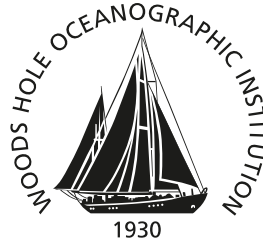


WHOI-2013-06

# Woods Hole Oceanographic Institution



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## **OBSANP Data Acquisition System: Operator's Manual and System Overview**

by

S. P. McPeak, G. L. D'Spain, R. A. Stephen,  
K. von der Heydt, P. F. Worcester

October 2013

## **Technical Report**

Funding was provided by the Office of Naval Research  
under contract N00014-10-1-0987 and N00014-10-1-0510.

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**Approved for Distribution:**



**Daniel McCorkle, Chair**

Department of Geology and Geophysics

# **OBSANP Data Acquisition System: Operator's Manual and System Overview**

**McPeak, S.P. \*, D'Spain, G.L.\*\*, Stephen, R.A.\*\*\*,  
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## **Technical Report**

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## ***Table of Contents***

<b>Table of Contents</b>	<b>2</b>
<b>Figures</b>	<b>4</b>
<b>I. Abstract</b>	<b>5</b>
<b>II. Software Summary</b>	<b>5</b>
<b>III. Hardware Summary</b>	<b>6</b>
<b>A. System Hardware</b>	<b>6</b>
<b>B. Source and Sensors Used during OBSANP experiment</b>	<b>6</b>
<b>C. System A/D Performance</b>	<b>6</b>
<b>D. System D/A Performance</b>	<b>7</b>
<b>E. System Timing with GPS Antenna Connected to PXI-6682</b>	<b>7</b>
<b>F. PXI-6682 (PXI Slot 2 in Software) Connection Description/Summary</b>	<b>7</b>
<b>G. PXI-6251 (PXI Slot 3 in Software) Connection Description/Summary</b>	<b>7</b>
<b>H. BNC 2090 Front Panel Connections</b>	<b>7</b>
<b>I. Signal Conditioning Overview</b>	<b>8</b>
<b>J. FTE - Future Time Event</b>	<b>8</b>
<b>IV. Introduction</b>	<b>9</b>
<b>V. Software Overview and Functionality</b>	<b>9</b>
<b>A. Display features</b>	<b>12</b>
<b>B. Audible Alarms</b>	<b>12</b>
<b>VI. Software Operation Procedure</b>	<b>13</b>
<b>VII. Chroma Power Amp setup information</b>	<b>26</b>
<b>A. Instructions for series connection of 2 Chroma 61502 units (taken from a note by Keith von der Heydt at WHOI)</b>	<b>26</b>
<b>B. Description of program tabs on the front panel</b>	<b>31</b>
1. 'WatchStanders'	31
2. 'SET FTE'	31
3. 'Read sio File'	31
4. 'Time Domain'	31
5. 'H-91 Spectral'	31
6. 'Additional Spectral Plots'	31
7. 'GPS NMEA String'	31
8. 'Gyro NMEA String'	32
9. 'NMEA File Log'	32
10. 'DAQ Out'	32
11. 'DAQ In'	32
12. 'Misc.'	32
13. Information available to the right of the 'tabs'	32
<b>VIII. Known Bugs/ Issues</b>	<b>33</b>
<b>IX. Future features to implement and changes to make</b>	<b>35</b>

<b>Appendix A: NMEA Log File Description – OBSANP Expedition</b>	<b>37</b>
<b>Appendix B: Explanation of Druck Voltage to Depth Conversion used during OBSANP (June-July'13)</b>	<b>39</b>
<b>Appendix C: Conversion from AUV file ADC data to engineering units for each channel</b>	<b>41</b>
<b>Appendix D: PA Vout Isolation &amp; Scaling “Blue Box” scaling factor based on frequency</b>	<b>41</b>
<b>Appendix E: Chroma PA phase measurements and drive levels</b>	<b>43</b>
<b>Table 1. Chroma typical input &amp; output drive levels</b>	<b>44</b>
<b>Appendix F: AIS Logging Summary</b>	<b>46</b>
<b>Appendix G: Laboratory Photos</b>	<b>48</b>
<b>Appendix H: System Notes:</b>	<b>50</b>
<b>Table 2. J15-3 S/N 11 coil checks done during expedition</b>	<b>51</b>
<b>XIV. REFERENCES</b>	<b>54</b>

## Figures

Figure 1. NMEA Information	13
Figure 2. Time Domain Display	14
Figure 3. Watch Stander Tab – basic setup screen for operation of software	15
Figure 4. Watch Stander Tab – setting the start time for transmissions and logging	17
Figure 5a. Watch Stander Tab – programming the PXI-6682 HRDW with start time	18
Figure 5b. Watch Stander Tab – After FTE Occurrence	19
Figure 6. Critical Information Display to the right of the main green tab block on the front panel	20
Figure 7. Time Series Display	21
Figure 8. H-91 monitor hydrophone voltage spectral graph	22
Figure 9. Vref into Chroma PA's spectral graph	23
Figure 10. NMEA log file location and sample interval setting	23
Figure 11. GPS NMEA string unwound	24
Figure 12. Gyro NMEA string unwound	25
Figure 13. NI PXI-6251 DAC output	25
Figure 14. PXI-6251 ADC input and AUV file creation	26
Figure 15. Chroma Master and Slave Power Amp rear panel connections	28
Figure 16. OBSANP DAQ System ADC Inputs & PA Output to J15-3	29
Figure 17 OBSANP DAQ System DAC Output & Connection to NI PXI-6682 Timing & Synchronization	30
Figure 18. Example of high frequency spikes on H-91 and J15-3 current signals. "OBSANP_Sea_04.sio" was being transmitted.	34
Figure 19. Druck Pressure Transducer Interface Box & PA Voltage Isolation/Scaling Box	40
Figure 20. Druck Pressure Transducer Interface Box & Schematic	40
Figure 21. PA Isolation/Scaling Box & Schematic	42
Figure 22. Oscilloscope Images of Clean Power Supply – Chroma PA power source	45
Figure 23. Oscilloscope Images of UPS Power Supply – DAQ System power source	45
Figure 24. Oscilloscope Images of Dirty Power Supply – Not a power source for ANY portion of the DAQ System	45
Figure 25. Antenna Placement on R/V Melville	48
Figure 26. System Setup in main lab of R/V Melville	49
Figure 27. J15-3 SN 11 – updated TCR from Arlie Farlie during expedition	52
Figure 28. Octopus Wiring Diagram / Neil McPhee (WHOI)	53

## ***I. Abstract***

On the Ocean Bottom Seismometer Augmentation in the North Pacific Experiment (OBSANP, June-July, 2013, *R/V Melville*), a VLA and twelve OBSs were deployed to listen to an active acoustic source, a J15-3. This report describes the hardware and software used to control and record the acoustic transmissions from the source. Some significant features of the system are:

- 1) The system transmits general user-defined source functions, such as M-sequences (.SIO files).
- 2) In addition to controlling the source waveform, the system also records six real-time channels in binary files with user-selectable lengths: the monitor hydrophone mounted near the source, the power amplifier voltage and current, the depth of the source, Vref signal driving the power amplifiers and an IRIG-B time reference. Files are output in .AUV format with a precision GPS-based time stamp in the file name.
- 3) The transmission start time along with ADC and DAC sample rates are disciplined to GPS time.
- 4) A convenient, Labview based, user interface provides real-time source control and monitoring.
- 5) The software provides parsing and logging of gyro and GPS NMEA sentences. The system, which was based on an earlier system from Scripps MPL, worked well on OBSANP and is available for future projects.

## ***II. Software Summary***

The data acquisition software is written in Labview 9.0. The program provides the following features:

1. Data acquisition of 6 analog channels at 8kHz sample rate each with an analog range of (+/-5V). Timing and sample clock are determined by a GPS time reference disciplined clock source.
2. 1 channel of DAC output with adjustable gain setting (+/-5V). The sample rate is also user adjustable (4kHz or 8kHz). The DAC output sample clock is disciplined to the GPS time reference.
3. Ability to read .SIO files for playback using the DAC output channel.
4. Time Domain Displays for all 6 channels of ADC.
5. Frequency Domain Displays for H-91, PA Voltage, PA Current and Vref driving power amplifiers and Druck pressure sensor analog inputs.
6. Software settable thresholds for H-91, PA Voltage, PA Current and Depth peak values.
7. Sound Pressure Level (SPL) determination for J15-3 based on source RMS current and H-91 RMS voltage levels.
8. Provide the ability to start transmitting and recording at a user defined precise time.
9. Generate AUV files of recorded 6 ADC channels.
10. Parse and log 2 NMEA Strings (GPS 'GGA' and Gyro 'HDT').
11. The user has the ability to "preview" 6 analog channels without initiating recording.

### ***III. Hardware Summary***

#### **A. System Hardware**

1. Dell T1650 Precision PC (4-core, 3.2GHZ, 16GB DDR3 UDIMM Memory 1600MHz, ECC)
2. NI PXI-6251 multi-function DAQ
3. NI PXI-6682 timing and synchronization board w/ Garmin GA30 GPS Antenna
4. NI BNC-2090 breakout box
5. NI PXI-1033 chassis
6. NI PCIe-8361 interface card between PC and PXI chassis
7. Stanford Research System SR650 (HP and LP filters)
8. Stanford Research System SR640 (dual LP filters)
9. 1 x Stanford Research System SIM983 scaling amplifier
10. 4 x Stanford Research System SIM650 Low Pass Filters
11. 1 x Stanford Research SIM900 Mainframe
12. Tektronix TDS2004C Oscilloscope
13. Dual Chroma 61502 power amps (PA)
14. H-91 fish, modulator and demodulator hydrophone system
15. J15-3 acoustic source and tow body
16. Arbiter 1084C Station Clock with Trimble GPS Antenna P/N 48360-00
17. Analogic 2020 Waveform Generator
18. Custom box for isolation and scaling of PA output voltage
19. Custom dry side box for Druck Pressure Sensor supply voltage and dropping resistor.
20. BK Precision 1735A power supply for Druck power
21. Druck PTX 1830 Pressure Sensor
22. Fluke 175 Digital Volt Meter
23. Extech 380942 magnetic pickup current meter
24. Extech 380260 digital megohmmeter

#### **B. Source and Sensors Used during OBSANP experiment**

J15-3 S/N 11

H-91 S/N 18

Druck Pressure Transducer S/N 3469435

Chroma 61502 powers amps, serial numbers 615020000691 and  
615020000489

#### **C. System A/D Performance**

16 bit resolution

6 single ended channels

8kHz sample rate

Input range = +/- 5V



## **D. System D/A Performance**

16 bit resolution  
 8kHz or 4kHz user selectable sample rate  
 1 single ended output  
 Output range = +/-5V

## **E. System Timing with GPS Antenna Connected to PXI-6682**

GPS Synchronization Accuracy: +/- 100nS, <13nS standard deviation  
 GPS PPS accuracy: within 15nS to GPS/UTC  
 Internal Time base synchronization to GPS with 10nS resolution  
 AIS timescale is used on ALL PXI-6682 internal time stamps and converted to UTC in software. UTC offset from GPS time is received from GPS signal

## **F. PXI-6682 (PXI Slot 2 in Software) Connection Description/Summary**

PXISlot2/PFI1 = 8kHz clock out (A/D and D/A clock source)  
 PXISlot2/PFI2 = Pulse Output (used to trigger ADC and DAC start at user defined FTE)

## **G. PXI-6251 (PXI Slot 3 in Software) Connection Description/Summary**

PXISlot3/PFI0 = A/D clock source  
 PXISlot3/PFI1 = FTE Pulse (1 micro second) input – triggers both A/D & D/A tasks  
 PXISlot3/ai0:5 = ADC channels  
 PXISlot3/ao0 = DAC output

## **H. BNC 2090 Front Panel Connections**

ACH0 = H-91 demodulated (LP and HP filtered) signal  
 ACH1 = PA Voltage (LP filtered)  
 ACH2 = PA Current (LP filtered)  
 ACH3 = Druck Pressure signal (voltage developed across 118 ohm resistor from 4-20 mA sensor output)  
 ACH4 = Vref (LP filtered) signal  
 ACH5 = IRIG-B modulated signal  
 PFI0/TRIG1 = 8kHz Clock pulse from PXI-6682 (PXISlot2/PFI1)  
 USER1 = Pulse signal from PXI-6682 (PXISlot2/PFI2)

## I. Signal Conditioning Overview

**DAC Output from PXI 6251** -> SR SIM983 x2 scaling amp -> SR SIM965 LPF (48 dB/octave, AC coupling, Butterworth, 0dB gain) -> Vref into Chroma

**H-91 Demodulator** -> SR650 HPF (10Hz, AC coupling 0dB) -> SR650 LPF (1kHz, AC coupling, 0dB gain) -> PXI-6251 ADC channel #0

**PA Voltage from blue box** -> SR SIM965 LPF (1kHz, 48 dB/octave, AC coupling, Butterworth, 0dB gain) -> PXI-6251 ADC channel #1

**PA Current from AM503 magnetic current amp terminated with 50ohms** -> SR SIM965 LPF (1kHz, 48 dB/octave, AC coupling, Butterworth, 0dB gain) -> PXI-6252 ADC channel #2

**Druck pressure sensor** -> 117 ohm dropping resistor -> SR SIM965 LPF (1kHz, 48 dB/octave, DC coupling, Butterworth, 0dB gain) -> PXI-6251 ADC channel #3

**Vref into Chroma** -> PXI-6251 ADC channel#4

**Modulated Irig B from Arbiter 1084C Station Clock** -> PXI-6251 ADC channel#5

## J. FTE – Future Time Event

The FTE is the time for when the operator wants the ADC, DAC and logging functions to begin. The following events occur at the FTE:

- Pulse (1 micro second) out from the PXI-6682
- 8kHz clock begins - sourced from the PXI-6682
- PXI-6682 begins to buffer time stamps on rising edges of the clock
- PXI-6251 begins both A/D and D/A tasks on rising edges of clock pulse

## ***IV. Introduction***

On the Ocean Bottom Seismometer Augmentation in the North Pacific Experiment (OBSANP, June-July, 2013, *R/V Melville*), a vertical line array (VLA) of hydrophones and twelve OBSs were deployed to listen to an active acoustic source, a J15-3 from NUWC (Naval Underwater Weapons Center, Newport). The objectives and operations of the experiment closely resembled the Ocean Bottom Seismometer Augmentation of the Philippine Sea (OBSAPS) Experiment (McPeak *et al.*, 2011; Stephen *et al.*, 2011). This report describes the hardware and software used to control and record the acoustic transmissions from the source on OBSANP.

Some significant features of the system are:

- 1) The system enables general user defined source functions, such as M-sequences. It is not restricted to CW (continuous wave) or LFM (linear frequency modulated) waveforms. It reads the source function from .SIO files and outputs a mono signal suitable for input to the power amplifier.
- 2) The transmission start time and the ADC and DAC sample rates are all disciplined to GPS time.
- 3) In addition to controlling the source waveform, the system also records six real-time channels: the monitor hydrophone mounted near the source, the power amplifier voltage, the power amplifier current, the depth of the source, Vref into the Chroma PA's and an IRIG-B time reference. Files are output in .AUV binary format, in user-selectable file lengths, with a precision GPS-based time stamp in the file name.
- 4) The system has a convenient, Labview based, user interface for real-time source control and monitoring. Software provides automatic selection of source functions and the corresponding setting of playback (record start/stop) times. This is a feature implemented for ease of operator use.
- 5) The software provides parsing and logging w/timestamps of gyro and GPS NMEA sentences.

The system, which was based on an earlier system from Scripps MPL, worked well on PhilSea'09 and OBSAPS in 2011 and is available for future projects.

## ***V. Software Overview and Functionality***

This software was developed to provide 6 channels of ADC recording and 1 channel of DAC output. The software was developed to be used for data acquisition and transmission playback for an acoustic source. The software drives the acoustic source with pre-loaded SIO files and monitors/records 6 analog channels (H-91 monitor hydrophone, PA voltage, PA current, depth, Vref into Chroma PA's and IRIG-B). Both the ADC and DAC sample rates are driven from a

WHOI-2013-06  
OBSANP Data Acquisition System: Operator's Manual and System Overview

disciplined 8kHz clock source which is sync'd to the GPS time reference. The ADC sample rate is fixed at 8kHz. The DAC output can be set to either 4kHz or 8kHz by the user.

The software interacts with two National Instruments pieces of hardware. The NI PXI-6251 is a multi-function data acquisition board used for ADC conversions and analog output. The NI PXI-6682 is used for GPS timing and synchronization and generation of the disciplined clock signal used for ADC and DAC functionality. The PXI-6682 also provides the ability to set the preprogrammed start time (FTE). The PXI-6251 buffers the ADC samples and this data is then read and queued by the software. Likewise, the PXI-6682 buffers the associated time stamps for each sample and these buffered time stamps are read and queued by software. The software then de-queues the ADC and time stamp data and aligns them for file writing and file naming purposes. The queue'ing and de-queue'ing of the ADC samples and timestamps is done as asynchronous tasks. This 'producer/consumer' architecture allows for the data file writing process to be fairly immune to OS timing issues. The PXI-6682 is responsible for generating the GPS disciplined 8kHz sample clock which is used by the PXI-6251 for both ADC and DAC sample clocks. The PXI-6682 is also responsible for providing the start pulse to initiate logging and transmission at user defined times.

The program opens and reads SIO files. Once read these files are converted to Labview waveforms and output on the DAC channel specified. The largest SIO files read during OBSANP were 1 hour in length (54.9MB). The operator can control the gain applied to the SIO file at the time when the file is loaded. The user can also choose between 'Sun' or 'Linux' SIO files to specify the byte order used in reading the file as well. The byte order of the SIO files is determined by the system which generates them.

