MOOS Mooring Engineering Deployment Requirements

REV X.A.2

Purpose
1. Test reliability of data/power cable & mooring mechanical hardware
2. Test reliability/feasibility of ROV operations in connection to mooring
Items to monitor
1. Loads
2. Visual wear
3. Sea keeping ability
4. Riser strain relief
a. length
b. connection position
c. connection wear
d. connection movement
5. Meteorology using M2 or local NOAA

MOOS Electrical/Communications Subsystem Functional Requirements

1. Support the Engineering Deployment requirements by providing telemetry regarding
   a. Loads
2. Reduce NRE by designing as closely as possible to the future MOOS requirements as stated in the documents at http://mww.mbari.org/moos/Systems_Engineering/moos_systems_engineering1.htm including
   a. Geographic deployment locations
   b. Deployment location water depth
   c. Deployment duration
   d. Episodic event response
   e. Supported instruments
      i. Bandwidth
      ii. Power
      iii. Interface
      iv. Location (surface/midwater/benthic)
   f. Local storage consideration
   g. Cost

Software Functional Requirements:

Introduction

These are the software requirements for the MOOS test mooring.

MOOS test mooring instruments:

1. Compass
   Manufacturer: KVH

Part Number: KVH-C100 w/opt SE-10

2. GPS
   Manufactuer: Garmin
   Part Number: GPS25-HVS

3. Satellite Transceiver
   Manufacturer: Qualcomm
   Part Number: GSP-1620

4. Serial ADC - Controller Can
   Manufacturer: Z-world
   Part Number(s):
   a. SR9050 (101-0487) - Backplane
   b. SR9160 w/RAM (101-0506 w/130-0092) - CPU
   c. SR9300 (101-0392) - 0-10V ADC
   d. SR9320 (101-0444) - 4-20mA ADC

5. Serial ADC - Power Can
   Manufacturer: Z-world
   Part Number(s):
   a. SR9010 (101-0512) - Backplane
   b. SR9160 w/RAM (101-0506 w/130-0092) - CPU
   c. SR9300 (101-0392) - 0-10V ADC
   d. SR9310 (101-0423) - -10-+10V ADC
   e. SR9210 (101-0390) - DIO

6. Heave Sensor
   Manufacturer: Triaxys
   Part Number(s): HEAVE SENSOR Buoy mounted wave heave sensor with 1 EA RAW DATA LOGGER Buoy mounted data logger with analysis software

Instrument Requirements

See appendices A, B & C for detailed information regarding each instrument.

For appendix A, these file formats are based on the data currently retreived from OASIS and presented on the MBARI website. The final format is still **to be determined**.

For appendix C, the interface spreadsheet:

Column	Description
1	The software engineer responsible for writing the software driver
2	The hardware engineer assigned to assist the software engineer as an expert for the hardware item
3	A description of the software channel/signal
4	An unofficial statement of the required voltage/current for the sensor if known
5	A generic classification of the type of signal
6	If a sensor is involved, the full range of the physical phenomenon being measured
7	If known, the hardware engineer's desired precision for the sensor/signal (should be the actual precision)
8	If known, the hardware engineer's desired accuracy for the sensor/signal (should be the actual accuracy)
9	Given the range and precision, this is the desired ADC resolution

10	The required software sample rate as specified by the hardware engineer
11	For logged data, how often the current value should be logged
12	For logged data, how often the minimum value, of the log period, should be logged
13	For logged data, how often the maximum value, of the log period, should be logged
14	For logged data, how often the average value, of the log period, should be logged
15	For the actual ADC, the total number of bits per sample
16	For the actual ADC, the full range of the channel/signal
17	For the actual ADC, the actual precision given the full range and total number of bits
18	If known, the method to convert between the ADC value and the logged value
19	For logged data, the logged value's full range (should be the same as column 6)
20	Whether the data should be logged, sent back to shore, or an event indicated in the log or a combination of the three
21	The method used to access the hardware channel/signal
22	A boolean indicator of whether to send the data back to shore
23	Miscellaneous notes regarding the channel/signal

For example,

> *for Battery Current 1, item 9: Mike Risi has been assigned to write the software driver and Ed Mellinger has been assigned as the expert to assist Mike if he has any questions. There is no specific supply voltage and current for this item since it is a single channel in a larger subsystem. It is an analog signal. The full range of the sensor is 0 to 10A. Ed would like the sensor to be precise to 7.5mA and accurate to within 0.10% of the full range. Given the full range and precision, Ed would like to use a 12-bit ADC. Ed would like the software to sample the ADC at 1Hz and average the data over 1 hr, storing the minimum, maximum and average to the log file every hour (NOTE: he does not need the current value). The actual hardware provides a 12-bit count over a full range of 0 to +10V, giving each count a precision of 2.441mV. The sensor will put out 192mV/A and has an offset of +5V. The final log file should present the data in a -10.XXXXA to +10.XXXXA scale (see the precision for the XXXX). Ideally, the data will be logged and sent back to shore. The signal is accessed via a serial port on a DPA. If necessary, the data is not required to be sent back to shore. You can read the notes.*

1. Compass & Turns indicator

By default, the compass' serial port is set up as: **4800baud, 1 start, 8 data, 1 stop, and no parity**.

