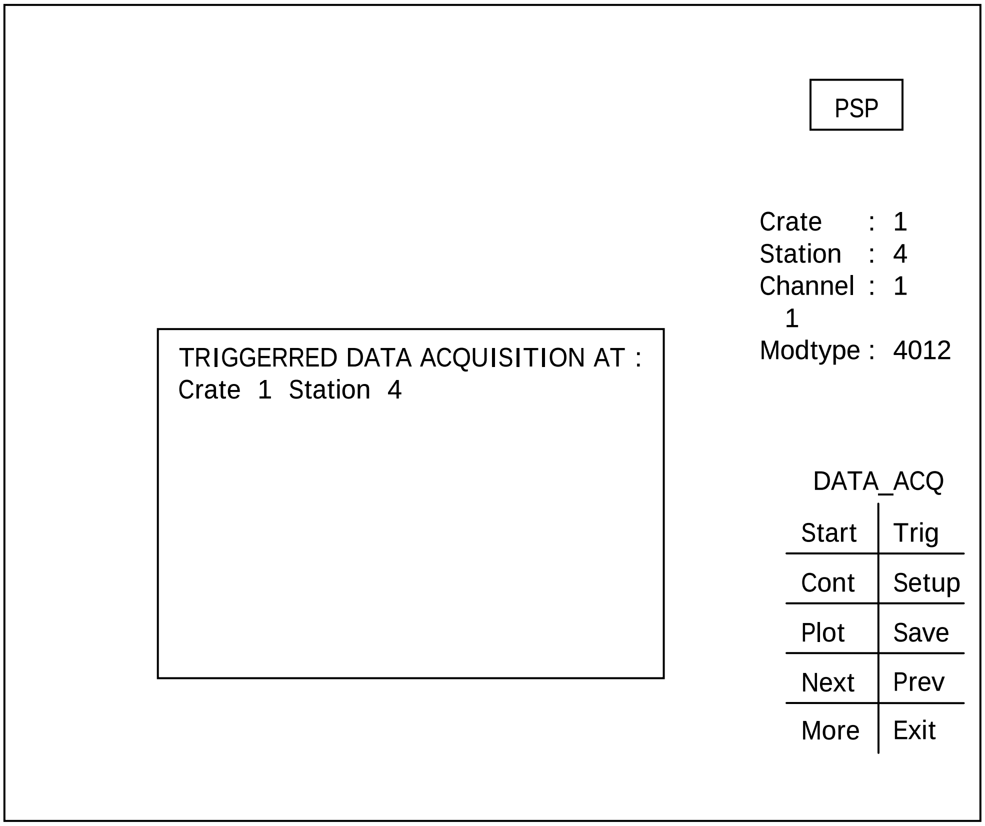
2. The data acquisition is a two-step procedure. Firstly, the operator will have to hit **F1** to **start** the data acquisition process in a standby mode. The data will be streamed into the active 1008 digitizer modules for *sampling* but will not be *captured* until an external trigger tells the DAQ system to capture both pre-trigger and post-trigger data according to the ratio stated in the **SYSTEM CONFIGURATION** under 4012 system controller settings.

3. **F3** (**Cont**) has no effects on the present setup as it affects only averaging modules. **F4** (**Setup**) will return the operator back to the **SYSTEM CONFIGURATION** screen. **F9** (**More**) will show more menu commands but the most useful function will be to tell the software to save the data of all channels at one go instead of channel by channel manually.