The software provides the user the ability to set a 'Future Time Event' (FTE) for the desired start time for both ADC and DAC functionality as well as logging. It should be noted that both the ADC and DAC functionality will both begin at the pre-programmed 'FTE' time. If no DAC output is desired (such as for an ambient noise measurement), the user can achieve this in one of the following three ways...

- a. Do not load an SIO file prior to setting the FTE
- b. Disconnect the DAC output manually from the BNC-2090.
- c. Disable the PA output

The program generates two types of files as output. These file type are 'AUV' and 'CSV' files. The AUV format stores the 6 channels of ADC data in binary format. The 'CSV' files store the NMEA data in comma separated ascii readable text. The NMEA data is time stamped in software and includes both GPS and Gyro strings. These data streams are input to the software via two comports. A detailed description of this file structure is contained at the end of this document. Both the GPS and Gyro NMEA data streams are parsed in real time and displayed to the user as well.

The user can select the file size in seconds for the AUV files. This value is defaulted to 60 second files. When the program is stopped, the software will pad the most recent AUV file with

WHOI-2013-06  
OBSANP Data Acquisition System: Operator's Manual and System Overview

0's so all files will be the same size. It should be noted that in order to stop logging the user must stop the program. It is then necessary to restart the program for the next transmission and data logging session.

As the data is acquired the software will close and open new files as they are filled to continuously log the 6 channels of ADC data in a time series. The logged ADC data should be continuous from one file to the next.

The AUV filename format implemented in software corresponds to the time stamp associated with the very first sample in each file. This time stamp is received from the PXI-6682 and is determined at the hardware level of the board. The time stamps from the PXI-6682 are accurate to within +/- 100nS <13 nS standard deviation. The AUV filename format is

“%y%j%H%M%S%4u.auv”

Data symbol	Data type	Example
Y	year within century (00-99)	11
J	day number of the year (001-366)	127
H	hour (00-23)	10
M	minutes (00-59)	04
S	seconds (00-59)	00
4u	4 decimal points of fractional seconds	0000

The software also logs the GPS and Gyro NMEA data strings. The filename format corresponds to when NMEA file logging was initiated. That format is

“NMEA\_Data\_%y%j%H%M%S.csv”

The user can set the desired file size in seconds for the NMEA logs. The user can also select the desired sample rate for the NMEA file logs. The default values are 3600 seconds/file and 1 sample per second. So with these default parameters the software generates 1 hour NMEA files containing a NMEA GPS and Gyro string every second. There are time stamps in the NMEA file logs themselves for each new line of data. It should be noted that these time stamps are generated by Labview functions which read the PC clock. So there is some amount of latency due to the OS and the function call itself. The raw logged GPS and Hydro NMEA strings themselves also contain timestamps.

The logging of AUV and NMEA files begins when the 'FTE' occurs. This is when the software will begin writing ADC data to file as well as outputting the waveform contained in the SIO file to the DAC.

The software provides time series displays of all 6 ADC channels. These six time series graphs are updated at a 0.75 second rate. This rate is possible to adjust, but nominally fixed in software. The rate is determined by the number of 'samples read per channel' from the multi-function DAQ board and the sample frequency rate. The frequency rate and 'samples read per channel'

are fixed in software. The sample rate is set to 8kHz and the 'samples read per channel' is defaulted to 6000. The 'number of samples read per channel' corresponds to the number of ADC and time stamp samples buffered and read from the PXI-6251 and PXI-6682 devices each time their respective function's are called. It should be noted that successful operation of the code during OBSANP was with the sample rate settings mentioned above. Adjusting these rates could impact the codes functionality and should be thoroughly tested.

The software also provides a decimated time series display of the depth information with adjustable history length. This provides the user the ability to monitor a certain length of depth history on the front panel.

The software also provides a spectral display of the H-91 monitor hydrophone scaled for db Sound Pressure Level (SPL) re  $1\mu\text{PA}^2$ . There is also a selectable spectral display generated for PA Voltage, PA Current, Vref or Depth.

## A. Display features

1. Time series displays for monitor hydrophone, PA voltage, PA current, Depth, Vref and IRIG-B signals.
2. Decimated depth display with adjustable history length and averaging.
3. Peak and hold indicators for monitor hydrophone levels, PA voltage and PA current.
4. Spectral plots for monitor hydrophone, PA voltage, PA current, Vref and Depth.
5. Unwound GPS and Gyro NMEA strings.


## B. Audible Alarms

1. H-91 Peak Volts > User Defined Threshold (150 micro second beeps @ 250 Hz)
2. PA Peak Volts > User Defined Threshold (150 micro second beeps @ 300Hz)
3. PA Peak Current > User Defined Threshold (150 micro second beeps @ 350Hz)
4. Druck Depth > User Defined Threshold (150 micro second beeps @ 400Hz)
5. The software produces a 440 Hz 5 second tone when manually stopped by the user OR the occurrence of automatic shut off.
6. PA voltage drops to a low level (user defined) indicating that the SIO file being output is in a "gap" and the source is momentarily NOT transmitting. This was useful for alerting watch standers when an output frequency change was about to occur in the source.

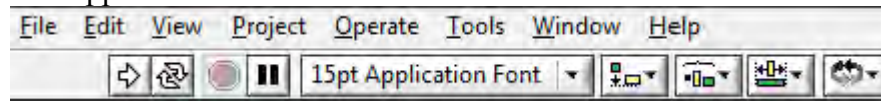
## VI. Software Operation Procedure

1. Verify the following drivers are up to date and properly installed
  - a. NIDAQ9231f1 (DAQmx driver for PXI-6251 multifunction DAQ card)
  - b. Sync3.2.2 (PXI-6682 Timing and Synchronization)

2. Double click on the DAQ program which will launch Labview 9.0

 OBSANP\_DAQ.vi

Once the program has opened it can be started by pressing the 'Play' (right facing arrow) button in the far upper left hand corner of the screen.



**\*\*\*Note:** the VERY first time that the software is run it is necessary to immediately press the 'STOP' (red circular button) and restart the software. This is only necessary on the very first attempt to run the program after Labview launches.

3. Once the program has started running, verify that both the NMEA GPS and Gyro data streams are being received and parsed. This is done by looking to the right of the green tab block on the front panel. Verify data is NOT stale and has valid checksums.

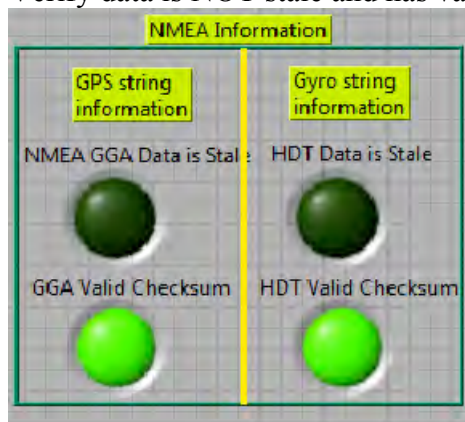


Figure 1. NMEA Information

Under the "Time Domain" tab verify that the PXI-6682 GPS and Time Reference Indicators are ALL green as shown below and displaying valid data.

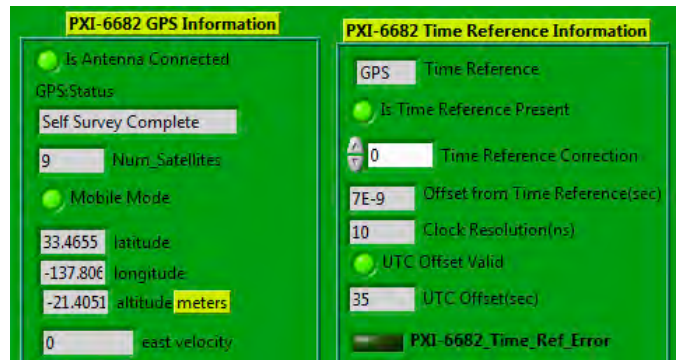


Figure 2. Time Domain Display

4. To the right of the main green tab block set the software thresholds for PA peak current, PA peak voltage, H-91 peak voltage and Druck depth.
5. On the Time Domain tab confirm that the proper PA Voltage, PA Current, H-91, Druck scaling and offset factors. These default to the following values:
  - a. H-91 scale factor = 1
  - b. PA Voltage scale factor = 212
  - c. PA Current scale factor = 59
  - d. Druck Scale factor = 53.1780779382
  - e. Druck offset of 0.6577

\*\*\* A detailed description of the Druck Offset can be found at the bottom of this document \*\*\*
6. Click the 'Watch Stander' tab
7. Set the desired DAC output gain. This control can be found on the "Read SIO file" tab.

\*\*\*Note: It is very important to set the DAC gain BEFORE reading the SIO file. Once the SIO file is read, the DAC gain can not be adjusted without stopping the program and restarting this procedure.



WHOI-2013-06  
OBSANP Data Acquisition System: Operator's Manual and System Overview

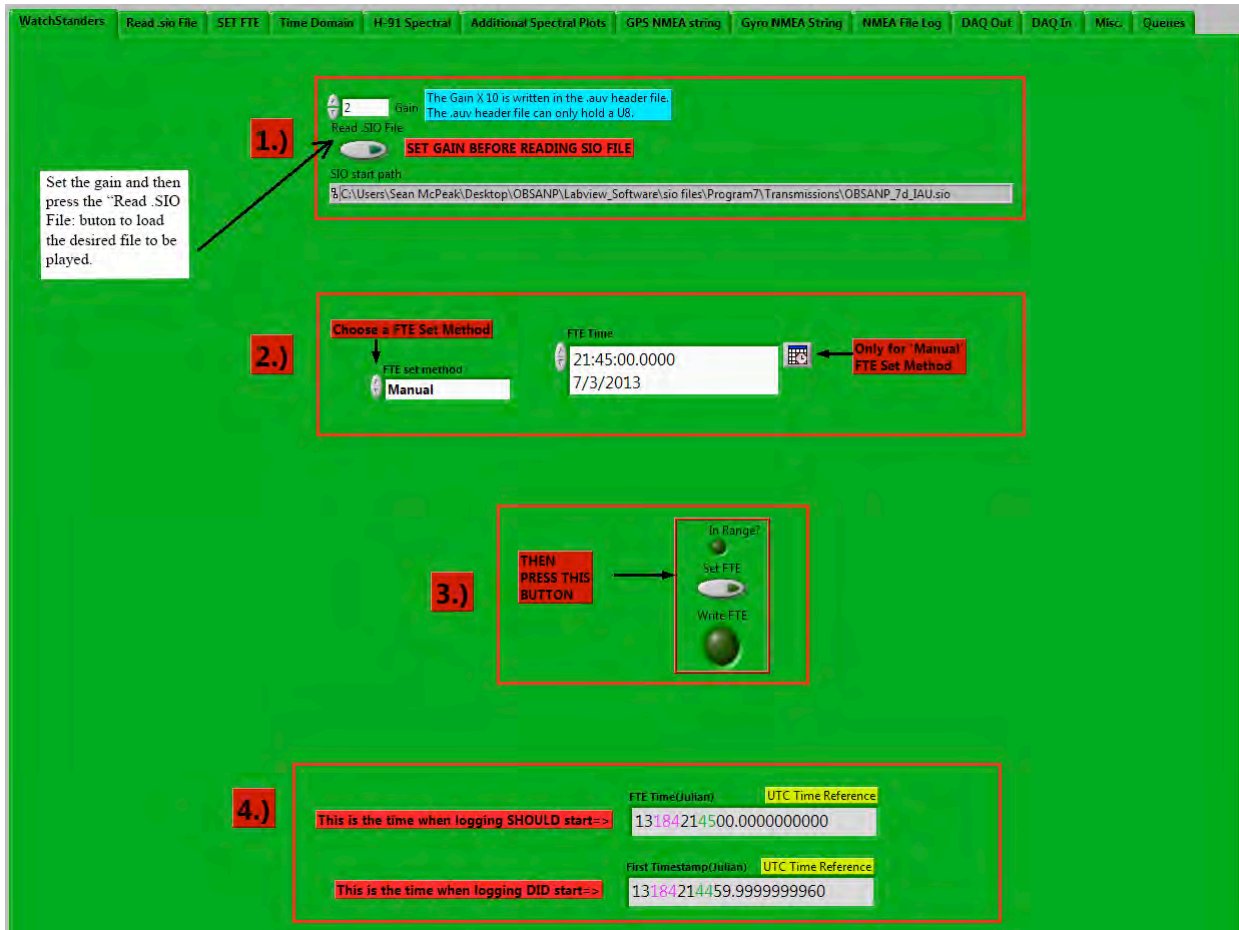


Figure 3. Watch Stander Tab – basic setup screen for operation of software

8. Read the desired SIO file. This can be done on the “Read .sio file” tab.
9. Check to make sure that all wiring and hardware are properly set up and configured. Verify that the DAC output of the Labview system is at 0V and then enable the PA amplifiers. If dual Chroma amplifiers are used it is important to make sure that both amplifiers are enabled and properly synced for master/slave series operation. It is also important to verify that any other necessary signal processing/conditioning hardware is enabled at this point such as:
  - a. DAC output from NI-6251 is taken to 6dB scaling amp (if Chroma amps are used) and then through a properly configured low pass filter before Vref input to Chromas.
  - b. H-91 demodulator deck box
  - c. LP and HP filters used for signal conditioning
  - d. Tektronix AM503 current amplifier w/50 ohm load connected to output
  - e. Druck deck box connected to 9-30V power supply
  - f. Oscilloscope for monitoring signals being recorded by the system.
  - g. Extech magnetic current probe connected to measure PA output current

- h. Fluke DMM connected to measure PA output voltage.
  - i. Connection of the deck cable to the winch and tow cable on deck
10. Set the 'FTE' (Future Time Event). The FTE is the time at which the program will begin transmission and logging of the 6 ADC channels. Setting the FTE is accomplished in the 'Set FTE' tab.
- a. Select the 'FTE set method'. There are 4 main choices in the drop down menu:
    - Primary 6a
    - Primary 6b
    - Primary 6c
    - Manual

For the Primary 6a, 6b and 6c selections the program will automatically set the desired start and stop times based on the current time. These start and stop times are defaulted for the "OBSAPS\_Primary\_Sea\_6a.sio", "OBSAPS\_Primary\_Sea\_6b.sio" and "OBSAPS\_Primary\_Sea\_6c.sio" files. These files are defined in the OBSAPS cruise report (Stephen et al, 2011). Specific start and stop times were necessary because of a data acquisition gap in the hydrophone receivers. In any of these three modes the software will automatically start and stop logging once the FTE is set. The start and stop times are based on the parameters found in the Misc. tab. The ability to quickly set the start and stop times for various SIO files to be transmitted is a convenient tool when a user is cycling through a transmission list and start/stop schedule. The 6a, 6b and 6c start and stop times can be changed under the "Misc" tab.

When in Manual mode the user has two further options for setting the FTE. This selection is chosen by the "FTE Selection" toggle switch. The two different settings are:

- Absolute – when in this mode the user must select the desired start time by using the Calendar button shown below.
- Relative – when in this mode the FTE will occur a set amount of time from whenever the 'Set FTE' button is pressed. The amount of time is determined by the 'FTE Delay from current time(sec)' control which can be found on the "SET FTE" tab. This is a convenient way to set an FTE if the user does not require any specific absolute time.

WHOI-2013-06  
 OBSANP Data Acquisition System: Operator's Manual and System Overview

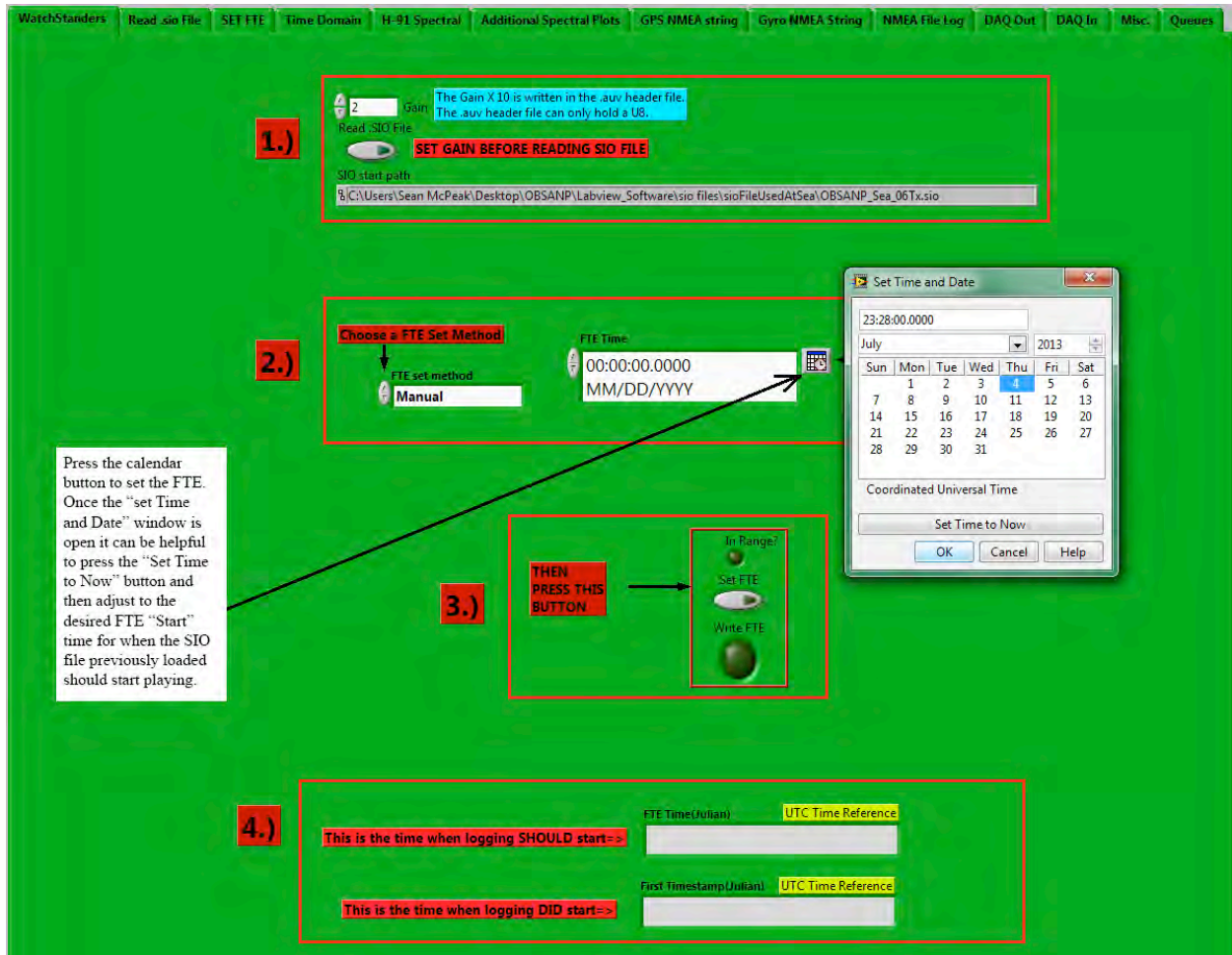


Figure 4. Watch Stander Tab – setting the start time for transmissions and logging

Press the small calendar button to the upper right of the 'FTE Time' indicator. Press the 'Set Time to Now' to update to the current time. Then, type in the desired time for the FTE to occur. For convenience in post-processing it is a good idea to set this time to an even minute.