2. GPS

By default, the GPS unit's serial port is set up as: **4800baud, 8 data, 1 stop, and no parity**.

3. Satellite Transceiver

By default, the satellite transceiver's serial port is set up as: **38400baud, 8 data, 1 stop, and no parity**.

4. Serial ADC - Controller Can

By default, the serial ADC's serial port is set up as: **9600baud, 8 data, 1 stop, and no parity**.

i. Buoy & anchor load cells

- sensor range/units : 0-10,000 lbs. = 4-20mA
- sensor precision: 2.5 lbs.
- sensor accuracy: +/- 0.2% of FS

- desired ADC resolution (based on desired resultant data accuracy): 12 bit
- software conversion algorithm (i.e. lookup table with table size)
  Linear conversion of current reading to lbs. tension using the formula:
  Tension (lbs.) = input current in uA / 1.6uA
- format you'd like to see the resultant data in: lbs. tension

The following items from the returned data string are required to be time stamped and logged on the NMC at the fastest sample interval we can reasonably sustain given bandwidth and memory limitations:

Upper load cell - maximum, minimum and average (mean) values. Sampled at 4Hz, sample bin size TBD.

Lower load cell - maximum, minimum and average (mean) values. Sampled at 4Hz, sample bin size TBD.

The following items from the returned data string are desired to be returned via comms link to shoreside:

Return interval	Data items
1 hour	Upper load cell - maximum, minimum and average (mean) values for sample bins of previous hour. Lower load cell - maximum, minimum and average (mean) values for sample bins of previous hour.

ii. Fiber optic test

- software conversion algorithm (i.e. lookup table with table size)
  Linear conversion of voltage reading to dBm of optical power using the formula:
  Power dBm = input voltage in uV / ***to be determined*** *conversion factor*
- format you'd like to see the resultant data in (i.e. 0.01dB).
  dBm (Power)

The following items from the returned data string are required to be time stamped and logged on the NMC at the fastest sample interval we can reasonably sustain given bandwidth and memory limitations:

Reference optical reading - maximum, minimum and average (mean) values. Sampled at 4Hz, sample bin size TBD.

Channel 1 optical reading - maximum, minimum and average (mean) values. Sampled at 4Hz, sample bin size TBD.

Channel 2 optical reading - maximum, minimum and average (mean) values. Sampled at 4Hz, sample bin size TBD.

The following items from the returned data string are desired to be returned via comms link to shoreside:

Return interval	Data items

1 hour	Reference optical reading - maximum, minimum and average (mean) values for sample bins of previous hour. Channel 1 optical reading - maximum, minimum and average (mean) values. For sample bins of previous hour. Channel 2 optical reading - maximum, minimum and average (mean) values. For sample bins of previous hour.

5. Serial ADC - Power Can

By default, the serial ADC's serial port is set up as: **9600baud, 8 data, 1 stop, and no parity**.

6. Heave Sensor

Mode of operation is for the raw data generated to be logged to the internal Flash card using the onboard data logger. A data acquisition run and duration (AC DUR) will be requested at the acquisition interval time (AC INT) and after acquisition is complete the processed data will be queried, time stamped and logged on the NMC/MOOS controller and selectively sent to shore.

Initialization commands:

1. Set Time: At initialization time should be set to match the NMC clock.
2. Set Center of Translation Offsets. At initialization time these values need to be sent to the Wave Sensor. Their value will be determined when the sensor is mounted in September.
3. Set File Enable: At initialization time no files should be enabled.
4. Set Run Mode: The set run mode command is used and the minutes of sampling (AC DUR) set to 25 minutes. The interval of commanding the run should be 30 minutes (see below).

All raw data is always stored at 4Hz on the on-board instrument 1GB disk and available for post processing.

The recommended mode is to set the desired sampling parameters, wait for the end of a sampling run and use the "?MWC<cr>" query to get the wave stats and the house keeping stats.