4. The following screen appears after hitting **F1**:



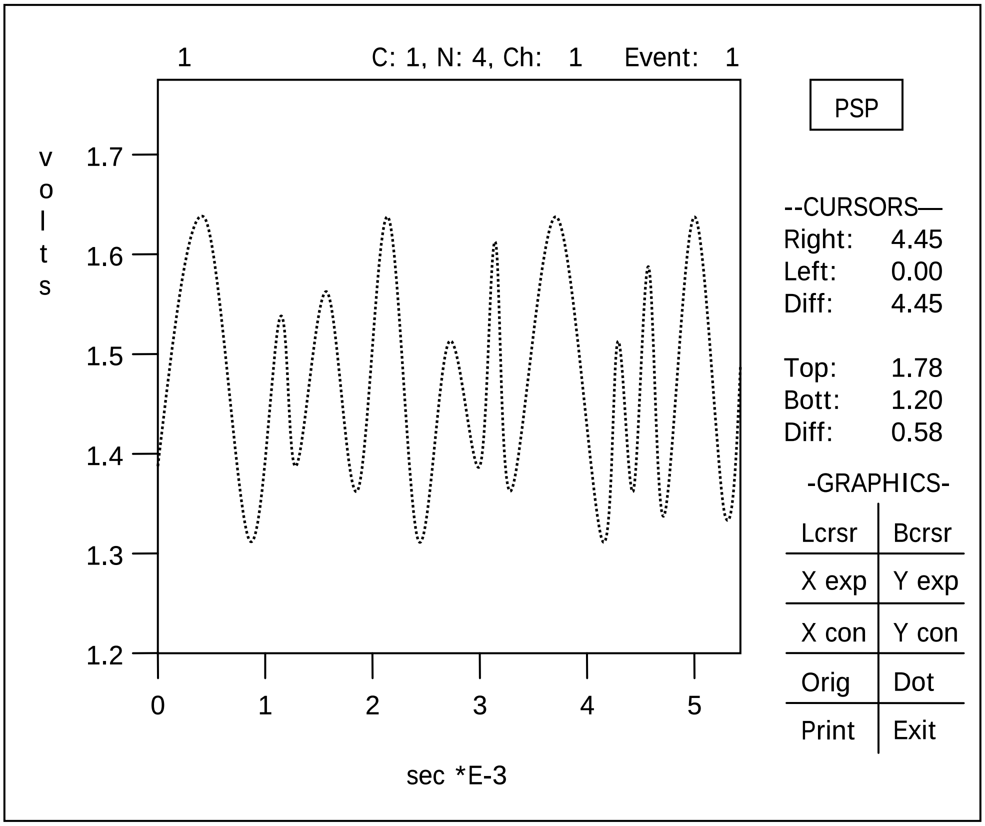
5. The triggering can come in three forms, either manual triggering by hitting **F2**, a stated non-zero time delay or by an external triggering. The latter two can be selected n the **SYSTEM CONFIGURATION** under 4012 system controller settings as well. The following screen appears after hitting **F2**:



6. Upon receiving the trigger either from the operator or external sources, the digitizer will take the triggering point as time=0sec and begin the capturing. Pre-trigger data will appear in the negative time-domain while post-trigger will appear in the positive time domain. The ratio of pre-trigger to post-trigger data can be set as mentioned earlier.

7. As the program will not inform the operator when the capturing stage of the data acquisition process will end, it is always prudent to find out the time needed under **SYSTEM CONFIGURATION** for 4012 system controller setting and wait it out before trying to review the data plots onscreen.

8. When the necessary time has passed, hit **F5** to **plot** the data for the channel number shown near the top-left region. The following example plot will appear:



9. Notice that the crate, station and channel information are listed along the top axis of the plot.

10. The plot is in dot-plotting mode by default. The horizontal axis marks the time-axis while the vertical axis marks the volts, psi or whatever the unit selected during configuration.

11. The operator is able to zoom in certain portions of the plot by using **F1** (**Lcrsr**) and **F2** (**Bcrsr**). **F1** is a toggle between left and right arrow (**Lcrsr** and **Rcrsr**) and when active (indicated at the right bottom corner), it allows the operator to change the minimum and maximum times. Similarly, **F2** is a toggle between up and down arrows (**Tcrsr** and **Bcrsr**) and allows changes to the minimum and maximum measurement readings.

