LOBSTER & 6D6

Longterm Ocean Bottom Seismometer for Tsunami and Earthquake Research

K/MT 510

Manual

May 2018

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REMARK

This manual is a reference book only. It does not claim completeness and refers to other literature in certain chapters. This manual cannot and shall not substitute an instrument introduction through an expert. Programming and deployment of an autonomous deep-sea instrument is an utmost complex affair and require the detailed know-how of all components and their composition in order to guarantee successful operation. That's why we expressly recommend that solely trained personnel shall operate and maintain the instruments.

Contents

1 Technical Data

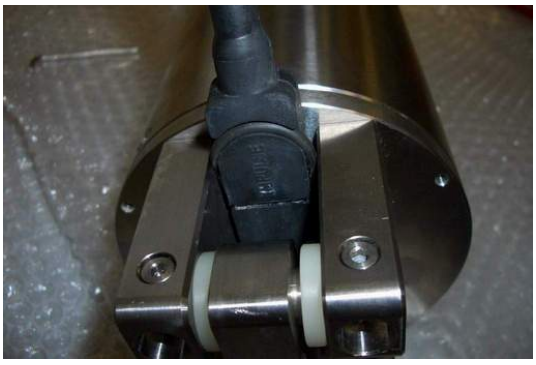
weights with 96 Li-Cells	on air (in salt water)
weights without anchor	230 kg (-37 kg)
weights with anchor	300 kg (36 kg)
weight of pressure tube	36,5 kg (17,6 kg)
weight of Releaser KUMQuat	11 kg (6,4 kg)
maximum operation depth	6000m
maximum operation time	14 month (96 LiThCl D-cells)
size without flag w x h x d	635mm x 770mm x 800mm
anchor size	800mm x 600mm
Sensor	nanometrics trillium compact in titanium housing
	HighTech Hydrophon
Data Logger	K.U.M. 6D6
Releaser	KUMQuat 562

2 Assembly of Release Unit and Seismometer

You need at least following tools when working with the carrier:

- Wrench size 30 2 x
- Wrench size 17 2 x
- Wrench size 13 2 x
- torque wrench 5Nm with Nut size 19 and Wrench size 19 (to tighten the anchor)
- Socket wrench SW8 (to close pressure tubes)
- Set metric Allen-wrench

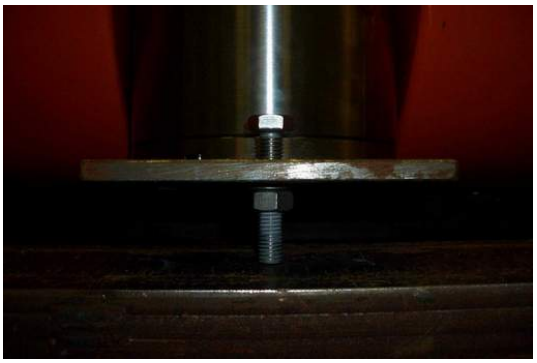
The connecting cable between Releaser and Data Logger has got a loop that – see picture below – avoids that the connector loosens.




Both cable and clamp should remain attached to the Releaser – if possible.

First put the Releaser‘s bottom into the groove / empty space of the releaser seat, push it with the clamp ahead, the connector shows in direction to the pressure tubes. Attach with the corresponding screws.

In the picture below you see the clamp bolt of the anchor. The lever is high – if you work with too much force the releaser hook can break! If you do not become aware of this the OBS will be lost during deployment! **Tighten the clamp bolt with 5Nm torsion at maximum.**



3 Preparation in the laboratory

3.1 Work place and initiative steps

As the pressure tube – according to their inner life – weight up to 46kg, the laboratory should be near to the deck – no stairs: danger of falling! For 10 OBS you need a table area of 15m

round about, since both Recorder pressure tubes and Releasers need to be prepared.

Furthermore, you need a Linux-PC/Laptop for programming, a GPS-connection (for signal output), and memory capacities for the enormous data quantities (each Recorder can record up to 512 GB).

First, install the GPS-clock and test it with a 6D6-recorder. Next you should discuss with the chief scientist if and when the time releases shall be programmed. Do not open the Releaser – normally. With the hand terminal you can read out and programm the time releases as well as measure the battery voltages from the outside. You will find further information in the Releaser Manual.

Note the time releases in the protocol, we recommend to write both UTC and bord time down. The protocols must be carefully completed in order to have the correct deployment succession guaranteed. Usually, the time releases are programmed in one-hour intervals, the OBS-Systems — of course -– should have a maximum one-hour distance only. If you don´t pay attention and deploy the OBS-Systems e.g. in the order 1-4-2-3, you certainly know in which order the OBS-Systems will ascend but you won´t have enough time to get from 1 to 2.

Now, collect the radio beacons. The beacons do have 4 different frequencies, if possible, never place two of the same frequencies next to each other. Make a plan, check their function. If you also have a direction finder check it, too.

Open all Recorder pressure tubes and check the o-rings. Actually it is not necessary to mention: when opening and closing the pressure tubes turn the screws evenly and alternately. There is no need of using a rubber mallet. Check the battery connectors (also those of the battery packs). Carefully check the battery voltages! Never use doubtful battery packs!

According to discussion with the head of excursion, according to airgun power, water depth and time schedule program the Recorders (programming instruction see chapter 4).

3.2 Battery packages/rechargable batteries of the Recorder

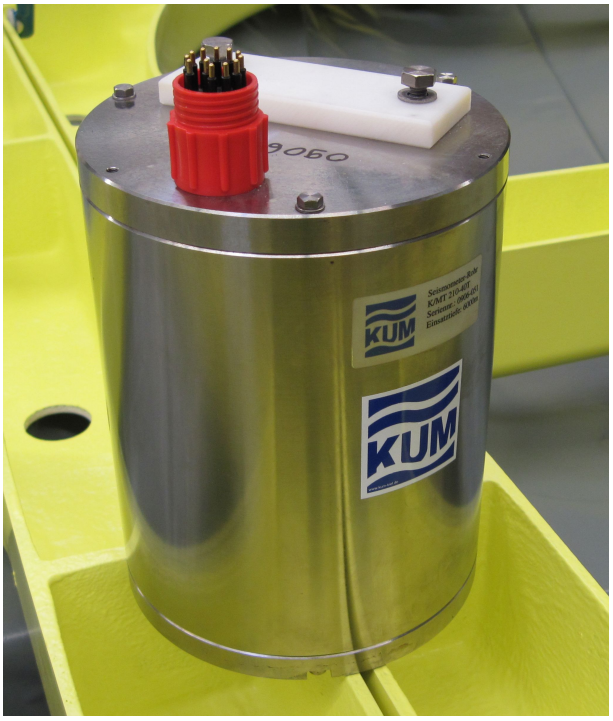
The Recorder can be operated with both Alkali-battery packs (18V) and Lithium-battery packs (10.8V). Never mix different battery types!!

The battery pack has either 48 or 36 batteries. The Alkali-cells are connected 12 to 18V each, the Lithium-cells 3 to 10.8V each. Our experience shows that a 6D6-Recorder combined

with a trillium compact consumes 305mW and a Mono-cell lasts for 4.4 days[1]. In the annex you find a list of battery packs and their longevity (see paragraph 9).