The following items from the returned data string are required to be time stamped and logged on the NMC at the AC INT:

- ASCII string from the combined "Short Wave Message" and the "Housekeeping message", (WC)

The following items from the returned data string are desired to be returned via comms link to shoreside:

Return interval	Data items
1 hour	Previously unsent ASCII strings from the combined "Short Wave Message" and the "Housekeeping message", (WC)

Appendix A: Data File Formats

#
MOOS Data Header
#
Instrument: POWER SYSTEM
Mooring: MOOS
Deployment Date: 19 August, 2002
#
DataFields:
Name Description Format
---------- ---------- ----------
time GMT time (decimal julian day) ddd.fffff
Battery Voltage 1 - chemistry type A
Battery Voltage 2 - chemistry type B
Battery Voltage 3 - chemistry type C
Battery Voltage 4 - chemistry type D
Battery Current 1 ###.###
Battery Current 2
Battery Current 3
Battery Current 4
Battery Current 5
Battery Current 6
Battery Current 7
Battery Current 8
Battery Voltage
Water detection 1
Water detection 2
Water detection 3
Water detection 4
Water detection 5
Water detection 6
Water detection 7
Water detection 8
Solar Array Current North
Solar Array Current East
Solar Array Current South
Solar Array Current West
Solar Array Voltage North
Solar Array Voltage East
Solar Array Voltage South
Solar Array Voltage West
Load resistor (lost potential energy)
Light sensor (PAR or pyrometer)
Wind Generator Load resistor (lost potential energy)
Power Feed NMC Current
Cable Current
Cable Voltage
Ground fault
Pwr Hsg Temp
Pwr Hsg Humidity
Dummy Loads
- 1 W
- 2 W
- 2 W
- 5 W
- 10 W
- 20 W
Ambient Air Temp

2002
time
230.70000
231.15833
231.61666
232.07499
232.53332
232.99165
233.44998

#
MOOS Data Header
#
Instrument: CONTROLLER SYSTEM
Mooring: MOOS
Deployment Date: 19 August, 2002
#
DataFields:

# Name	Description	Format
# time	GMT time (decimal julian day)	ddd.fffff
# compass	Buoy magnetic heading	###.##
# *Turns indicator*	Integrated heading	###
# Satellite Link strength	Receive Signal Strenght Indicator	#
# Pager (reset)	Has a reset occurred?	Y or -
# ground fault	Has a ground fault occurred?	Y or -
# moisture detection	Has moisture been detected	Y or -
# severed cable detection	Has the cable been severed	Y or -
# Benthic cable voltage	Cable voltage at the benthic node	###.###
# Benthic ground fault	Has a ground fault occurred?	Y or -
# Benthic moisture detection	Has moisture been detected	Y or -

2002

230.70000

```
#
#               MOOS Data Header
#
# Instrument:      Garmin 12 Channel GPS
# Mooring:         M1
# Deployment Date: 5 October, 2001
#
# Data Fields:
#  Name             Description                    Format
# ----------------------------------------------------------
#  time           GMT time (decimal julian day)   ddd.fffff
#  latitude       Latitude (deg north)            floating point
#  longitude      Longitude (deg west)            floating point
#  std_dev        Position Standard Deviation (m) floating point
#  samples        Number of samples taken         integer
#  time_on        Power-On duration (s)           integer
#  diffSamples    Number Differential GPS Samples integer
#  hdop           Horizontal Dilution of Precision
#  temp           GPS Receiver Temp (deg C)       floating point
#  status         Garmin Status Byte              hex (see note)
#
# Note: Status Byte Format
#   Bit  Description                 Values
#    0   ROM checksum test           1 = Pass     0 = Fail
#    1   Receiver failure discrete   1 = Pass     0 = Fail
#    2   Stored data lost            1 = Retained 0 = Lost
#    3   Real time clock lost        1 = Retained 0 = Lost
#    4   Oscillator drift discrete   1 = Pass     0 = Excessive Drift
#    5   Board configuration data    1 = Retained 0 = Lost
#    6,7 Unused
#
```

```
DATE          : 27-10-1999
TIME          : 00:00:00
WAVAN4  2.0
MTN_F1        :    0.030
MAGNETIC_VAR  :    0.000
FREQ_SPACING  :    0.005
LOW_FREQ_CUT  :    0.030
HI_FREQ_CUT   :    0.640
WVN_STR       :    0.010
N1            :     7761
T1            :   59.978
DT1           :    0.139
M33_STATUS    :        0
N_ZERO_CROSS  :      281
AVE_HEIGHT    :    0.136
AVE_PERIOD    :    3.828
MAX_HEIGHT    :    0.346
SIG_HEIGHT    :    0.209
SIG_PERIOD    :    6.235
F1            :    0.030
F2            :    0.640
PEAK_PERIOD   :   28.571
TP5           :   28.854
4*(M0^0.5))   :    0.265
N_FRQ_NONDIR  :      123
INIT_FREQ     :    0.030
FREQ_SPACING  :    0.005
              1    0.030 1.34452641010284E-0001
              2    0.035 2.21106648445129E-0001
              3    0.040 8.43078494071960E-0002
              4    0.045 3.14780473709106E-0002
            119    0.620 1.69821281451732E-0003
            120    0.625 2.26324098184705E-0003
            121    0.630 2.32355110347271E-0003
            122    0.635 2.30335025116801E-0003
            123    0.640 1.72895647119731E-0003
MEAN_DIR      :  222.353
MEAN_SPREAD   :   63.297
N_FOURIER     :      118
INIT_FOURIER  :    0.030
FREQ_SPACING  :    0.005
              1    0.030 -7.83297792077064514E-0002 -7.21813365817070007E-
0002 -5.53748726844787598E-0001  1.23462758958339691E-0001
              2    0.035 -6.40451833605766296E-0002 -8.91567021608352661E-
0002 -5.42389452457427978E-0001  1.05476781725883484E-0001
              3    0.040 -3.87482307851314545E-0002 -1.40509992837905884E-
0001 -5.27283012866973877E-0001  7.43258669972419739E-0002
              4    0.045  1.09544638544321060E-0002 -1.96370631456375122E-
                   0001 -5.74521005153656006E-0001 -1.04809254407882690E-
                   0002
              .
              .
              .
              .
            117    0.610 -2.52318441867828369E-0001 -5.43326199054718018E-
0001 -4.98808830976486206E-0001  2.25346058607101440E-0001
            118    0.615 -2.55536735057830811E-0001 -5.32469749450683594E-
0001 -4.92384165525436401E-0001  2.60102629661560059E-0001
```

```
STATUS
:9910270000,OWNERID,+022.9,3022.614N08638.913W,13.18,4.0,4800,30,30,3,TAS
00080,2.07,1.05,6,0,0.005,+00.0
```

