Datalogger (DAQ) Specifications:

DATE	MODIFS	AUTHORS :
5 oct 2016	Creation	Romuald Wayne
15 nov 2016	Changed to tabular representation with signature column	Wayne
18 mar 2017	Added some criteria on robustness	Wayne
03 Aug 2017	Added a few comments to the descriptions and criteria	Carlos

Second column is for approval of item by peron/facility: II=INSU-IPGP, …

Functional description of DAQ:

General Description :

Functions that the DAQ must perform.

A1	Data format 24 or 32 bits.	II
A2	Programmable sampling frequency: 100, 200, 500,1000 or 2000 SPS	II
A3	Linear signal response	II

A4	Signal/Noise >= 130 dB [21.5 bits] from 0.001 to 100 Hz
	• (ideally 170 dB [28 bits] to match Trillium Compact and T120Q)
	• KUM 6D6 claims 142 dB (24 bits)
	Dynamic range >= 121 dB [20 bits] from 100 to 2000 Hz
	`ADS1281 (32-bit, 8-12 mW): 130 dB @250SPS [21.5 bits]`
	`127 dB @500SPS`
	`CS5321/2 (24-bit, <100 mW): 130 dB @25Hz`
	`121dB@411Hz`
	`LTC2440 (24-bit, 40 mW): 134 dB @ 100 Hz`
	
	`Higher range A/Ds are 24 bit!: MAX11214/6 @140dB, AD7714 @137dB`
		II

A5	Dynamic range appropriate for Seafloor-compatible seismometers (Trillium compact: 0.5µV-5V differential) [135 dB with clip @ 11V p-p (15 mm/s*750 V*s/m] (Trillium 240: 0.5µV-10V differential) [145 dB with clip @ 20V p-p (15 mm/s*1150 V*s/m]	II
A6	Timekeeping drift <= 1 ms/day, linear.	II
A7	Possibility to interchange time bases (MCXO/SEASCAN and chip-scale atomic).	II
A8	Ability to store 2 years of data at 2000 SPS on 4 channels [1TB w/compression, 2TB without).	II
A9	Storage to standard, reliable flash memory with probable long-term future support. It would be preferable (power efficient) to use embedded NAND memory banks instead of the traditional flash memory cards.	II
A10	Data can be offloaded as miniSEED.	II

Functional modes :

(starting, stopping, sleep, etc…).

B1	Auto test of the basic DAQ (ADC ,HardDrive, RAM, Time Base). It would be desirable to be able to check the state of health of the system on the deck via a connector through the endcap or via acoustics at the sea bottom.	II
B2	Programmable delayed DAQ start. This would save power and allow to accommodate variable drop times and sensor leveling sequence.	II
B3	Programmable DAQ stop(?). Why?	
B4	Time base continues updating RTC if system energy is lost, allowing end of mission synchronization. An independent and rugged power supply to be used only by the time base and microcontroller.	II
B5	Robust data/parameter storage in case of malfunction or power loss.. Use small data buffers in order for data to be dumped on a 'continuous' fashion.	II
B6	Robust restart (continues storing and writing data using initial parameters and without overwriting existing data) In case of accidental reboot?	II
B7	Possibility to add auxiliary functions by a user-programmable open bus.	II
B8	Storage to flash with possibility of onboard backup (parallel flash devices Desirable but not crucial.	II
B9	Program and storage must work on at least 99% of deploys.	II
B10	Simple and robust clock synchronization start and end of mission clock synchronization (e.g. writing out simultaneous inst and GPS values on same line (and in SOH file?))	II
B11	Possibility for automatic synchronization with an internal GPS. Automated GPS pulse detection would give the user the option to either start, stop or check timing on the instrument.	

User interface :

How we expect to communicate with the DAQ

C1	Simple graphical interface for programming and verifying the device without opening it. Interface does not depend on commercial software The interface should allow the user to run the system health check described above.	II
C2	Simple graphical interface for downloading software.	
C3	Possibility of running these functions via a command-line terminal using simple commands (ASCII characters) in case of problem with the graphical interfaces.	II
C4	Simple graphical interface for downloading data Data download via Ethernet interface	II
C5		

C6		
C7		

Desirable features:

Non-essential functions that we would like the DAQ to perform.

