Underwater Circuit Connector

Outline

- Introductions
- Background/Need
- Problem
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- Conceptual Designs

Team Members

Jonathan Branscomb

Emmanuel Morrow

Apar Pokharel

Cheriece Davidson

Stephen Young

Mike Hall

Backround

Company/Sponsor

- Northrop Grumman

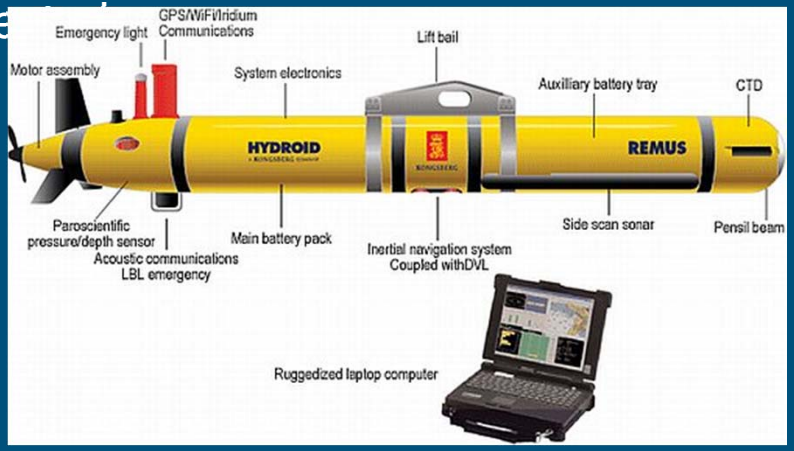
Customers/Clients

- Navy
- Airforce
- Department of Defense
- Naval Research Labs

Background Cont.

UUVs and AUVs are commonly used for detaching and mapping wrecks and obstructions that can cause a hazard

Once the mission is completed it returns to a preprogrammed location where data can be colle



Problem

- UUV's currently use onboard batteries
- Length of the mission depends heavily on battery life
- Currently no efficient way to charge onboard batteries while underwater
- Current wet mate connectors use complex sealing and wiping mechanisms which are unreliable
- Current Complex Inductive Coupling tech for power seculation has significant loss, large in size and weight

How can we solve this problem? Can we find a way to extend battery life or find

Objectives

- Develop a two contact wet mate connector
- Input Power: 50V DC, 25A
- Capable of functioning in salt and fresh water at depths up to 600m
- Capable of functioning at temperatures ranging from -2^{o}C to 50^{o}C
- Capable of surviving 25+ years underwater
- Capable of sending a 2.4Ghz 802.11 signal across the connector
- Utilizing niobium as the primary contacts between the two platforms

Why Niobium?

Niobium allows the flow of electric current only when it comes in contact with other niobium metal.

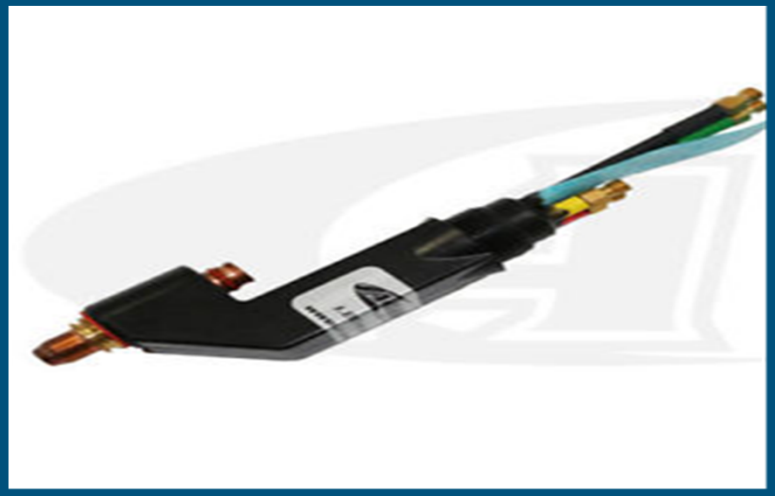
It has a high resistance to heat.

At cryogenic temperature (-150 C and below), it acts as a superconductor.

Soldering two Niobium Metals

Conventional Soldering Techniques do not work while dealing with Niobium.

Plasma-Arc welding is a better alternative approach.