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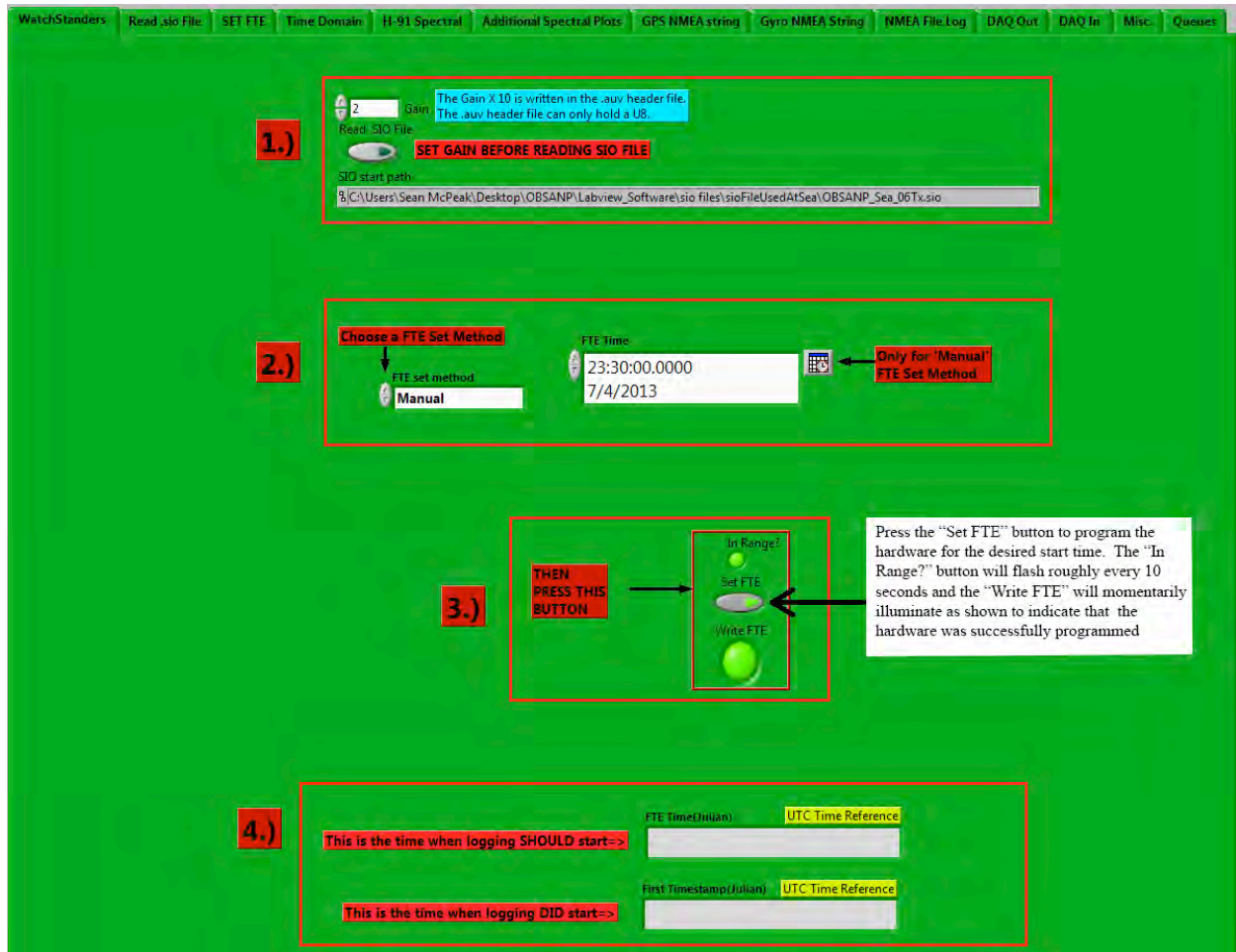


Figure 5a. Watch Stander Tab – programming the PXI-6682 HRDW with start time

- b. Press the 'Set FTE' button which is in the middle of the same page. The next time the 'In Range?' button illuminates the 'Write FTE' radial button should momentarily illuminate indicating that the desired FTE time was written to the PXI-6682 device. Now the 'FTE Time' display should show the correct Julian time for when the FTE event is expected to occur. Once the FTE actually occurs the 'First Timestamp' display will show the actual event time which should be extremely close to the desired time.

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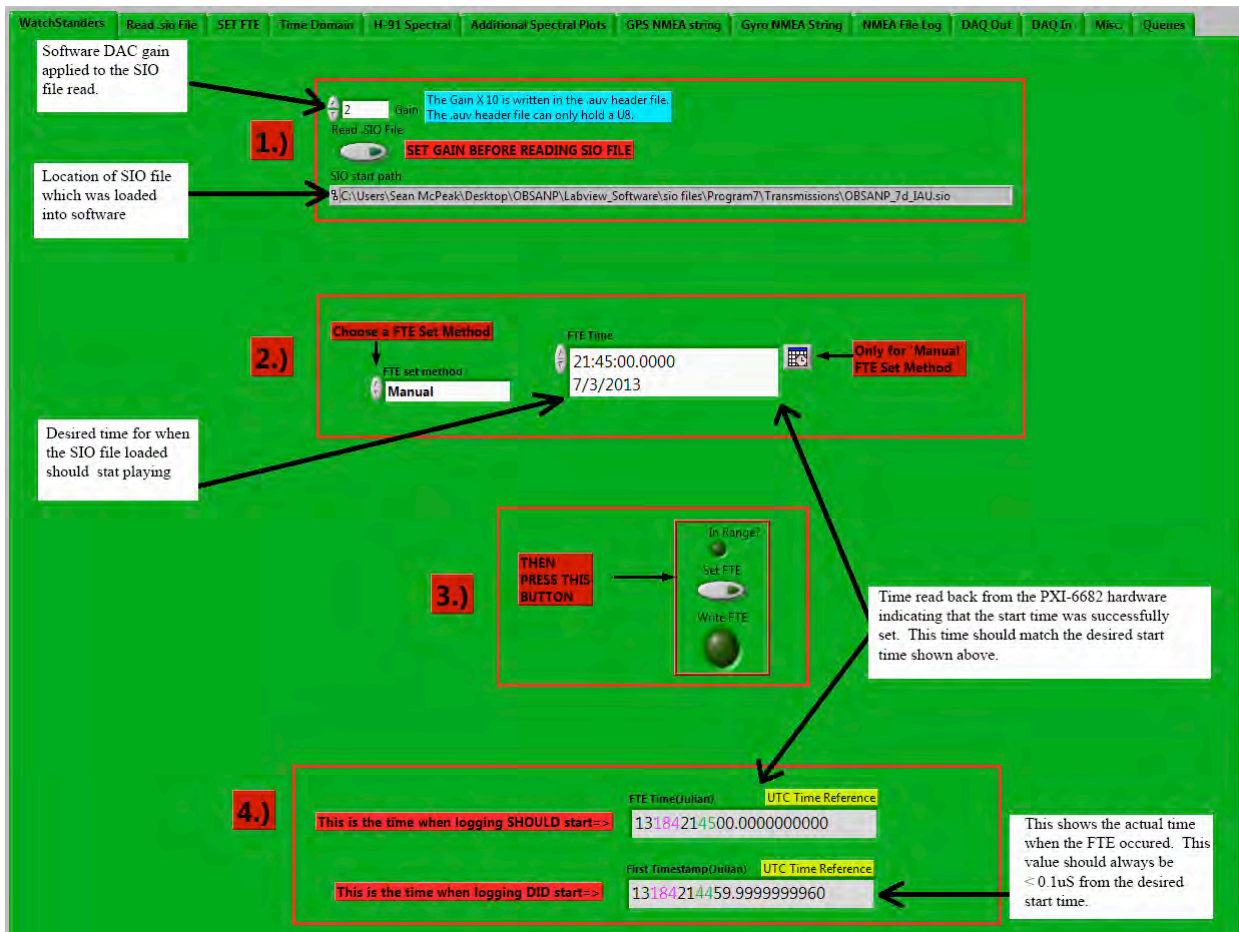


Figure 5b. Watch Stander Tab – After FTE Occurrence

- Wait for the FTE to occur. The playback and recording of the 6 channels will begin when the FTE occurs. The ADC data read by the software can be displayed in either the Time Domain or spectral plot tabs.
- Immediately after the FTE occurs verify that ALL indicators are green to the right of the main tab displays. This indicates that the FTE event occurred successfully without any errors. There are also RMS current & voltage and SPL measurements displayed in this section that should be checked periodically and especially immediately following an FTE event occurrence. Verify that none of the timing errors or threshold errors are present which are shown in the 'Critical Information Display' section on the following page. It is also good practice to periodically verify that the GPS and Gyro NMEA data are being received and parsed correctly by the system. A 'Stale' GPS or Gyro data error implies that there is an issue with the RS232 data being received by either of these devices. It is also good practice to make sure that the Chroma power amp current, voltage and power factor front panel display are as expected just after an FTE event as well as periodically during transmissions for safe operation.

WHOI-2013-06  
OBSANP Data Acquisition System: Operator's Manual and System Overview

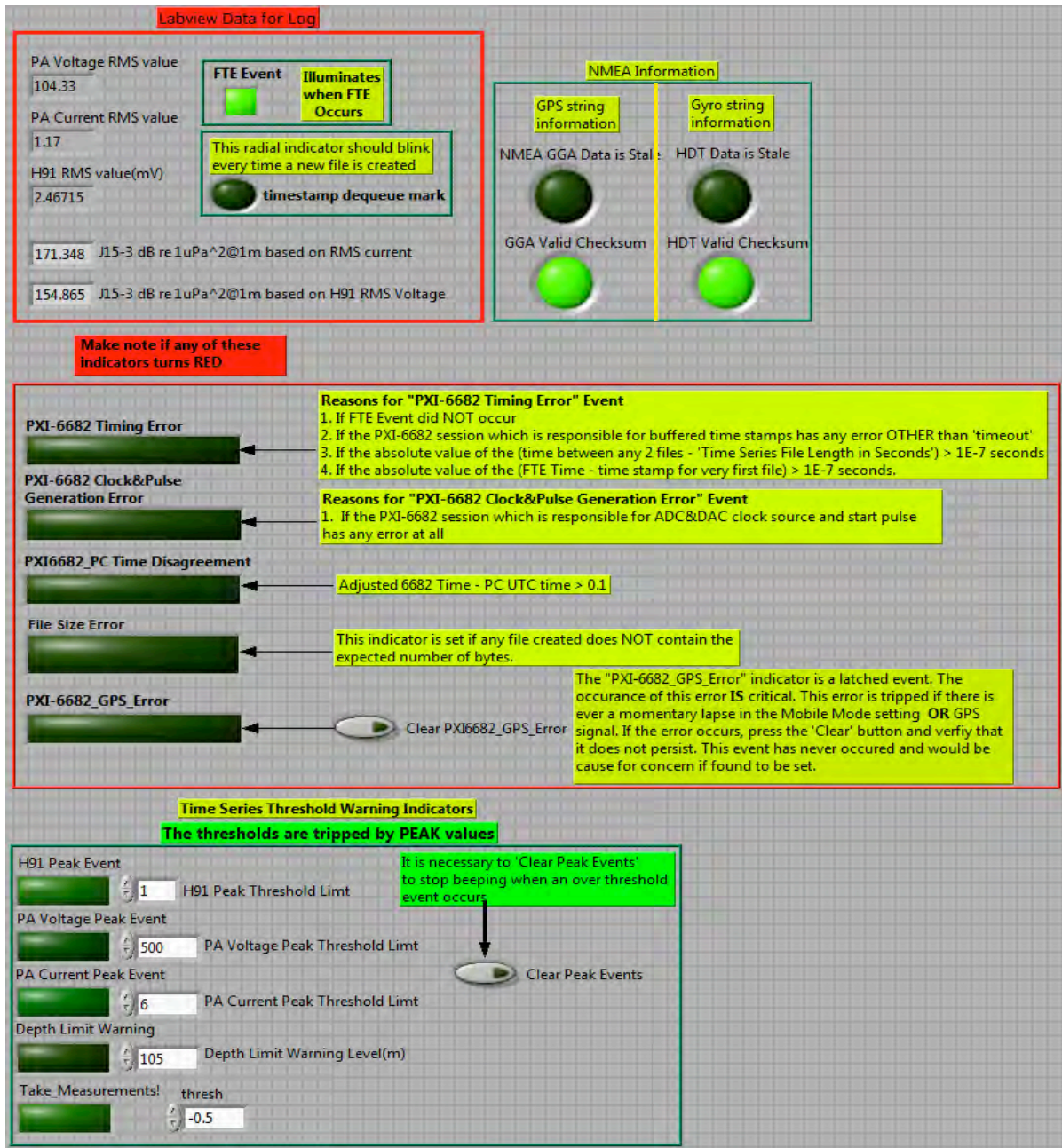


Figure 6. Critical Information Display to the right of the main green tab block on the front panel

- At the end of the acquisition period, if the 'FTE set method' was chosen to be 'manual' then press the large rectangular 'STOP' button in the upper left hand corner of the screen. The program will take 15 seconds to completely shut down. The user will know when the software is no longer running because a 5 second 440Hz tone burst will occur just as the software is shutting down. If the user has selected 'Primary 6A', 'Primary 6B' or 'Primary 6C' as the 'FTE set method' then the program will shut down automatically at the user

defined stop times. The 5 second 440Hz tone will still occur when the program turns itself off.

14. Time series and spectral displays for real time analysis

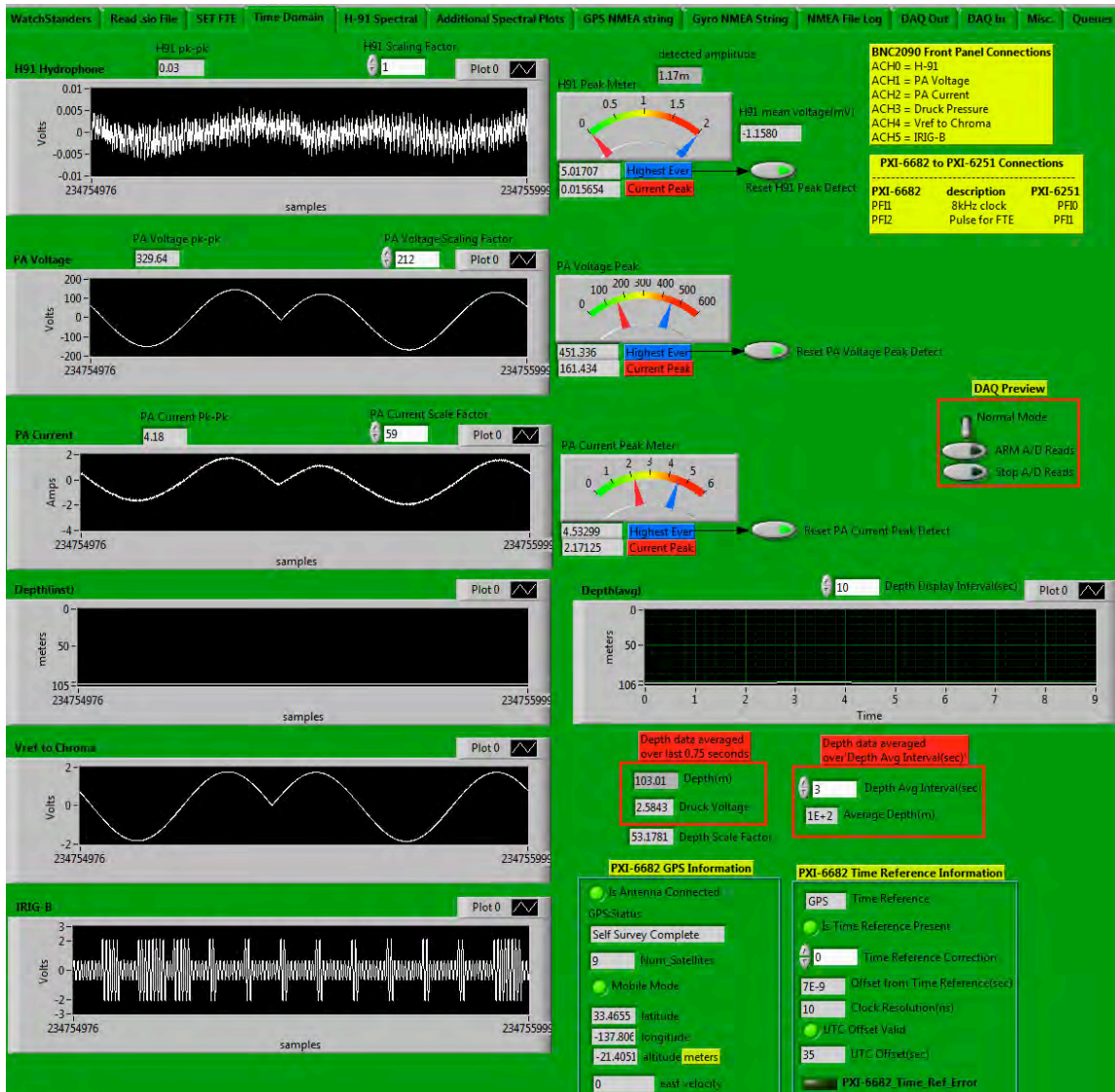


Figure 7. Time Series Display

**Note:** Once data is being acquired verify that the PA current and Voltage are IN PHASE (as shown above). The orientation of the AM503 magnetic current probe can affect this.

