



Marine  
National Facility

# Development of a CTD Modem

From Dial-Up to Broadband

By Trevor Goodwin

Operated by CSIRO, Australia's National Science Agency,  
on behalf of the nation





Commissioned on  
12 December 2014,  
*RV Investigator* is capable  
of delivering up to  
**300 research days**  
each year



Length **94 m**

Beam (width) **18.5 m**

Height (waterline to top of ship) **37 m**

Draft (waterline to bottom of ship) **6.2 m**

Gross tonnage **6082 t**

**10** Internal stories

**12** On board laboratories

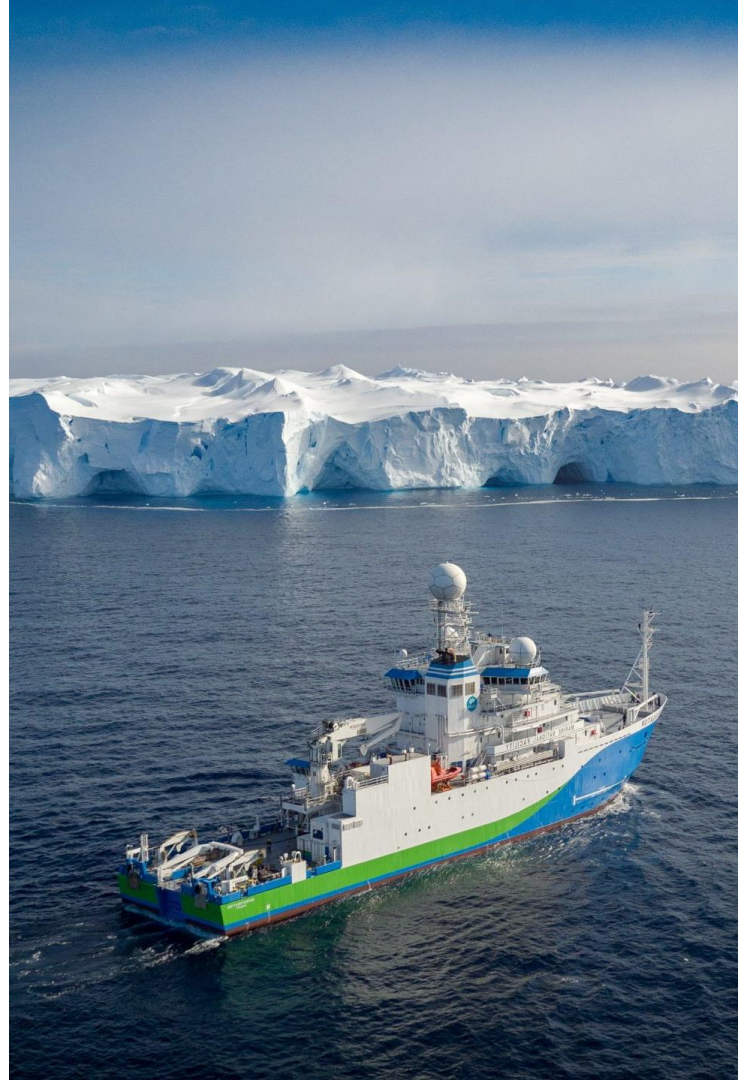
**20** Ship crew

**10** CSIRO staff (approx.)

**30** Science participants

**60** Days endurance

**10,000**  
Nautical miles range

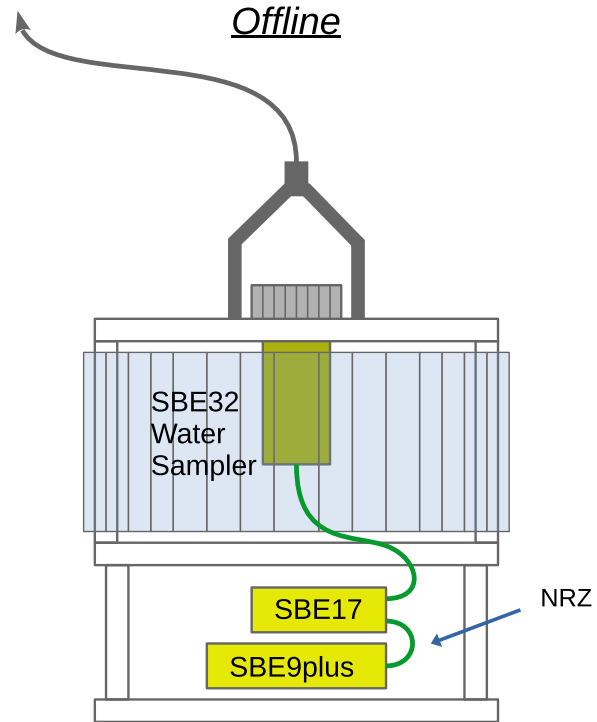
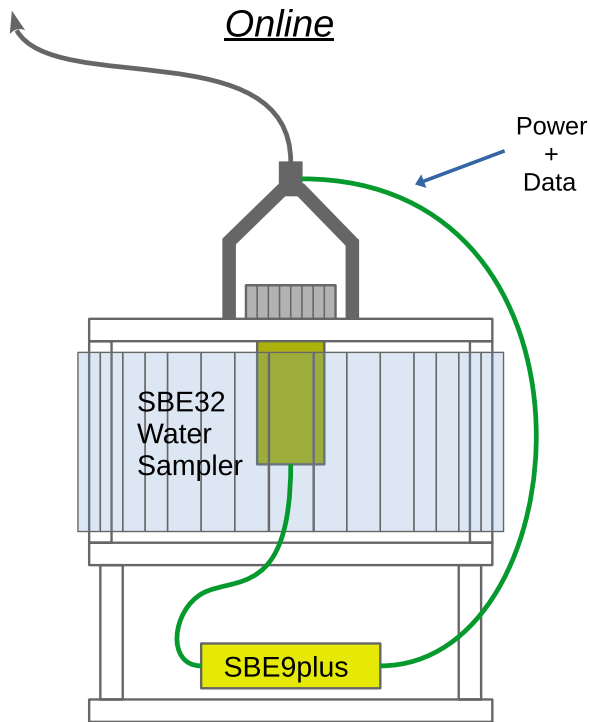
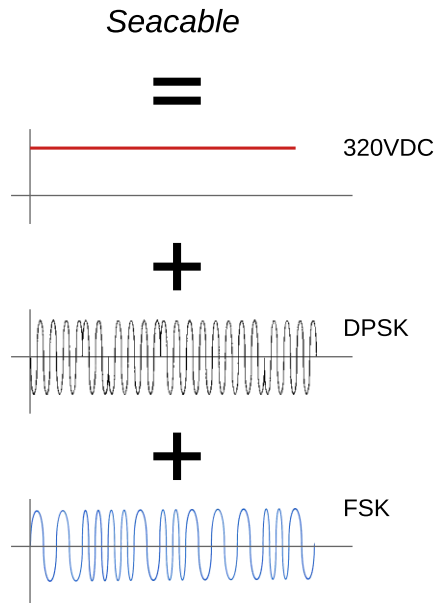


# Our CTD

- Seabird SBE911plus.
- SBE32 water sampler.
- 24 and 36 bottle frames.
- Dual T, C, DO sensors.
- Dual ADCP's.
- Seasave DAQ software.
- Rochester A216314 cable.