Conductivity

Niobium

Electrical properties

Electrical Type Conductor

Electrical Conductivity 6.7×10^{6} S/m

Resistivity 1.5×10^{-7} m Ω

Superconducting Point 9.25

Copper

Electrical properties

Electrical Type Conductor

Electrical Conductivity 5.9×10^{7} S/m

Resistivity 1.7×10^{-8} m Ω

Superconducting Point N/A

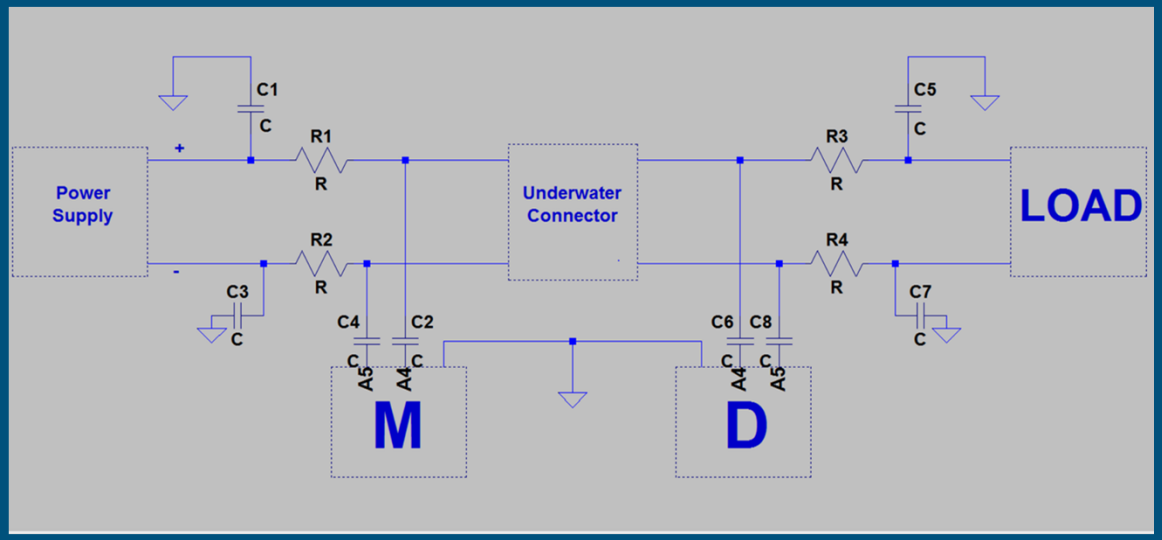
2 awg = 0.25 in

$$R = \frac{\rho L}{A}$$

ρ = resistivity
L = length
A = cross sectional area

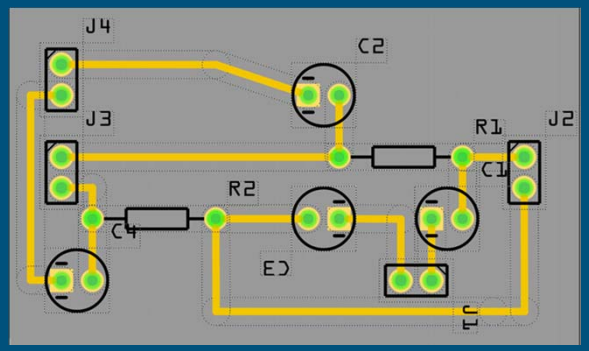
Underwater Circuit

Consists of high-pass and low-pass filters

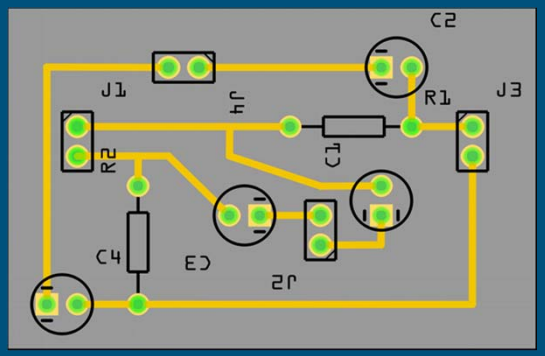


Printed Circuit Board

Actual Size comparable to a postage stamp.



