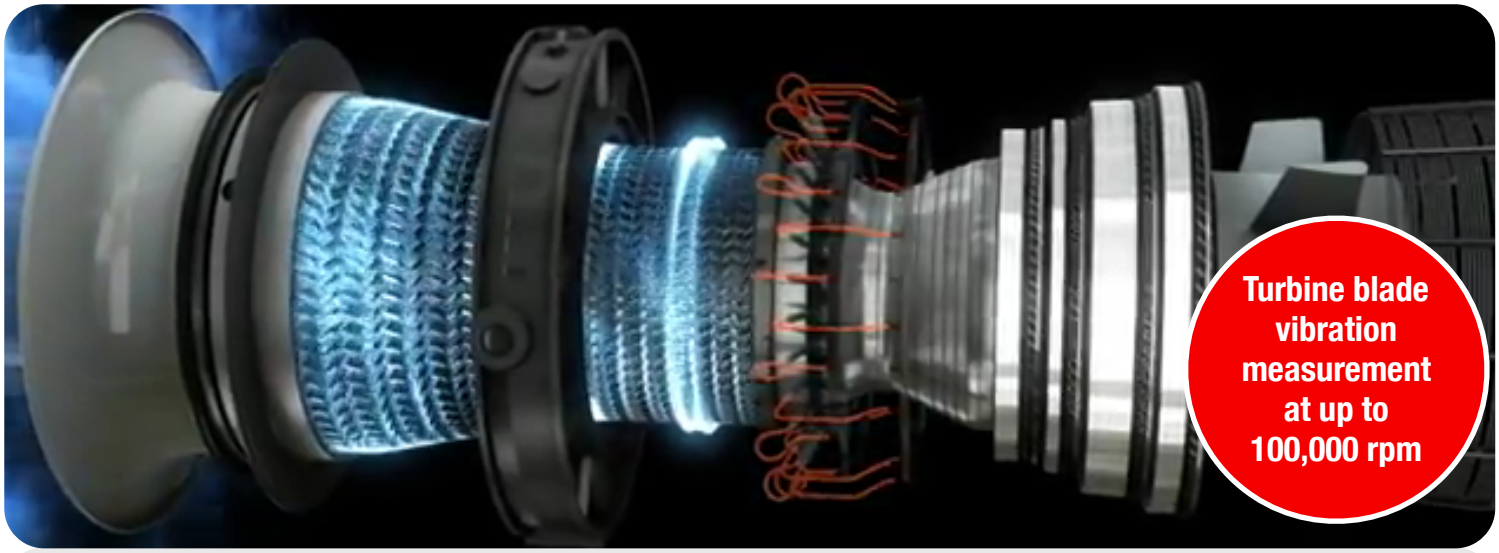
Instrumentel

March 2012

Dr Neil Curry
Senior Products Engineer
enquiries@instrumentel.com



TAKE OUR TURBINE TELEMETRY SYSTEM FOR A SPIN!

Instrumentel's advanced wireless turbine telemetry system has demonstrated it's ability to transmit turbine blade data from inside sealed turbine units tested at up to 100,000 rpm, dispensing of the need for unreliable mechanical slip rings.

Overview

Gas turbine blade assemblies must be tested and balanced prior to operation in order to avoid damaging levels of vibration at the turbine's resonant frequencies. Such testing requires spinning up the assembly, usually under a vacuum, and monitoring the vibration from selected blades at representative rotational turbine speeds.

This testing regime presents considerable challenges for conventional metrology systems, requiring continuous collection of data from several points on a high speed rotating part, and transmission of that data through a sealed unit to an external data logger. This often requires the use of of unreliable mechanical slip rings to maintain electrical contact with he sensors during testing.

The wireless Instrumentel Turbine Telemetry System (ITTS) has been designed specifically to address the challenges of turbine telemetry. This Case Study reports the use of the ITTS to collect and transmit turbine blade strain data collected from a gas turbine during spin-up testing.