D1	Ability to store miniSEED data using Steim 1 compression	II
D2	Optional onboard GPS for automatic synchronization before/after deployment This level of automation would be good to have	II
D3	Other useful sampling rates: 400, 800 sps	
D4	Higher sampling rates: 4000, ... sps	II
D5	Possibility to have multiple loggers for increased channels on same time base and same external interface Perhaps it would be better if a single logger consists of 4 to 8 channels and the user can determine how many channels are enabled.	II
D6	Software-selectable choice of minimum phase or zero-phase final digital filter stage	II
D7	Software selectable gain	II
D8	Web or App interface to instrument (bluetooth? wifi?)	II
D9	Mechanism to rapidly/parallel set up/synchronize multiple instruments	II
D10	Ability to output data in real-time (e.g. SEEDLINK) format for laboratory testing and possible seafloor connection to cable/buoy/external processing board	II
D11		
D12		
D13		
D14		
D15		

Power supply/consumption

E1	Average DAQ power consumption (without auxillary functions) as low as possible (and absolutely less than 300mW at 100 SPS). Given the inclusion of a modern micro-controller, SoC or FPGA's; along with on-board memory, power consumption should be lower than the values stated below.	II
E2	Maximum power consumption less than ?? mW. A persistor-based DAQ consumes about 240mW with a Seascan time-base. The same DAQ consumes 330mW with a CSAC.	II
E3	Power supply mode using standard « D » or « DD » alkaline or NiMH (or other standard technology) cells (no custom-made battery pack) Regardless of chemistry, the standard 3.3V will most likely be needed for the DAQ's processing unit. Avoiding Lithium batteries will certainly reduce cost, ease procurement and safety concerns, however given energy density characteristics, this is only feasible for short deployments.	
E4	Possibility to use DD lithium cells for longer deployments	II
E5	Battery protection circuit on power supply card. Standard protection from accidental short-circuit, battery over-load, incorrect connection of batteries and charging of primary cells.	II
E6	One battery pack voltage for the ensemble of the DAQ. Equivalent to a single primary Lithium battery voltage, 3.4V to 3.9V	II
E7		
E8		
E9		
E10		
E11		

Electrical connectors

Interfaces of the DAQ with the exterieur:

F1	USB and/or Ethernet interface for programming and data transfer. Ethernet provides faster data transfer rates than USB 3.0. Power is not an issue given that this occurs post-experiment.	II
F2	4 analog sensor channels connectable with différent seismolgy and pressure sensors ((Trillium 240, Trillium compact, Sercel L28, Hydrophone HTI, DPG…) In order to accommodate such flexibility, it might be wise to implement a modular approach: Individual ADC boards can be tailor-made and swapped in accordance to the sensor used. That way, the underlying logger never changes, only the ADC boards do. A single logger could consists of 4 to 8 channels and the user can determine how many channels are enabled	II
F3	Ability to provide sensors with different supply voltages (+-12V, +-5V, ...).	

F4	Connection for one or more external battery supplies (possibility of chaining external battery supplies)	II
F5		
F6		
F7		
F8		
F9		

Size of DAQ and its pressure container

Dimensions of the rack and the electrical (length x width x height) :
Weight limit. Choice of rack (style). Imposed connector positions.

G1	Group of 3 cards (FRONTEND+ADC, CPU+DATASTORAGE, CLOCK+SYNCHRONIZATION+POWERSAVE) + one power supply card	II
G2	All electronic cards plus batteries must fit in a cylindrical container with an inner diameter of 100mm and length of 450 mm. To make efficient use of space within the pressure case, a mechanical harness/structure should be developed in order to maximize the number of battery cells which can fit.	II
G3	The filled cylinder (with batteries) should be carryable by one person.	II
G4		
G5		
G6		
G7		
G8		
G9		

Environmental conditions of the DAQ in its pressure container

H1	Working temperature: Ship's lab and seafloor (-10°C to 70°C)	II
H2	Storage temperature: Up to container in tropical zone (-10°C to 70°C)	II
H3	Humidity: the cylinders may be stored outside off the ground (potentially in the rain) and on ships (saline environment)	II
H4	Vibrations : Instruments will be carried in container on trucks and container ships.	II
H5	Shock: Instruments will be launched and recovered from various boats, will hit hard seafloor at 1m/s, may strike the hull at relatively low	

	speeds	
H6		
H7		
H8		
H9		
H10		
H11		

Documentation to provide

I1	Electrical schematics and PCB layouts of cards, allowing their reproduction.	II
I2	All software and the possibility to modify sources	II
I3	Instruction manual.	II
I4	All of the above will be Open Source. Yes!	II
I5		
I6		
I7		
I8		
I9		
I10		

Suggested implementations

Recommended devices/configurations to attain objectives.:

J1	Storage to 2+ CF or SDXC-type storage media with possibility of parallel writing (for security) or serial (for greater storage) Consideration should be given to use on-board (PCB) NAND memory banks instead of the traditional flash memory cards.	II
J2	Multiple microcontrollers: • 1 low-power continuous for writing to RAM banks, • 1 high-speed for occasional transfer from RAM to permanent storage (including generation of miniSEED format), • 1 other (software powerable) for real-time solutions (SEEDlink	II

	output and/or triggering/communication) 1 other (software powerable) for future applications/developments? Will the multiple microcontrollers approach also feature an FPGA? Another possible approach would be to implement a system on a chip (SoC) which includes a microcontroller with embedded FPGA. These also feature low-power/sleep modes which only draw quiescent current when not in use. This could result in power savings given that both architectures are in a single package. Xilinx, Altera and Microsemi offer a variety of SoC products.	
J3		
J4		
J5		
J6		
J7		
J8		