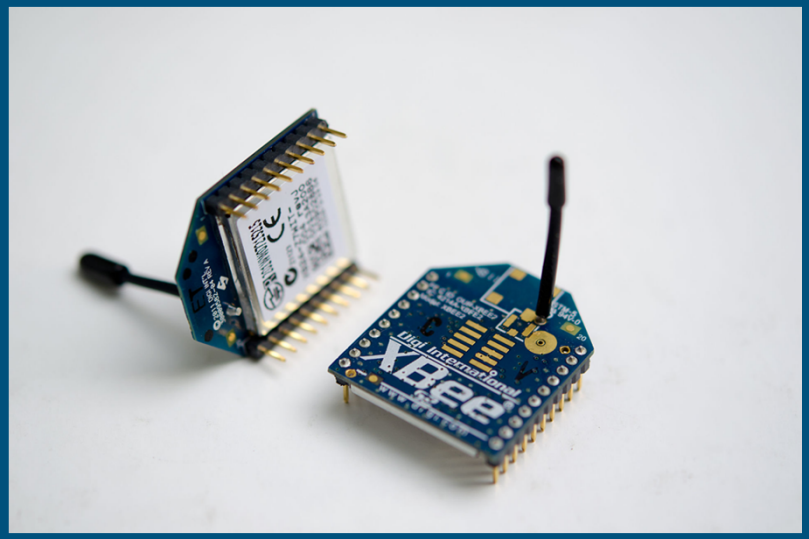
mother side



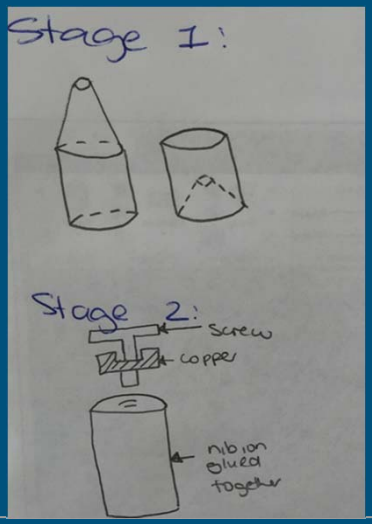
daughter side

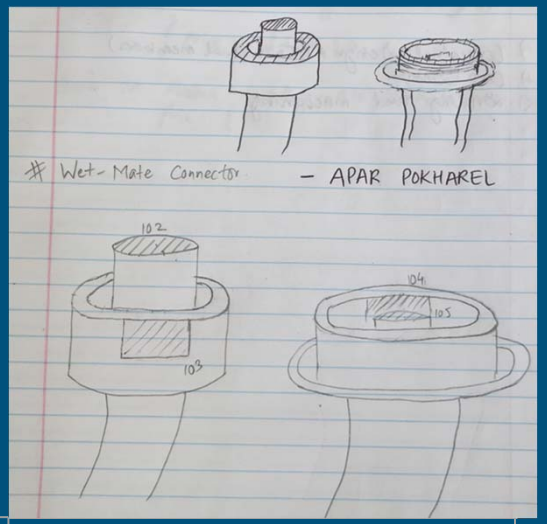
XBEE Communication

XBEE allows arduino boards to communicate.



Conceptual Design





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 100m	3.666666667	3.666666667
Total Score	17.16666667	14.83333333

Design Comparisons: 1 Over 2

The Cone Shape

Helps to guide the connector into the docking station at any angle.

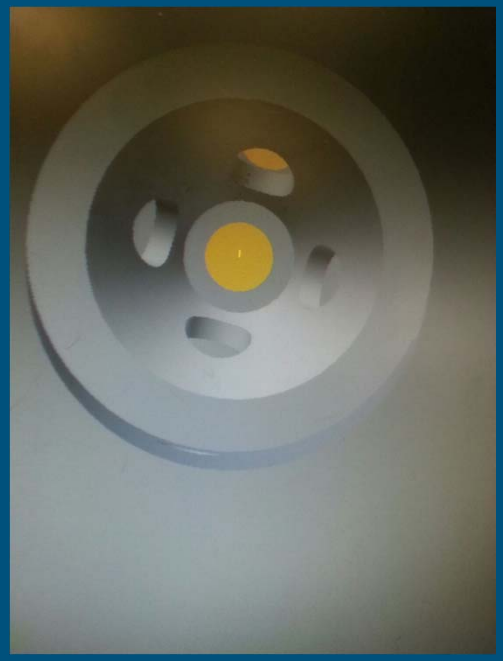
The Solid Cylinder Docking Station

Not flexible and is very sturdy to prevent underwater damage from debris .

The Cone Shape & Cylinder Connected

Prevents any harsh movement or breaking while the cone is within the station compared to the wire concept.