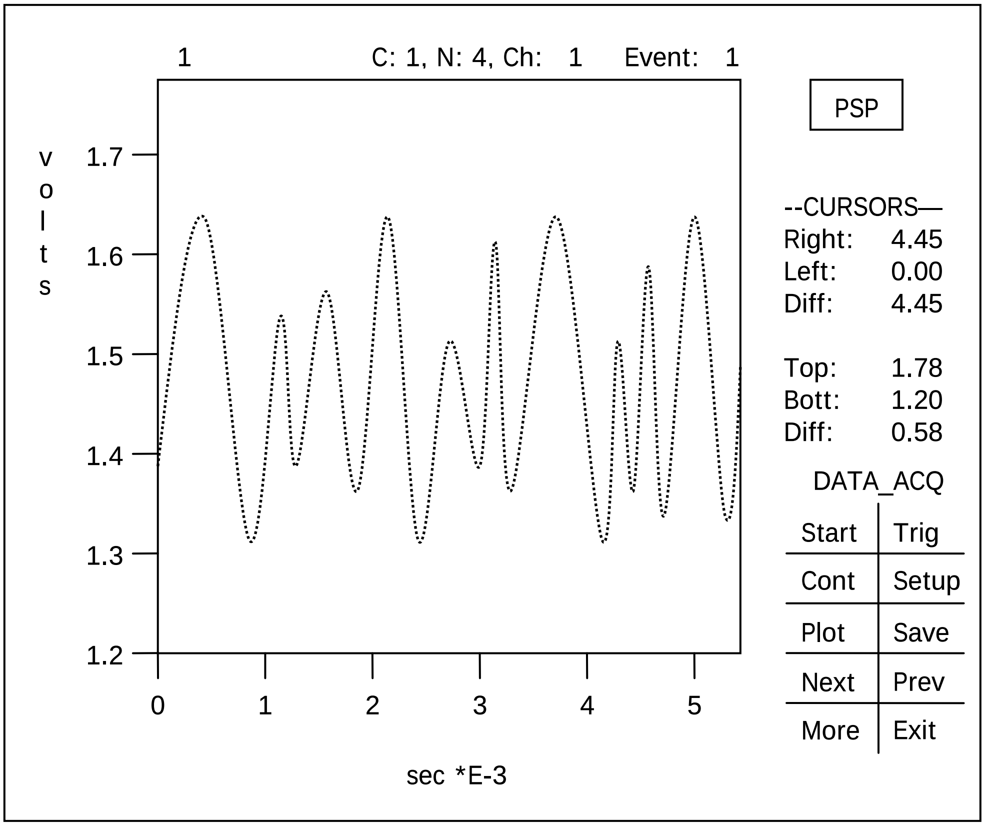
12. Once the limits have been set by the cursors, hit **F3** (**X exp**and) or **F4** (**Y exp**and) to zoom into the plot both in the x- and y-axis respectively. Conversely, hit **F5** (**X con**tract) or **F6** (**Y con**tract) to zoom out in the x-axis and y-axis respectively.

13. To return to the original plot, hit **F7** (**Orig**).

14. To toggle between dot-plotting or line-plotting, hit **F8** (**Dot/Line**). Line-plotting may be significantly slower when the number of data points is very high, but may be much more informative when sampling rate is not too high.

15. Although not immediately applicable here, the operator can hit **F9** (**Print**) and essentially do a PrintScreen and send the print job to a system printer (read: probably only 9 or 24-pin dot-matrix printer) hooked up to the PC.