#
MOOS Data Header
#
Instrument: LOAD CELLS
Mooring: MOOS
Deployment Date: 19 August, 2002
#
DataFields:

# Name	Description	Format
# time	GMT time (decimal julian day)	ddd.fffff
# buoy tension load cell (strain guage)		
# anchor tension load cell (strain gauge)		

2002

230.70000

Appendix B: Channel Assignments

Controller Channel Assignment

Controller Backplane	*connects to*	
Slot 0 (J4)	Cerfboard	*connects to*
	Ethernet	SideKick
	Serial 1	Globalstar Modem
	Serial 2	
	Serial 3	Wireless Console
	USB	
	GPIO 0	
	GPIO 1	
	GPIO 2	
	GPIO 3	
	GPIO 4	
	GPIO 5	RF GGI Warning Interupt
	GPIO 6	RF GFI Error Interupt
	GPIO 7	RF GFI Test
	GPIO 8	
	GPIO 9	RF DSR
	GPIO 10	RF RI
	GPIO 11	RF POWER ON
	GPIO 12	RF RTS
	GPIO 13	RF DTR
	GPIO 14	RF CD
	GPIO 15	RF CTS
Slot 1 (J7)	SideKick	
	Ethernet	SideARM/Cerfboard
	Local Serial "8"	
	Local Serial "9"	
	Local Serial "10"	
	Uplink Serial "11"	
Slot 2 (J21)	DPA	
	Channel 6 Serial	Heave Sensor
	Channel 6 Power	Heave Sensor
	Channel 7 Serial	Power Controller (Smart Star)
	Channel 7 Power	Power Controller (Smart Star)
Slot 3 (J19)	DPA	
	Channel 4 Serial	Garmin GPS
	Channel 4 Power	Garmin GPS
	Channel 5 Serial	Controller Serial ADC
	Channel 5 Power	Controller Serial ADC
Slot 4 (J13)	DPA	
	Channel 2 Serial	KVH Compass
	Channel 2 Power	KVH Compass
	Channel 3 Serial	
	Channel 3 Power	
Slot 5 (J8)		