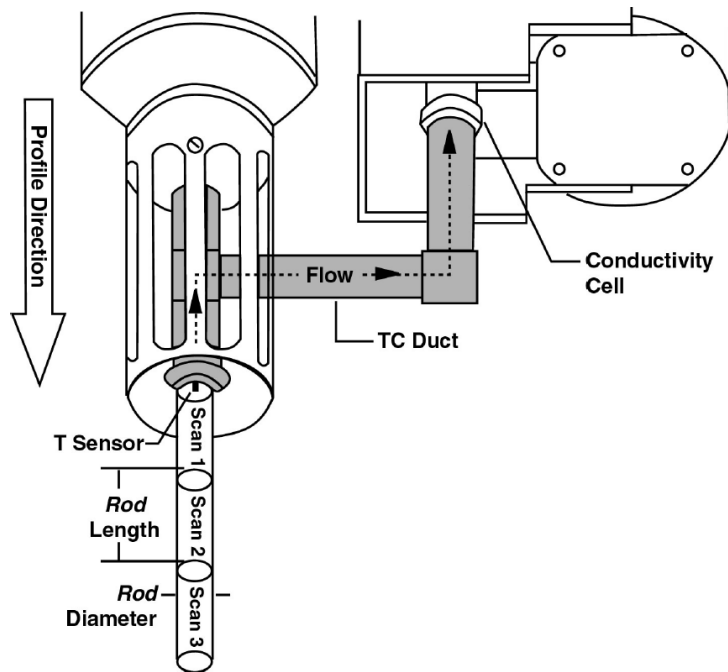


# SBE9plus



# SBE11plus V2

- Couples data and power.
- Demodulates 35kHz DPSK. Converts raw counts to decimal frequency.
- Interpolates data points for conductivity advance.
- 24Hz scan rate.
- 30bytes of CTD + 40bytes serial uplink per scan.



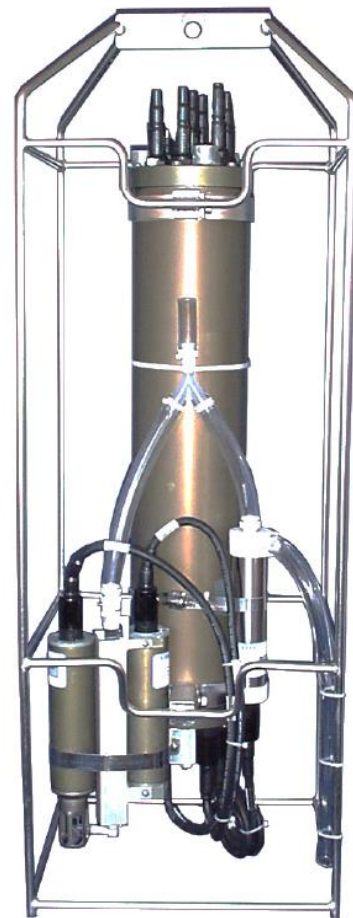
*DPSK = Differential Phase Shift Keying*

*FSK = Frequency Shift Keying*

*NRZ = Non-Return to Zero*

# Limitations of the SBE911*plus*

- Limited auxiliary power (15V 1A).
- Only 1 RS232 sensor @ 9600bps.
- LADCP requires a battery.



# Project Goals



UPGRADE TELEMETRY  
AND POWER CAPABILITY.



SEND POWER AND DATA  
OVER SINGLE  
CONDUCTOR.



PROVIDE ENOUGH  
POWER ADCP'S,  
AUXILIARY SENSORS.  
ELIMINATE BATTERY.



MAINTAIN  
COMPATIBILITY WITH  
SEASAVE SOFTWARE.



CREATE A MODULAR  
DESIGN THAT CAN GO ON  
OTHER PLATFORMS.

# This isn't new!

- WHOI data-link project (2009).
- 400kBit/s, relied on battery power.
- Streamed ADCP real-time (WinADCP).
- Similar tech exists in Side Scan Sonars.



Edgetech 2050 Side Scan Sonar (ADSL) [1]



Video Transmission over 10km  
Coaxial Tow cable (SHDSL)  
Hangzhou Dianzi University 2008 [2]



WHOI Data-Link (SDSL)  
(Swartz et al. 2009-2017) [3]



# Single-pair high-speed digital subscriber line.

- SHDSL
- Commonly used in ethernet extenders.
- 64kbit/s – 5Mbit/s.
- 10km range.



Phoenix Contact TC Extender [4]



Moxa IEX-402-SHDSL [5]



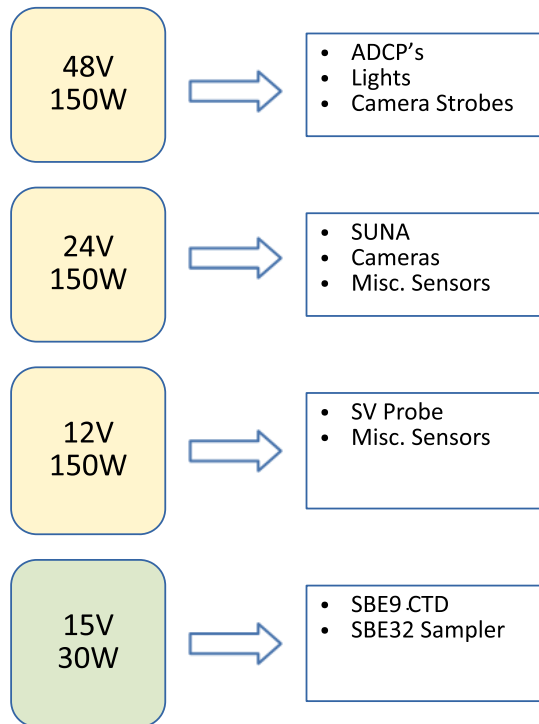
Black Box DeeSL [7]



