



RDT company

BRAGG ASSET SENSING

# BASF

MULTIPLEXED BY FREQUENCY

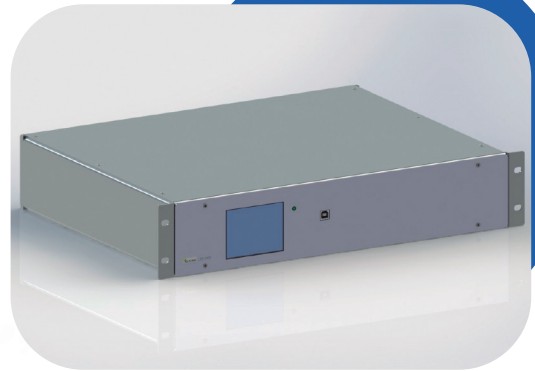


*BASF Interrogator unit*

BRAGG ASSET SENSING

# BAST

MULTIPLEXED BY TIME



*BAST Interrogator unit*

Lumiker develops complete Bragg technology monitoring systems including interrogators, multiplexing units and different types of sensors.

We have two different sensing platforms based on Bragg technology, **BASF (Bragg Asset Sensing multiplexed by Frequency)** and **BAST (Bragg Asset Sensing multiplexed by Time)**. One or the other will be chosen depending on the application requests.

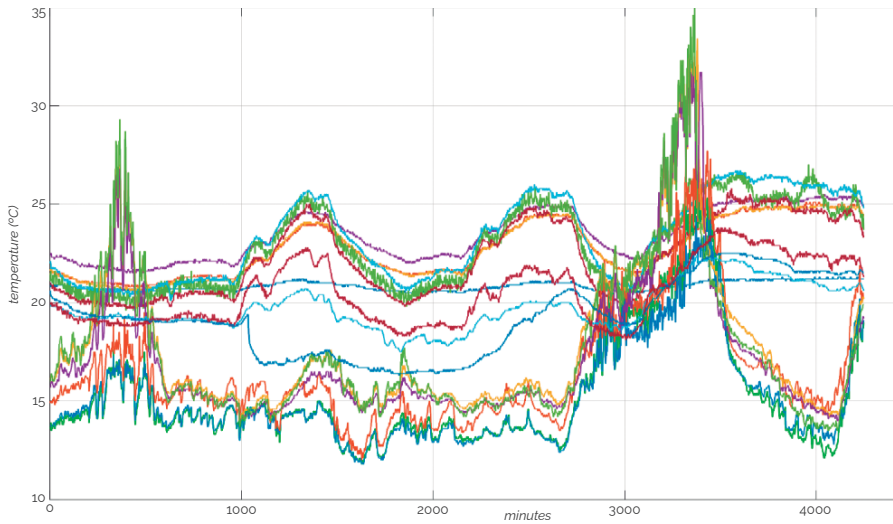
**BASF** would be used in cases where **slow measurements are needed**. Different type of applications for BASF would be structural monitoring in civil industry (low frequency), temperature monitoring for any application as oil and gas, electric assets, etc.



STS (Bragg Temperature Sensor)

Installed STS

For example, one of the most used applications of **BASF** nowadays is **Dynamic Cable Rating**. This is carried out by using **BASF** interrogator and Lumiker's **Temperature Bragg Sensors (STS)** installed along the monitored cable in the critical points.



Temperature behaviour of a cable monitored with BASF system over 72h

With **BASF** system, different sensors on the same fiber can be placed. In the case of cable temperature measurement, the time response is not excessively high, being possible a response time of one minute. This allows different fibers multiplexed on the same interrogator set.