16. To change to another channel's plot, hit **F10** to **exit** and the plot screen will appear as follows:



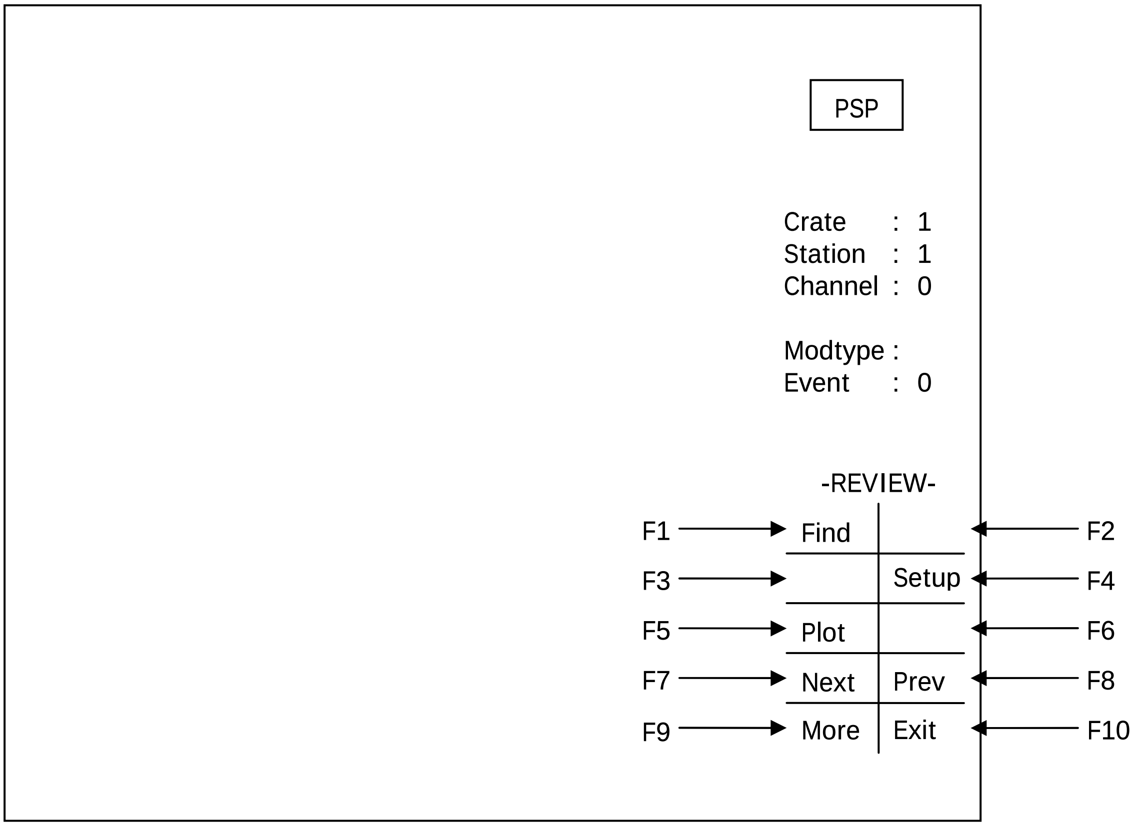
17. To change the channel number, hit **F7** or **F8** to advance one channel up or down. Hit **F5** to refresh the plot and the new plot for the new channel will appear.

18. Once the operator has review the relevant data plots and satisfied with the data integrity, the data for each relevant channel may be saved. Ensure that the plot belonging to the channel to be saved is showing on the screen and hit **F6 (Save)**. A small window will appear and overlay upon the plot to inform the operator that the particular channel's data is being saved. Information on that channel will be shown in the window as well. Once the saving has finished and the small window disappears, the operator can go to **Next** or **Prev** channel and repeat the sequence to save more channel data into the main data file.

19. Once all relevant data has been saved, the operator may hit **F10** to **exit** to the **MAIN MENU** for further operations.

F. Reviewing of saved data file

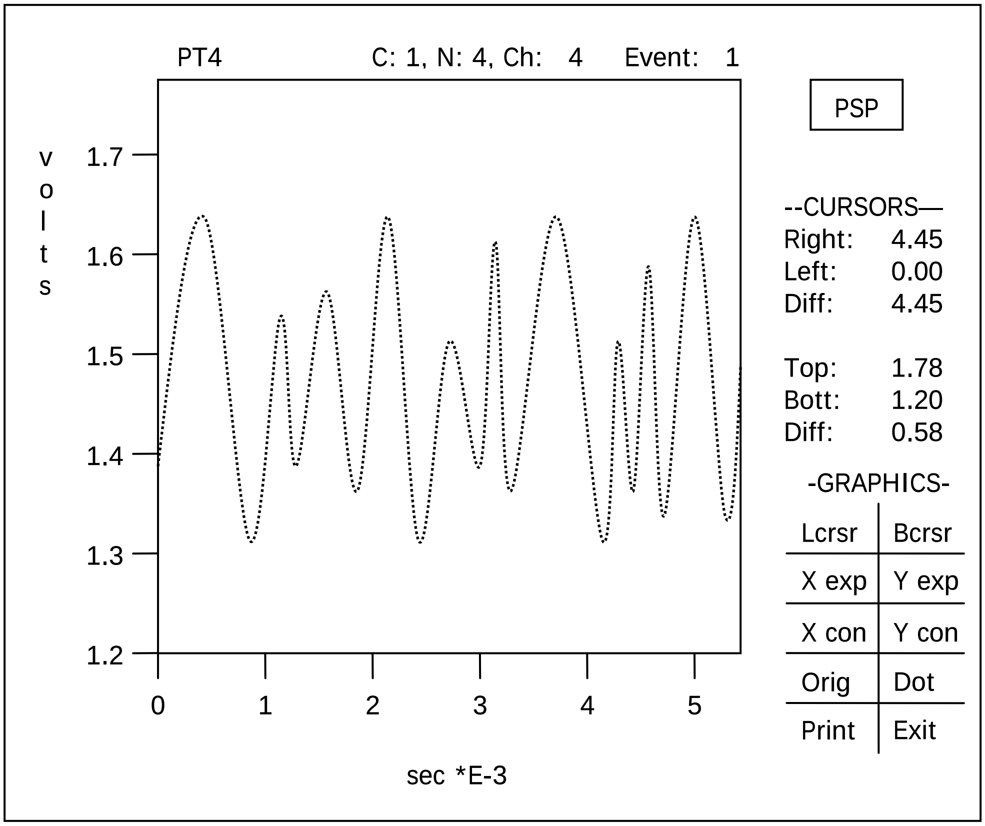
1. Hit **F4** in the **MAIN MENU** to go to **Data Review** section. This is to read in previously written data files and review them on the PC. The following screen will appear:



