Fibre Optic Acquisition Systems Based on FBG Applied to Over-heat Detection for Commercial Aircraft

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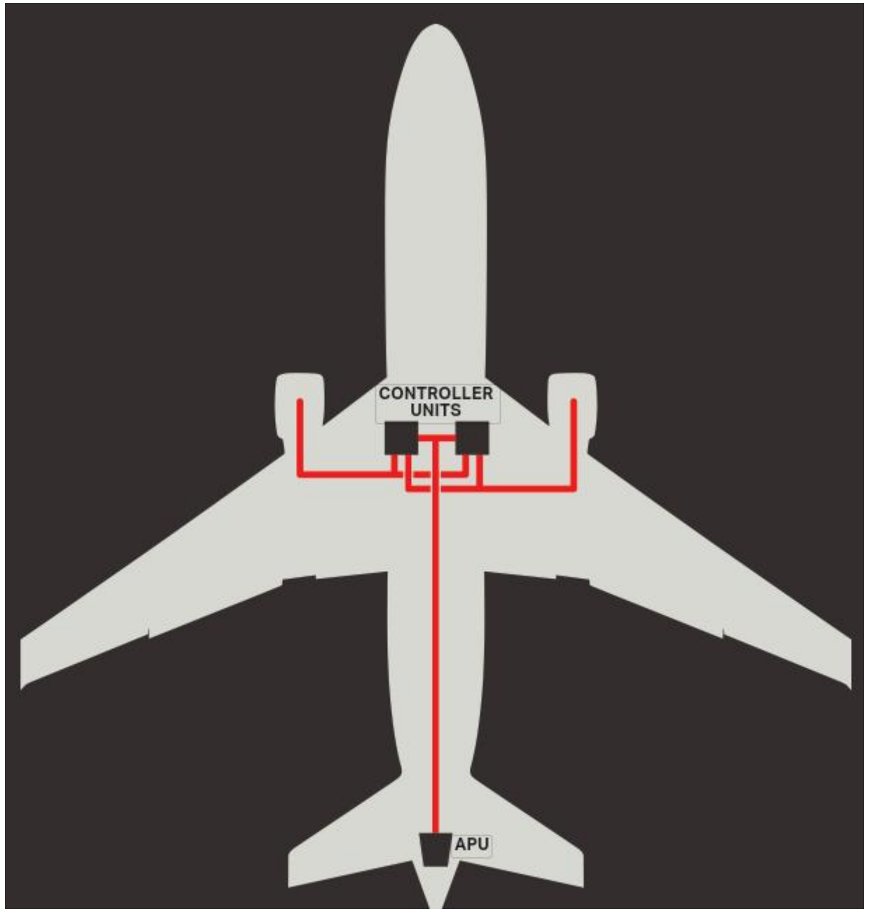
Bleed Air Leak Detection

- Bleed air taken from engines and APU to:
  - pressurize and temper the passenger cabin
  - create cooling air to technical systems
- Long ducts to lead the air from the engines to the air conditioning unit in central bay.
- Engine bleed air is hot, ~250°C.
- Air leakage can affect aircraft structure!



Saab's Fibre Optic Overheat Detection System

Background

- Utilizing fibre optic Fibre Bragg Grating sensors
    - Gratings written into the fibre - changes in reflected wavelength depending on temperature
- Saab development program for aircraft applications since 2013
- Monitoring high temperature bleed air leakage