WHOI-2013-06  
OBSANP Data Acquisition System: Operator's Manual and System Overview

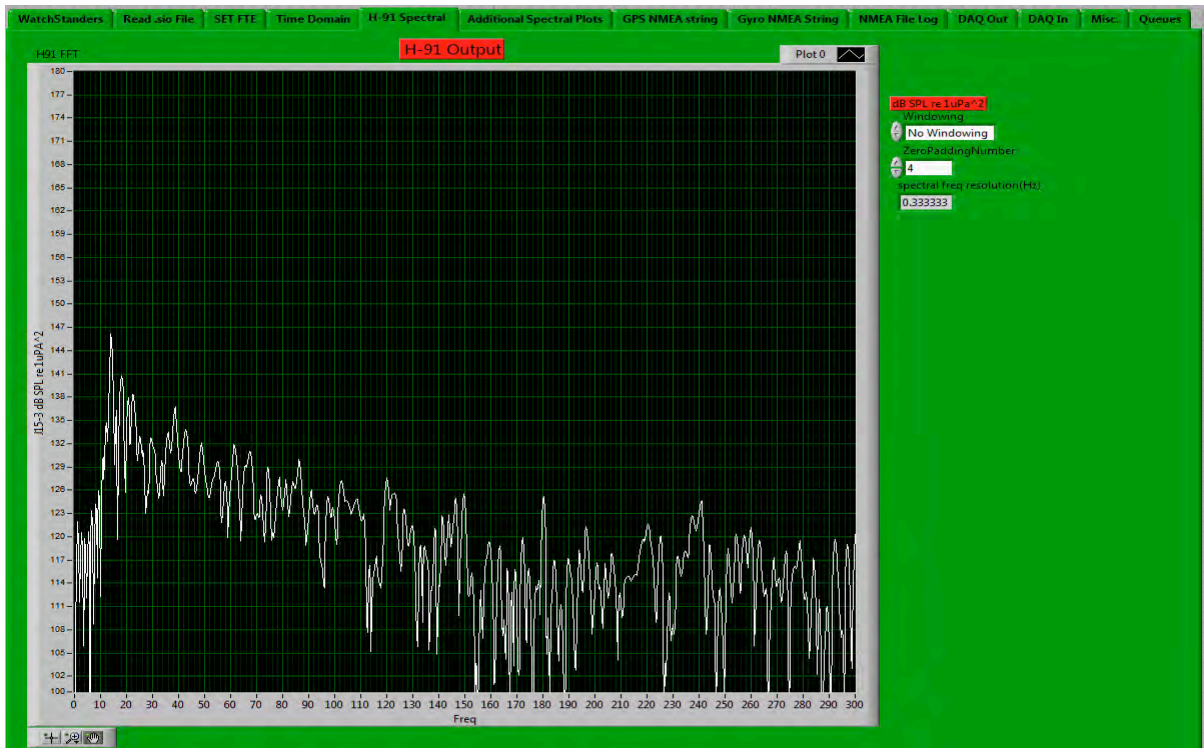


Figure 8. H-91 monitor hydrophone voltage spectral graph



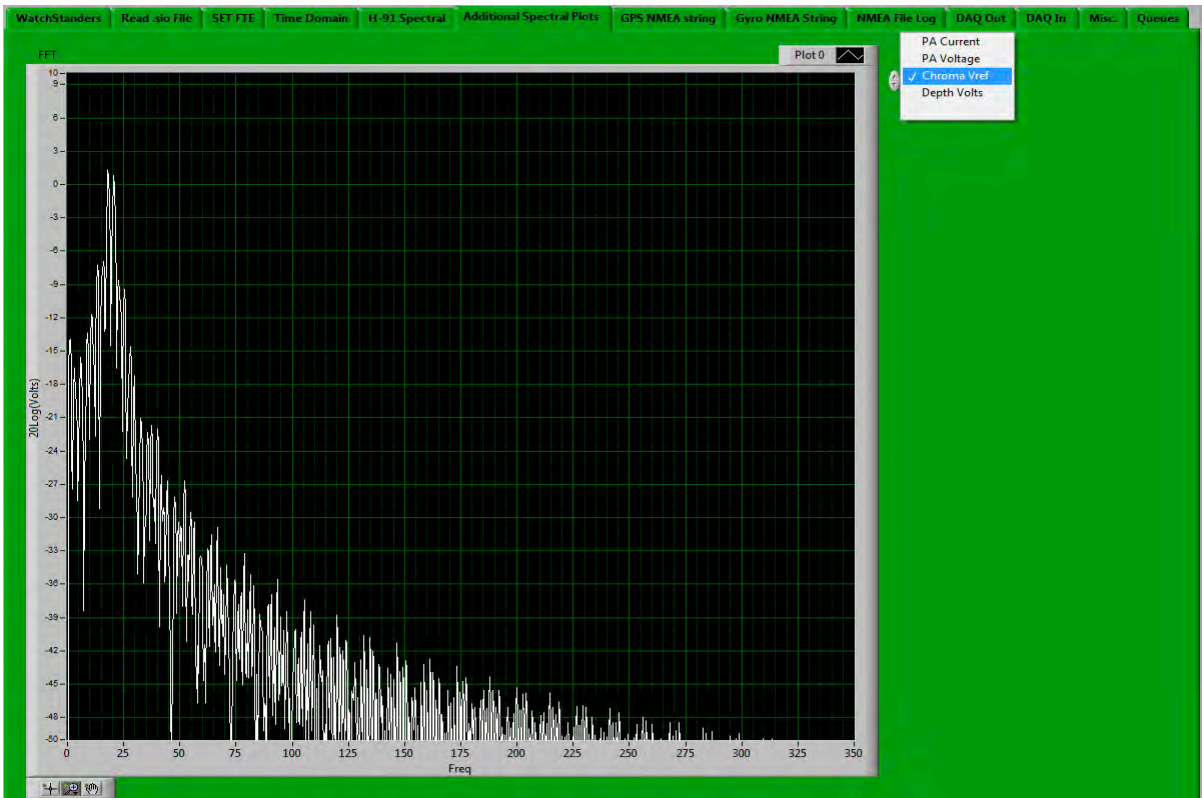


Figure 9. Vref into Chroma PA's spectral graph

## 15. NMEA logging tab

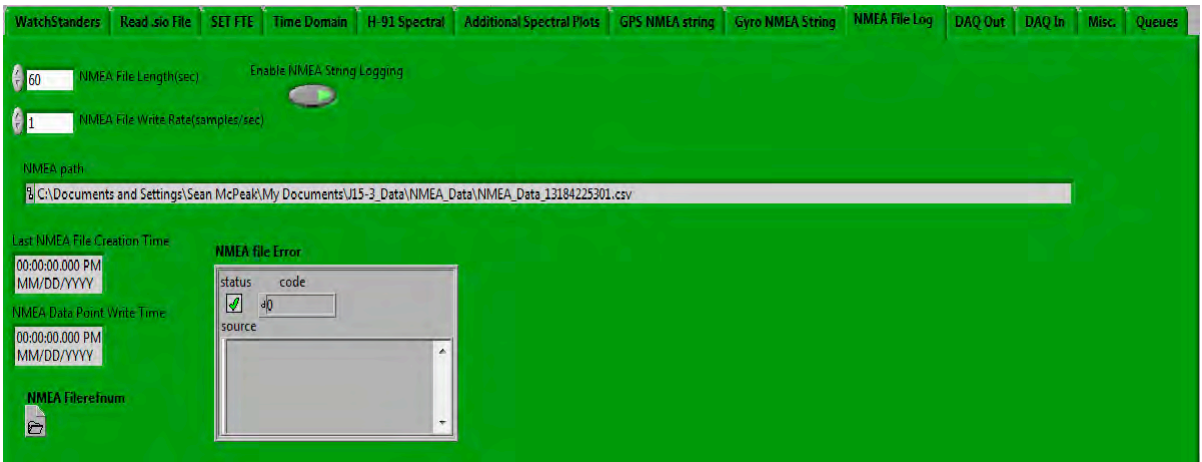


Figure 10. NMEA log file location and sample interval setting

WHOI-2013-06  
 OBSANP Data Acquisition System: Operator's Manual and System Overview

The screenshot displays the OBSANP Data Acquisition System interface. The top menu bar includes: WatchStanders, Read .sio file, SET FTE, Time Domain, H-91 Spectral, Additional Spectral Plots, GPS NMEA string, Gyro NMEA String, NMEA File Log, DAQ Out, DAQ In, Misc, and Queues.

**GGA Configuration:**

- GGA baud rate (9600): 4800
- GGA RS232 Connection: %COM5
- GGA data bits (8): 8
- GGA parity (0:none): None
- GGA flow control (0:none): None
- GGA stop bits (10:1 bit): 1.0

**GGA Nema String:** \$GPGGA,225310,3327.9134,N,13748.3596,W,2,9,2.7,34,M,M,,"55

**GGA subset:** GPGGA,225310,3327.9134,N,13748.3596,W,2,9,2.7,34,M,M,,"55

**Last received GGA String:** 10:53:09.997 PM, 7/3/2013

**Calculated GGA Checksum:** 55

**GGA Checksum in Nema String:** 55

**GGA Cluster:**

UTC time	Latitude	Longitude	GPS Quality	Number of Satellites	HDOP	Altitude above mean sea level	Altitude unit of measure	Geoidal seperation value	Geoidal seperation unit of measure	Checksum
225310	3327.9134	N 13748.3596	2	9	2.7	34	M	0	M	55

**GGA unsigned byte-array:**

50
44
57
44
50
46
55
44
51
52
44
77
44
77
44
44
42
53
53
0
0
0
0

**Latitude Breakdown:**

Latitude	Longitude
Lat Degrees: 33	Long Degrees: 137
Lat Minutes: 27	Long Minutes: 48
Lat Seconds: 54.804	Long Seconds: 21.576

Figure 11. GPS NMEA string unwound

WHOI-2013-06  
 OBSANP Data Acquisition System: Operator's Manual and System Overview