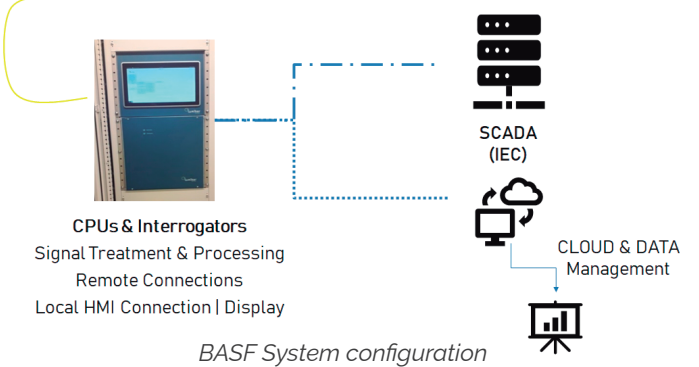
**Optical Box**

Light Emitter and Receiver  
LK Patent - Multiplexer.  
Can read from with the same fibre from different Sensors

**Bragg Optic Sensors**  
Temperature, Strain, Vibrations...



OB (Multiplexing Box)



BASF System configuration

# APPLICATIONS

The application of these systems also includes the following:

**Short Linear Assets** such as **Cables, Pipes, Bridges and Tunnels** require sensors that can:

- Synchronize and process at the same time levels of thermal detail with other variables (Vibrations, Displacement, Humidity).
- Dramatically reduce cabling and wiring.
- Be immune to the many environmental conditions (High and Low Temperatures, Corrosion, E.M. Waves...).
- Process Critical variable at specific critical locations with high precision.

**BASF** is a monitoring solution developed from LUMIKER's previous **LTS Temperature Monitoring Solution**, based in FBG that can integrate several measurements with Temperature and

- Detect small leaks or unplanned presence.
- Detect Asset Displacement or Movements due to seismic or surrounding works effects.
- Analyse power cables dynamic rating, presence of fires.
- Enables to perform a 24/7 Asset condition monitoring to detect and locate faults at an early stage and prevent additional damage thus avoiding costly reparations.



*STS Installation tests*

**BASF** is also applicable to the monitoring of foundations of aging structures or new constructions where a real-time condition monitoring is critical to the long-term safety and operation. Linked to **Floating or Bottom Fixed Offshore Platforms, Buildings, Monuments, Ports, and Airport landing tracks**.

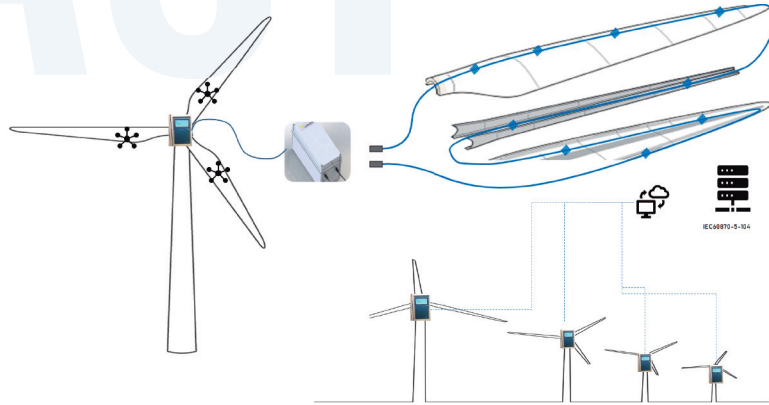
**BASF** proves to be a Versatile, fibre optic sensing solution that delivers accurate structural health data including, Geotechnical monitoring, Fatigue monitoring, Correlation of Measurements to perform Dynamic structural analysis. This enables the monitoring of more extreme impacts or more intense natural disasters.

**BASF** provides continuous, resilient, reliable and accurate measurements of hundreds of optical strain, temperature, acceleration and displacement sensors, delivering data from more sensor locations.



**BAST** would be used in cases where **fast measurements are needed** and/or a large number of sensors are needed in each channel due to the characteristics of the installation layout.

**BAST** is on development at the moment for a blade structural integrity monitoring and blade pitch monitoring application for wind sector, and it is awakening interest from the market.