3.3 The Seismometer trillium compact

The seismometer is a broadband instrument called trillium compact from nanometrics. Its frequency ranges covers 50 Hz down to 120 s (0.0083 Hz). Both seismometer and 6D6-recorder consume approximately 305 mW. Please refer to the trilliuum manual for further information.



[1]If anybody takes the time and checks this he will notice that mono cells have less than 40% of the nominal capacity – on one hand this is due to the very optimistic calculation of the supplier and on the other hand due to the temperatures +/- O°C at the sea floor. The low current consumption, too, contributes to less capacity.

3.4 The Recorder 6D6

The LOBSTERs are equipped with the Recorder “6D6” from K.U.M. In any case of doubt the recorder manual is decisive. Here we present only a short extract out of the original manual.

The recorder has four seismic channels and additional inputs for technical data e.g. battery voltage, temperature and humidity. Data are stored on external StiK^{TM} or an internal SD-card. After having the Recorder installed you can program it, you need the ”DIRC in the box” to connect to your PC or to establish an Access Point for your WiFi device.

For Recorder programming you need a PC/Laptop, a GPS-Receiver ”UHURA” for the time signal, a ”DIRC in the box”, a battery pack (or accumulator, mono cells...) and the sensors (hydrophone, seismometer).

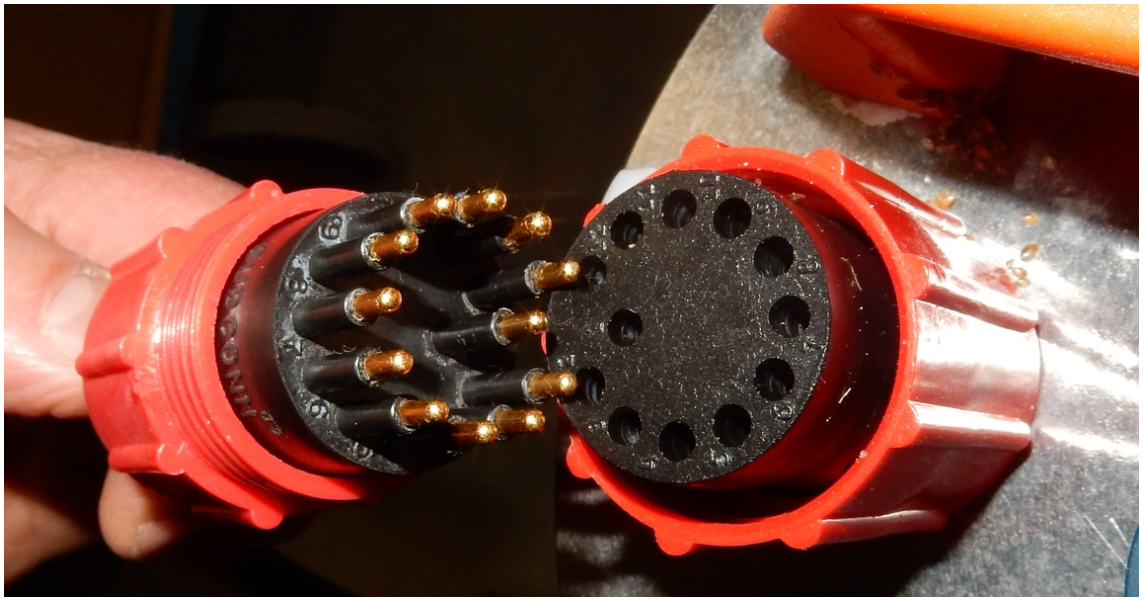
4 Connection and Use of the Datalogger

4.1 External connections

WARNING!

To communicate with the datalogger a cable between DIRC and datalogger is need. At the endcap of the pressure tube this connection is realized using 1 12 pin subconn micro connector. One of the pins is located off circle to assign the correct orientation of the connector.

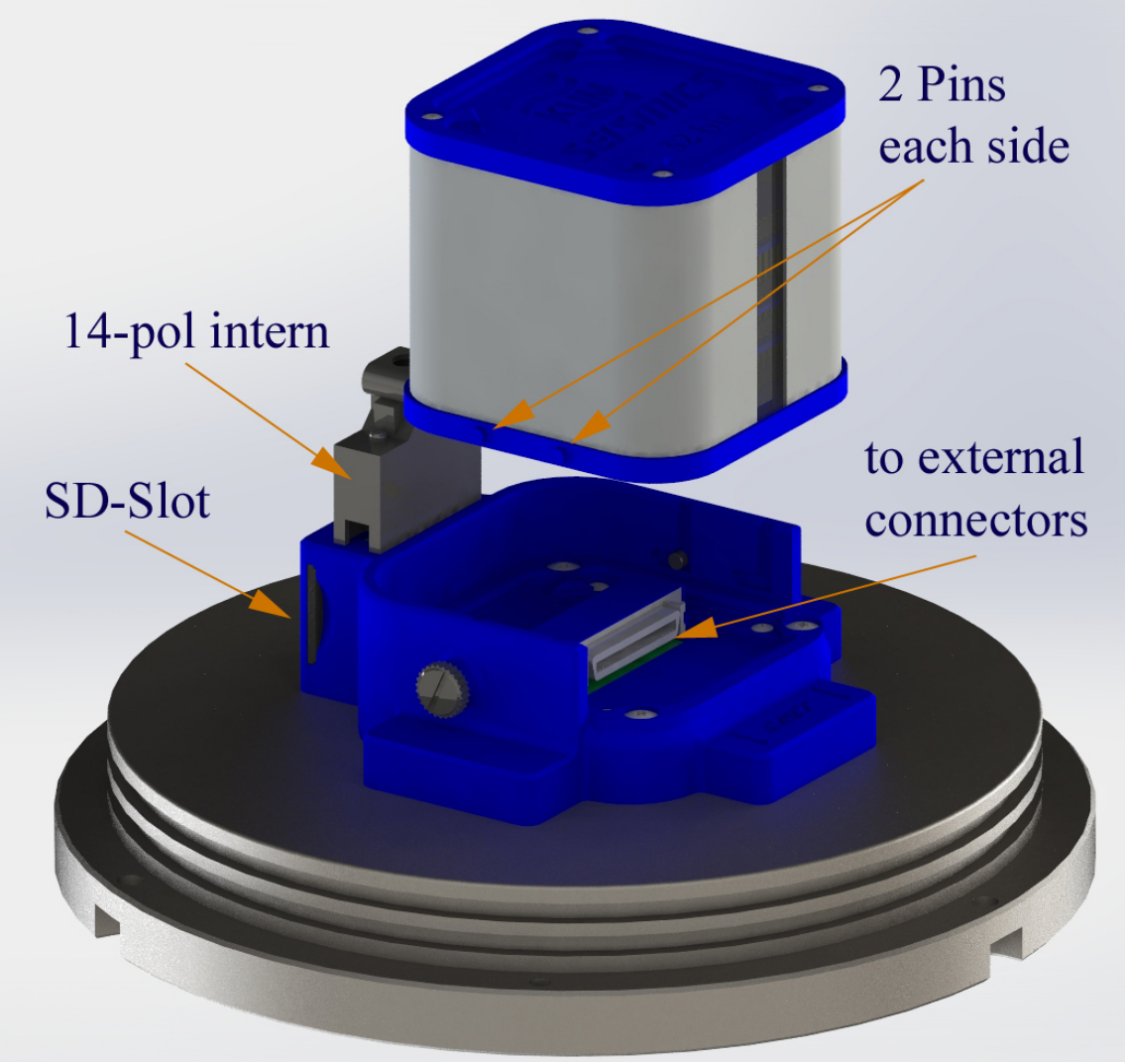
It happened in past that despite this assigning pin that connector had been turned and people tried to push it together in wrong position. It will not work, but it is possible to push both parts together in a way that pins shortcut. In that case, full battery power can be connected to battery ground and a wire inside the datalogger will burn down.