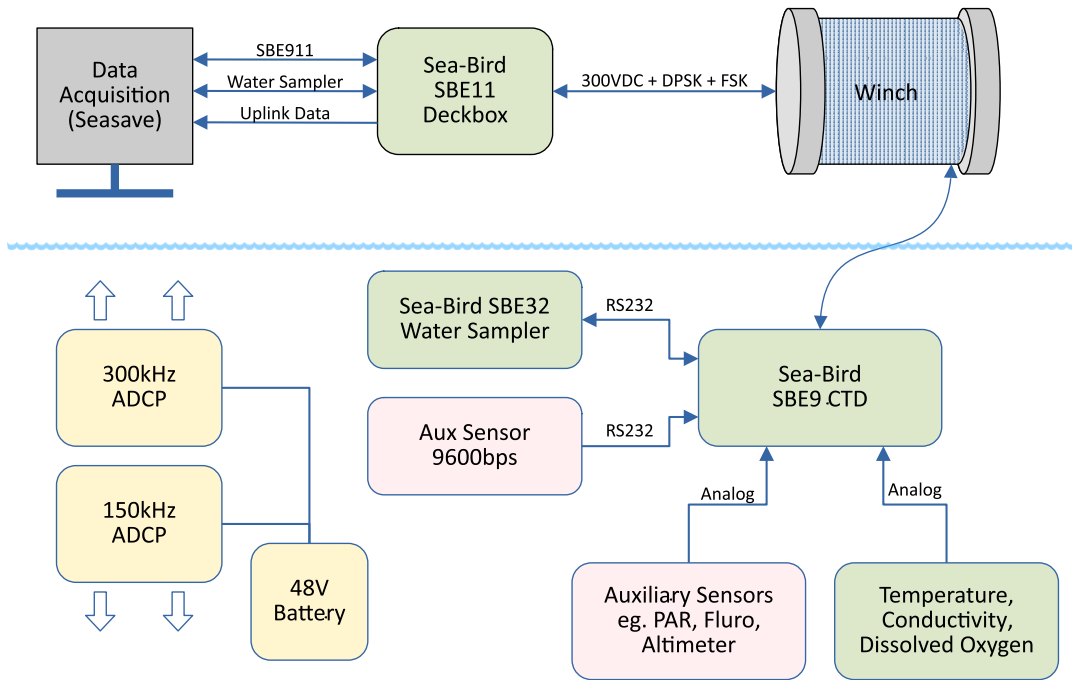
Patton RocketLink 3200 [6]

