UCC Team

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Background

Northrop Grumman Enterprise

Niobium Metal Underwater Circuit Connector

Customers:

- Aquatic Research Labs
- Navy
- Air Force
- Department of Defense

Problem Definition

Unmanned Underwater Vehicles/submarines have onboard batteries for power and therefore have mission lives limited by battery capacity. Having a system to dock and charge the UUV without human interaction would improve data collection, and allow UUVs to stay submerged for longer periods of time.

Current Status of art

Wet-mate connectors

- Current complex inductive coupling tech for power circulation has significant loss, large in size and weight
- Rely on complex sealing and wiping mechanisms which are not very reliable

Sub-sea transformers

- Bulky
- Much Higher voltage and current
- Harder to preform maintenance if necessary

Design Requirements

A functional wet mate connector using niobium contacts

Contacts must be self insulating

Carry DC power at up to 48V @25A with very low resistance

Capable of sending a 2.4Ghz 802.11 signal across the connector

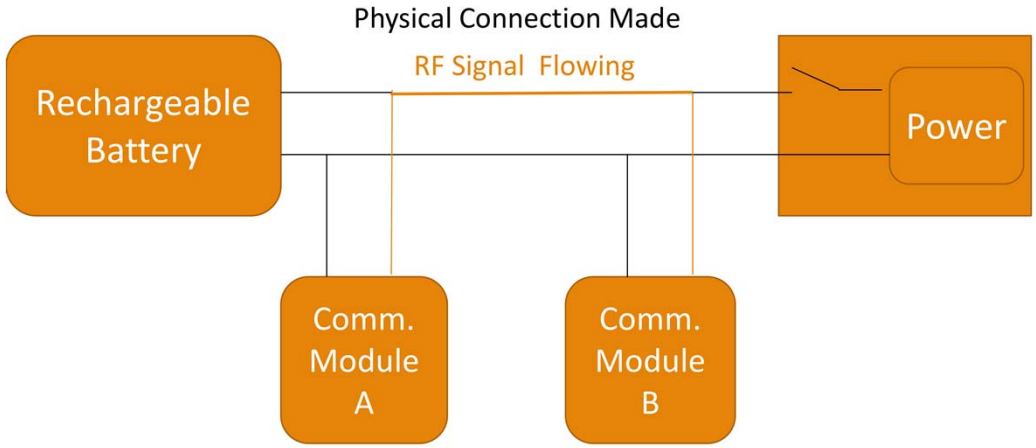
Capable of functioning in salt and fresh water at up to 600m

Capable of function at temperatures ranging from –2°C to 50°C

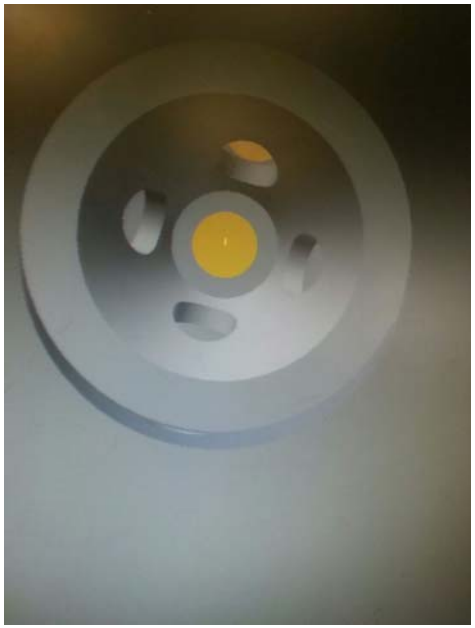
Capable of surviving 25+ years underwater