Please take utmost care when connecting the cable.

4.2 Connection

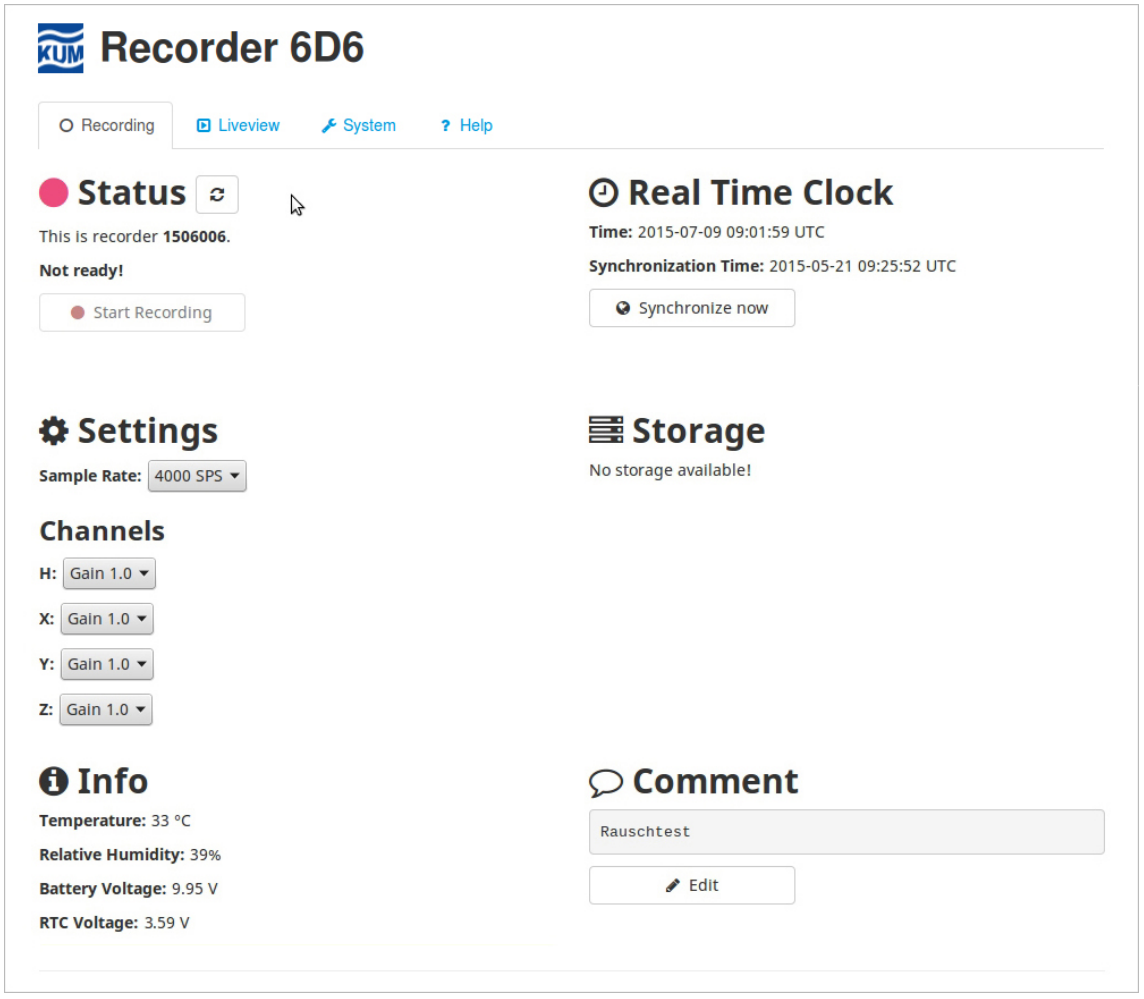
The power for the datalogger comes from inside the pressure tube normally. There exist four little pins top on both sides of the recorder that fit into a bayonet nut to guide the connector. After placing the datalogger fix it by carefully tightening the knurled screws. The recorder is ready for use now.



Recorder and Mount

4.3 Web Interface

The basic configuration of the datalogger "6D6" has a web-server integrated, added by an Access-Point inside "DIRC in the box". If connected to DIRC in the box a WiFi is established and you can use any web browser for communication. You will find the SSID on a sticker placed on the logger, the default password is "seismics". Connect your device to the WiFi and type the IP-address (it is *always* "10.0.0.1") into the address field of your web browser. The following website will appear:



Homepage of the "6D6" datalogger

4.3.1 Status

You can not start a recording in the example above because there is no storage available – this is indicated by both the magenta colored LED of the datalogger and the magenta colored dot on the web site.

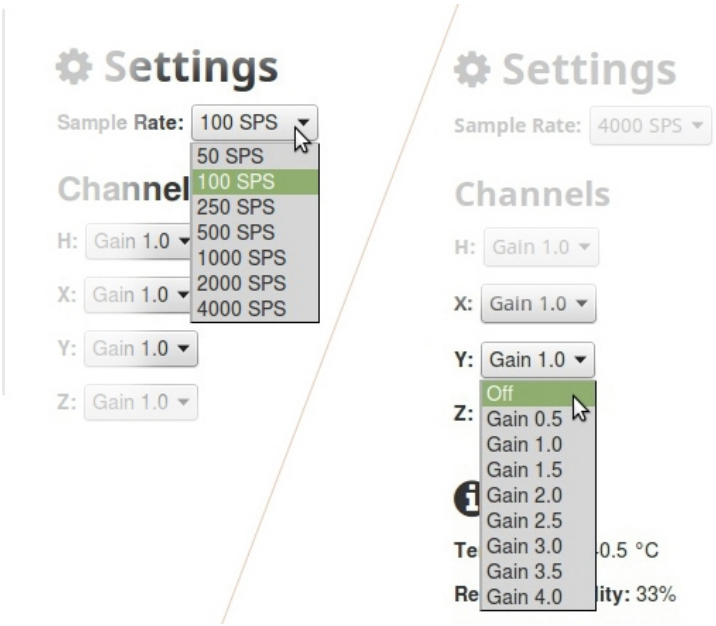
4.3.2 Real Time Clock

It is shown in the area "Real Time Clock" that the clock is synchronized. If an external GPS called "UHURA" is attached, you may synchronize it again (but you do not need to).

Important: In contrast to other dataloggers the "6D6" has its own clock battery incorporated. Therefore it is not mandatory to synchronize the clock *directly before* use or *directly after* end of recording – you might do both synchronizations in the lab at home, even months before or after operation.

4.3.3 Settings

To change number and gain of the channels and the samplerate use the buttons in the area "Settings".