2. The commands to review the data files are accessible by the function keys associated with the commands at the right bottom corner. For example, in this case where a data file needs to be loaded for review, hit **F1** and the **SESSION CONTROL** screen will appear. Set the command from "**closed**" to "**read**" as per instructions given in the **SESSION CONTROL** section. Hit **ENTER** and key in the data file name. The following screen will appear:

```
                         SESSION CONTROL

              LU    STATUS     SESSION

         =>   0       read      092404     <=
              1     closed
              2     closed
------------------------------------------------------------------
   Title: tyler
   Start time  : 09-24-04   @  11:53:48           Mode    : singles
   Stop time   : 09-24-04   @  12:19:26           Records :      8
------------------------------------------------------------------
   Index key        Search        Value
   Record Nbr         =               1

------------------------------------------------------------------
   Record            :      1      Signal Name:           PT1
   Address – Crate :   1    Station:   4   Channel:    1    Event:    1
   Time – Trigger  : 09-24   12:17:43.000      Restart:  00:00:00.000

                                                              Ins: ↑↓
F1:First  F2:Last  F3:Prev  F4:Next  F5:Find  F6:Search          F10:exit
```

3. Verify that this data file is indeed the correct file by using the function keys to go through the channel listings. As the selected channel changes, it will be reflected in the **Signal Name** and **Channel** listings. The **Signal Name** will show names allocated to the channel during configuration before the data acquisition. If the file is correct, hit **F10** to **exit**. The screen that appears subsequently will show a plot of the channel last listed in the previous screen.



4. The plot is in dot-plotting mode by default. The horizontal axis marks the time-axis while the vertical axis marks the volts, psi or whatever the unit selected during configuration.

5. The operator is able to zoom in certain portions of the plot by using **F1** (**Lcrsr**) and **F2** (**Bcrsr**). **F1** is a toggle between left and right arrow (**Lcrsr** and **Rcrsr**) and when active (indicated at the right bottom corner), it allows the operator to change the minimum and maximum times. Similarly, **F2** is a toggle between up and down arrows (**Tcrsr** and **Bcrsr**) and allows changes to the minimum and maximum measurement readings.