# Power Requirements

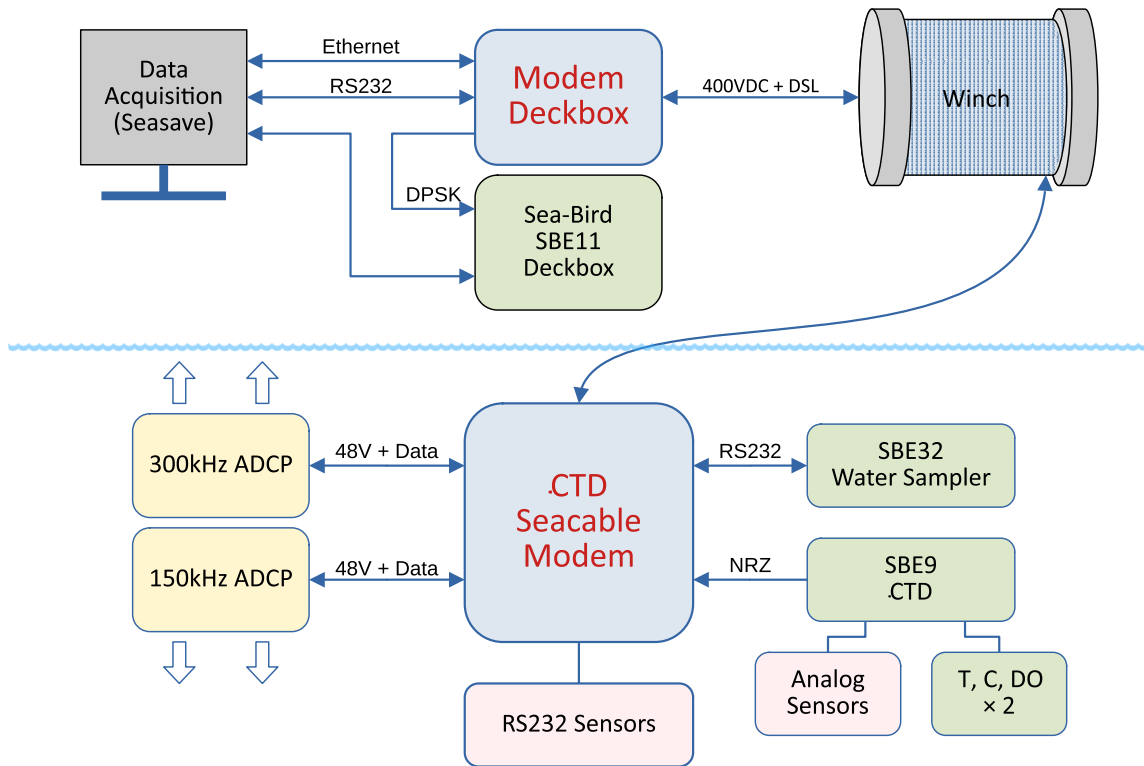
- 48V ~3A for LADCP's.
- 12V, 24V for general use.
- 15V for SBE9, SBE32.
- 5V, 3.3V for logic.
- 400V used at top-end.