*BAST configuration system for blade pitch monitoring*

Lumiker's solution implies some benefits comparing with other **Bragg monitoring systems** in the market for the same application:

- **Minimize number of optical connectors.** Thus, the maintenance of the elements installed in blades is drastically reduced.
- **Redundancy.** The emitter system is duplicated due to use the secondary if something happens with the principal one.
- **Reduction costs.** BAST system applied for blade structural integrity monitoring and blade pitch monitoring is sensibly less expensive than other systems in the market.

This solution is going to be tested in aeronautic installations (*CTA, Parque Tecnológico de Álava*) in order to validate and certificate this monitoring system.

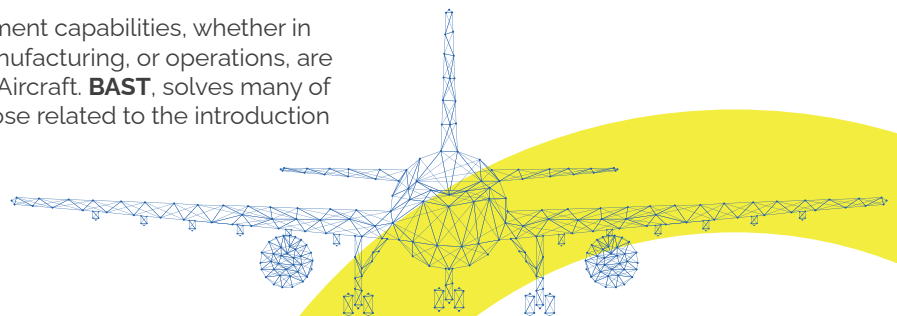
## APPLICATIONS

The application of these systems also includes the following:

**Wind Energy Assets:** Our solutions are applicable to the structural health monitoring of several WTG components:

- **Blades:** Fibre optic sensing enables their installation embedded between the different Composite Laminae. This enables the obtention of high-definition strain and temperature maps of stressed composite structures throughout their manufacturing, integration process, and operational life. Providing in-situ characterization from coupon testing, curing process validation, component testing and operation with **many advantages over the use of traditional strain gages.**
- Rugged systems for fibre optic sensing, are compatible with the **BAST** platform, providing simple and reliable measurements for acceleration and displacement. Specifically, designed Sensor networks can acquire data from hundreds of measurement locations and be semi-distributed over large areas, making them ideal for high frequency structural health monitoring in **Towers & Foundations.**

**Aerospace & Transportation:** Critical measurement capabilities, whether in product validation, testing and certification, manufacturing, or operations, are essential to ensure the reliability and quality of Aircraft. **BAST**, solves many of the industry's challenging needs, especially those related to the introduction of composite materials and electrification, such as our **Laser Redundancy**, to obtain best telemetry system resiliency, the **Ability to Process Multi (Hundreds)-FBG Sensor Arrays**, with different magnitudes, **Reduction of Connectors with our multiplexors**, and **elimination of signal attenuation.**



## Sensors based on **Bragg technology (FBGs)** have a lot of advantages over traditional sensor technologies:

### **Harsh Environments Resistance**

FBG sensors are completely passive and use dielectric components. Thus, they can work under extreme temperatures from very low to several hundred degrees centigrade and offer long-term resistance in extremely harsh environments where traditional sensors and gauges are unable to operate.

### **Electrical Immunity**

As FBG sensors are passive, they are immune to interference from electrostatic, electromagnetic or radio frequency sources, allowing them to be installed in locations with severe electrical noise. Furthermore, as they do not need power supply, they can be used in the most hazardous explosive environments

### **Remote Sensing**

The interrogator unit can be placed some kms away from the sensors location. This is a significant benefit over conventional monitoring systems especially in applications where large and remote structures are needed to be monitored such as on-shore and off-shore wind turbines, tunnels, bridges, pipelines, HV underground cables, etc.