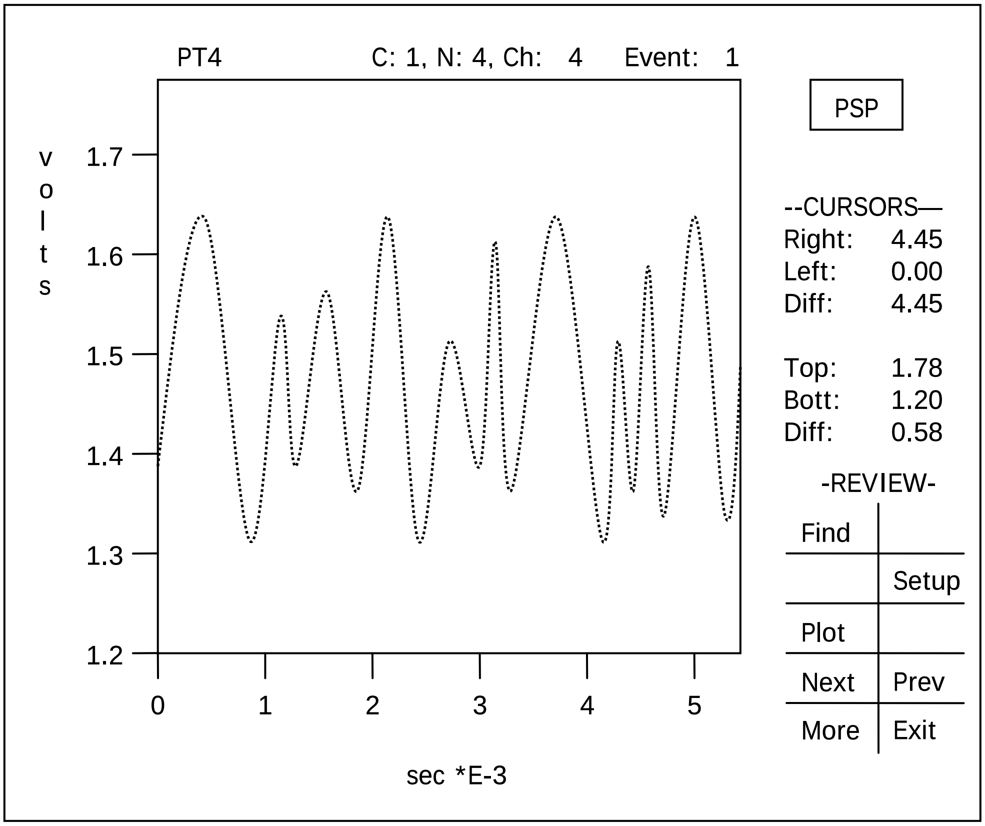
6. Once the limits have been set by the cursors, hit **F3** (**X exp**and) or **F4** (**Y exp**and) to zoom into the plot both in the x- and y-axis respectively. Conversely, hit **F5** (**X con**tract) or **F6** (**Y con**tract) to zoom out in the x-axis and y-axis respectively.

7. To return to the original plot, hit **F7** (**Orig**).

8. To toggle between dot-plotting or line-plotting, hit **F8** (**Dot/Line**). Line-plotting may be significantly slower when the number of data points is very high, but may be much more informative when sampling rate is not too high.

9. Although not immediately applicable here, the operator can hit **F9** (**Print**) and essentially do a PrintScreen and send the print job to a system printer (read: probably only 9 or 24-pin dot-matrix printer) hooked up to the PC.

10. To exit the **Data Review** or to change the channel, hit **F10** (**Exit**) and the following screen appears:



11. To change the channel number, hit **F7** or **F8** to advance one channel up or down. Hit **F5** to refresh the plot and the new plot for the new channel will appear.

12. Note that there is no option to save any data because the data came from a saved data file.

13. Once the operator is done with reviewing the data, hit **F10** to **exit**.

G. Conversion and exporting of data file into ASCII file

1. To export previously saved binary data files into ASCII data files with numeric data, a two-step procedure involving **btrieve** and **pspascii** commands is required.

2. Firstly, go to D drive by entering "**d:**" and hit **ENTER** key.

```
C:\d:
```

3. Get into the DAQ operating directory by entering "**cd psp**" and hit **ENTER** key.

```
C:\d:
D:\cd psp
```

4. The first step in the conversion is to load the **btrieve** program, enter "**btrieve/m:32/p:1024**" and hit **ENTER** key.

```
C:\d:
D:\cd psp
D:\PSP\ btrieve/m:32/p:1024
```

5. The PC screen will indicate that the Btrieve Recorder Manager has been loaded and the C prompt will appear again. Run the conversion program by entering "**pspascii**" and hit **ENTER** key.

```
C:\d:
D:\cd psp
D:\PSP\ btrieve/m:32/p:1024

Btrieve Recorder Manager
Version 3.03 Copyright (c) 1982,83,84 Softcraft, Inc.

31631 bytes used

D:\PSP>pspascii
```

6. The following screen will appear:

```
C:\d:
D:\cd psp
D:\PSP\ btrieve/m:32/p:1024

Btrieve Recorder Manager
Version 3.03 Copyright (c) 1982,83,84 Softcraft, Inc.

31631 bytes used

D:\PSP>pspascii

PSPASCII converts a User-selected record from a PSP
data file format to ASCII format and writes it to a
separate file
Now select the desired Session/data record using the
Session Control menu
(press <cr> to continue):
```

7. The displayed information essentially prompts the user to load a binary data file saved from an earlier data acquisition run. Hit **ENTER** to continue.