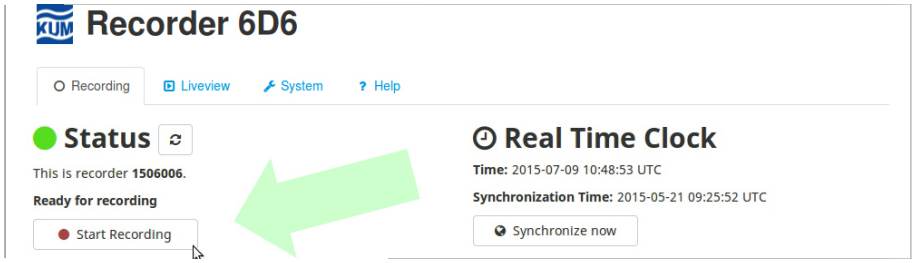


4.3.4 Storage

Two different storage modules are available: An SD card that is placed inside the mount of the datalogger, and the storage module "StiK^{TM}" that is placed on a connector outside of the endcap of the pressure vessel. If both the storage modules are connected to the datalogger, generally StiK^{TM} is priorized.

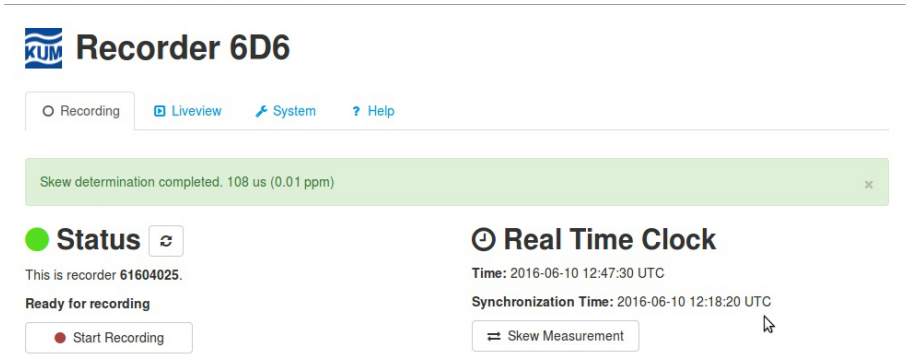
4.3.5 Recording

After formatting the storage the datalogger indicates "ready for recording" using a green dot at the web page (and a green LED at the datalogger itself).



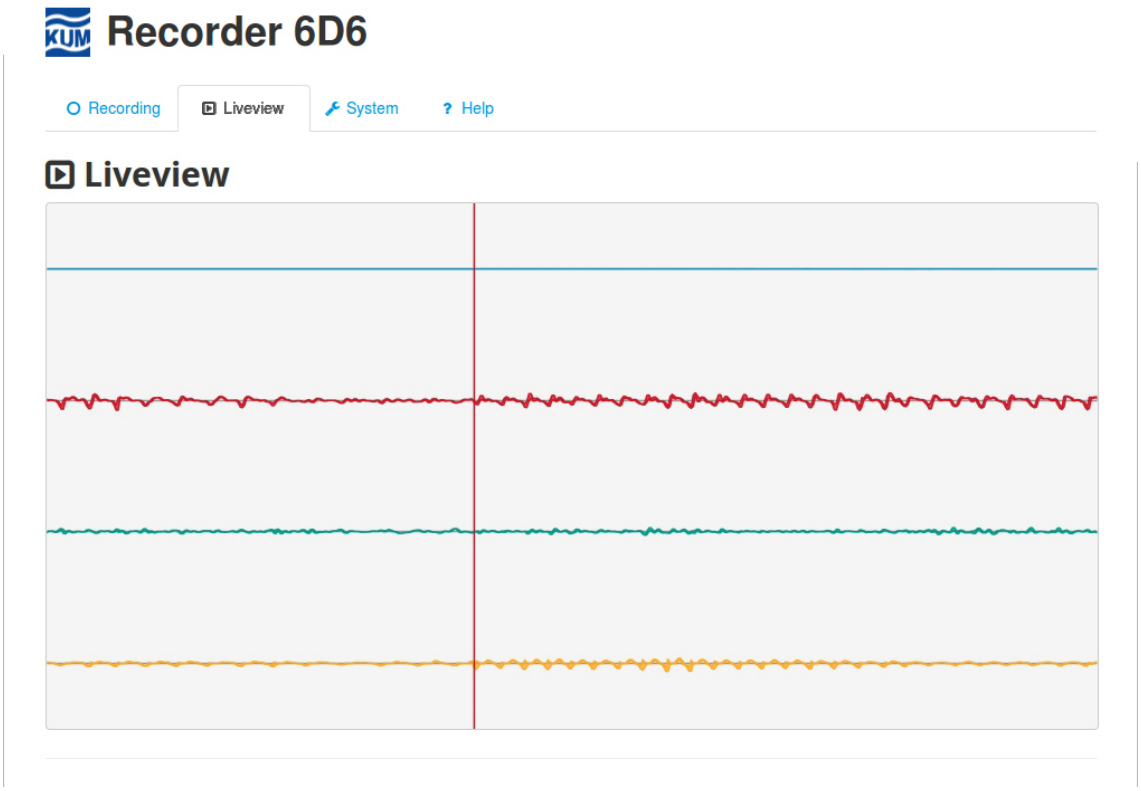
4.3.6 Skew

After recording you can make a second GPS fix to determine any clock drift. A colored bar will show the progress – in this example a deviation of 108 μs.



4.3.7 Liveview

Click on “Liveview” in the task menu to switch to a display of online data from all the channels in use:



Please note that the signals shown are just a coarse representation of the data recorded – even on a 4k screen it is not possible to show four channels of 32 bit data...

4.3.8 System

Use the item “System” in the task menu to change SSID and password for this datalogger, however, we recommand to do so with good reasons only.

You can also upload a new firmware image to the datalogger, if necessary.

4.3.9 Help

At this tab you will find a html-version of the datalogger manual.

4.4 Pressure tubes and mounting

When working with the different LOBSTER pressure tubes meticulous cleanness is utmost important! Even little dirt on the sealing areas or o-rings as well as smallest damages can cause water intrusion! Never open the pressure tubes on deck, never at a dusty or dirty work place!

Each time you work with the tubes check the sealing areas on scratches. Check the connectors (deformed?, oxidized?) and the o-rings, replace them if necessary. Grease them slightly with Molicote 44.

One person takes the battery pack, another person the Recorder. First check whether old drying agent bags are in the tube — remove them. Put the battery pack carefully into the tube, push it down to the bottom and add a drying agent bag. Add a cylinder of damping foam, if neccessary. Then install the cover with the Recorder and again add a drying agent bag. Close the cover regularly and alternately and screw plastic screws in the threads in order to protect them against sand and salt. Protect the connectors with dummies until operation.

By means of metal clamps attach the pressure tube to the OBS-frame. Connect the sensors, protect the connectors not in use with dummies and locking sleeves.

4.5 Releaser

You do not need to open the Releaser‘s body for battery voltage measurement. How to do this is described in the Manual KUMQuat. If desired program the Timer. Note system time and release time in the protocol. We recommend setting the *DISABLE* command: the Releaser then won´t answer anymore to the Range command. By that on the one hand you avoid that the Releaser answers with a ping to *each* 10kHz-signal (a 10kHZ-signal can also generate from e.g. machine noise etc.) and discharges the batteries, on the other hand it is useful to activate only this one Releaser for ranging — if not it could happen that all the other Releasers send an answer.