Rev X.E

Prepared by Lance McBride

Controller SmartStar Channel Assignment/System Analysis

CPU Slot		Sample
Slot 0	4Hz	
ADC 0-10V Ch 0	Fiber Optic Cable Tester ch. 1	4Hz
ADC 0-10V Ch 1	Fiber Optic Cable Tester ch. 2	4Hz
ADC 0-10V Ch 2	Fiber Optic Cable Tester ch. 3	4Hz
ADC 0-10V Ch 3	Fiber Optic Cable Tester ch. 4	4Hz
ADC 0-10V Ch 4		
ADC 0-10V Ch 5		
ADC 0-10V Ch 6		
ADC 0-10V Ch 7		
ADC 0-10V Ch 8		
ADC 0-10V Ch 9		
ADC 0-10V Ch 10		
Slot 1	4Hz	
ADC 4-20mA Ch 0	buoy tension load cell (strain guage)	4Hz
ADC 4-20mA Ch 1	anchor tension load cell (strain gauge)	4Hz
ADC 4-20mA Ch 2		
ADC 4-20mA Ch 3		
ADC 4-20mA Ch 4		
ADC 4-20mA Ch 5		
ADC 4-20mA Ch 6		
ADC 4-20mA Ch 7		
ADC 4-20mA Ch 8		
ADC 4-20mA Ch 9		
ADC 4-20mA Ch 10		
Slot 2		

Rev X.A

Prepared by Lance McBride

Appendix C: Detailed Channel Specifications

Spreadsheet

M B A R I

Interfaces on the initial (engineering) MOOS deployment

Monterey Bay Aquarium Research Institute
7700 Sandholdt Rd.
Moss Landing, CA 95039-9644

Drawn by: Lance McBride
Date: 9/11/2002
Doc. #: 1001474
Rev: D.2

Purpose
1. Reliability of data/power cable & mooring mechanical hardware
2. Reliability/feasability of ROV operations in connection to mooring