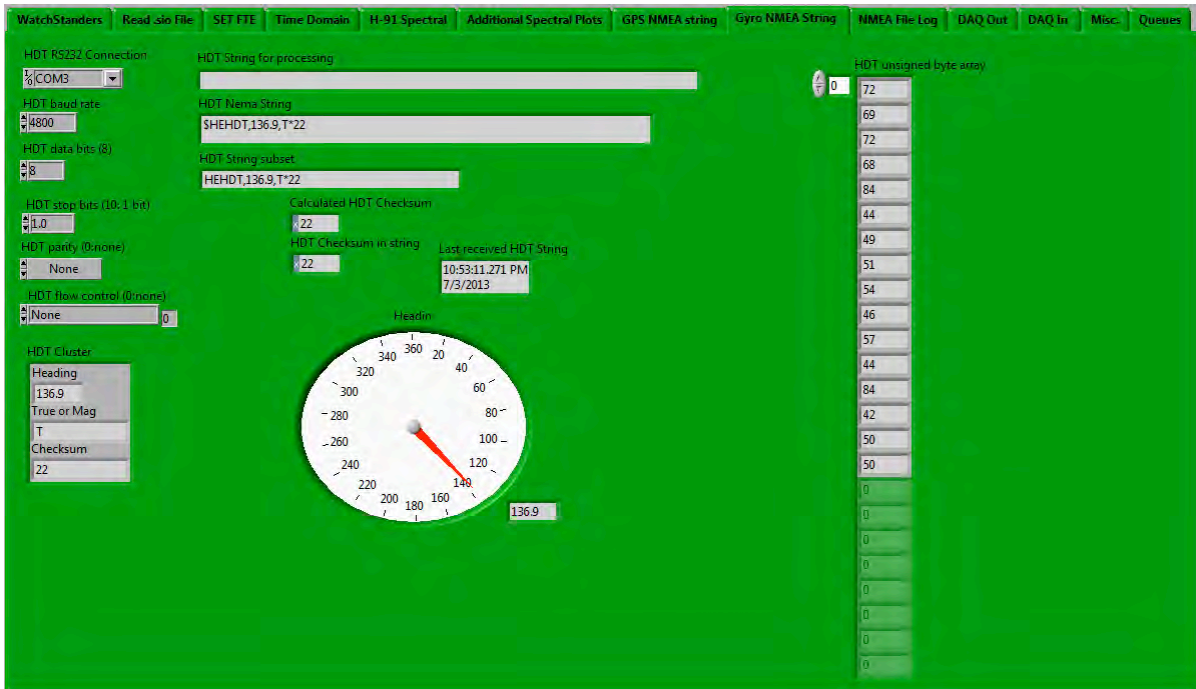


Figure 12. Gyro NMEA string unwound

16. PXI-6251 DAC and ADC settings

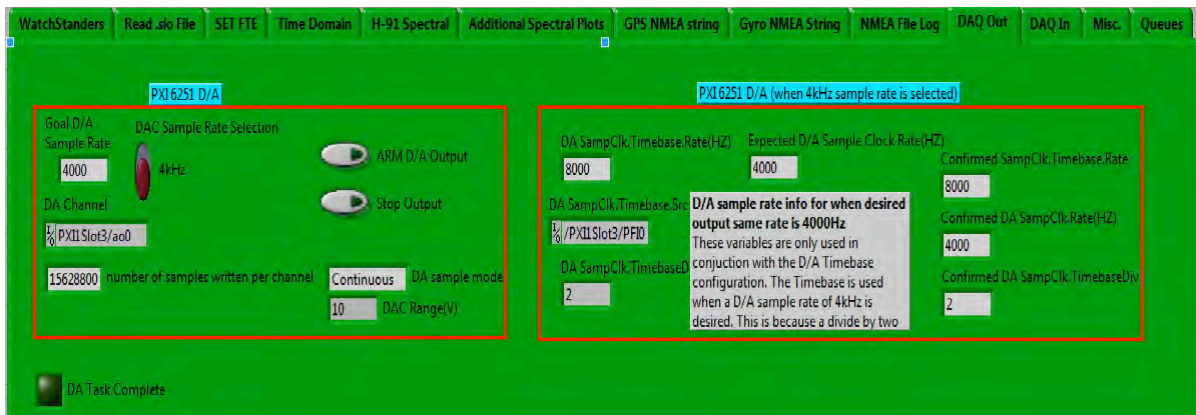


Figure 13. NI PXI-6251 DAC output

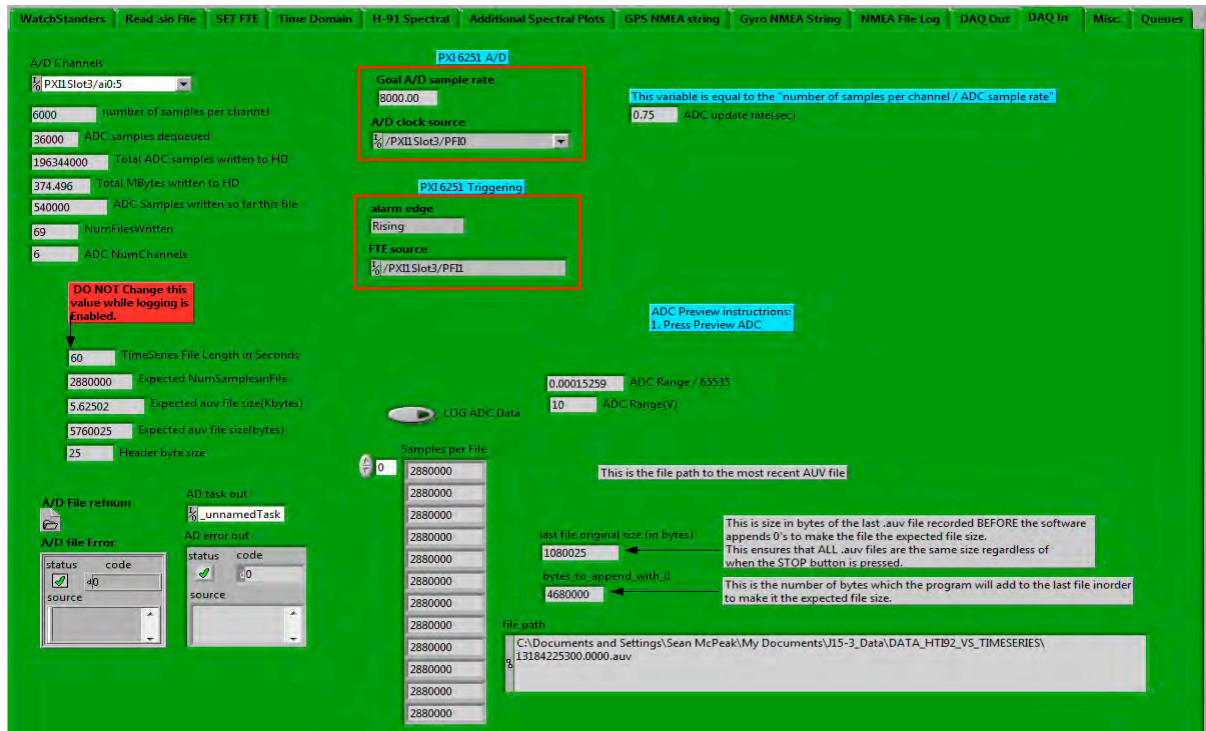


Figure 14. PXI-6251 ADC input and AUV file creation

## VII. Chroma Power Amp setup information

**Power Requirements:** 110VAC, 60Hz with each amp on separate 15A circuits

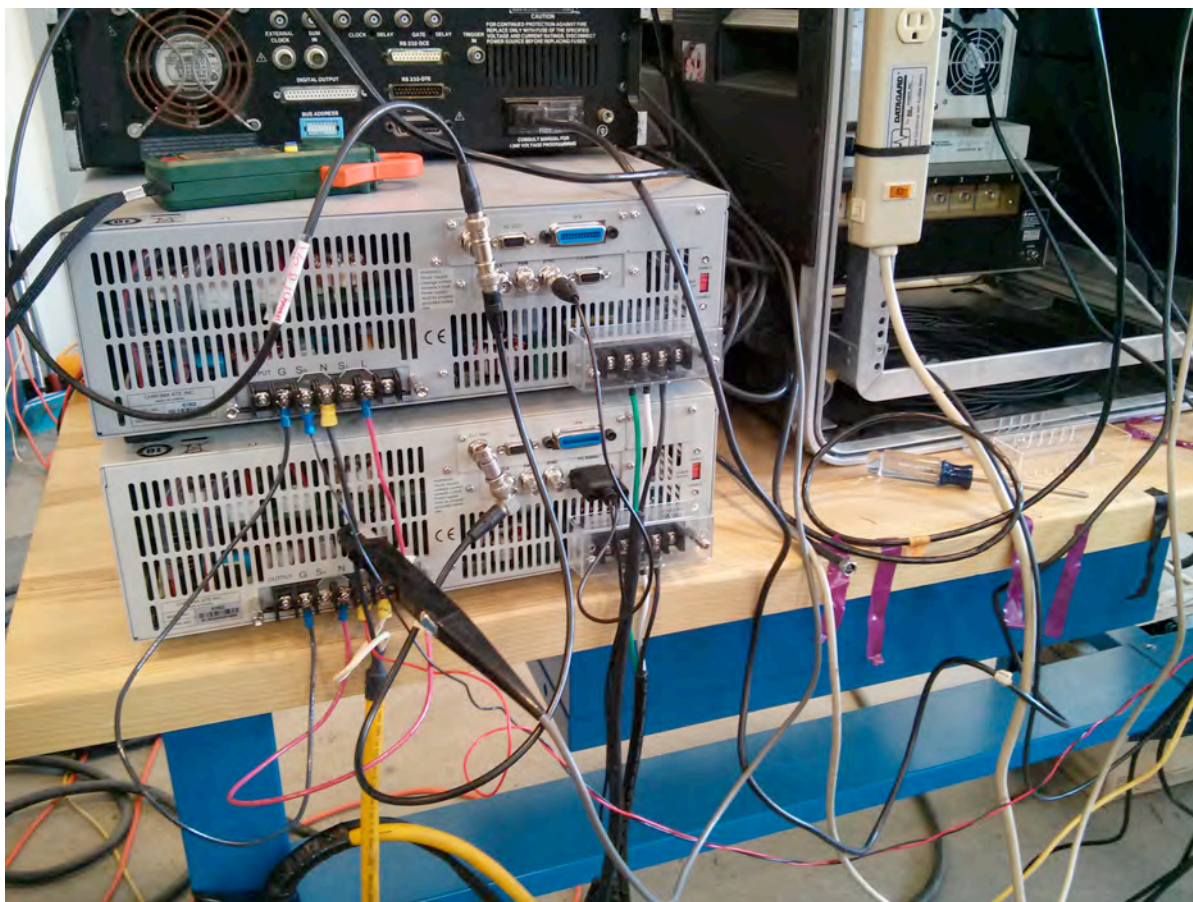
**Current Limit Protection:** Make certain to set both master and slave Chroma amps to < 3A current limit AND set delay time to 0 seconds.

Chroma 61502 Vref input impedance = 48k ohms  
 Vref input range = +/-10V range

### A. Instructions for series connection of 2 Chroma 61502 units (taken from a note by Keith von der Heydt at WHOI)

- 1.) One unit must be selected as the MASTER and the other as SLAVE. Essentially, configure the connection between the 2 units as described in the Chroma App Note "Connecting Output in Series to Achieve High Voltage Transients"
- 2.) Connect sync cable BNC to MASTER unit "SYNC" output on the rear panel. Connect one of the DB9P connectors on the same cable to the "TTL SIGNAL" DB9S on the slave unit.

- 3.) Connect the input signal to the Ext. Ref input on both units. The full scale (maximum) input is +/-10V. These inputs are fairly high impedance so a 50 ohm output source will be very close to 2x the rated source into 50ohms. (if driven from Analogic 2020 waveform generator)
- 4.) As the Chroma app note shows, connect MASTER "L" output to SLAVE "N" output. Connect "G" on output connector of both units together. Take series output across the MASTER "N" and the SLAVE "L" outputs.
- 5.) Connect the 110VAC input cables to each input. Green to "G", BLACK to "L" and WHITE to "N"
- 6.) Turn on both units at the front panel
- 7.) Setting Ext.V Vref = ON for both units
  - a. Press PAGE/EXIT
  - b. Select PAGE CHOICE = 2
  - c. Press ENTER and check that Ext.V Vref = ON. If it isn't, press the DOWN ARROW once, rotate the selector knob one way or the other to show "ON" and then press ENTER.
  - d. Press PAGE/EXIT to return to the PAGE CHOICE screen. Both units should remember this setting thru power cycles so normally it should NOT be necessary to set this parameter but it is prudent to check before operation.
- 8.) Setting the MASTER/SLAVE configuration for both units
  - a. Select PAGE CHOICE = 3 by pressing 3 and then pressing ENTER
  - b. Press blue SHIFT button followed by a DOWN ARROW again so the cursor shows up at the 3-PHASE MODE parameter.
  - c. If it is OFF, rotate the selector knob to MASTER for the MASTER unit and press ENTER
  - d. Set to SLAVE for the SLAVE unit and press ENTER
  - e. Press PAGE/EXIT twice to return to the screen showing Vac = 0.0 in the upper left hand corner of the display screen.
- 9.) **\*\*\*The following is very important and NOT documented by Chroma \*\*\* Properly configuring the MASTER unit to be in serial output mode.**
  - a. Set Vac = 1 or anything non zero and press ENTER
  - b. Set Vac = 0.0 and press ENTER
  - c. Now you can press the OUT/QUIT button on the MASTER and the output should be the EXT REF signal with a linear gain very close to 84. The RED LEDs on both the MASTER and SLAVE units should turn ON, however the SLAVE unit's LED may be delayed by a second or two. Pressing the OUT/QUIT button again will disable the output. As long as the units are NOT power cycled it should NOT be necessary to do anything other than pressing OUT/QUIT to enable or disable output.



*Figure 15. Chroma Master and Slave Power Amp rear panel connections*

### OBSANP DAQ System ADC Inputs & PA Output to J15-3

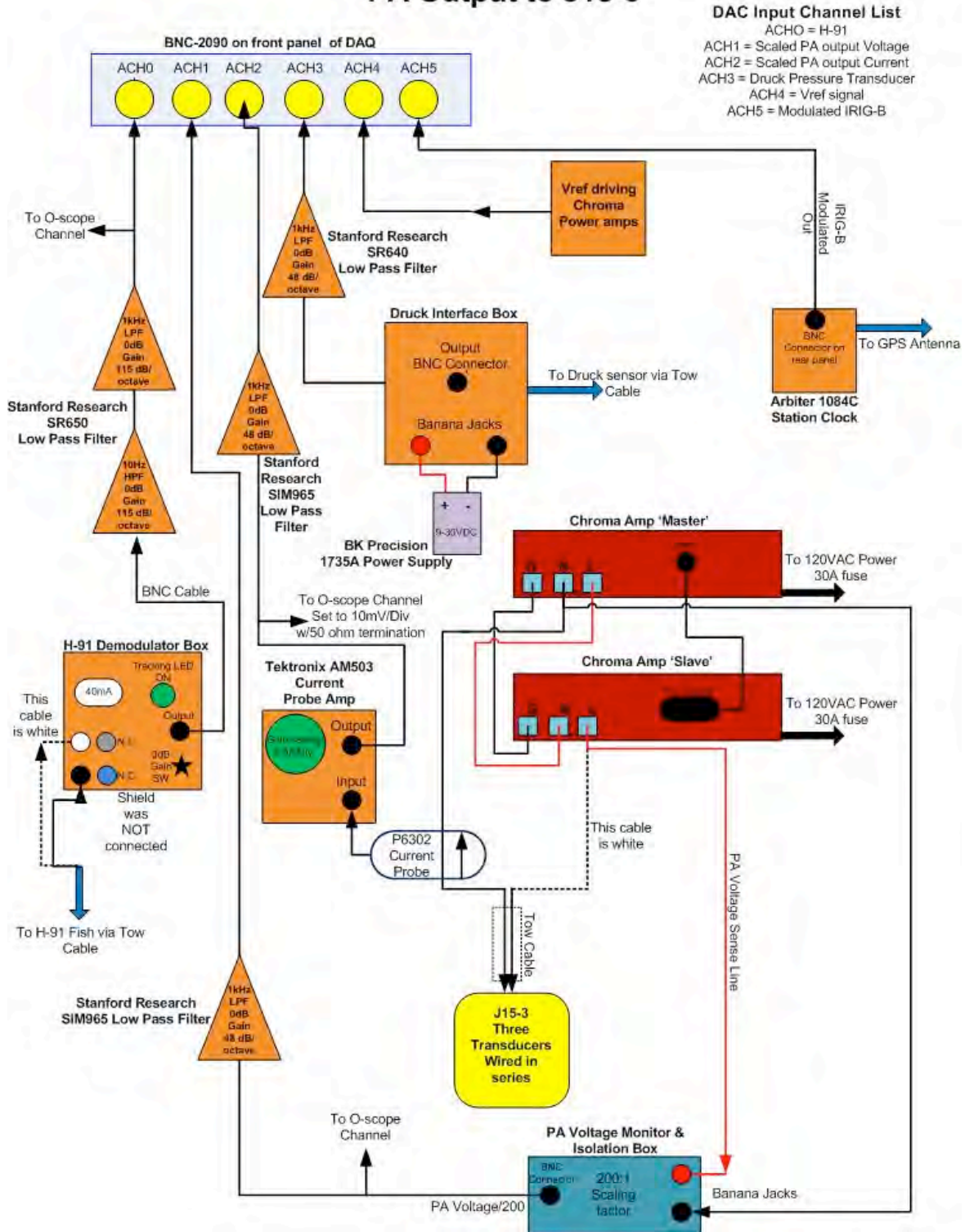


Figure 16. OBSANP DAQ System ADC Inputs & PA Output to J15-3

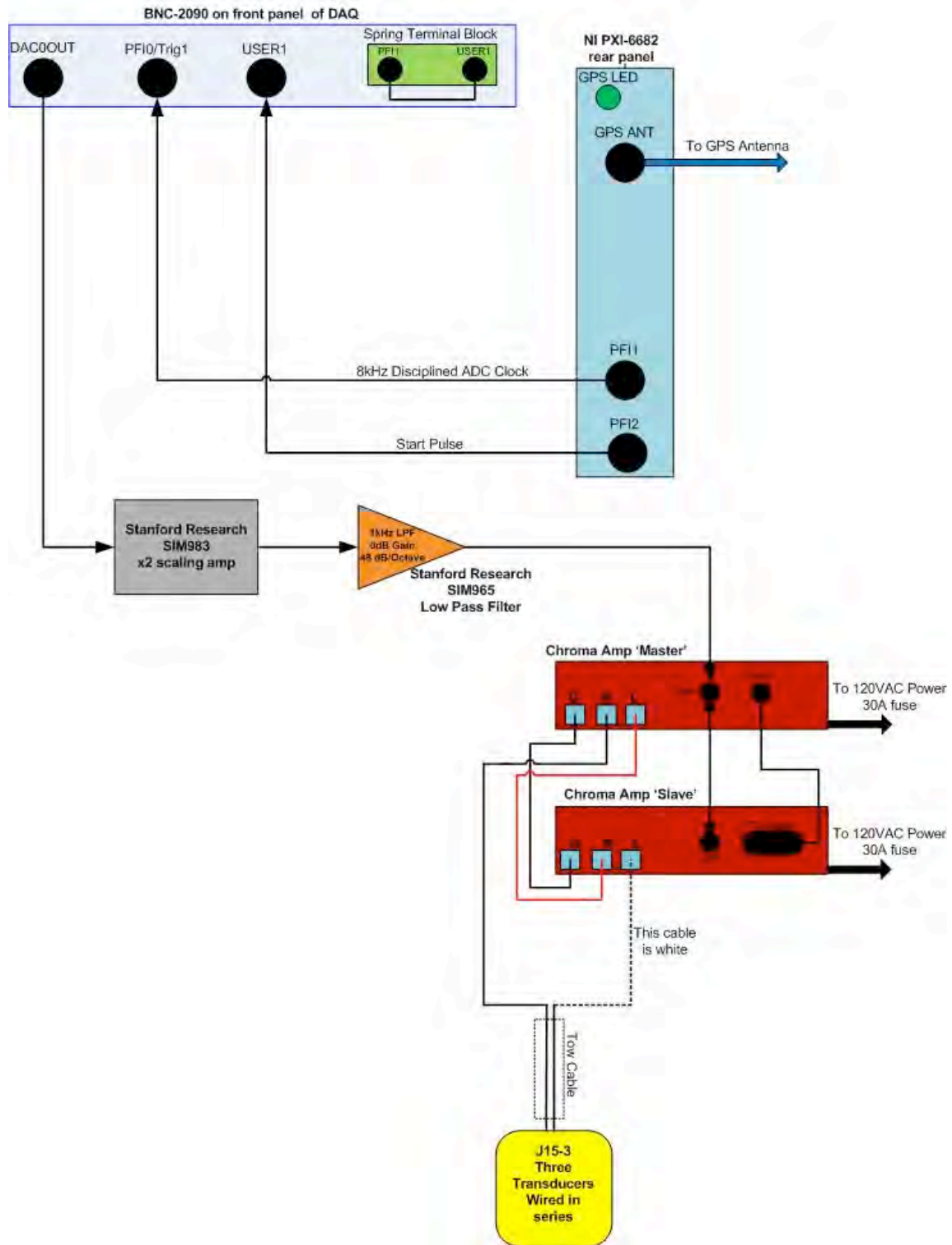


Figure 17 OBSANP DAQ System DAC Output & Connection to NI PXI-6682 Timing & Synchronization



## **B. Description of program tabs on the front panel**

### **1. *'WatchStanders'***

- a. Set gain for 'SIO' file
- b. Selection of 'SIO' file for the software to read
- c. Set FTE method and time for when to occur
- d. Display for FTE time programmed into PXI-6682 hardware

### **2. *'SET FTE'***

- a. Control for setting the Future Time Event (absolute or relative time)
- b. Julian day time stamp updates from PXI-6682
- c. Configuration information for PXI-6682
- d. PXI-6682 sample clock generation information

### **3. *'Read sio File'***

- a. Selection of 'Sun' or 'Linux' byte order
- b. Display of number of points in SIO file read
- c. Display of SIO file size in bytes
- d. PXI-6251 DAC output waveform Vp-p after scaling factor applied
- e. PXI-6251 DAC output waveform RMS voltage after scaling factor is applied

### **4. *'Time Domain'***

- a. Time domain graphs for all six channels of ADC
- b. Peak and Hold displays for H-91, PA Voltage and PA Current
- c. Decimated Depth display
- d. NI PXI-6682 hardware GPS and time reference information
- e. DAQ Preview or Normal mode setting

### **5. *'H-91 Spectral'***

Spectral display for H-91 output scaled to db SPL re  $1\mu\text{Pa}^2$

### **6. *'Additional Spectral Plots'***

Spectral Displays for PA Current, PA Voltage, Vref driving Chroma PA and Druck Pressure sensor voltage

### **7. *'GPS NMEA String'***

Display and parsing of the incoming GPS 'GGA' NMEA string

### **8. 'Gyro NMEA String'**

Display and parsing of the incoming Gyro 'HDT' NMEA string

### **9. 'NMEA File Log'**

NMEA file log controls, "File Length", "Sample Rate"

### **10. 'DAQ Out'**

DAC output sample rate settings

### **11. 'DAQ In'**

- a. DAC input sample rate setting and number of samples read from NI hardware per pass in software.
- b. Time series file size information
- c. PXI 6251 multi-function DAQ trigger setup information
- d. File path for most recent AUV file created

### **12. 'Misc.'**

- a. Display of 6 channels of acquired data (signed 16 bit integer array)
- b. H-91, PA Peak Voltage, PA Peak Current Peak and Hold variables
- c. Various PXI-6682 Time Stamp controls
- d. Three Booleans indicators for trouble debugging purposes specific to the PXI-6682 device.
- e. Auto start and stop time controls for SIO files '6a', '6b' and '6c'
- f. J15-3 Sound Pressure Level calculation constants

### **13. Information available to the right of the 'tabs'**

This information is located to the right of the main tab display and is the best place to get a quick synopsis of the overall condition of the DAQ system.