5 Preparation on deck

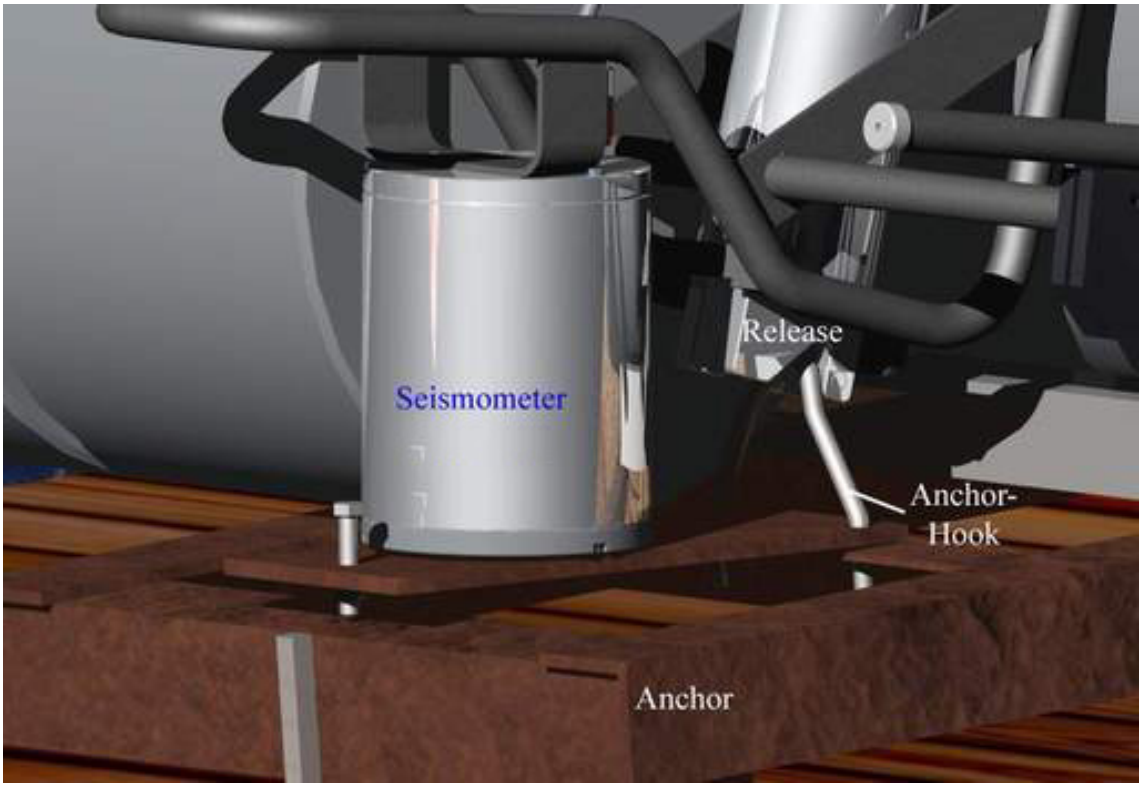
You need approximately 6m x 6m free space near to the crane. Less space is possible but could endanger the safety for crew members and technicians. According to the circumstances on deck each technician himself decides which risk he is willing to bear and where he needs more space.

This is a completely equipped OBS:

5.1 Anchor tightening

Attach the Releaser with the corresponding clamp. Pay attention to the opening direction of the hook, only one position goes with the anchor. The clamps from the tubes and the Releaser stay with them when demounting later on.

In the picture you see the frame (some float units are missing for a better view), the Releaser, the anchor, the anchor hook and two attachment screws that tighten the anchor. You see very well the orientation of both Releaser and anchor hook.



For closing/opening the Releaser note the individual Release code in the protocol, put the code in and transmit. Many pings show transmission, after rotation a sequence of pings tells the status report of the Releaser (see Releaser Manual). With the clamp bolt you push the anchor plate against the seismometer, the anchor is tightened now and the seismometer has a good coupling.

The lever arm of the clamp bolt is very high! Therefore, do not tighten it stronger than 5Nm maximum! If you do so, the load to the Releaser exceeds 250kg and hence the nominal load. The overloaded Releaser doesn´t work safely anymore and in the worst case you will loose the instrument!

Sometimes, when ground is soft, we recommend a sand metal sheet that avoids Releaser pene-

tration in the slick. The sand metal sheet with holes is fixed under the anchor and covers the area under the Releaser.

When ground is very hard the anchor can be equipped with three additional feet in order to guarantee safe and sturdy standing on the rock.

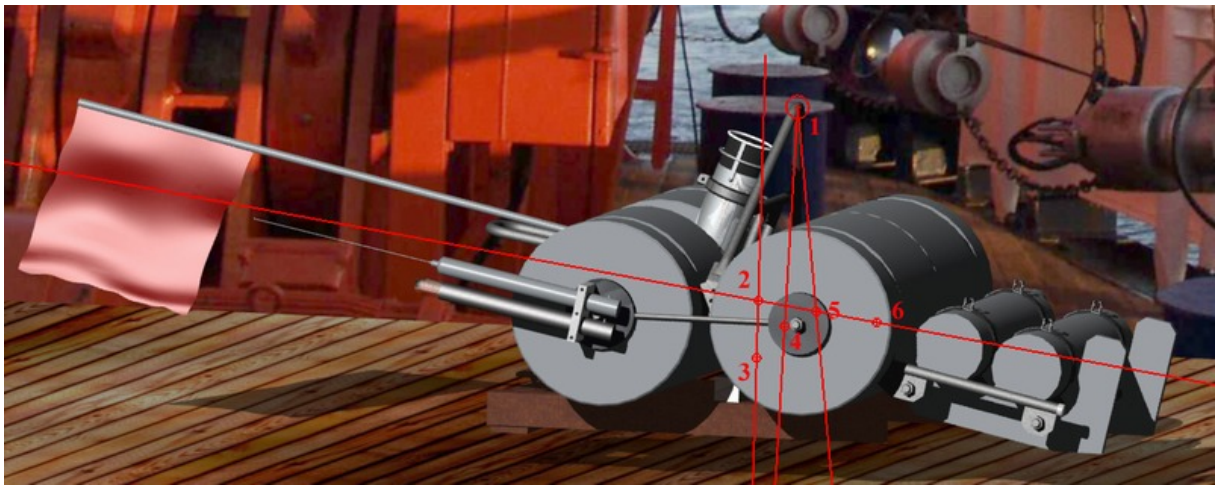
Upon recovery it is useful to put the OBS down on the next anchor (provided that more deployments are planned). That reduces the number of crane operations and accelerates the next operation.

6 OBS deployment

LOBSTER‘s main task is the detection of small and smallest movements of the seafloor and of pressure waves in the water. Therefore — that goes without saying – noise avoidance is utmost important. In order to avoid interferences caused by the water current the OBS-System was designed as flat as possible. But the flat construction certainly has its natural limits: the mass center of the *floatation* still must be obviously above from the mass center of the *weight* for that the OBS-System doesn‘t spin when descending and possibly lands top down or in an oblique position. In addition the mass centers must be directly one over the other, if not the OBS-System descends slopingly. The mass center, however, changes due to the different battery packs that can be used. This displacement must be compensated through battery dummies, different anchors and additional weights. If the OBS-System isn‘t balanced out, the value of the data suffers, in the worst case the OBS-System itself is in danger.