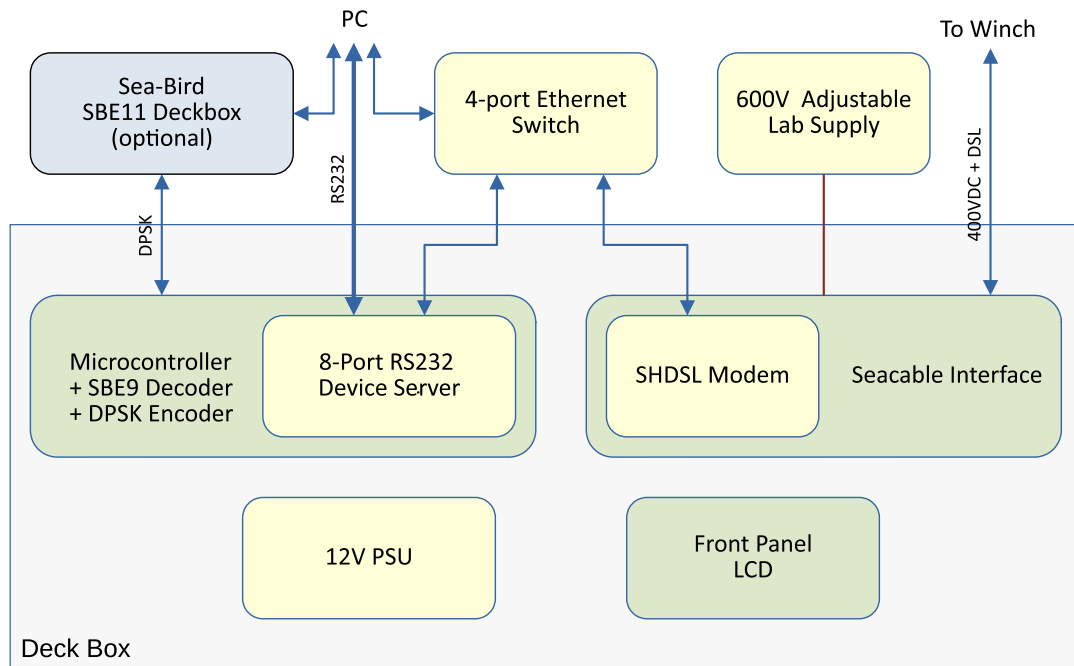
# Old Topology



# New Topology



# Deckbox

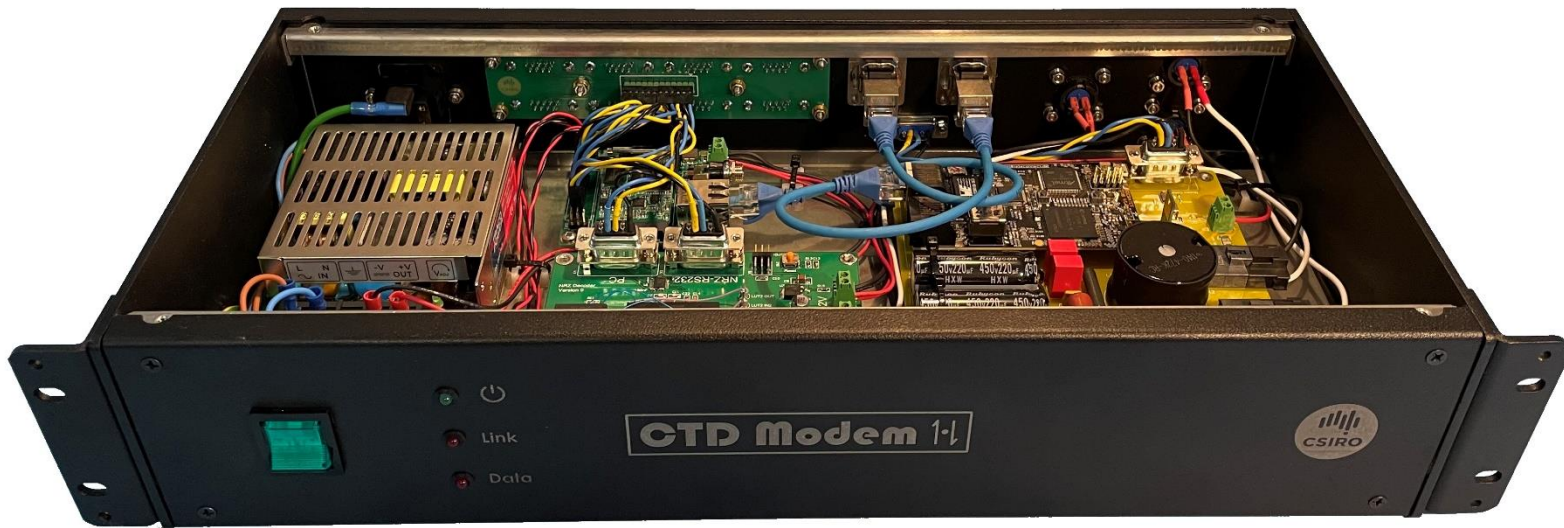


= Seabird
  = Bespoke PCB
  = Off-shelf

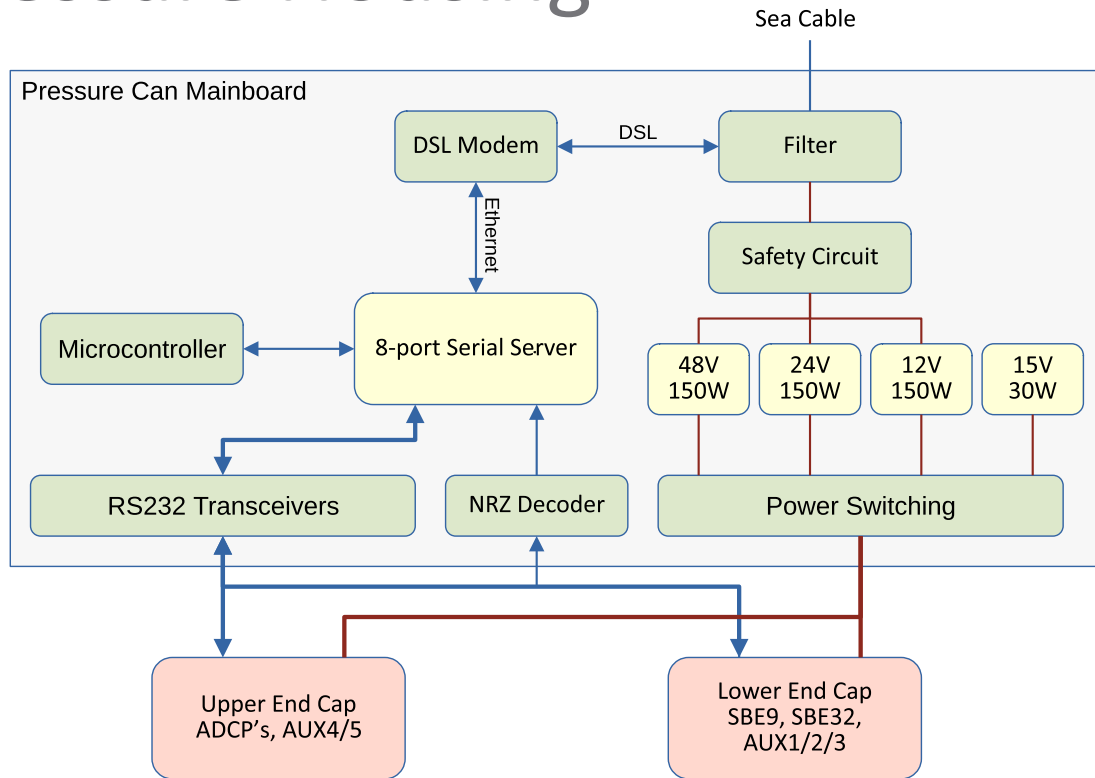
# Deckbox Design



*600VDC Lab Supply*