### **No recalibration needed**

Another huge advantage that FBG sensors offer for remote monitoring is their stability over time. Being a passive sensor, a FBG sensor can be used for many years with no need for recalibration. Indeed, it is practical to attach sensors to a structure and return with an instrument to interrogate the sensors every few years to get a true picture of any structural movement since the last reading. This further increases the economic advantage of the technology since one single interrogation unit can service numerous structures

### **Small size**

FBG fiber diameter is just 0.2 mm. Thus, a lot of sensors can be installed in a structure with very little intrusion. For example, a fiber sensor array can be embedded inside a composite to monitor internal strain, temperature and damage with no effect on the structural performance of the composite.

### **Multiplexing**

Many FBGs can be etched in a unique optical fiber, and furthermore, many of these fibers can be simultaneously interrogated by one multi-channel instrument (BASF or BASF). For this reason, a very huge monitoring system can be installed with a lot of sensing points with less wiring volume and, for that matter less cost, than monitoring systems based on conventional sensing.

### **Fatigue Durability**

Tests with different composite materials such as glass fiber or carbon fiber composites have determined that embedded FBG sensors show no signs of fatigue or disbonding after one million cycles. For example, in a wind turbine application, this would indicate that this type of monitoring will function for over 25-year service life of the blades without need of maintenance in the embedded sensors.

In all of its solutions LUMIKER enables **cloud-based monitoring suits** that ensure access to data that is relevant to the structural health of the monitored assets, via the Internet at any time, and IEC SCADA Communications to deploy early warning alarms to plan preventive actions well ahead.

LUMIKER's team of skilled and Project Engineers provides the **Best Solution Design, On-Site Installation Support, Selection and Calibration of the Required Instrumentation, Cloud Connection to the Desired Data, Asset Management Digita Interfaces, and SCADA Connectivity.**

## BASF INTERROGATOR CHARACTERISTICS

<b>Wavelength measurement accuracy</b>		±0.5 pm
<b>Data Register</b>	Electronic format	Server files Ethernet / PC / SD card
	Register Time	1s PC and Ethernet
<b>Synchronism</b>		SNTP
<b>Real Time Clock (RTC)</b>		YES
<b>Language</b>		Spanish, English, French, Italian
<b>Channels</b>		1 – 8 (for temperature application 30 sensors / channel)
<b>FBG sensors</b>	Wavelength	2 nm separation
	Bandwidth	0.3 nm minimum
	Temperature range	-25°C a +100°C (adding F.O. coatings up to 700°C)
<b>Emitter: SLED</b>	Wavelength	1550 nm
	Bandwidth	±40 nm
	Power	0 dBm
<b>Fiber optic link</b>		G657
<b>Fiber optic connection</b>		FC/APC
<b>Back panel communication</b>	Protocol	Modbus RTU
	Physical media	FO multimode ST
<b>TCP/IP communication</b>	Protocol	FTP
	Physical media	RJ-45 Ethernet
<b>Digital outputs</b>	Number	2,1 for internal failure, 1 for optical failure
	Nominal voltage	250 Vac
	Max current	16 A in DC 30 A during 4 s
	Operation time	< 8 ms
	Reset time	< 6 ms
	Connectors	Phoenix type 5,08mm
<b>Mechanics</b>	Dimensions	1 rack 3U x 49"x 355 mm
	Weight	5 Kg
	Material	Aluminium
	IP	IP51
<b>Electromagnetic compatibility</b>	Substation, power supply and signalling	Class 4
<b>Climatic tests</b>	Operation temperature	0°C +50°C
	Storage temperature	-20°C +70°C
	Humidity	Up to 95% without condensation
<b>Power Supply</b>	Auxiliary voltage	24 Vdc
	Consumption	16W
	Connector	Phoenix type 5,08mm

### LUMIKER APLICACIONES TECNOLÓGICAS

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