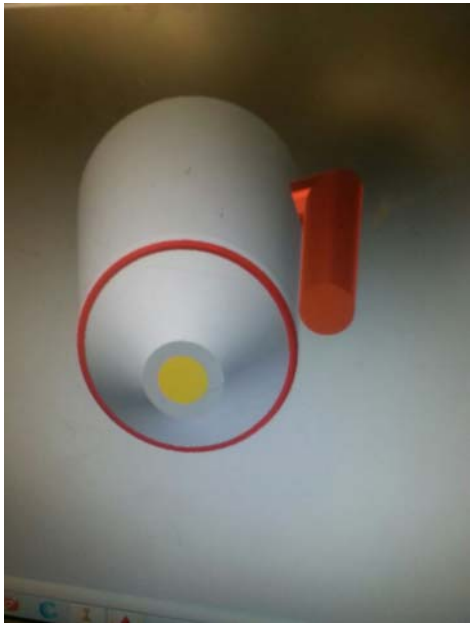
Solution approach

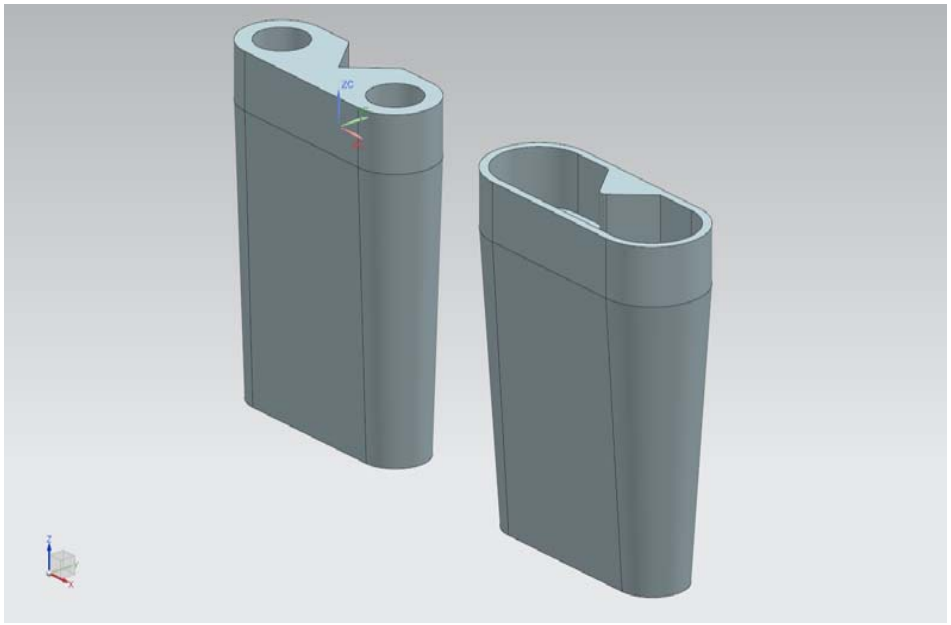
- Power supply is held in the charging station
- Communication module A is in the UAV while Communication module B is in the Charging station



Conceptual designs







Design matrix

	Design 1	Design 2
Water Leaks (Protection of internal compartments)	4.666666667	3.666666667
Durability (When not Connected)	4.5	3.333333333
Durability (When Connected)	4.333333333	4.166666667
Water Pressure below 600m	3.666666667	3.666666667
Total Score	17.16666667	14.83333333

Project final goal and deliverables

A working niobium contact wet-mate connector

Carries DC current rated at 48V @ 25 Amps

Connector functions properly underwater at depths of up to 600m

Can function in varying temperatures

Capable of sending a 2.4Ghz signal across the connector

Spring 2016 target goal

A functional niobium contact wet mate connector

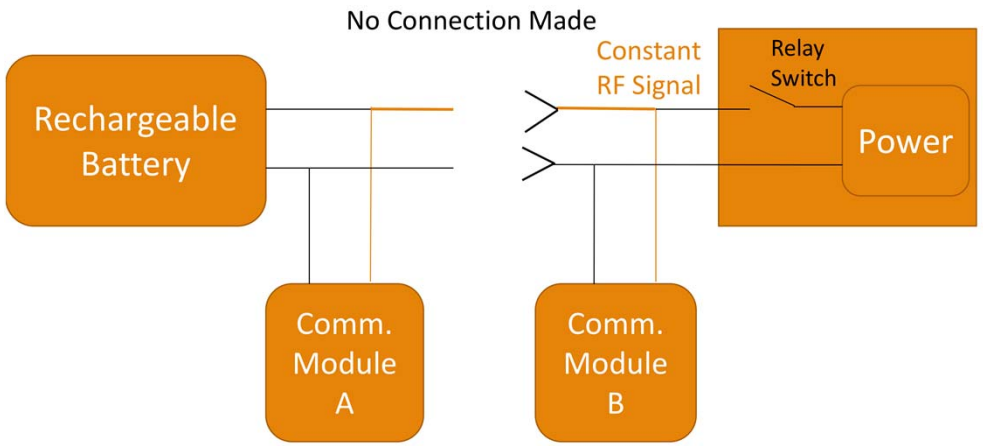
CAD housing constructed

Capable of DC voltage across the connector

Connector works inside and outside of fresh water and salt water

Implementation

- The design consists of two Communication Modules and a relay switch
- Communication module A sends a signal and waits for Communication module B to receive it
- Once confirmation occurs Communication module B sends a signal to which causes the relay switch which the DC power to flow



Evaluation and Testing

Collection and evaluation of material

- Evaluation of necessary electrical components
- Measurements and estimations of most optimal parts.
- Management of budgeting and cost efficiency

Testing System Components

- Low Voltage Testing
- Niobium Water Testing

Evaluating Niobium Oxide Layer

Electric current in the anodizing bath causes oxygen to separate from the liquid. It combines with niobium to form a layer of niobium oxide (NbO_2).

The higher the voltage the thicker the oxide formed.

The thickness of the layer determines what color is seen.

Costs and resources

Materials and Costs			
Pasternack Order			$136.23
	SMA Connectors (x3)	$136.23	
Eagle Allow			$176.00
	Niobium Rod	$176.00	
Amazon			$343.35
	Electrical Terminal	$19.95	
	Screws	$29.99	
	14 AWG Copper Wire	$19.99	
	Crimpers	$26.13	
	Xbee Modules (x4)	$175.80	
	Tapping Wrench	$49.50	
	Hot Glue Gun	$21.99	
Midway USA			$17.00
	Bit for Tapping Wrench	$17.00	
Total			$672.58

Costs and resources (Cont'd)

Metal Workers

- Consultation about welding of niobium

Mechanical Engineers

- Machining Niobium rods to size
- Threading inner wall of niobium

3D Print

- Shell/Housing of the Connectors

Conclusion

UUVs need a way to be able to replenish/extend battery life while underwater

Since niobium is self passivating the contacts can be exposed to water

Current wet mate connector and underwater transformers are not very efficient and do not transfer data

Used a Bias Tee design to for a two contact niobium connector with a relay switch

Future works

Ordering and implementing relays

High voltage testing of the filter circuit

High Pressure Testing

Temperature Testing