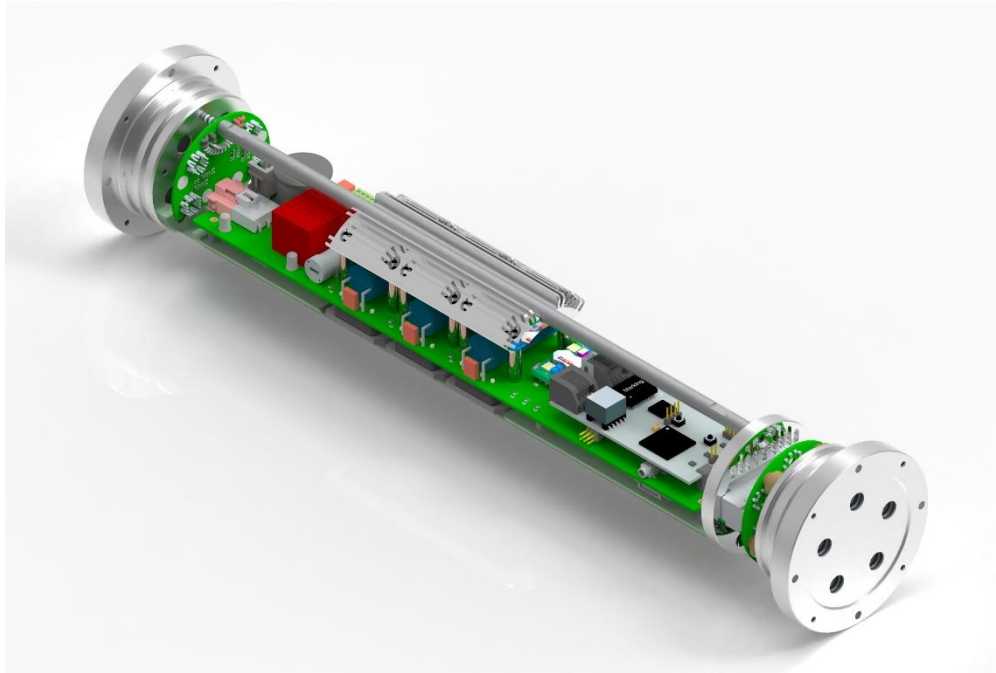


# Modem Pressure Housing



# Pressure Housing Design

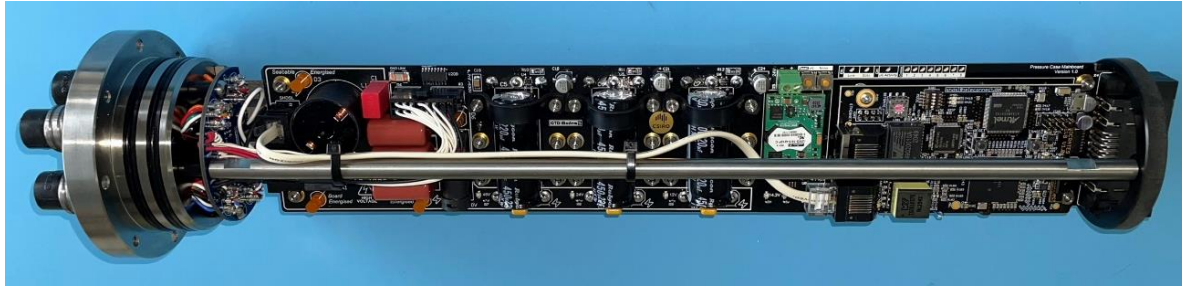
- 470 × 93Ø mm Titanium.
- 6500m depth rating.
- Subconn MCIL connectors.





