Electro-Optical Section of Small Subsea Fiber Optic Repeater

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Introduction

Fiber optic telecommunication is important to the Navy because it provides a high speed, reliable, and safe way of transmitting information across long distances.

PROBLEM | Fiber optic telecommunication systems transmit information via data-encoded light pulses. These light signals degenerate after traveling vast distances.

CURRENT SOLUTION | To ensure proper data transmission, the data signals are regenerated with fiber optic repeaters. Commercially available repeaters, though reliable and efficient, are too large and heavy for some Naval applications.

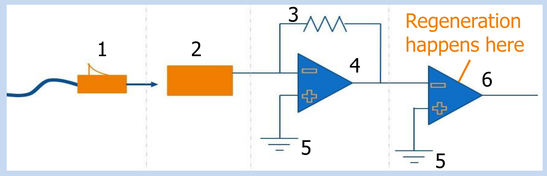
OVERALL GOAL | To design a fiber optic system for Naval applications that is cost-, time-, and labor-effective for deployment and use.

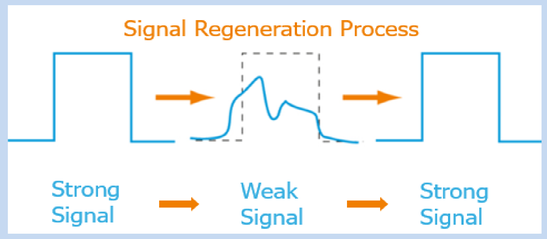
IMPROVED SOLUTION | To develop a miniaturized fiber optic repeater that is about one fifth the size of traditional units.

*The team focused solely on the electro-optical section of this miniaturized design.

What Do Repeaters Do?

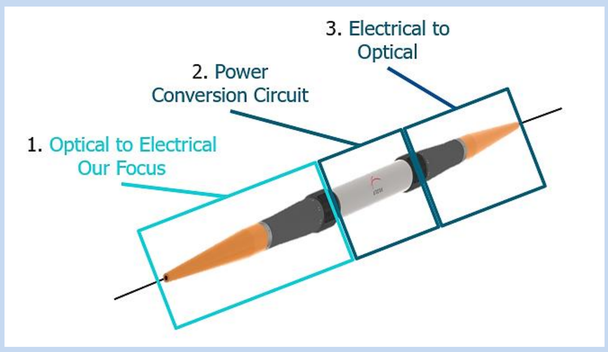
1. **Fiber Optic Cable Plug:** Carries optical signal.
2. **Receptacle:** Converts optical signal into electrical current.
3. **Resistor:** Required for Trans-impedance Amplifier to operate.
4. **Trans-impedance Amplifier:** Converts high voltage, low current into appropriate voltage and current.
5. **Ground**: Allows circuit to start at equal electric potential.
6. **Limiting Amplifier:** Regenerates signal by appropriately adjusting voltage.





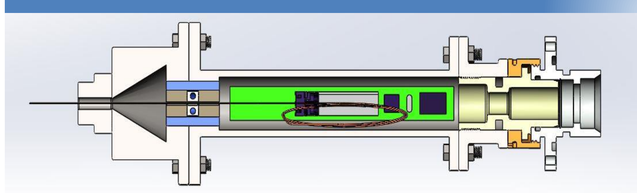
As signals travel down a fiber optic cable, they lose their strength. Repeaters take these weak signals while they are still interpretable and regenerate them to ensure that signals accurately travel from end to end.

Sections Of Repeater



1. Converts optical signal into electric current and regenerates the signal.
2. Regulates distribution of power throughout the system.
3. Converts electrical current back into optical signal.

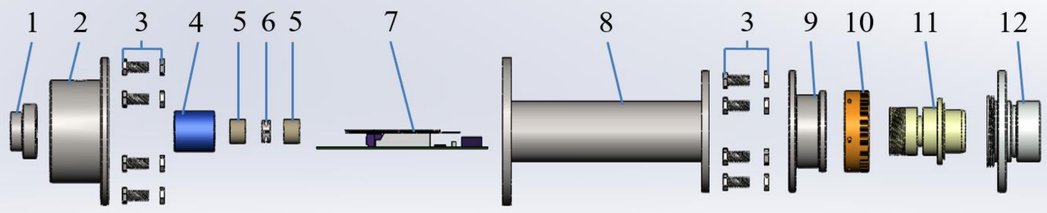
Cross Sectional View



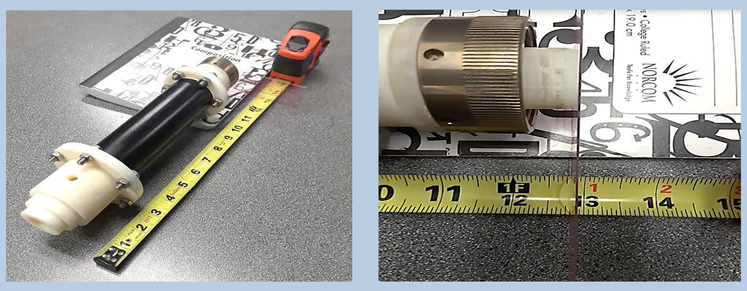
Miniaturizing Methods

- Reduce diameter of fiber optic cable from the traditional 26mm to 7mm.
- Use smaller diameter copper conductor because of reduced power consumption.
- Remove redundant circuitry components.

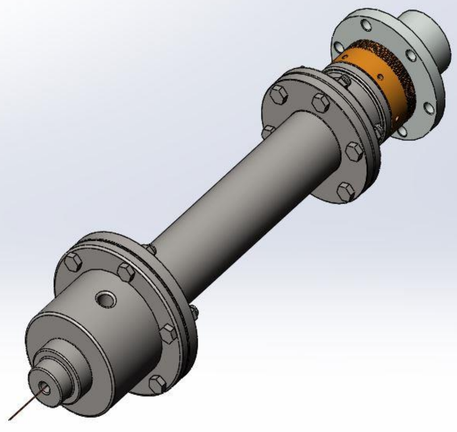
Exploded View



1. Termination Seal
2. Strength Member Termination
3. Nuts and Bolts
4. Tube
5. Seals
6. Conductive collar
7. Circuitry Components
8. Circuitry Housing
9. Plug-in Attachment
10. Coupling
11. Plug-in Shell
12. Receptacle Housing

Pictures	Test Stage	Description	Pass or Fail Why?
	**Fit and Finish**	• Ensured pieces fit together appropriately • Inspected finish of faces, alignment, and tolerances	✓ **Pass** The team was able to successfully assemble the prototype
	**Length**	• Measured and ensured assembled prototype was less than 14 inches in length	✓ **Pass** Assembly was 12.75 inches in length
	**Sealing**	• Submerged prototype in fresh water • Soak time of 1 hour • Verified pressure vessel was dry	X **Fail** Temporary seals failed during testing

Isometric View



Conclusion

For this project, the team developed a small subsea fiber optic repeater prototype and put it through a series of tests. The team successfully assembled this prototype and met the size requirement.

FUTURE WORKS include applying marine adhesive instead of the temporary seals used for the prototype. The team wants to integrate electrical components into the repeater and make sure they function properly. In addition, the repeater needs to be built using intended materials such as 316 stainless steel, copper plating, and O-rings. Ultimately, we want the repeater to have a deeper depth rating to allow for broader applications and a more stream lined design for improved ease of deployment. This will provide the Navy with an efficient small subsea fiber optic repeater.

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