- e. GPS and Gyro NMEA string information
- f. Software threshold events, limits and reset control
- g. Future Time Event status
- h. Indication of new 'AUV' file creation – this will occur at a regular interval defined by the desired file length size.
- i. PA output RMS voltage and current measurements
- j. Monitor Hydrophone output voltage RMS values
- k. J15-3 SPL measurements based on source current and monitor hydrophone RMS voltage

## ***VIII. Known Bugs/ Issues***

1. File Size errors are still occasionally occurring so the software fix that was added prior to OBSANP 2013 is not 100% successful. This fix was intended to delay the actual “pressing” of the ‘Set FTE’ until the 5,15,25,35,45,55 minute marks to avoid accidental alignment with the PXI-6682 10 second timeout... which was previously proven to cause File Size Error events.
2. PXI-6682 Timing Errors have been occasionally occurring – the FTE is late by several tenths of a second in these instances. It has also been noticed during the OBSANP 2013 expedition that the “PXI-6682 Time Reference” error event was occurring extremely frequently. This occurs when the GPS signal quality gets too low OR there is momentary loss of GPS time reference. It is possible that the ‘PXI-6682 Timing Error’ and ‘PXI-6682 Time Reference’ error occurrences are related. Getting a better GPS cable may resolve this issue.
3. There were 2 instances when the PXI Timing Error occurred because NO FTE occurred. In these instances the software did NOT begin logging due to the fact that the FTE boolean variable was NOT set in code. However the ADC and DAC outputs were functioning properly. So it is as if the 1uS pulse from the PXI-6682 did in fact happen because the PXI-6251 triggered on this event and initiated sampling. However the PXI-6682 reported a non zero error code which caused the program to NOT set the FTE boolean event. The error code reported is unfortunately NOT known. The full nature of this event is not fully understood but should be explored in more detail.
4. The software had trouble stopping after the ‘Set FTE’ button had been pressed but BEFORE the event actually occurred.
5. During an improper shutdown event the software somehow accidentally created a “04001000000.0000.auv” file as described above in item#4.
6. When first starting Labview and the DAQ program is run for the very first time it is necessary to cycle the DAQ program ‘Start/Stop/Start’ with Labview’s main control panel on the top left of the screen. This is necessary for proper setup and communication with the PXI-6682 board. It was once thought that this was due to the usage of the compact PC chassis but during this expedition an NI PXI 1033 chassis was used and the problem was NOT resolved. So this is still an issue that needs further investigation.
7. Arlie Farlie provided a Transmitting Current Response (TCR) curve for the J15-3 S/N 11 during this expedition. That curve can be seen at the end of this document. It was noticed that the J15-3 dB SPL as calculated by the H-91mVrms was usually approximately 10dB lower than the source level as calculated by the J15-3 RMS current. Using the updated TCR curve value of 164 dB SPL v.s. 170 dB SPL (from the J15-3 generic spec) did help with making the two dB SPL calculations agree more closely. It’s also not fully understood why

the recent S/N 11 J15-3 TCR curve was 6dB lower than the levels shown in the standard spec sheet. In an email from Arlie Farley at NUWC he mentions different boundary conditions and impedance mismatch between the test equipment and the J15-3 as to why the updated TCR curve is different. Since our equipment has different boundary conditions and impedances the supplied TCR curve is not guaranteed as accurate for our setup.

8. High frequency noise spikes (<5uS) were seen frequently on the output of the H-91 bandpass filtered signal as well as the output of the AM503 magnetic current probe signal after passing through a low pass filter. The high frequency noise spikes seem to be mostly isolated to these two channels. The SR650 HP and LP filters were inspected for proper grounding. A power isolation Xformer was experimented with for this filter but had no effect on the HF spikes present on the H-91 signal. On JD 176 at 05:09 UTC it was discovered that the H-91 demodulator box had a faulty fuse connection which was not making good contact. The fuse holder was replaced with a new unit. This seemed to reduce the noise spikes seen on the H-91 signal. However the noise spike on the AM503 magnetic current probe did not significantly change in size or rate of occurrence. It should be noted that these HF spikes could be seen when the Chroma power amps were disabled and NOT transmitting as well as when they were transmitting.

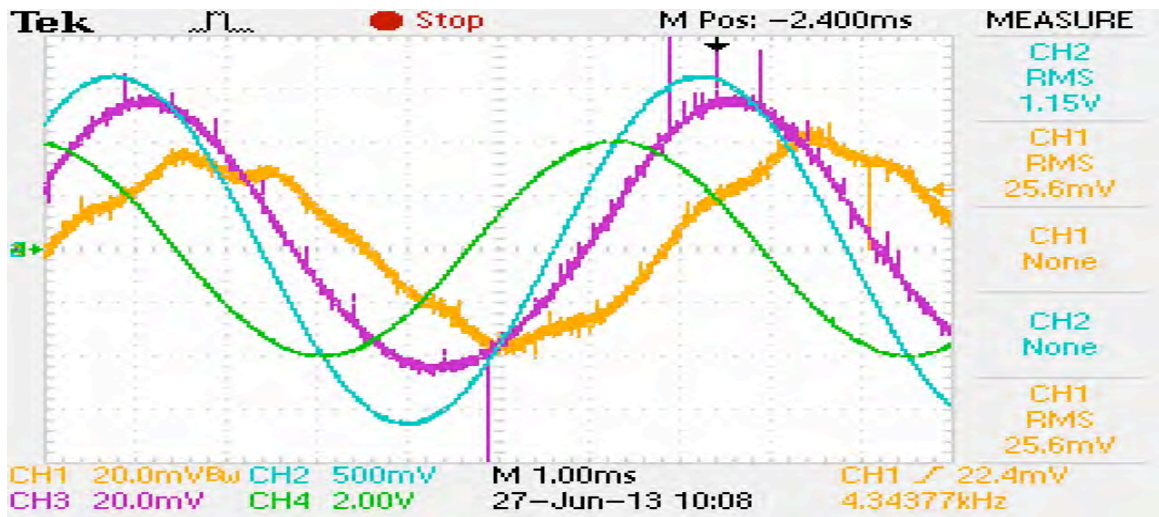


Figure 18. Example of high frequency spikes on H-91 and J15-3 current signals. "OBSANP\_Sea\_04.sio" was being transmitted.

155Hz, J15-3 @ 75m

Yellow trace = H-91 after bandpass filter

Green Trace = Vref drive signal into Chroma PA

Blue Trace = PA Vout driving J15-3

Purple Trace = PA Current from AM503 magnetic current probe after LPF

## ***IX. Future features to implement and changes to make***

1. Lower loss cable should be purchased for both NI-6682 and Arbiter 1084C Station Clock GPS antennas
2. Labview Software should have RS232 comms with Chroma power amps logging PA Volts, PA current and power factor at 1/sec rate.
3. A better J15-3 dummy load is need which more closely matches the impedance of the source. Using a space heater is problematic due to its lower resistance and thus large current draw which trips the Chroma current limit. There also tends to be additional switching circuitry in space heaters in between the drive (120VAC/60Hz) voltage and actual resistive load. On several occasions it has been attempted to use a space heater as a dummy load for the J15-3, however it has proven difficult to prevent Chroma over current events from occurring when the space heater load switches in.
4. Add verification of the J15-3 coil polarity to the initial checkout list
5. There needs to be a method by which the software logs the SIO file path read, DAC gain and wire out for each run. This could be achieved with one of the following two methods
  - a. AUV file headers are modified to contain this information – this would require modification of other software used to read AUV files
  - b. Separate 'readme' files are automatically generated by the software. These files could be logged in a new folder which the program generates (such as 'nmeafiles', 'auvfiles' and 'readmefile').
6. The software should automatically create subfolders titled 'auvfiles' and 'nmeafiles' located under a main data folder. The software should automatically place all AUV files and NMEA files created in the appropriate new folder. This will make less work for the watch standers.
7. The software should provide the user with a visual indication of where the playback currently is within the loaded SIO file. This could be a file playback timer, output frequency indicator OR a graphical display showing the operator the current playback location in the SIO file.
8. Software should calculate and display power factor, J15-3 impedance as well as measurement of distortion given H-91 spectral calculations
9. Be careful to use J15-3 documentation specific to the S/N provided. Request calibration documentation from NUWC specific to J15-3 S/N received. **[Pin-out diagrams for the J15-3 differ with the version of the documentation]**

10. Confirm J15-3 calibration curves for our acquisition hardware – probably at the same facility that calibrates J15-3's in Florida.
11. Discuss and coordinate the output data formats (file structure, names, etc.) with the data analysts and post processors prior to the start of the expedition.
12. Simplify the front panel for a cleaner and less confusing “watch stander” screen. Try to keep “engineering/design” related data on a separate and isolated panel so as not to clutter and confuse watch standers.

## ***Appendix A: NMEA Log File Description – OBSANP Expedition***

The NMEA files contain the gyro and GPS NMEA strings that the *R/V Melville* provides at approximately a 1 second rate. The GPS NMEA data was generated by the GP150 GPS unit and the Gyro NMEA data was generated by the Meridian device. These two RS232 strings were received on 2 separate com ports with the DAQ System PC.

The NMEA file name contains the time stamp for when the file was created. The operator could define a "NMEA File Length (sec)" which would control how many seconds of data each file would contain. At these regular intervals the software would close the existing file and open a new one. The timestamp in the file name is of the following format:

**NMEA\_Data\_%y%j%H%M%S.csv**

Data symbol	Data type	Example
Y	year within century (00-99)	11
J	day number of the year (001-366)	127
H	hour (00-23)	09
M	minutes (00-59)	52
S	seconds (00-59)	35

At a user defined interval the software will take a 'snapshot' of the current NMEA (GPS and Gyro) strings that had been received on the com ports and write these strings to the NMEA file. A timestamp will also be pre-pended to each new line, which is written to file. This time stamp will follow the format stated below:

**%y%j%H%M%S%4u**

Data symbol	Data type	Example
y	year within century (00-99)	11
j	day number of the year (001-366)	127
H	hour (00-23)	09
M	minutes (00-59)	52
S	seconds (00-59)	36
4U	4 decimal places of precision for the seconds	

The first 5 lines of each NMEA file are filled with a header. Below is an example of that header:

Data Format:

TimeStamp,X,NMEA GGA string,X,NMEA HDT string<cr><lf>

X=Data Valid?

if X=0 : Valid Data

if X=1 : Stale Data

WHOI-2013-06  
OBSANP Data Acquisition System: Operator's Manual and System Overview

The file's 'Valid Data' or 'Stale Data' (X) indicator was determined by the software depending on the rate at which NMEA strings were received. If the PC does not detect a valid GPS or Gyro NMEA string within the last 2 seconds, the software will set the value 'X' to 1 for the appropriate NMEA string to indicate that the data has gone stale. Otherwise the NMEA string will be considered valid and 'X' will be set to 0. This valid or stale data check also drives an indicator on the Labview program front panel. This is an indicator to the operator to alert them if a problem occurred with either of the NMEA strings such as an unplugged RS232 cable or some other interruption in the RS232 data.

The following is a breakdown of the GPS or (GPGGA string) received from the *R/V Melville* during OBSANP and logged to the NMEA files.

**\$GPGGA,%f,%f,%1s,%f,%1s,%d,%d,%f,%f,%1s,%1s,\*%s**  
\$GPGGA,094502,2132.8597,N,12606.1389,E,2,7,1.4,25,M,,M,,\*4F

UTC Time  
Latitude  
Latitude Sector  
Longitude  
Longitude Sector  
GPS Quality  
Number of Satellites  
HDOP  
Altitude above mean sea level  
Altitude unit of measure  
Geoidal speration unit of measure  
Checksum

The following is a breakdown of the Gyro or (HEHDT string) received from the *R/V Melville* during OBSANP and logged to the NMEA files.

**\$HEHDT,%f,%1s\*%s**  
\$HEHDT,164.984,T\*29

Heading True or Magnetic  
Checksum



## ***Appendix B: Explanation of Druck Voltage to Depth Conversion used during OBSANP (June-July'13)***

The Labview code does the following calculations with the signed 16 bit integers representing Druck voltage which are produced by the ADC.

1. Multiply by 10V / 65536 to convert to volts. This is a common step for all ADC measurements. The ADC has a 10V range and there are  $2^{16} = 65536$  counts in that range.
2. Apply a 30Hz 1st order LP filter to the 6000 point array of Druck data. This removes HF noise due to the lack of capacitance across the 118 ohm resistor which the Druck current develops a voltage across. The voltage developed across this resistor is measured by the DAQ system.
4. Then subtract a constant 0.6577 -> this is the initial on deck voltage measurement taken on June 16, 2013 before we arrived on station for OBSANP.
5. Multiply by 53.1780779382 to get depth in meters.

Below is a more detailed description of this procedure which is placed in the Labview code where this measurement is taken.

### **Druck Pressure sensor conversion from volts to depth**

This calibration was done using a SBE-39 attached to the Druck sensor on the J15-3.

On deck Druck Voltage as measured by DAQ = 0.6577V

@40m wire out Druck Voltage as measured by DAQ = 1.443V (mean value from AUV file at this depth)

@100m wire out Druck Voltage as measured by DAQ = 2.59V (mean value from AUV file at this depth)

On deck SBE-39 = -0.0946 meters depth

@40m wire out SBE-39 = 41.4345 meters depth

@100m wire out SBE-39 = 102.756 meters depth

Slope Calc:  $(102.756 - 0) / (2.59 - 0.6577) = 53.1780779382$  (Surface to 100m depth)

OR

Slope Calc:  $(102.756 - 41.4345) / (2.59 - 1.443) = 53.462510898$  (40 to 100m depth)

The first data range was used for calculating slope

Calc. depth(m) from Druck = (Druck Volts - 0.6577) \* 53.1780779382



Figure 19. Druck Pressure Transducer Interface Box & PA Voltage Isolation/Scaling Box

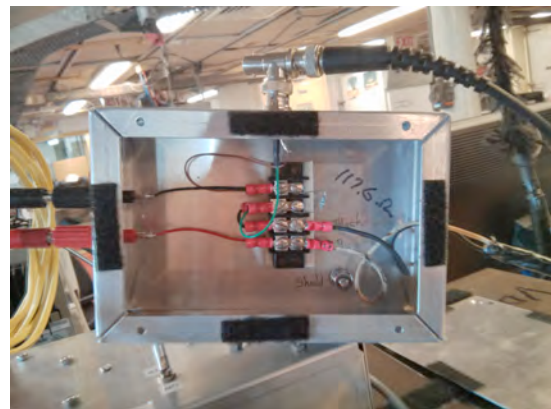
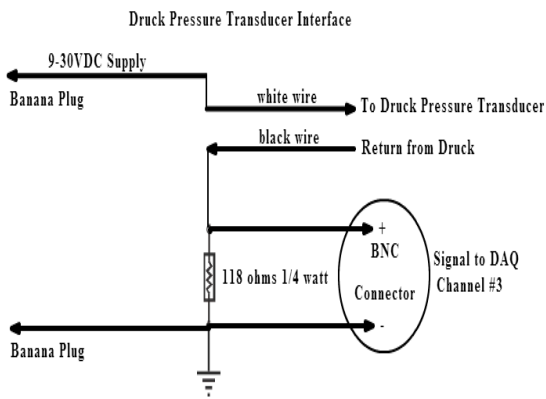


Figure 20. Druck Pressure Transducer Interface Box & Schematic

### ***Appendix C: Conversion from AUV file ADC data to engineering units for each channel***

AUV files contain 6 channels of A/D counts. The ADC resolution is 16 bits and the voltage range on each channel is 10V. To convert to volts (@ DAQ) for each channel:

$$V_{ch} = (\text{ADC}/2^{16}) * 10$$

Next it is necessary to scale each channel's signal by the appropriate factor.

**Channel 0 (H-91 volts):** Vch0 (hydrophone) has no scaling

**Channel 1 (PA volts):** Vch1 \* **212** = Chroma PA volts driving J15-3

**Channel 2 (PA Current amps):** Vch2 \* **59** = Chroma PA amps driving J15-3

**Channel 3 (Druck Pressure transducer meters):** (Vch3 – **0.6577**) \* **53.1780779382**

The Druck voltage measured on deck = 0.6577 volts

The Druck scaling factor is 53.1780779382 meters/volt

**Channel 4 (Vref volts into Chroma):** Vch4 has no scaling

**Channel 5 (Arbiter 1084C Station Clock modulated Irig B volts):** Vch5 has no scaling

### ***Appendix D: PA Vout Isolation & Scaling “Blue Box” scaling factor based on frequency***

determined on Julian Day 185, 2013 at sea.