Items to monitor
1. Loads
2. Visual wear
3. Sea keeping ability
4. Riser strain releif
   a. length
   b. connection position
   c. connection wear
   d. connection movement
5. Meteorology using M2 or local NOAA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Responsible Engineer		**Signal Description**	**Supply voltage & current**	**Sensor interface**	**Input Sensor range / units**	**Desired Precision**	**Desired Accuracy (% error)**	**Desired ADC resolution**	**Software Sample frequencv**	**Log Interval**				**Actual Software Values**			**Software Conversion**	**Log/Display range**	**Log / Send/Event**	**Software Channel**	**Return data to shore via RF?**	**Notes**
														ADC	**ADC Range**	**ADC Precision**						
Software	Hardware	Surface side								current	min	max	avg									
Mike Risi	Ed Mellenger	*Power System – 0.1% accuracy & resolution (desired)*																				
Mike Risi	Ed Mellenger	*Seawater Battery (prototype)*																				
Mike Risi	Ed Mellenger	Battery Voltage 1 - chemistry type A	n/a	Analog	0 to 2 VDC	1mV	1%	11-bit	1/min	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Linear Scale	0 to 2 VDC	Log/Send	Serial via DPA	no	0 to 1VDC, up to 4 batteries, simple voltage across a resistor
Mike Risi	Ed Mellenger	Battery Voltage 2 - chemistry type B	n/a	Analog	0 to 2 VDC	1mV	1%	11-bit	1/min	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Linear Scale	0 to 2 VDC	Log/Send	Serial via DPA	no	0 to 1VDC, up to 4 batteries, simple voltage across a resistor
Mike Risi	Ed Mellenger	Battery Voltage 3 - chemistry type C	n/a	Analog	0 to 2 VDC	1mV	1%	11-bit	1/min	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Linear Scale	0 to 2 VDC	Log/Send	Serial via DPA	no	0 to 1VDC, up to 4 batteries, simple voltage across a resistor
Mike Risi	Ed Mellenger	Battery Voltage 4 - chemistry type D	n/a	Analog	0 to 2 VDC	1mV	1%	11-bit	1/min	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Linear Scale	0 to 2 VDC	Log/Send	Serial via DPA	no	0 to 1VDC, up to 4 batteries, simple voltage across a resistor
Mike Risi	Ed Mellenger	*Battery (possibly two battery banks up to 8 batteries)*																				
Mike Risi	Ed Mellenger	Battery Current Sensor Enable	n/a	Digital	n/a	n/a	n/a	n/a	1/day?	n/a	n/a	n/a	n/a					On/Off	n/a	Serial via DPA	no	Turns on the current sensors prior to take current measurements
Mike Risi	Ed Mellenger	Battery Current 1	n/a	Analog	10A	7.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Battery Current 2	n/a	Analog	10A	7.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement - leave if we can (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Battery Current 3	n/a	Analog	10A	7.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement - leave if we can (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Battery Current 4	n/a	Analog	10A	7.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement - leave if we can (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Battery Current 5	n/a	Analog	10A	7.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement - leave if we can (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Battery Current 6	n/a	Analog	10A	7.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement - leave if we can (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Battery Current 7	n/a	Analog	10A	7.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement - leave if we can (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Battery Current 8	n/a	Analog	10A	7.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement - leave if we can (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Battery Voltage	n/a	Analog	0 to between 8 & 16 VDC	10mV	0.10%	11-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Linear Scale	0 to between 8 & 16 VDC	Log/Send	Serial via DPA	no	
Mike Risi	Ed Mellenger	Water detection 1	n/a	Analog	0 to +5V	100mV	5%	6-bit	1/sec	instantaneous	n/a	n/a	n/a	12-bit	10V	2.441mV	Linear Scale	0 to +5V	Log/Send/Event	Serial via DPA	no	Is there moisture in the battery case
Mike Risi	Ed Mellenger	Water detection 2	n/a	Analog	0 to +5V	100mV	5%	6-bit	1/sec	instantaneous	n/a	n/a	n/a	12-bit	10V	2.441mV	Linear Scale	0 to +5V	Log/Send/Event	Serial via DPA	no	Is there moisture in the battery case
Mike Risi	Ed Mellenger	Water detection 3	n/a	Analog	0 to +5V	100mV	5%	6-bit	1/sec	instantaneous	n/a	n/a	n/a	12-bit	10V	2.441mV	Linear Scale	0 to +5V	Log/Send/Event	Serial via DPA	no	Is there moisture in the battery case
Mike Risi	Ed Mellenger	Water detection 4	n/a	Analog	0 to +5V	100mV	5%	6-bit	1/sec	instantaneous	n/a	n/a	n/a	12-bit	10V	2.441mV	Linear Scale	0 to +5V	Log/Send/Event	Serial via DPA	no	Is there moisture in the battery case
Mike Risi	Ed Mellenger	Water detection 5	n/a	Analog	0 to +5V	100mV	5%	6-bit	1/sec	instantaneous	n/a	n/a	n/a	12-bit	10V	2.441mV	Linear Scale	0 to +5V	Log/Send/Event	Serial via DPA	no	Is there moisture in the battery case