# Pressure Housing Photos

- No cable harnesses.
- Easy to assemble.
- Standardised Pinout.
- Can power with 24V.



# Results

- Tests performed on 7400m Rochester A216314

	Old	New
Power	15V 1A + 48V Battery	48V 3A, 24V 6A, 15V 2A, 12V 12A (350W total).
Data (incl. CTD)	17.3kBit/s	256kBit/s
RS232 Channels	1	8 total (4 spare)

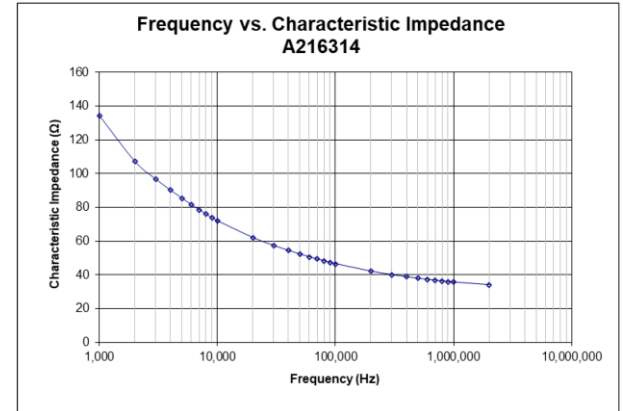


# Summary

- 256kBit/s on Rochester 7.4km A216314 (8mm coax).
- 1MBit/s+ on Rochester 6km A305382 (10mm twisted-pair).
- The design is modular – the DSL modem could be swapped for a fibre modem, or used as back-up alongside fibre.
- DSL takes time to connect – SBE911 doesn't.
- Ideally, the SBE911 has it's own conductor.

# Further work

- Consolidate PSU, switch, and LCD in deckbox.
- Software – GUI for configuring modem and power switching.
- Impedance tuning for the cable.
- Improve data rate and attenuation.
- Bypass the SBE11.
- Much more testing.





# Further Reading

[1] EdgeTech Side Scan Sonar

<https://www.edgetech.com/product/2000-combined-side-scan-sonar-sub-bottom-profiler/>

[2] Deep-sea unrepeated video transmission system over 10 km coaxial tow cable based on SHDSL:

<https://doi.org/10.1109/OCEANS.2008.5151944>

[3] WHOI SDSL Data-Link Project—Ethernet Telemetry through Sea Cables

<https://doi.org/10.1175/JTECH-D-11-00196.1>

<https://www.unols.org/sites/default/files/200911rvtap34.pdf>

The data coupler design in transmission technology based on coaxial cable (2008)

<https://doi.org/10.1109/ICCT.2008.4716258>

A New Generation Power-Data Hybrid Transmission System Based-on G.SHDSL and Power Filter (2011)

<https://doi.org/10.1109/OCEANS-Yeosu.2012.6263560>

[4] Phoenix Contact TC Extender

<https://www.phoenixcontact.com/en-au/products/modem-tc-extender-2001-eth-2s-2702409>

[5] Moxa IEX-402-SHDSL

<https://www.moxa.com/en/products/industrial-network-infrastructure/ethernet-switches/ethernet-extenders/iex-402-series/iex-402-shdsl>

[6] Black Box DeeSL.2 Ethernet Extender

<https://www.blackbox.be/wa-be/i/13602/DeeSL2-Ethernet-Extender-Kit/>

[7] Patton RocketLink Model 3200

[https://www.patton.com/dsl\\_cpe-routers/3200/](https://www.patton.com/dsl_cpe-routers/3200/)

# Thank you



## **CSIRO NCMi**

Trevor Goodwin

Electronics Technician

+61 3 6232 5164

[trevor.goodwin@csiro.au](mailto:trevor.goodwin@csiro.au)

[csiro.au/ncmi](http://csiro.au/ncmi)