Frequency (Hz)	PA Vout measured with O-scope directly Volts(peak to peak) measured	Output of Blue Isolation & Scaling “Blue Box” Volts(peak-peak) measured	Calculated Scale Factor
20	302	1.38	218.84
30	302	1.39	217.26
50	302	1.40	215.71
75	302	1.42	212.68
100	303	1.42	213.38
150	306	1.43	213.99
200	309	1.45	213.10
250	310	1.46	212.33
300	312	1.46	213.70
350	314	1.46	215.07
400	314	1.47	213.61
450	314	1.47	213.61
500	314	1.47	213.61
600	310	1.46	212.33

PA Output Isolation & Scaling Interface

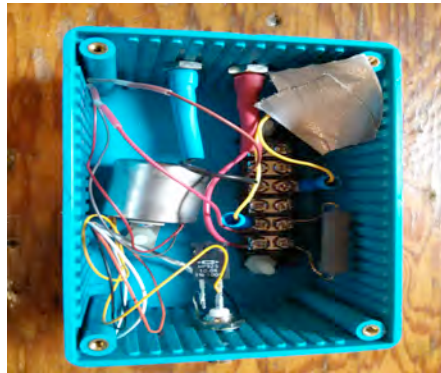
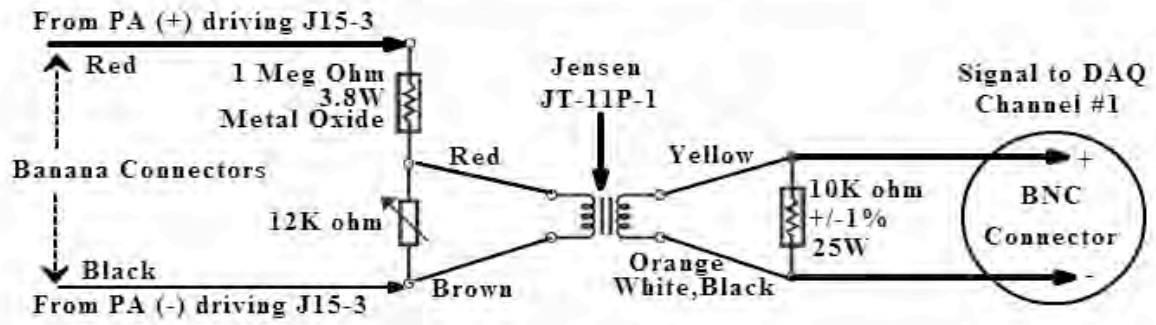


Figure 21. PA Isolation/Scaling Box & Schematic

## *Appendix E: Chroma PA phase measurements and drive levels*

**Chroma PA Output (Master & Slave) phase offset from Vref drive signal based on frequency**

**The Chroma amps were run with NO load (no J15-3 OR Blue Isolation & Scaling Box)**

Frequency (Hz)	Phase of PA Vout as measured by O-scope with respect to Vref Measured in Degrees
20	≈ 0
30	1-2
50	≈ 3
75	≈ 4.5
100	5 to 6.5
150	8
200	12
250	15
300	20-21
350	22-23
400	≈ 26
450	≈ 30
500	≈ 33
550	≈ 37
600	≈ 40

Note: PA Vout as measured by O-scope lags Vref

**Chroma PA Output (Master & Slave) phase offset from Vref drive signal based on frequency  
(under load with J15-3 AND Blue Isolation & Scaling Box)**

Frequency (Hz)	Phase difference between Vref and output of Blue Isolation & Scaling Box as measured by O-scope (degrees)	Phase difference between output of Chromas and output of Blue Isolation & Scaling Box as measured by O-scope (degrees)
20	≈ 0	0
30	≈ 6	3 to 6.5
50	≈ 13	≈ 13.7
75	≈ 25	≈ 20
100	≈ 34	28 to 29
150	≈ 52	42
200	≈ 70	≈ 60
250	≈ 88	≈ 73
300	≈ 109	≈ 88
350	≈ 128	104
400	≈ 148	120
450	≈ 167	134
500	≈ 175	≈ 152
550	≈ 155	≈ 168
600	≈ 135	176

Notes:

1. Output of Blue Isolation & Scaling Box lags Vref
2. Output of Blue Isolation & Scaling Box lags Chroma Vout as measured by O-scope
3. Vref was 400mVp-p for the above data set

**Table 1. Chroma typical input & output drive levels**

Freq Hz	PA Amps driving J15-3 RMS	PA Vrms driving J15-3	Power Factor	dB SPL based on J15-3 current	dB SPL based on H-91 Vrms	H-91 mVrms
77.5	2.07	238	0.977	176	167	10
155	2.04	240	0.947	176	170	15-21
310	1.67	244	0.888	174	167	10
102.3	2.09	239	0.975	176	171	15-18
204.6	1.90	242	0.922	175.5	170	13-15

**6TX SIO file was being transmitted**

**DAQ Gain = 2.0**

**Scaling Amp gain = 2.0**

**J15-3 depth = 62m**

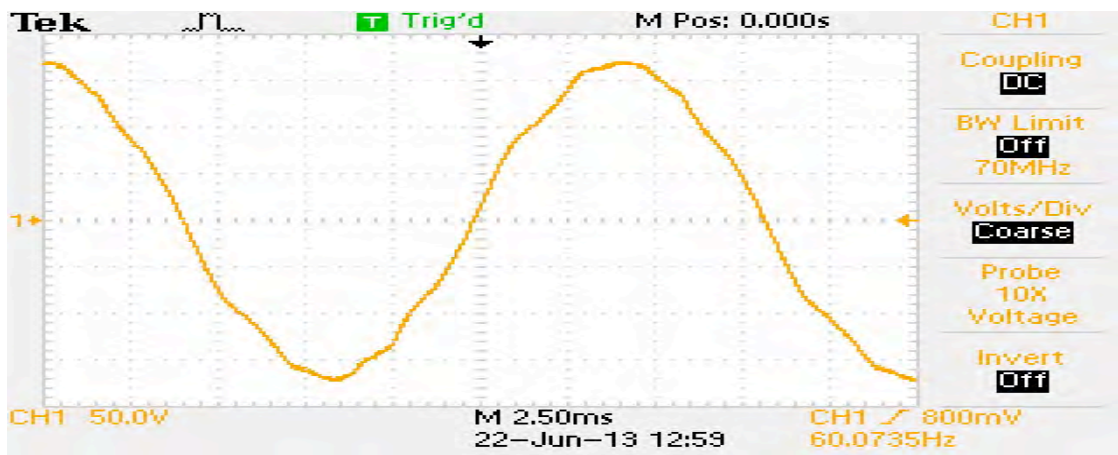


Figure 22. Oscilloscope Images of Clean Power Supply – Chroma PA power source  
June 22,2013

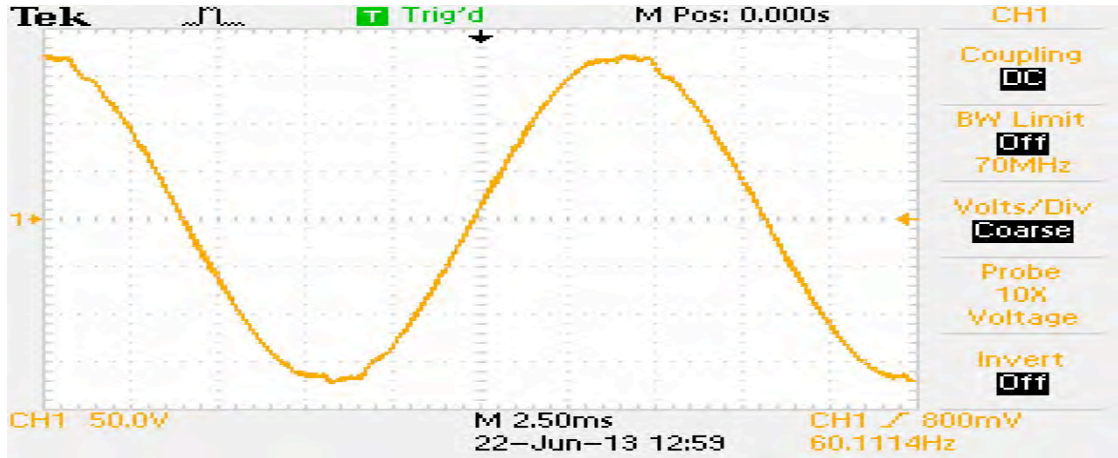


Figure 23. Oscilloscope Images of UPS Power Supply – DAQ System power source  
June 22,2013

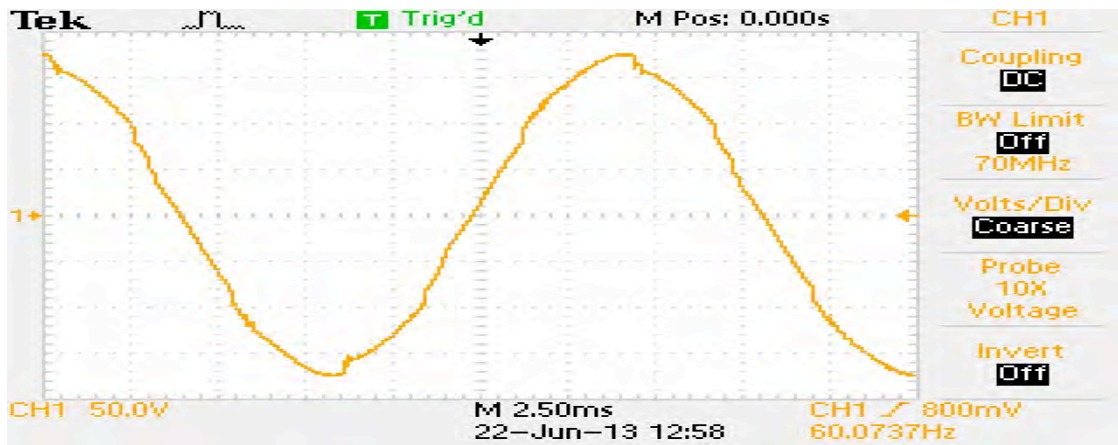


Figure 24. Oscilloscope Images of Dirty Power Supply – Not a power source for ANY  
portion of the DAQ System  
June 22,2013

## ***Appendix F: AIS Logging Summary***

There were two AIS systems being logged during the OBSANP expedition. Bud Hale from SIO loaned us an AIS receiver which we referred to as the "Spare AIS" system. We had initially been told that the ship would be able to log the bridge's AIS and provide this data set to us at the end of the expedition. However shortly before arriving at the *R/V Melville* we learned that the logging of the bridge's AIS system would unfortunately not be ready for our expedition. But we were told that the bridge's AIS data stream could be made available. This would be made available via a 'Wifly' device (commercially available product) connected to the Furuno FA-100 "Extra I/O Port" output data stream. This DB9 is located on the bottom right most corner of the back of the FA-100 device. The 'Wifly' device would then put this data stream on the ship's wireless network and would be provided to us via a telnet session to the following address:

IP: 172.19.150.100  
Port: 2000

A Labview program was created to connect via Telnet to the data stream for time stamping and logging. The data stream we were receiving was full of characters which were outside of the ASCII printable range which at the time we could not explain. The bridge's AIS system was giving us vastly different data streams than our Spare AIS system was. Therefore the Labview software was modified to log the raw hex codes for each incoming character. This approach would then allow for decoding at a later time of the raw hex values.

A second Labview program was used to connect to the "Spare AIS" system via an RS232 connection using an RS232 to USB converter.

Both Labview programs responsible for AIS data logging were ran on a laptop computer provided by WHOI. This computer was running the "Network Time System (Client) Manager" program to insure that the PC's clock was synced once per minute to the ship's NTP broadcast. This NTP broadcast was provided at 137.110.150.5.

Both Labview AIS logging programs would create a new file every hour containing the time stamp of file creation in the file name with the following format:

**Bridge\_AIS\_Data\_%y%j%H%M%S.csv**

**Spare\_AIS\_Data\_%y%j%H%M%S.csv**

The programs would time stamp and log each received message from either the Spare AIS or the Bridge's AIS data stream with the following format:

**For Spare AIS Data Files:**

Time Stamp (%y%j%H%M%S%3u),AIS Data

**For Bridge AIS Data Files:**

Time Stamp (%y%j%H%M%S%3u),AIS Data hex coded ascii



WHOI-2013-06  
OBSANP Data Acquisition System: Operator's Manual and System Overview

The Bridge's AIS logging began on JD 168 18:38:49 UTC and the last file was created on JD 187 14:53:30 UTC.

The Spare AIS logging began on JD168 18:38:23 UTC and the last file was created on JD 187 14:45:37 UTC. On JD 180 the Spare AIS logging stopped at 13:04:12 UTC due to an RS232 cable becoming partially disconnected. The logging was resumed at 16:12:33 UTC. I went to the bridge twice between 16:12 and 17:10 and they reported only seeing the "Pacific Collector MMSI# 367130000 @ approximately 26 miles" on their Furuno FA-100 AIS from the 8am watch which started at 14:00 UTC. I also spoke with the captain at lunch and he did not see anything on the bridge AIS during his 4-8am watch.

On the morning of JD 180 it was determined that the bridge's AIS system was not properly being connected to the 'Wifly' device. The Wifly device requires RS232 input. However the connection had been made to the FA-100's Extra I/O port which is believed to be RS422. The conversion between RS422 and RS232 did not appear to be done correctly which would have explained the odd characters outside of the regular printable ASCII range that we had been receiving since the beginning of the expedition. So a decision was made to connect the 'Wifly' device to the FA-100's junction box (CB-100) where an RS232 data stream could be found on pin 43 TD, pin 44 RD and pin 21 GND. As soon as this change was made the bridge AIS data received over the telnet connection looked like a valid AIS data stream and no longer contained characters outside of the normal printable ASCII range. So on JD 180 at 23:57:22 UTC we were able to begin logging valid bridge AIS data.

**Note:** On JD 180 at 23:57:22 UTC the Bridge AIS logging Labview software was modified to no longer log the raw hex ASCII values and instead to simply log the ASCII strings as received from the FA-100 since these data streams now were valid. However... the header line in each file was accidentally left stating that the logs were "hex coded ASCII".

## Appendix G: Laboratory Photos

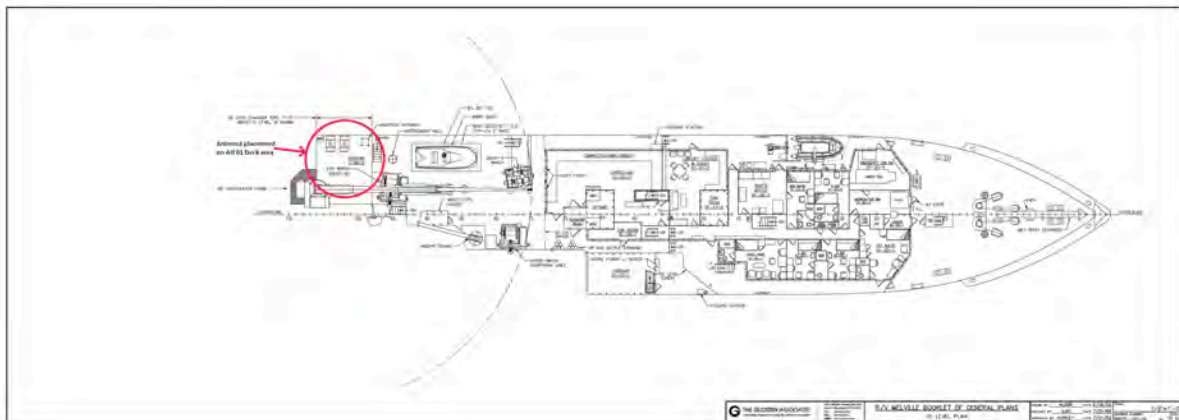
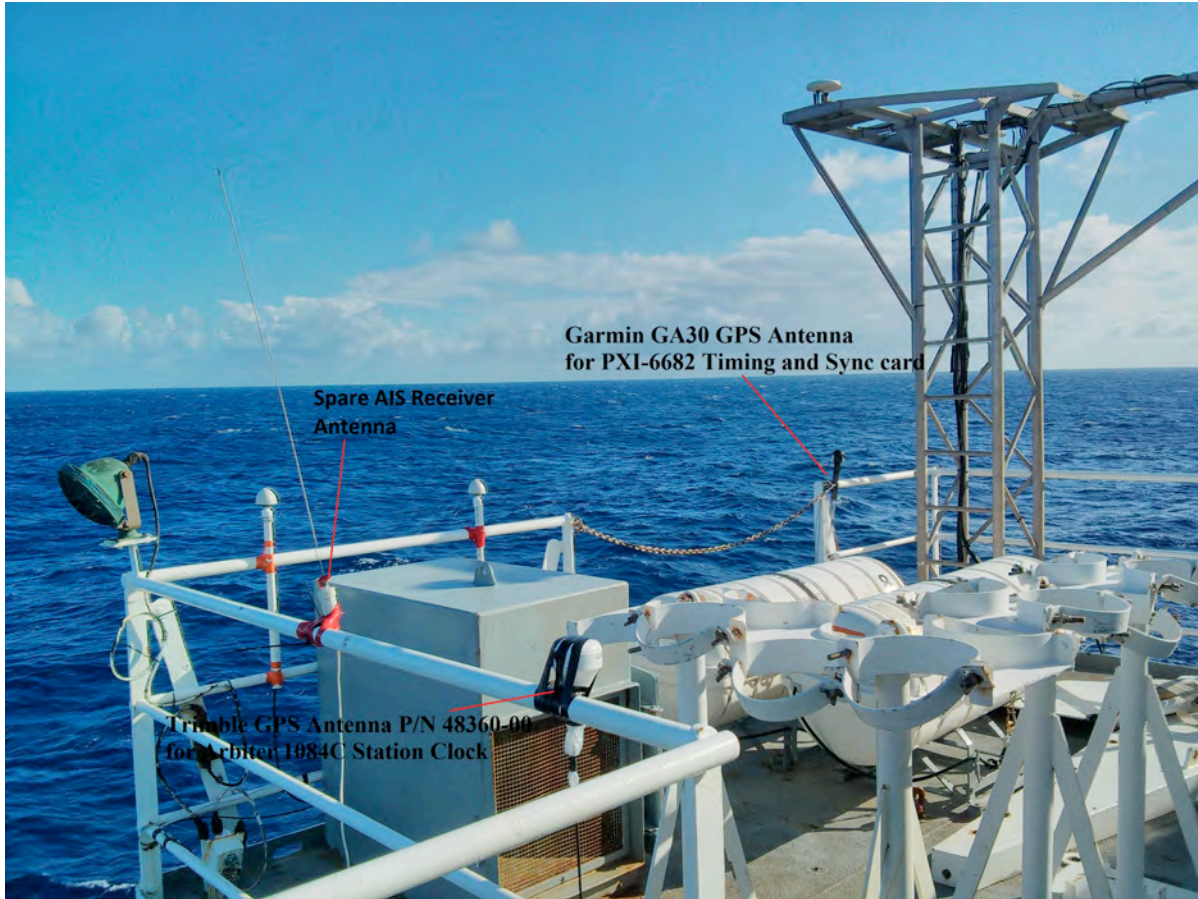


Figure 25. Antenna Placement on R/V Melville

WHOI-2013-06  
OBSANP Data Acquisition System: Operator's Manual and System Overview