Mike Risi	Ed Mellenger	Water detection 6	n/a	Analog	0 to +5V	100mV	5%	6-bit	1/sec	instantaneous	n/a	n/a	n/a	12-bit	10V	2.441mV	Linear Scale	0 to +5V	Log/Send/Event	Serial via DPA	no	Is there moisture in the battery case
Mike Risi	Ed Mellenger	Water detection 7	n/a	Analog	0 to +5V	100mV	5%	6-bit	1/sec	instantaneous	n/a	n/a	n/a	12-bit	10V	2.441mV	Linear Scale	0 to +5V	Log/Send/Event	Serial via DPA	no	Is there moisture in the battery case
Mike Risi	Ed Mellenger	Water detection 8	n/a	Analog	0 to +5V	100mV	5%	6-bit	1/sec	instantaneous	n/a	n/a	n/a	12-bit	10V	2.441mV	Linear Scale	0 to +5V	Log/Send/Event	Serial via DPA	no	Is there moisture in the battery case
Mike Risi	Ed Mellenger	*Solar panels (each of four)*																				
Mike Risi	Ed Mellenger	Array Current North	n/a	Analog	10A	2.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Array Current East	n/a	Analog	10A	2.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Array Current South	n/a	Analog	10A	2.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Array Current West	n/a	Analog	10A	2.5mA	0.10%	12-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Array Voltage North	n/a	Analog	0 to 50 VDC	25mV	0.10%	11-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Linear Scale	0 to 50 VDC	Log/Send	Serial via DPA	no	
Mike Risi	Ed Mellenger	Array Voltage East	n/a	Analog	0 to 50 VDC	25mV	0.10%	11-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Linear Scale	0 to 50 VDC	Log/Send	Serial via DPA	no	
Mike Risi	Ed Mellenger	Array Voltage South	n/a	Analog	0 to 50 VDC	25mV	0.10%	11-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Linear Scale	0 to 50 VDC	Log/Send	Serial via DPA	no	
Mike Risi	Ed Mellenger	Array Voltage West	n/a	Analog	0 to 50 VDC	25mV	0.10%	11-bit	1/sec	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Linear Scale	0 to 50 VDC	Log/Send	Serial via DPA	no	
Mike Risi	Ed Mellenger	Load resistor (lost potential energy)	n/a	Analog	0 to 16 VDC	10mV	0.10%	11-bit	1/sec	n/a	1hr	1hr	1hr	12-bit	10V	2.441mV	Linear Scale	0 to 16 VDC	Log/Send	Serial via DPA	no	simple voltage across a resistor after a 12V zener
Mike Risi	Ed Mellenger	*Wind Turbine*																				
Mike Risi	Ed Mellenger	Load resistor (lost potential energy)	n/a	Analog	0 to 16 VDC	10mV	0.10%	11-bit	1/sec	n/a	1hr	1hr	1hr	12-bit	10V	2.441mV	Linear Scale	0 to 16 VDC	Log/Send	Serial via DPA	no	simple voltage across a resistor after a 12V zener
Mike Risi	Ed Mellenger	*Power Feed (NMC)*																				
Mike Risi	Ed Mellenger	Current	n/a	Analog	10A	2mA	0.10%	12-bit	10/sec	n/a	1hr	1hr	1hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	*Cable Feed*																				
Mike Risi	Ed Mellenger	Cable Current	n/a	Analog	10A	0.25mA	0.10%	12-bit	10/sec	n/a	1hr	1hr	1hr	12-bit	10V	2.441mV	+192mV/A + 5V	-10 to +10 A	Log/Send	Serial via DPA	no	Current to voltage measurement (sensor = +5Voffset, 192mV/A 10A range)
Mike Risi	Ed Mellenger	Cable Voltage	n/a	Analog	0 to 500 VDC	1V	0.10%	9-bit	10/sec	n/a	1hr	1hr	1hr	12-bit	10V	2.441mV	Linear Scale	0 to 500 VDC	Log/Send	Serial via DPA	no	
Mike Risi	Ed Mellenger	Ground fault	n/a	Analog	-1mA to +1mA	5mV	0.10%	10-bit	interupt	instantaneous	n/a	n/a	n/a	12-bit	10V	2.441mV	Linear Scale	0 to +5V	Log/Send/Event	Serial via DPA	no	
Mike Risi	Ed Mellenger	*Environmental (power housing)*																				
Mike Risi	Ed Mellenger	Pwr Hsg Temp	n/a	Analog	TBD	2c	1%	6-bit	1/min	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Calib. Lkup Tbl	-25 to +75c	Log/Send	Serial via DPA	no	
Mike Risi	Ed Mellenger	Pwr Hsg Humidity	n/a	Analog	0-100%	5%	1%	5-bit	1/min	n/a	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	Linear Scale	0 to 100%	Log/Send	Serial via DPA	no	0.8V @ 0%, 3.65V @ 100%
Mike Risi	Ed Mellenger	*Controller with data storage*																				
Mike Risi	Ed Mellenger	Pwr Sys Control Functions																				
Rich Henthorn	Mark Chaffey	Heave Wave sensor	12-14 VDC @ 45mA	Serial																Serial via DPA	yes	Triaxys
Rich Henthorn	Mark Chaffey	i Spectral Analysis Statistics																				
Rich Henthorn	Mark Chaffey	*Significant Wave Height (Hmo)*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					0.000 to 9.999m	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	*Peak Period (Tp, Tp5)*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					0.000 to 9.999s	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	*Mean Spectral Period (Tz)*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					see manual	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	i Zero Crossing Statistics																				
