INDUSTRIAL SOLUTIONS LABORATORY

Company Information

Company Name	*RWE Renewables Americas, LLC*	**Date Submitted**	*MM/DD/YYYY*
Project Title	*Advanced vibration sensors for wind turbines* ***(RWE_WIND)***	**Planned Starting Semester**	*Spring 2023*

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	Number	Discipline	Number
Mechanical	2	Electrical	3
Computer		Systems	

Company and Project Overview:

RWE Renewables Americas is among the top 10 onshore wind operators in the U.S. with over 5 gigawatts of renewable energy capacity since 2007. The company develops, owns, and operates some of the most efficient, highest performing renewable energy projects in the United States including onshore & offshore wind, photovoltaic renewable generation, and energy storage.

As a major owner and operator of wind turbines across the world, RWE Renewables recognizes the importance of advancing its operating and maintenance (O&M) strategy. During the operational life of a wind farm, significant cost can stem from undetected and unaddressed failures. By using Condition Monitoring – with combinations of advance sensing technologies and automation – wind farm operators can gain real-time insight into wind turbine health and accurately diagnose and address issues before they grow into larger failures. This project will take part in advancing wind turbine condition monitoring by developing a new sensor that will give data that current technology is unable to provide.

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Project Requirements:

Energy generation asset operators frequently use condition monitoring systems to gauge the health of their assets. For rotational components, such as bearings and gears, vibration signatures are monitored for particular frequencies associated with defects. Tracking of the energy contained in these frequencies over time is a good mechanism to evaluate failure progression in particular components, and plan for their replacement before the failures become severe.

For low speed rotational components in wind turbines, such as main bearings and primary gearbox stages, measurement of these defect frequencies is often difficult due to poor low-frequency response of accelerometers (particularly those with industry-standard IEPE – Integrated Electronics Piezo-Electric – signal conditioning). This difficulty can lead to delays in detection of the defects, and thus delay repairs. Use of strain gage-based displacement sensors can provide significantly better response, however at the sacrifice of measurement dynamic range. In these cases the sensors often have to be tailored to each specific component.

The goal of this project is to design and create operational prototypes of displacement and velocity vibration sensors that may serve as drop-in replacements for existing IEPE-based acceleration vibration sensors and do not suffer from the range limits of strain gages.

The vibration sensor element could be standard accelerometer (e.g. piezoelectric, or a MEMS sensor such as the Analog Devices ADXL1004) with circuitry to convert the signal to velocity or displacement prior to the IEPE circuitry. Or the sensing element could provide direct measurement of velocity or displacement. An example of the sensor circuitry is shown in Figure 1. The prototype sensors shall:

1. Be capable of connecting to and being powered by an IEPE-enabled signal conditioner
2. Be mounted in a robust metal housing capable of being threaded onto a mounting stud
3. Have its internal circuitry protected from vibration damage
4. Be electrically isolated from the housing
5. Have a frequency response (+/- 3 dB) encompassing at least the 0 Hz – 500 Hz range

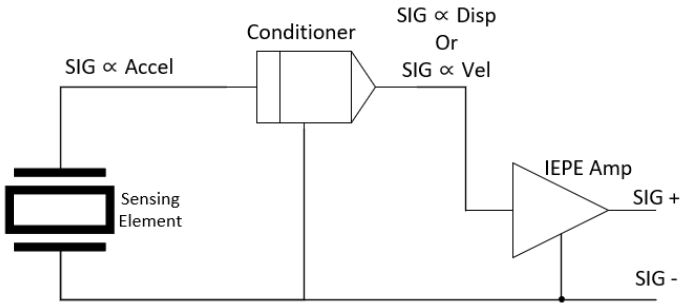

Figure 1: Simple schematic representation of the sensor and integrator circuit.

Expected Deliverables/Results:

- Mechanical drawing of prototype sensors (electronic format OKAY)
- Electrical schematic of sensor circuit (electronic format OKAY)
- BOM for all purchased components in the sensor (electronic format OKAY)
- 6 prototype sensors (3 ea. velocity output and displacement output)
- Description of set-up to test the sensors at UNC Charlotte
- Report of the testing results, including sensor frequency response

Disposition of Deliverables at the End of the Project:

Students will return all operational sensors to RWE after their exposition. They may keep copies of the design products (drawings, schematics, BOMs, etc.).

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- General understanding of dynamic systems – both electrical and mechanical
- Basic circuit design and assembly capability