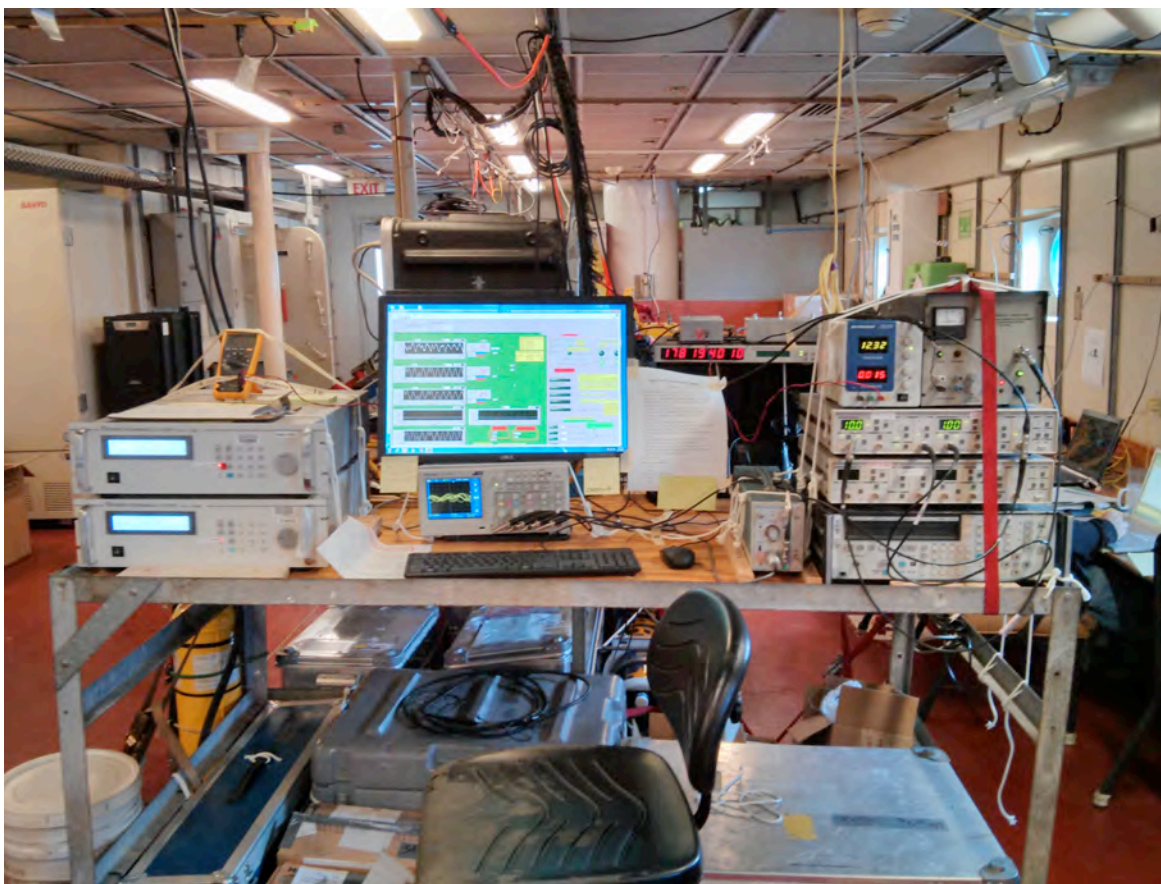
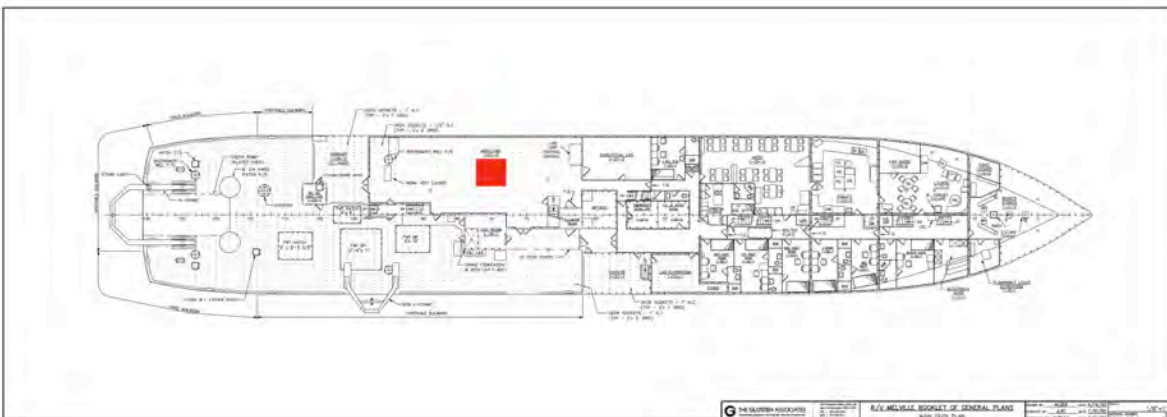


Figure 26. System Setup in main lab of R/V Melville

### ***Appendix H: System Notes:***

1. The Druck Pressure transducer was powered by a BK Precision 1735A power supply set to 12.3VDC.
2. All filters, PC and NI DAQ gear were plugged into 2UPS-101 supply
3. Chroma 'Master' and 'Slave' amps were plugged into Clean Power supply 8CP-102
4. No 1:1 power isolation transformer was used during this expedition
5. AM503 current amplifier was set to 0.5A/div, AC coupling, 5MHz Bandwidth
6. NI PXI-6682 GPS antenna was small egg shaped Trimble P/N 48360-00 antenna loaned by Keith von der Heydt. The antenna was connected via 2 strands of white RG58 (approx. 30') cable joined by a BNC barrel connector. I believe this cable was taken from the Garmin antenna box.
7. Arbiter 1084C Station Clock was connected to Garmin GA30 GPS antenna through > 60' black RG58 cable which was loaned from Keith von der Heydt
8. The DAQ system computer (Dell Precision T1650) was sync'd to the *Melville's* NTP broadcast every 1 minute using the program "Network Time System Manager"
9. J15-3 S/N 11 polarity was confirmed valid and in phase for ALL three heads on June 22,13. This was done by pressing downward on each transducer one at a time with our hands and confirming that the same polarity of voltage was being created when measured with a Fluke multi-meter at the RM6MS connector on the J15-3. When testing each head, press down and hold to take a reading, then release and take a second reading (which should have opposite polarity). This is most easily done by two people, with the "presser" calling out "down" or "up" at each stage of the test.
10. The J15-3 S/N 11 was frequently checked for proper resistance, meg ohmmeter values from each coil to case as well as inflating and deflating the air bladder. Below is a brief summary of those checks. **All J15-3's should be checked on delivery for proper coil resistance and isolation meg-ohmmeter values.**

**Table 2. J15-3 S/N 11 coil checks done during expedition**

<b>Date</b>	<b>Coil #1 ohms</b>	<b>Coil #2 ohms</b>	<b>Coil # 3 ohms</b>	<b>Coil#1 to case meg-ohmmeter check @ 250V</b>	<b>Coil#2 to case meg-ohmmeter check @ 250V</b>	<b>Coil#3 to case meg-ohmmeter check @ 250V</b>	<b>Air bladder inflation and deflation</b>
JD169 15:49	23- 25	23- 25	23- 25	>200Mohms	>200Mohms	>200Mohms	Yes
JD173 20:03	23- 25	23- 25	23- 25	>200Mohms	>200Mohms	>200Mohms	Yes
JD176 21:22	23- 25	23- 25	23- 25	>200Mohms	>200Mohms	>200Mohms	No
JD179	23	23	23	>200Mohms	>200Mohms	>100Mohms Was getting less after 3 successive tests	Yes
JD184	23	23	23	>200Mohms	>200Mohms	>200Mohms	No

NAVAL UNDERSEA WARFARE CENTER  
 UNDERWATER SOUND REFERENCE DIVISION  
 1176 HOWELL STREET, NEWPORT, RI 02841

USRD NO. 4374  
 LEESBURG FACILITY  
 DECEMBER 2012

**TRANSMITTING CURRENT RESPONSE**

USRD J15-3 with Tow Body Serial 011  
 Pressure at one meter per ampere measured at end of 30 meter cable; Unbalanced  
 22 ° C; 14.3 m depth (140 kPa)

This transmitting response should be treated as typical, because boundary conditions may affect the sound pressure generated at a given point, USRD recommends that a reference hydrophone be used to determine the sound pressure level.

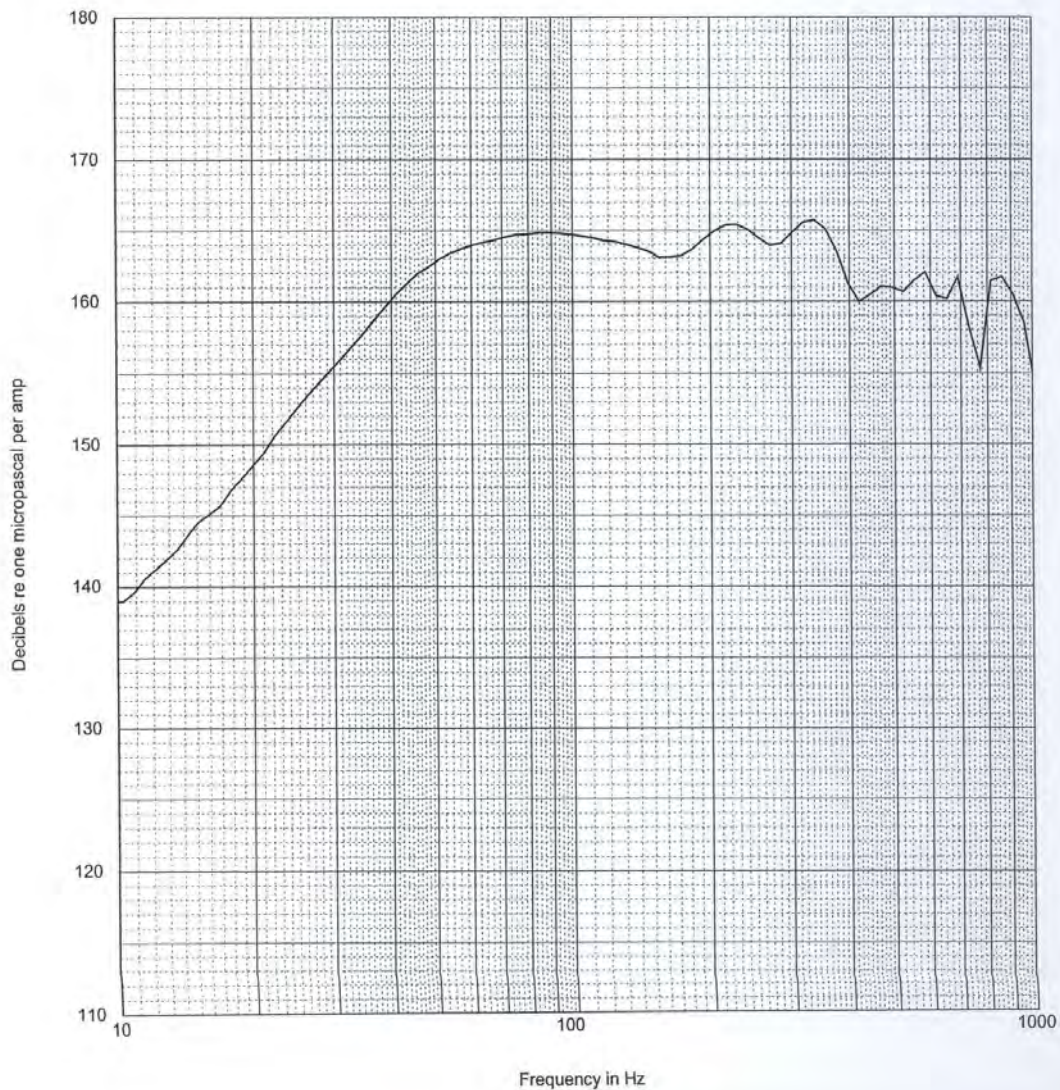


Figure 27. J15-3 SN 11 – updated TCR from Arlie Farlie during expedition

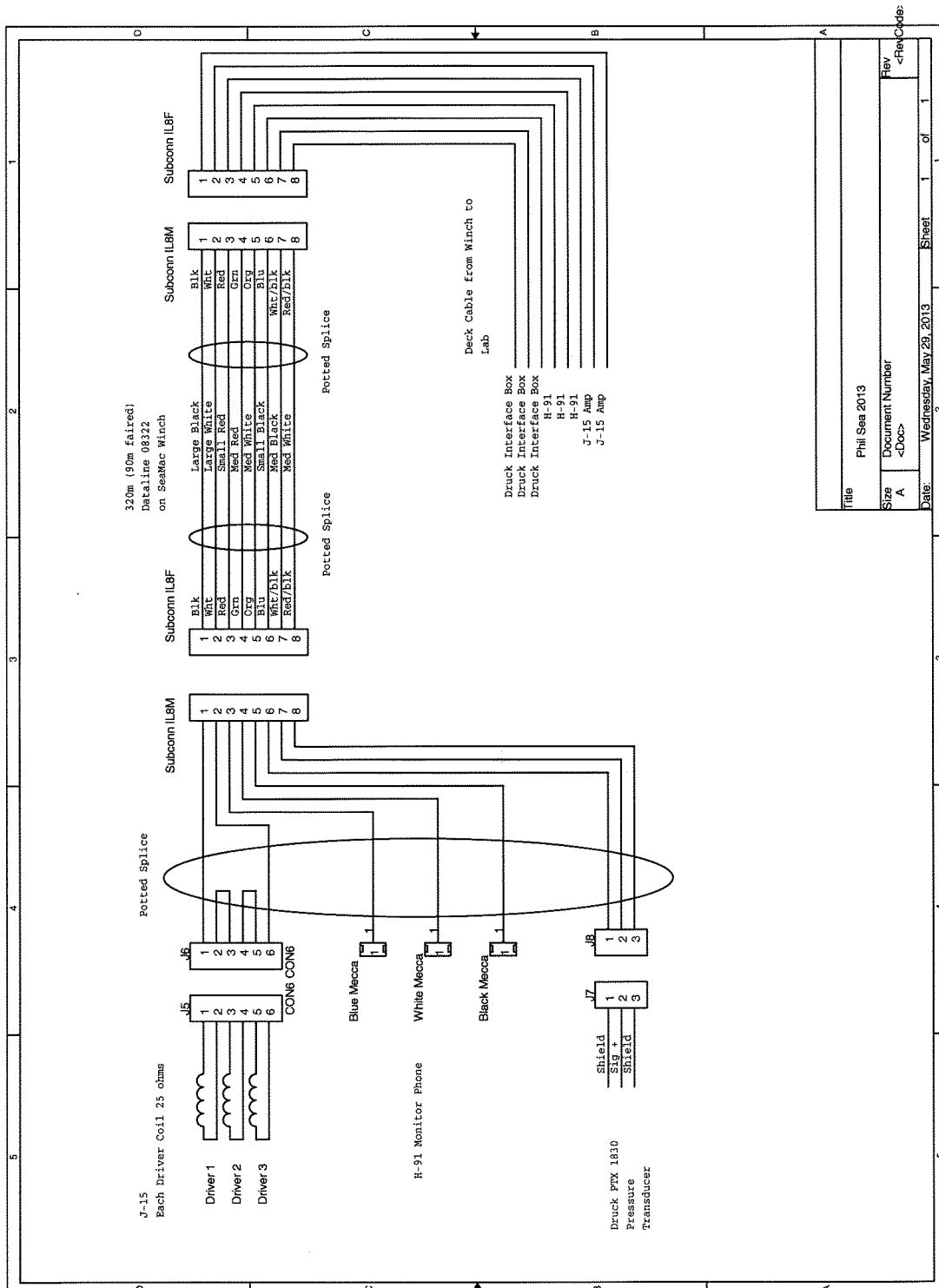


Figure 28. Octopus Wiring Diagram / Neil McPhee (WHOI)

## ***XIV. REFERENCES***

- McPeak, S. P., D'Spain, G. L., and Stephen, R. A. (2011), OBSAPS data acquisition system: Operator's manual and system overview, WHOI Technical Report 2011-05, (Woods Hole Oceanographic Institution, Woods Hole, MA).
- Stephen, R. A., Kemp, J., McPeak, S. P., Bolmer, S. T., Carey, S., Aaron, E., Campbell, R., Moskovitz, B., Calderwood, J., Cohen, B., Worcester, P. F., and Dzieciuch, M. A. (2011), Ocean Bottom Seismometer Augmentation of the Philippine Sea Experiment (OBSAPS) Cruise Report, WHOI Technical Report 2011-04, (Woods Hole Oceanographic Institution, Woods Hole, MA).



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<b>16. Abstract (Limit: 200 words)</b> On the Ocean Bottom Seismometer Augmentation in the North Pacific Experiment (OBSANP, June-July, 2013, R/V Melville), a VLA and twelve OBSs were deployed to listen to an active acoustic source, a J15-3. This report describes the hardware and software used to control and record the acoustic transmissions from the source. Some significant features of the system are: 1) The system transmits general user-defined source functions, such as M-sequences (.SIO files). 2) In addition to controlling the source waveform, the system also records six real-time channels in binary files with user-selectable lengths: the monitor hydrophone mounted near the source, the power amplifier voltage and current, the depth of the source, Vref signal driving the power amplifiers and an IRIG-B time reference. Files are output in .AUV format with a precision GPS-based time stamp in the file name. 3) The transmission start time along with ADC and DAC sample rates are disciplined to GPS time. 4) A convenient, Labview based, user interface provides real-time source control and monitoring. 5) The software provides parsing and logging of gyro and GPS NMEA sentences. The system, which was based on an earlier system from Scripps MPL, worked well on OBSANP and is available for future projects.			
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