Balance of the OBS-System changes as soon as the Releaser releases the anchor. Since the part of the drift that was at the bottom is missing now the mass center moves automatically in direction to the top – the OBS-System evidently would become instable. As its sole task is ascending this wouldn´t matter, but at the water surface at the latest problems would occur: radio beacon, flasher and flag wag and would be partly under water – positioning would become considerably more difficult. And also the wagging peck up hook would cause problems to attach the OBS-System to the crane.

In order to avoid these problems the OBS-System was designed asymmetrically: nearly the whole drift was placed on the right side, the drift of the anchor, however, nearly completely left. Both together effect that the drift - when the anchor is attached – then is in the center; without anchor, however, the OBS-System tilts by 90° into a stable vertical position in the water column.



Mass points:

The mass points: 1) crane suspension point

2) center of the buoyancy

3) center of the drift – together with point two they are the plumbline of the OBS when descending in water

4) mass center in air – together with point one they are the plumbline of the OBS at the crane

5) the same as 4, without anchor only

6) center of the drift without anchor – together with point two they are the plumbline of the OBS when ascending.

Current resistance now is less and the OBS-System ascends quicker; radio beacon, flasher, flag and peck up hook vertically come out of the water whereas the transducer head of the Releaser stays in the water.

Upon deployment it is of utmost importance that the OBS is balanced out well and that battery configuration and anchor coordinate with each other. In the annex you find a binding list!

7 Recovery

The OBS ascends with approximately 0,8 to 1,0m/s speed — hence it needs approximately one hour to emerge from 4000m depth. Customarily one releases an OBS at 500m distance away from the position -– a trained team, though, can even release several OBS with time differences provided that weather conditions are fine. Then, OBS1 is picked up while OBS2 ascends and OBS3 has just been released and starts ascending. This procedure saves time but if you don´t catch OBS1 and have to try it again you will loose time -– whereas OBS2 and OBS3 drift away in the meantime.

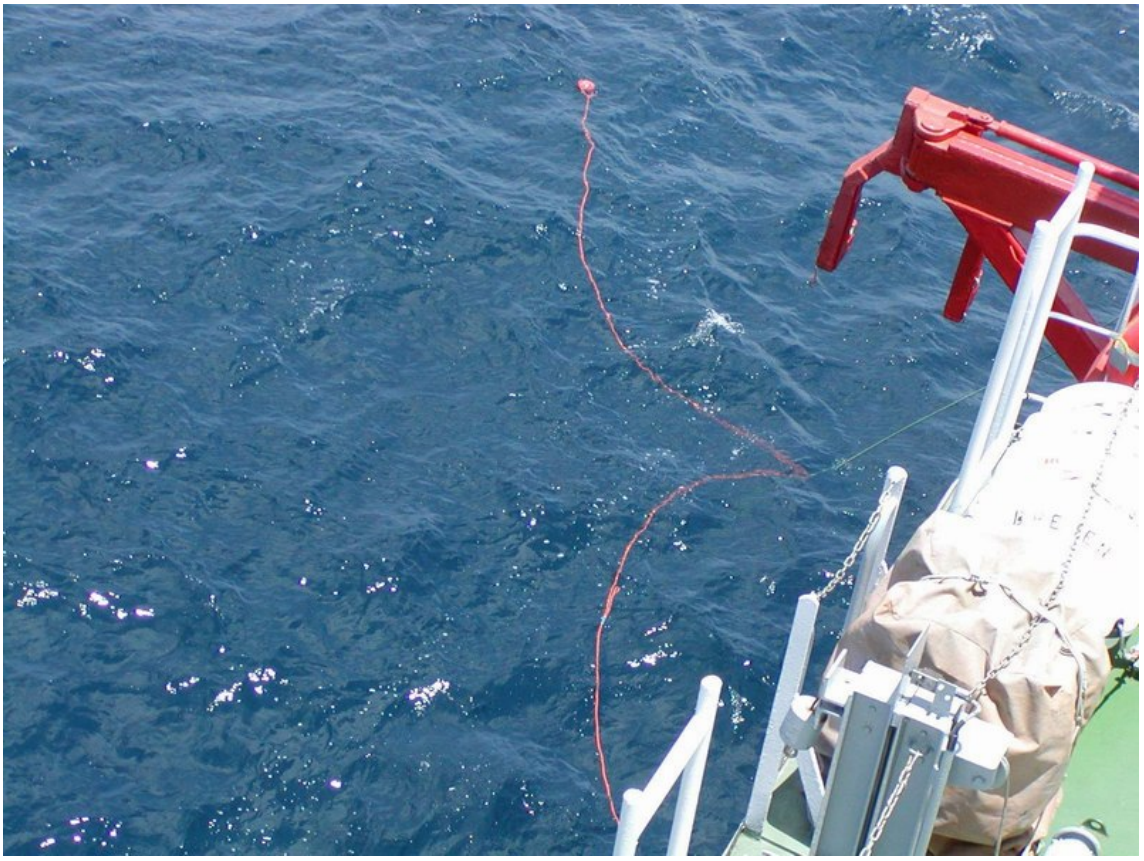
The OBS answer to the Release Code is a sequence of beeps. The sequence of pulses tells whether the hook has been turned; the number of beeps tells whether the Releaser is in horizontal or vertical position. That goes to show whether the Releaser still stands at the seafloor (Releaser vertical) or already ascends (Releaser horizontal). During ascent you can bleep the Releaser from time to time with the "`range`"command and follow the ascent with decreasing range. **Caution: Before Ranging you must put the Releaser with the "Enable" Command in the active Range mode.**

Once emerged you have the following four OBS recovery aids:

- flag for the view
- by means of the Releaser you can try to measure the distance – but: this doesn‘t work well as interferences directly under the water surface are high
- flasher (only by night)
- radio beacon: With the "Direction Finder" or "Little L-Per" from Metocean or Xeos you can trace the direction of the strongest signal (user‘s handling in the corresponding manual). In addition you should have switched a radio on with the corresponding frequence in order to hear when the OBS emerges.

The following picture shows that it is not easy to detect an OBS by day, at night it is easier. But, during night ship manoeuvres are much more difficult as it is hard to estimate the flasher‘s distance.

The OBS has got a swim rope for the peck up. A loop in the swim rope serves the suspension in the crane. You lift the OBS on deck and put it down either on a pallet or on the next anchor.



After recovery you first clean it carefully with fresh water. Then you take away flasher and radio beacon, switch them off and put them into a fresh water basin. You can leave the Releaser integrated in the OBS until the last deployment, but clean it carefully.

In case you are using StiK^{TM} for data storage, you might want to determine the clock drift now using your GPS. When synchronisation is done, you can remove Stik^{TM}, put a cover on the endcaps connector, and download the data from Stik^{TM}.