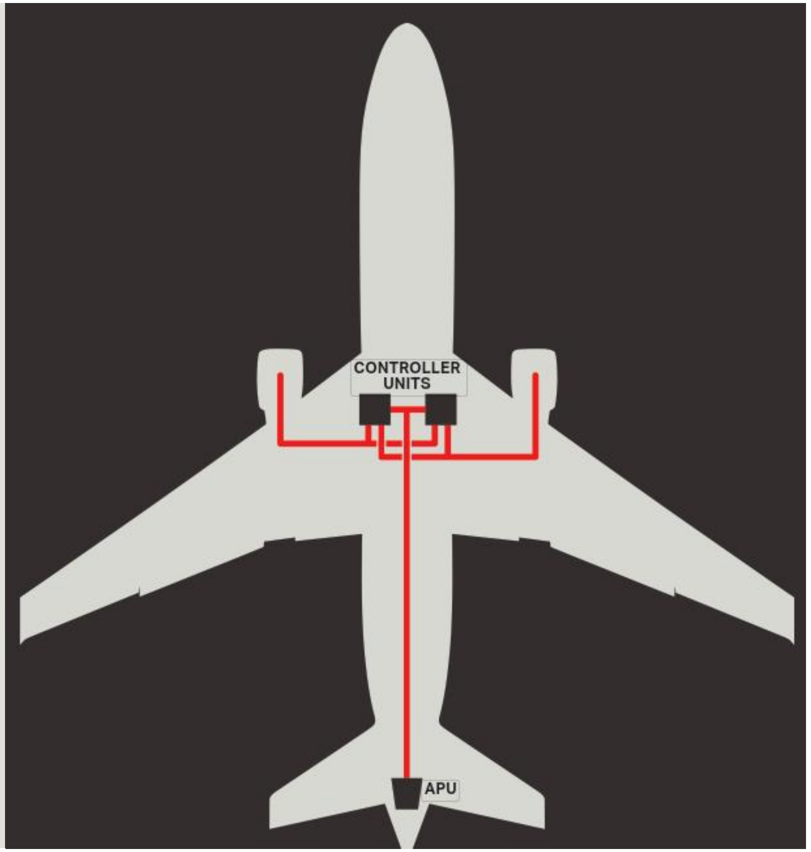
Saab's Fibre Optic System Devlopment

The technology has been adapted to generic commercial aircraft applications:

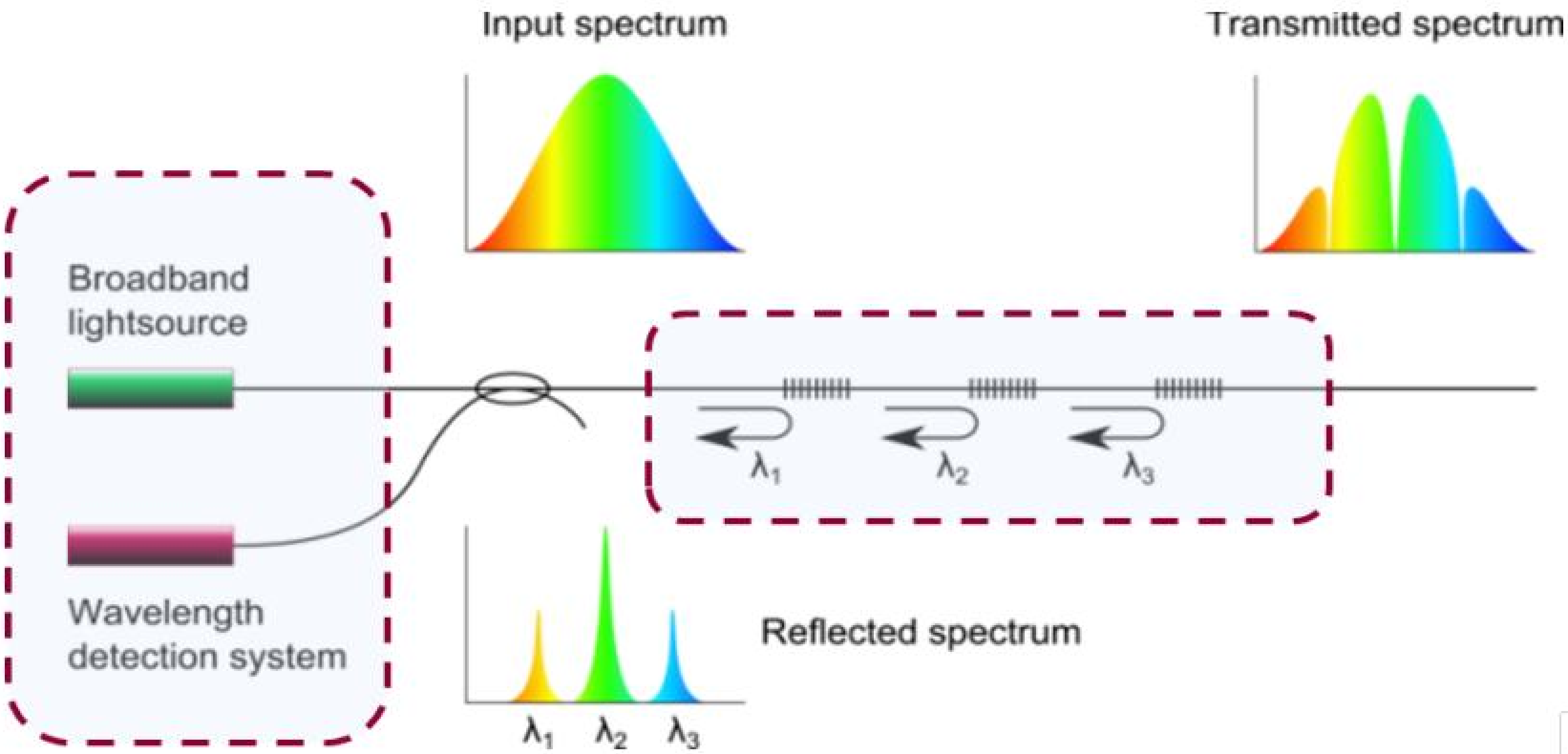
- High sensor density capability
- Generic sensor cable package design
- Generic Controller Unit design
- Civil aircraft requirements