The Instrumentel Turbine Telemetry System (ITTS)

The ITTS, shown to the right and schematically below, is comprised of up to twelve individual battery powered data acquisition modules. Each module samples data from one sensor, in this case from a strain gauge mounted to an individual turbine blade, giving up to twelve sensor inputs for a standard configuration.

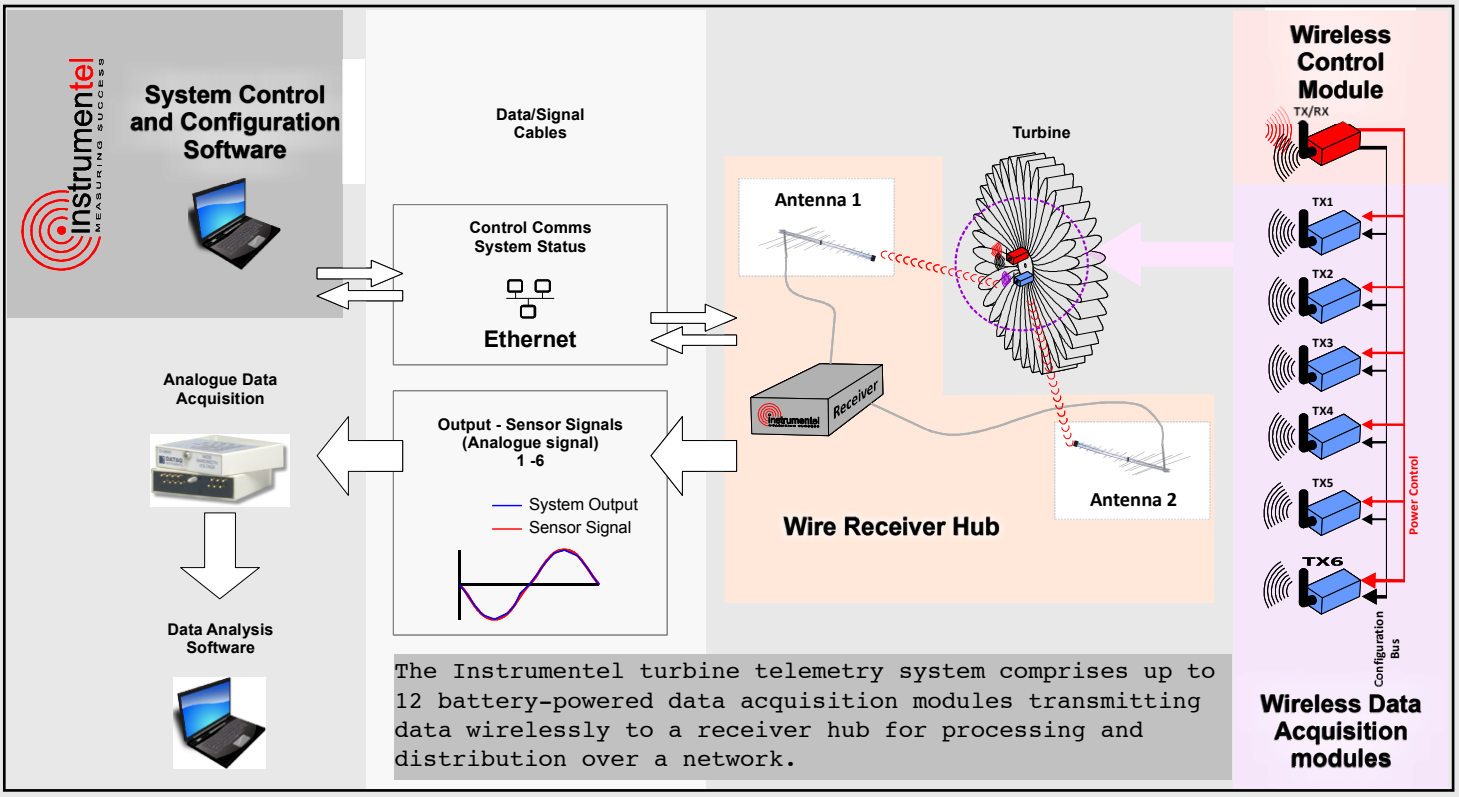
Sensor data is transmitted wirelessly to the Instrumentel Machine Diagnostics Unit (MDS) through one of two antennae mounted on the turbine assembly, with the system automatically switching between antennae as required.