If you use internal SD-card for data storage, separate hydrophone and seismometer from the pressure tube and cover the connectors with dummies. Demount the pressure tube and bring it into the laboratory. Secure the OBS on deck. There is no need to open the tube to stop the recording, synchronize the clock and download the data: it can all be done with DIRC while the tube is closed. Connect the Recorder to the PC, determine the skew and terminate recording according to the instruction in the manual. Save data (rather 5 times than 3 times...).

8 After recovery

If the units are to be stored after recovery one has to remove and carefully clean the pressure tubes. Cleaning must not stop at simple wash with freshwater: especially for the flasher and radio beacon more detailed maintenance is neccessary. Remove both upper and lower endcap and clean it from any salt water. Both flasher and radio beacon are partly made from aluminium and brass and otherwise corrosion might occur.

The titanium tubes are resistant against corrosion, however, salt water will become to salt crystals after a while. When opening or closing the tubes theese crystals might move below the o-rings: leakage is – at least in theory – possible.

Remove all batteries from the tubes. For transport, batteries of flasher, radio beacon and release unit may left inside the housing but have to be removed directly after transport. Check the time release of the release unit: if still actice, deactivate it. You also might reprogram it for a few minutes or hours in advance to check whether its working. When the time release is suppused to open during transport, be sure that the hook is closed and will open: if the hook is to close during transport, it might be damaged because you have no control over the corect position.

The recorder must not be transported inside the pressure tubes. Handle the recorder – as well as the sensors – with utmost care and store well safed against bumps.

Be careful when removing cables of the LOBSTER-frame: think twice and use diagonal cutting pliers only! Do not use a knife or simular: you might damage the cable in a way thats not visible at a first look.

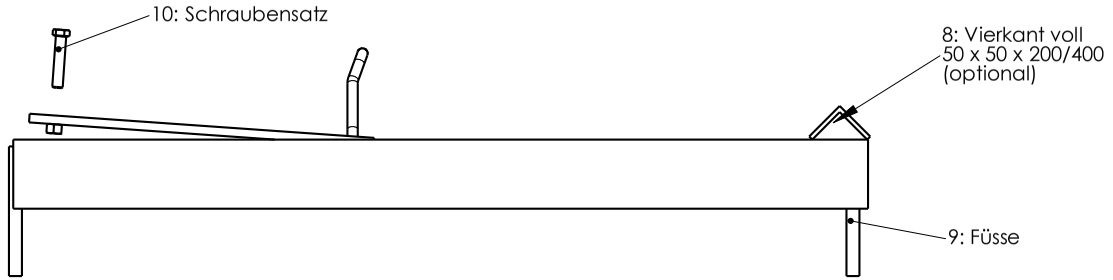
9 Attachment

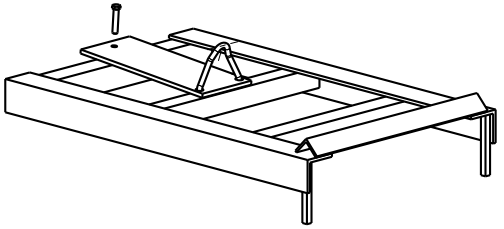
Battery configuration Lobster with 6D6 and trillium compact

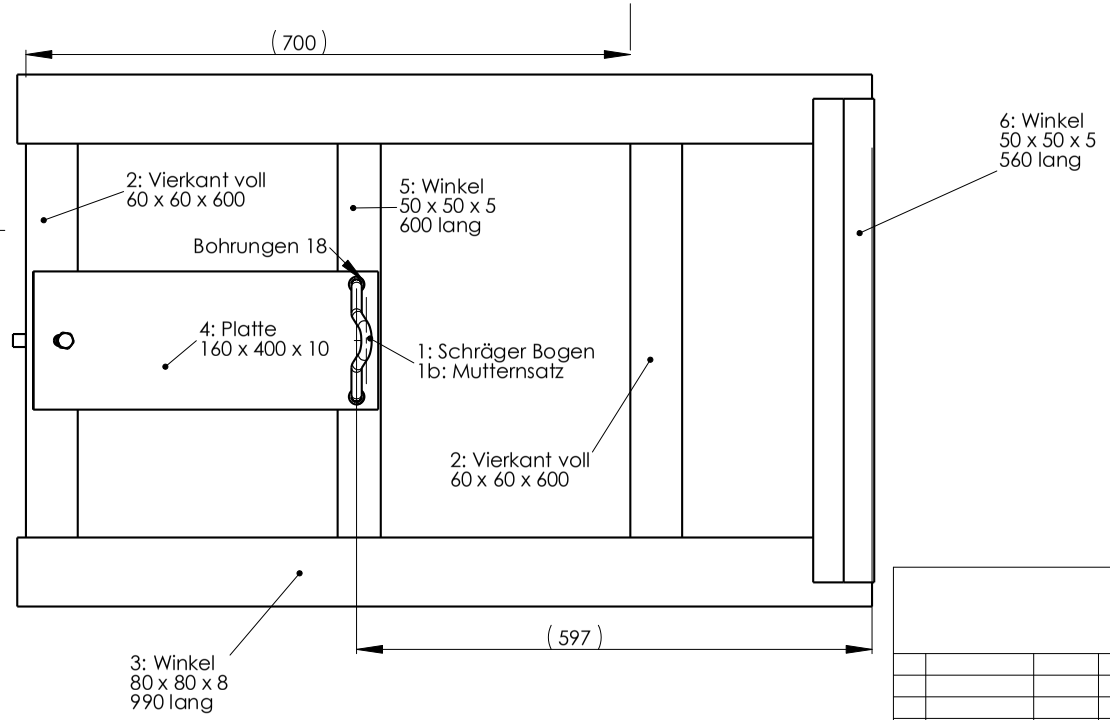
Actual power consumption Recorder and trillium 0,31 W
Capacity Alkaline KUM-calcs. 9,0 Wh
Capacity Lithium KUM-calcs. 37,7 Wh

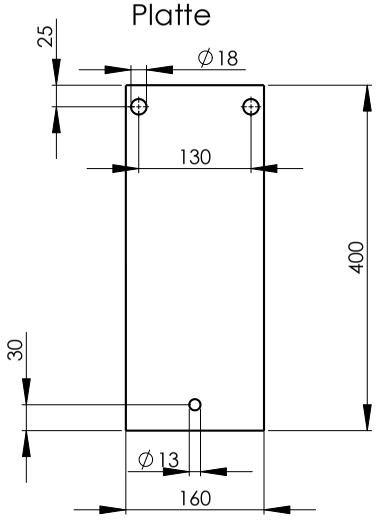
				Time of operation*					Total anchor
	Cells	Capacity		**days**	month	dummy	anchor	add. weight	weight
Alkaline 24	24	216	Wh	**29**	1	48	3)		62 kg
Alkaline 36	36	324	Wh	**44**	1,4	48	3)		62 kg
Alkaline 48	48	432	Wh	**59**	1,9	48	3)		62 kg
Alkaline 48+48	96	864	Wh	**118**	3,9		3)		62 kg
Lithium 48	48	1810	Wh	**247**	8,1	48	3)	50 x 50 x 400	70 kg
Lithium 48+48	96	3620	Wh	**494**	16,3		3)	50 x 50 x 400	70 kg

Anchor 3) lightweight anchor for a single pressure tube, main weights 60 x 60 and 60 x 60 with 980mm length
additional weigth 50 x 50 x 400 to balance weight differences between Alkaline and Lithium batteries