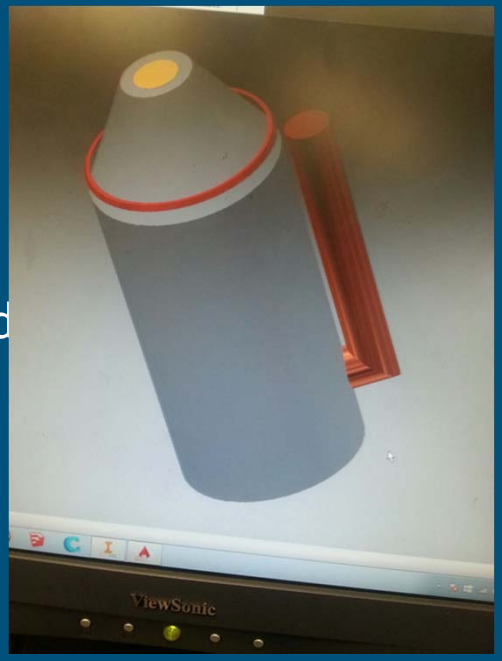
Design process



Final Product

The reduced size and given shape was to to allow the device to be more efficient and

resulted in less power loss and favorable connection.

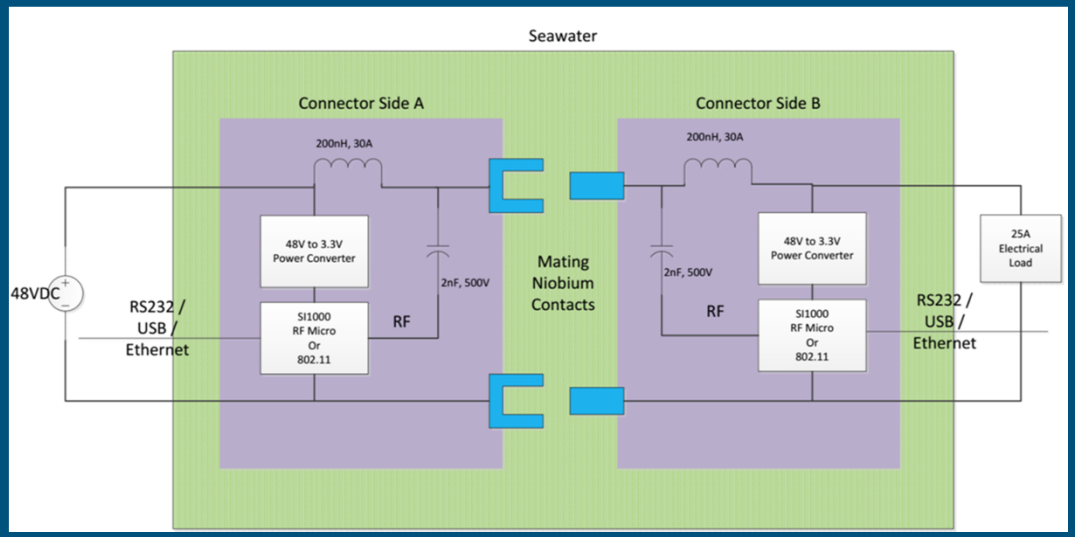


Inductor (Cylindrical)

Cylindrical

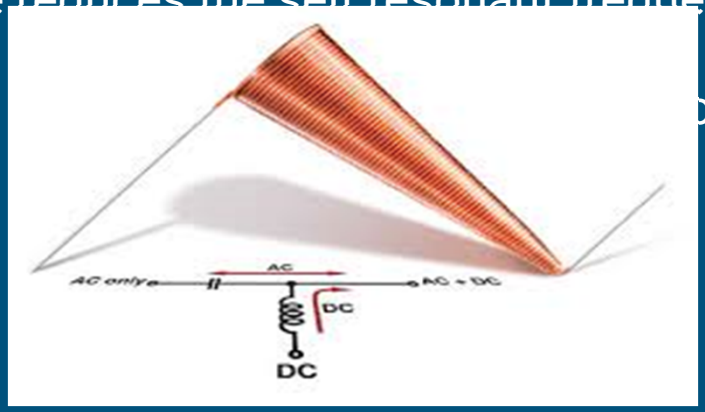
the inductance increases roughly proportionally to the number turns being active

Resists changes in electric current passing through it



Inductors(Conical)

- The inductance does not increase linearly in the number of active turns
- Use of the variable size diameter format reduces stray capacitance
- Stray capacitance reduces the self resonant frequency
- Conical Inductors om 10Mhz to 40Ghz



Next Steps

- Machining the Niobium Rod
- Simulated Pressure up to 11atm
- High current testing
- 3D print dock and connector
- Assemble all the components for underwater testing.