The Instrumentel Turbine Telemetry System

At the core of the Instrumentel turbine telemetry system is a battery powered data acquisition and wireless transmitter module or "tag" designed to fit in standard balancing grooves.

This tag samples data from a sensor mounted to the turbine blade being measured prior to transmitting data wirelessly to the Machine Diagnostics Unit.

Up to 12 tags can be monitored simultaneously from within the sealed turbine



System Features

The advanced design of the ITTS, with two wireless receiver antennae, eliminates blind spots, ensuring continuous data transmission through the entire range of operation. In practice this provides continuous collection and wireless transmission of data at operating speeds of up to 100,000rpm.

The Instrumentel MDS can collect data from up to twelve data acquisition modules. Sensor data can be output directly as an analogue signal or down-sampled and transmitted to a network over most standard communications protocols (WiFi, Ethernet etc).

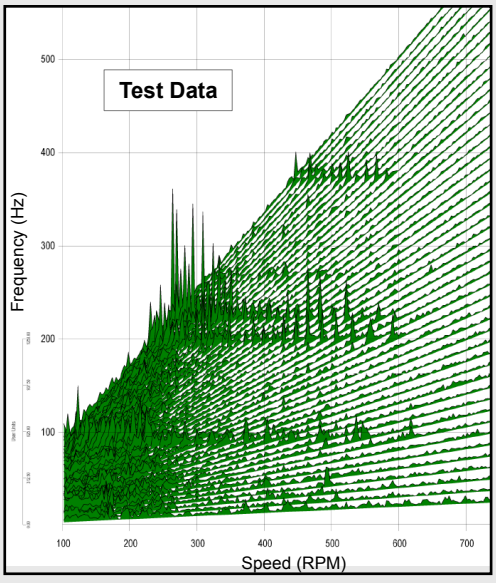
Results

In this example, data was collected from a single blade on the first stage of a large steam turbine as the turbine was spun up, under vacuum, to 1,000 rpm.

Data was sampled at 50k samples / second and down-sampled to 10k samples/second prior to transmission to a PC where a sliding window FFT was performed on the incoming data in real-time. The FFT analysis generated a dataset of frequency profiles at 1,000 discrete rotational speeds each covering 0 Hz to 1kHz. This data was used to create the Campbell plot shown to the right, showing the amplitude and frequency of vibration against engine order and speed.

Torsional natural frequencies, independent of rotational speed, can clearly be identified at c. 100Hz, 200Hz and 225Hz.

Such data is crucial to identify high risk operational engine speeds and orders that may coincide with resonant frequencies, providing the data required to balance the system to ensure safe operation.



Instrumentel - leaders in electronic systems for data acquisition from extreme environments

Instrumentel specialises in electronic systems for acquiring data from extreme and difficult to access environments.

Our expertise has been proven in multiple markets including engine and electric motor telemetry, explosion metrology and condition-based monitoring of industrial processes and railway rolling stock.

The Instrumentel product range includes:

MDS: A versatile system for collecting data from moving parts such as internal combustion engine pistons and valves, turbines and electric motors.

EDS: A robust high-temperature system for collection of process-related data from extreme environments. The EMU has been applied to a diverse range of applications including monitoring the temperature of molten steel in a foundry and determining the temperature and pressure form the centre of an explosive blast.

DDU: The Doors Diagnostic Unit is optimised for condition-based monitoring of sliding doors, particularly those used in rail rolling stock and elevators. The DDU is quickly retrofitted without the need to break into existing safety systems, and provides continuous feedback on door operation.