				Allgemeintoleranzen DIN 2768 mK	Werkstückkanten DIN 6784	Maßstab 1:5 (A3)	Gewicht 62kg
				Projektion:		Werkstoff Stahl schwarz	
					Datum	Name	
				Bearb.	11.01.2006	Schwenk	Anker Lobster ein Druckrohr
				Gepr.			
				Norm			
				KUM Umwelt- und Meerestechnik Kiel GmbH 0431-7209220 www.kum-kiel.de		2230-A-07-03-000	Blatt 1 / 1 Blätter
Zust.	Änderung	Datum	Name	Urspr. Anker Lobster ein Druckrohr		Ers. für:	Ers. durch:

LOBSTER STATION-PROTOCOL V1.3

Cruise: **Project:**

Profile: **Station:**

Date UTC: **Date local:**

Battery-packs: 48 of _____ at _____ Volts 48 of _____ at _____ Volts 6D6-SN: _____

two dry packs inserted ☐ sealing area checked ☐ all screws fixed ☐

Operator:

Recorder 6D6 SN: _____ Firmware: _____

_____ format ☐ capacity total _____

gain H ☐ Z ☐ Y ☐ X ☐ channels _____ rate _____

signals show H ☐ Z ☐ Y ☐ X ☐ remarks _____

trillium levelling: _____

GPS-Sync: No of Sats: ☐ GPS date (dd.mm.yyyy) _____ time (hh:mm:ss) _____

Start Date _____ time (GPS) _____

RECORDING STARTED ☐ CHECKED (capacity) ☐ OPERATOR:

Releaser SN: _____ User1: _____ User2: _____

Release: _____ Enable: _____ Disable: _____ DISABLE? ☐

ST date: _____ UTC time: _____ UTC RT date: _____ UTC time: _____ UTC

Batt 1: _____ Batt 2: _____ Operator:

Prepare on Deck

frame SN: _____ Flag: fixed ☐

Tube SN: _____ fixed ☐ all conn.: fixed ☐

Flash SN: _____ switched ON ☐ tested ☐

Radio SN: _____ switched ON ☐ tested ☐ channel A ☐ B ☐ C ☐ D ☐

Hydrophone SN: _____ fixed ☐

Anchor:

bolt material: added weight: _____ fasten with _____ Nm (max 5Nm!)

Deployment Date UTC _____ Time UTC _____

Operator _____ local date _____ local time _____

coordinates: lat _____ N/S long _____ E/W waterdepth _____

Recovery: First Release Date UTC _____ Time UTC _____

Operator: _____ local date _____ local time _____

Recovery: on surface local date _____ local time _____

Recovery: on deck local date _____ local time _____

coordinates: lat _____ N/S long _____ E/W waterdepth _____

Recorder GPS No of Sats: ☐ date _____ time _____

skew _____ recorded data _____

☐ no errors ☐ errors:

downloaded to:

10 Pin-out 6D6 - Trillium

10.1 Connection 6D6 to Trillium

Pressure tube MCBH12F	Seismometer MCBH12M	intern Trillium Molex flat 12pol	Description
Pin1	Pin1	12	Tx [1]
Pin2	Pin2	11	Rx [1]
Pin3	Pin3	6	Geo X-
Pin4	Pin4	8	Geo Y-
Pin5	Pin5	–	Re-Level [2]
Pin6	Pin6	9	Geo Z +
Pin7	Pin7	5	Geo X +
Pin8	Pin8	7	Geo Y +
Pin9	Pin9	3	AGND
Pin10	Pin10	1	+12V Power[3]
Pin11	Pin11	2	0V power [3]
Pin12	Pin12	10	Geo Z-

[1] The Trillium needs its own RS232-connector to program levelling .

[2] The Trillium levels autonomously.

[3] The sensor Trillium is switched on by the datalogger 6D6. If 6D6 is removed or switched off Trillium is switched off automatically. In addition, the sensor Trillium switches off when the voltages drops 9 Volts.

Attention: As soon as a seismometer is connected to a power source it starts to consume energy. The power consumption is much higher if the seismometer is not levelled or if levelling is not possible as on board of a vessel. We recommend to avoid – at a running 6D6 – long delays before deployment. If a recording in “continuous mode” is running please attach the storage shortly before deployment only or, with external seismometer, wait until deployment before attaching the seismometer cable.

10.2 14-pin connector of the Datalogger socket

Pin	Purpose	Description
1	–	unused[1]
2	–	unused
3	–	unused
4	–	unused
5	–	unused
6	–	unused
7	V+	VDD Battery
8	–	unused
9	–	unused
10	–	unused
11	–	unused
12	–	unused
13	–	unused
14	V-	VSS Battery

[1] 12 lines are reserved in case a seismometer is used in the same housing as the recorder.

10.3 50-pin internal connector

Pin	Function	Notes	used in base system
1	Vbat +	battery pack plus	yes
2	Vbat -	battery pack minus	yes
3	NC01	nc	no
4	H+	hydrophone +	yes
5	H-	hydrophone -	yes
6	X+	geophone/seismometer X+	yes
7	X-	geophone/seismometer X-	yes
8	Y+	geophone/seismometer Y+	yes
9	Y-	geophone/seismometer Y-	yes
10	Z+	geophone/seismometer Z+	yes
11	Z-	geophone/seismometer Z-	yes
12	NC02	nc	no
13	1PPS	second pulse from external GPS, CMOS level	yes
14	NMEA	NMEA messages from ext. GPS, CMOS level	yes
15	NC03	nc	no
16	TX	transmit data serial RS232, regular level +/-10V	yes
17	RX	receive data serial RS232, regular level +/- 10V	yes
18	LVL/VTRILL	Trillium: Power supply on (FET)	yes
19	NC04	nc	no
20	Z1-	optional second 3 channel sensor	no
21	Z1+	optional second 3 channel sensor	no
22	Y1-	optional second 3 channel sensor	no
23	Y1+	optional second 3 channel sensor	no
24	X1-	optional second 3 channel sensor	no
25	X1+	optional second 3 channel sensor	no
26	SCLKSD	SPI clock signal for external SD card	yes
27	MISOSD	SPI receive data from ext. SD card	yes
28	MOSISD	SPI transmit data to ext. SD card	yes
29	TX1	trillium RS232 transmit	yes
30	RX1	trillium RS232 receive	yes

Pin	Function	Notes	used in base system
31	NC05	nc	no
32	NC06	Request Releaser Status	no
33	NC07	Releaser Status 1	no
34	NC08	Releaser Status 2	no
35	NC09	turn AIS/GPS/IMU on (on release?)	no
36	NC10	I/O signal, request release from releaser	no
37	VUSB+	USB Power +	yes
38	DN	USB Data -	yes
39	DP	USB Data +	yes
40	VUSB-	USB Power -	yes
41	VCNC	Power for CNC board, externally switched	yes
42	NC11	nc	no
43	NC12	nc	no
44	DET1	SD card detect 1	yes
45	VCC3.3	VCC for SD card	yes
46	CSSD1	CS for SD card 1	yes
47	DET2	SD card detect 2	yes
48	CSSD2	CS for SD card 2	yes
49	NC13	optional analog input	no
50	NC14	nc	no