Rich Henthorn	Mark Chaffey	*Significant Wave Height (Hs)*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					0.000 to 9.999m	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	*Maximum Wave Height (Hmax)*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					0.000 to 9.999m	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	*Height of Highest 10% of Waves (H10)*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					see manual	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	*Average Wave Height (Hav.)*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					0.000 to 9.999s	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	*Average Wave Period (Tav.)*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					0.000 to 9.999s	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	*Average Period of H10 (T10)*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					see manual	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	*Significant Wave Period (Ts)*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					0.000 to 9.999s	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	*Zero Crossings*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					see manual	Log/Send	n/a		See Triaxys manual
Rich Henthorn	Mark Chaffey	I Power (non-directional) Spectra																				
Rich Henthorn	Mark Chaffey	*Energy for Each Frequency Band*			not specified	not specified	2%	n/a	35 minutes	n/a	n/a	n/a	35 minutes					see manual	Log/Send	n/a		See Triaxys manual
Mike Risi	Mark Chaffey	buoy tension load cell (strain guage)	13-24VDC @ ?? mA	Analog	0-10,000lb	2.5lb	0.20%	12-bit	4/sec	250ms	10 min	10 min	10 min	12-bit	4-20mA	4.88uA	T = x /1.6uA	0 to 10,000 lbs. Tension	Log/Send	Serial via DPA	yes	Wheatstone bridge - voltage measurement (measuring axial strain)
	Mark Chaffey	Environmental																				METSYS or ASIMET or other?
Tom O'Reilly	Mark Chaffey	compass	8-18 VDC @ 40mA.	Serial	current heading 0-360, turns +/-100	0.5 deg	1 deg	n/a	1/sec	n/a	n/a	n/a	1 min					current heading 0-360, turns +/-100	Log/Send	Sidekick serial	no	KVH compass
Tom O'Reilly	Lance McBride	*Turns indicator*	n/a	Software	see compass	0.1 turn	0.2 turn	n/a	1/sec	n/a	10min	10min	10min					-155..+155 turns	Log/Send	n/a	yes	**integrate the sampled compass heading. +1 for every pass of +360Ô -1 for every pass of -360Ô**
Mike Risi	Mark Chaffey	Fiber Optic Source	9V @ ?? mA																			Calibrated fiber optic laser source
Mike Risi	Mark Chaffey	Fiber Optic Receiver - Source	+4.8 to +12VDC @ <60mA	Analog	-45 to +10 dBm	0.01 dB	5%	13-bit	4/sec	250ms	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	TBD	TBD	Log/Send	Serial via DPA	yes	Calibrated fiber optic receiver
Mike Risi	Mark Chaffey	Fiber Optic Receiver - Line 1	+4.8 to +12VDC @ <60mA	Analog	-45 to +10 dBm	0.01 dB	5%	13-bit	4/sec	250ms	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	TBD	TBD	Log/Send	Serial via DPA	yes	Calibrated fiber optic receiver
Mike Risi	Mark Chaffey	Fiber Optic Receiver - Line 2	+4.8 to +12VDC @ <60mA	Analog	-45 to +10 dBm	0.01 dB	5%	13-bit	4/sec	250ms	1 hr	1 hr	1 hr	12-bit	10V	2.441mV	TBD	TBD	Log/Send	Serial via DPA	yes	Calibrated fiber optic receiver
	Lance McBride	MBARI wireless comms (VHF, Freewave, satellite, etc.)																				
Tim Meese	Lance McBride	- Satellite (Iridium, Orbcomm, Globalstar)	5.6-16VDC @ 1Amax	Serial	N/A	N/A	N/A	n/a	N/A	n/a	N/A	N/A	N/A					N/A	n/a	SideARM serial	no	Over the horizon comms
Tim Meese	Lance McBride	- Link strength	n/a	Software	0 to +50dbm	0.1dbm	1%	n/a	1/min	n/a	15min	15min	15min					0 to +50dbm	Log/Send	n/a	yes	Accurate report of link margin (RSSI via AT$QCSTATUS)
n/a	Lance McBride	- Local (BT console)	9-30VDC @ 500mW	Serial	N/A	N/A	N/A	n/a	N/A	n/a	N/A	N/A	N/A					N/A	n/a	SideARM serial	no	Ship to buoy comms
n/a	Lance McBride	- ARGOS transponder (ELT)	Stand Alone	Stand Alone	N/A	N/A	N/A	n/a	N/A	n/a	N/A	N/A	N/A					N/A	n/a	n/a	no	SEIMAC SMART CAT III, Sat Comms.
Kent Headley	Lance McBride	GPS	6-40VDC @ 870mWtyp	Serial	-180..+180N/S, -180..+180E/W	0.0001deg	100m	n/a	1/min	n/a	10min	10min	10min					-180..+180N/S, -180..+180E/W	Log/Send	Serial via DPA	yes	Are we implementing the 1ms (?) timing accuracy
n/a	Lance McBride	Pager (reset)	1.5V @ ??mA	2-wire differential	n/a	n/a	n/a	n/a	interupt	instantaneous	n/a	n/a	n/a					N/A	Log/Send	reset line	no	Satellite (?) reset for processor wakeup
Kent Headley	Lance McBride	SideKick																				
Kent Headley	Lance McBride	ground fault	n/a	Digital	0 or +5V	n/a	n/a	n/a	interupt	instantaneous	n/a	n/a	n/a					0 or +5V	Log/Send	Sidekick	no	
Kent Headley	Lance McBride	moisture detection	n/a	Digital	0 or +5V	n/a	n/a	n/a	interupt	instantaneous	n/a	n/a	n/a					0 or +5V	Log/Send	Sidekick	no	
		Riser cable																				
		no monitoring																				
		Benthic side																				
Mike Risi	Mark Chaffey	anchor tension load cell (strain gauge)	13-24VDC @ ?? mA	Analog	0-10,000lb	2.5lb	0.20%	12-bit	4/sec	250ms	10 min	10 min	10 min	12-bit	4-20mA	4.88uA	T = x /1.6uA	0 to 10,000 lbs. Tension	Log/Send	Serial via DPA	yes	Wheatstone bridge - voltage measurement (measuring axial strain)
n/a	Lance McBride	locator beacon, "homer" (contact Mike Conway 1wk prior to deployment)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a					n/a	Log/Send	n/a	no	Sonic location beacon (self-powered)