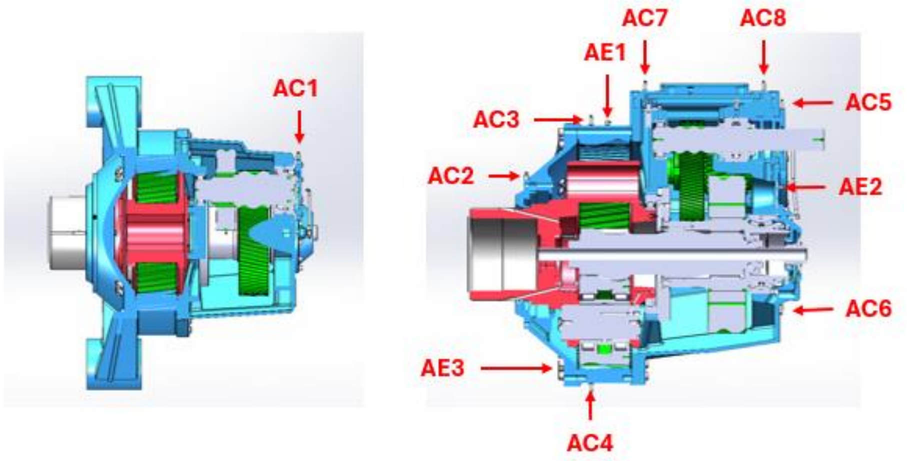

Sensor Number	Location
AC1	ISS Radial
AC2	Main Shaft Radial
AC3	Ring Gear 12 o'clock
AC4	Ring Gear 6 o'clock
AC5	HSS Radial
AC6	LSS Radial
AC7	Upwind HSS Bearing Radial
AC8	Downwind HSS Bearing Radial
AE1	Ring Gear
AE2	Rear Housing
AE3	Front Housing

Figure 26. A diagram showing the sensor placement within the turbine gearbox.

AE Sensors

While the deployment of AE sensors for early-stage fault detection is a valid consideration (Salameh et al. 2018), their effectiveness depends on precise placement and continuous calibration (Dukowitz 2025). The lack of explicit calibration procedures and placement justifications, particularly regarding wave propagation through certain gearbox materials, significantly limits confidence in their proposed effectiveness. Clearly outlined calibration and maintenance schedules for AE sensors as well as validated placements through acoustic propagation modelling or experimental studies would be needed for feasible rollout.

Accelerometers

Eight accelerometers have been positioned as close as possible to each bearing. Each accelerometer must be mounted in a location that minimises the vibration transmission route and avoids thin sections (Wilcoxon 2018). This has been applied wherever possible but due to limited access within the housing, there is not always a direct route to the monitored object. It can also be noted that all accelerometers will be stud mounted on clean, unpainted surfaces, to ensure optimal results (Hannah_G 2023). However, the accelerometers labelled AN7 and AN8 are mounted on a bolted cover, which is not ideal for accurate vibration measurement. Mounting accelerometers on such surfaces can lead to signal attenuation and distortion, as the cover may absorb or dampen vibrations, resulting in inaccurate readings.

Condition monitoring systems of wind turbines are often not publicly accessible with the only comprehensive study found being NREL (Sheng 2012). When comparing the designed system with NREL, the designed system features many more sensors. Using 8 accelerometers ensures full coverage of all bearing vibration routes around the gearbox to ensure all faults are detected. This increases the cost of the system in terms of hardware, processing, and data storage and therefore may want to be decreased in future development. With the aid of systems modelling and real-world data, sensor placement can be more thoroughly optimised to minimise data capture while ensuring complete fault detection.

The frequency range of the sensors have been determined through analysing the maximum characteristic frequencies of each bearing. The sample rate has then been applied based on the Nyquist frequency in order to avoid aliasing. The highest Nyquist frequency calculated is 183Hz. An arbitrary number above this frequency has been assigned for the sample rates. This should be further refined with real-world datasets and system modelling to ensure correct signal readings.

Critically, this arrangement remains flexible and subject to optimisation. Future improvements, particularly through detailed systems modelling and analysis, could refine the optimal number and placement of sensors. At this stage, this is not feasible due to the lack of precise gearbox data from the supplier.

Data Acquisition System (DAQ)

The DAQ has been designed to monitor gearbox health using the processing pathways of three acoustic emission (AE) sensors, eight accelerometers, and one oil debris sensor. The system is separated into high, medium, and low-