*<cr> stands for "carriage return". During the days when typewriters were still the norm, carriage return means moving the typewriter carriage from the end of the line to the beginning of the next line further down. In the PC world, hitting **ENTER** key results in the same thing and hence, different names for the same action.*

8. The familiar **SESSION CONTROL** menu will appear and the user has to tell the PC to read the binary data file.

```
                SESSION CONTROL

         LU     STATUS     SESSION

    =>   0       closed                    <=
         1       closed
         2       closed




                                              Ins: ↑↓

                                              F10:exit
```

9. Move the highlighted area to the **LU=0** line under **STATUS** column. Hit **INSERT** key and use the arrow keys until the **STATUS** is set to "**read**" mode. Hit **ENTER** key and the highlighted area will move to the **SESSION** column. Key in the relevant binary file name (Note: without the TDT

file extension) and hit **ENTER** key again. Depending whether the file has been loaded previously for exporting, file indexing may be carried out by the program during loading. The following screen will appear with the example binary data file:

```
                         SESSION CONTROL

                  LU    STATUS    SESSION

              =>  0        read     092404    <=
                  1      closed
                  2      closed
-----------------------------------------------------------------
    Title: tyler
    Start time  : 09-24-04  @  11:53:48           Mode    : singles
    Stop time   : 09-24-04  @  12:19:26           Records:      8
-----------------------------------------------------------------

    Index key       Search        Value
    Record Nbr        =              1

-----------------------------------------------------------------

    Record          :      1      Signal Name:          PT1
    Address – Crate :  1   Station:  4  Channel:   1   Event:   1
    Time – Trigger  : 09-24  12:17:43.000    Restart:  00:00:00.000


                                                        Ins: ↑↓
 F1:First  F2:Last  F3:Prev  F4:Next  F5:Find  F6:Search      F10:exit
```

10. Use the function keys i.e. **F1**, **F2** and etc to move among or search for the channels associated with the saved binary data. As the selected channel changes, it will be reflected in the **Signal Name** and **Channel** listings. The **Signal Name** will show names allocated to the channel during configuration before the data acquisition.

11. Once the desired channel has been selected, hit **F10** to **exit**. In doing so, the following screen will appear:

```
                    SESSION CONTROL

            LU   STATUS    SESSION

         =>  0     read     092404    <=
             1    closed
             2    closed
--------------------------------------------------------------
   Title: tyler
   Start time  : 09-24-04  @  11:53:48        Mode    : singles
   Stop time   : 09-24-04  @  12:19:26        Records :    8
--------------------------------------------------------------
   Index key      Search       Value
   Record Nbr       =            1

--------------------------------------------------------------
   Record            :      1      Signal Name:          PT1
   Address – Crate :  1   Station:  4   Channel:   1   Event:   1
   Time – Trigger  : 09-24   12:17:43.000    Restart:  00:00:00.000

                                                         Ins: ↑↓
Record has    51200 samples.
Enter starting sample and number of samples to convert (<cr> for all)F10:exit
```

12. At this point, the operator has to decide whether all data points are required to be converted, or only a portion of the data points. If all data points are to be converted, hit **ENTER** key. If only a portion of the data points is required, the operator will have to provide the location of the first desired starting data point and number of sample points thereafter desired (including the starting data point). In that case, the operator has to type in **starting data point number, number of points thereafter**, for example **1000,500** and hit **ENTER** key.

Due to the large amount of data points in high sampling rate data acquisitions, it may be advisable to extract only the pertinent range of data points. The operator will have to exercise his/her judgment. The starting data point and total number of data point thereafter will have to be decided during the Data Review stage, where the operator can learn from the data plots the range of desired data points.