The system consists of:

- One (or two for redundancy) electro-optic controller unit(s).
  - Optical interrogators
  - Processing hardware and software for collecting data and control.
  - Communication with the aircraft avionics is via digital databus (CAN).
- Fibre optic sensing cables with the FBG patterns, connected to the opto-electronic unit(s)
- Routing of sensor cables follows actual bleed air duct routing.



Basic FBG Spectrometer



Fibre Optic OHDS vs Conventional System

- **Actual measurements of the temperature** with a very high temperature and spatial resolution, not only react to a set alarm threshold.
- The system allows for **fault isolation** to a high **spatial accuracy** as well as for **tracing trends**.
- **Dramatically reduced amount of hardware** such as cables and connectors - improving reliability and reduces weight.
- **Redundancy** can be achieved with minimum hardware.
- The Fibre Optic FBG technology can also be applied to **fire detection** as well as measuring **strain and pressure** which open up for a very versatile sensor infrastructure in an aircraft.

Design Parameters

- The following parameters are vital for correct system optimization:
    - Overall sensor cable length
    - Longest section
    - Number of sections
    - Spatial resolution
    - Sampling frequency
    - Temperature range, ambient and measured
    - Temperature accuracy
    - Supply Voltage
    - Communication interface

Technical data

Electro-optic Controller Unit

Optical Fibre Sensing Cable

ELECTRO-OPTIC CONTROLLER UNIT

- Up to 6 optical channels
- CAN-bus interface
- 28 VDC supply (MIL 741)
- Capability of up to 10 000 sensing points
- ~500 ms loop time
- Temperature accuracy +/– 5°C
- Weight ~1,5 kg
- Environment –40 °C to + 70 °C / DO-160
- Designed to meet DO 178/254 DAL B
- No external calibration needed

OPTICAL FIBRE SENSING CABLE

- Up to 60 m per sensing line
- Standard measuring range up to 300°C
- Extended measuring range up to 600°C
- < 30 g/m excluding connectors

OHDS in Airbus A350

- Will be introduced in all models of Airbus A350

- Replacing old technology, based on eutectic salt sensors:
  - Reducing parts count
  - Reducing weight
  - Increasing reliability
  - Increasing fault isolation ability