*To get the range of desired data points, the operator can calculate from the timings from the data plots as well as the sampling rate used. For example, if the sampling rate used is 10000samples per sec and the desired starting point occurs at 0.5sec after triggering, the starting data point will be 5000. Furthermore, if the last desired data point occurs at 1.2sec after triggering, the total number of data points will be= 10000 samples per sec x (1.2sec – 0.5sec)= 7000. Hence, for this particular example, the operator will need to type in **5000,7000** and hit **ENTER** key.*

13. Regardless of whether all or a certain range of data points are desired, after hitting the **ENTER** key, the following screen will appear:

```
                          SESSION CONTROL

               LU    STATUS     SESSION

          =>   0        read      092404     <=
               1      closed
               2      closed
---------------------------------------------------------------
   Title: tyler
   Start time  : 09-24-04   @  11:53:48          Mode    : singles
   Stop time   : 09-24-04   @  12:19:26          Records :      8
---------------------------------------------------------------
   Index key       Search        Value
   Record Nbr        =              1

---------------------------------------------------------------
   Record           :       1       Signal Name:           PT1
   Address – Crate :   1    Station:   4   Channel:    1    Event:    1
   Time – Trigger  : 09-24   12:17:43.000      Restart:  00:00:00.000

Record has    51200 samples.                                     Ins: ↑↓
Enter starting sample and number of samples to convert (<cr> for all) F10:exit
    File name for Destination ASCII file =
```

14. Enter the desired file name and hit **ENTER** key.

*As the system is running under DOS Operating System, the file name has to be restricted to 8.3 format, meaning that the file name and extension cannot exceed eight and three characters respectively. The extension for a text file is usually .**txt** or .**dat**.*

15. The program will proceed to convert the binary data points into ASCII text and write them to the file.

16. After the conversion and file-writing, the program will prompt the user either to exit or convert another set of data points and write to another file.

H. Post-processing of ASCII file

1. The ASCII data file consists of a header section with important data acquisition information, followed by a 2D data array. The data are written horizontally first before moving down to the next row. Hence, some post-processing are required to make the data easier to be imported into a spreadsheet or written as a conventional tab-delimited column data file.

2. Open the ASCII data file in Microsoft Word and save it under another filename as a text file. The header information and the data array can be seen clearly as follows:

```
0923oxy ,09-23-04  ,12:21:47  ,OXYGEN        ,  1,  4,  7,    1,4012
Oxygen line 092304 5Hz
  20480,  .200000E-02,  .000000E+00,sec      ,  .244141E-02, -.500000E+01,volts
    2375,     2378,     2378,     2376,     2378,     2378,     2376,     2379
    2377,     2377,     2379,     2375,     2378,     2378,     2377,     2378
    2379,     2377,     2380,     2377,     2377,     2379,     2377,     2377
    ………………………………………………
```

3. Consider the first row of the header information. Each component is separated by a comma and they consist of information pertaining to the data acquisition. The sequence of the components is as follows:

   Session name, session date, session time, channel name, crate, station, channel number, event number and system controller model number.

4. The second row of the header information is the **Session title** which the operator typed in the **SESSION CONTROL** menu before the data acquisition.

5. The third row is the most important row in the entire header information as it provides the conversion factor and offset for post-processing. The sequence of the components is as follows:

   Total number of data points in the ASCII data file, time difference between each data point, time difference between the first data point here and that in the original binary data file, timebase unit, amplitude conversion factor, amplitude offset and amplitude unit.

6. Note down the information in the third row and delete the entire header information.

7. Click **Edit** in the menu bar and select **Replace**. Under **Find what**, enter "**,**" and click in the entry box for "**Replace with**". Click on the "Special" button at the bottom of the dialog box and select "**Manual Line Break**". The character in the "**Replace with**" entry box will appear as "**^ |**". Click on "**Replace All**" button.

8. Microsoft Word will proceed to replace all the commas with manual line breaks. The manual line breaks essentially replace the commas with an EOL or end of line command, which results in subsequent data values to move down to the next row. The end result will be a single data column.

9. Save the file and proceed to import it into Microsoft Excel. There are several ways to do post-processing on it through Matlab, Tecplot and some spreadsheet program. For simplicity however, Microsoft Excel will be used here to illustrate the pertinent points.

10. Import the data file as a tab-delimited file and click **Finish**. The data points will appear in a single column.

11. To convert the data points into actual data readings with their intended measurement units i.e. volts, psi and etc, **multiply the data values with the amplitude conversion factor and add the amplitude offset**. The measurement unit of the results will be amplitude unit.

    *Note: The amplitude conversion factor will take into consideration the measurement range set under **MODULE CONFIGURATION** for **4012** and the gain set under **MODULE CONFIGURATION** for **1008** for that particular channel. The amplitude offset will also be based on what was stated in the **MODULE CONFIGURATION** for **4012** and depends on whether **unipolar** or **bipolar** mode was used.*

- End -