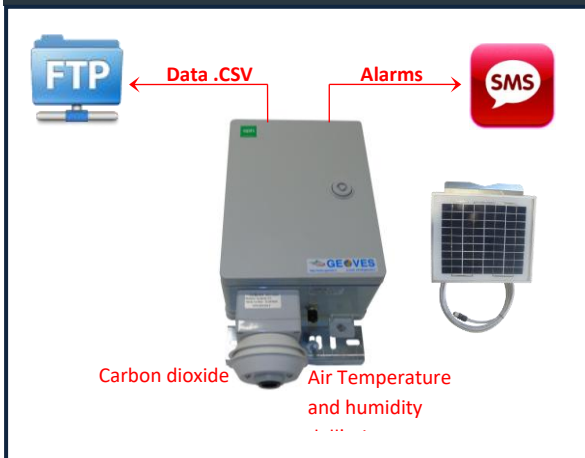


BUTTERFLY-SENTINEL MONITORING AND ALARM SYSTEM FOR FOREST FIRE (Rev.0 020624)



General description

Butterfly-Sentinel (hereinafter B-Sentinel) is a wireless multi-parameter sensor for **forest monitoring and forest fire warning**, capable of transmitting data via GPRS in a protected internet area (**FTP area**) and sending any alarms in real time via **SMS** to on-call personnel. The macro-descriptive climatic parameters of a fire that are monitored by B-Sentinel are typically carbon dioxide (CO₂), temperature and humidity of the air; the device also has a high versatility in connecting numerous transducers for environmental and industrial monitoring, making it extremely adaptable to any telemetry application.

B-Sentinel is an important component of the entire forest fire monitoring and warning network as it allows the operations centre to be alerted in real time in the event of a fire emergency.

In the monitoring network the functional elements are:

1. A series of wireless multi-parameter sensors mod. B-Sentinel located at strategic points in the wooded area to alert the on-call personnel and the operations centre in real time
2. A server with web software for monitoring the network and collecting and processing data
3. One or more web cameras to verify the presence of smoke/fire in the wooded area
4. A weather station mod. MicroMET for measuring environmental conditions
5. A communication system on a 2G-4G cellular network with data sending to an FTP area and alarms via SMS

The operating logic of the individual functional elements of the network listed above is described below.

1. Working logic of B-Sentinel smart sensors

B-Sentinel has an operating logic managed by a microprocessor that allows you to configure both the data storage and transmission rate and the **alarm thresholds** of all connected measurements.

Each individual B-Sentinel independently acquires the instantaneous data of the connected sensors and verifies that the CO₂ value is lower than the set threshold value (the value is always checked every 5 minutes to allow the CO₂ sensor to preheat):

- 1) If the value is below the threshold, B-Sentinel remains silent and stores the data without activating the alarm. In this mode, B-Sentinel periodically sends a simple confirmation of its functionality to the server.
- 2) If the value is above the set threshold, the system activates by sending two alarm SMS to two available people and at the same time begins to transfer the new information to the dedicated web server

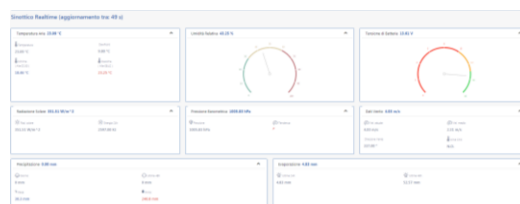


Intervention of staff at the occurrence of a forest fire

2. Operating logic of the server with web service

The server with web service will receive data from all B-Sentinels connected in GPRS mode and will display the following information on correct operation on synoptic windows:

- Date/time of last data transmission
- Battery voltage (diagnostic data)
- Air temperature value
- Air humidity value
- Measured CO2 value



Windows will be represented in the dedicated web area that will contain multiple B-Sentinels; the wooded area must be divided into zones, so that each individual B-Sentinel is able to cover a specific wooded area.

Multiple B-Sentinels and a Web Camera (FC-Web) can be associated with each **zone window**, which can transfer images of the controlled area. In alarm mode, the server will manage the alert sending package via e-mail. The server can also deactivate/modify one or more B-Sentinel units, as well as manually request images from a camera for any alarm checks or validations.

3. Operating logic of web cameras (FC-Web) in alarm mode

- 1) When one of the B-Sentinels detects that the CO2 threshold has been exceeded, it goes into alarm mode and transmits the alarm data to the server, which activates to send an e-mail to the registered people with the information relating to the threshold being exceeded in each area (10 e-mails x 10 people maximum).
- 2) The Server commands the FC-Web, relating to the area where the alarm started, to switch to fast acquisition mode; in this way the camera sends a series of photos every 5/10 minutes for a maximum time of 60 minutes.
- 3) From the server, with a manual request button, it is possible to have an impromptu photo sent even when the system is not in alarm mode. In this way, it is possible to carry out checks on the forest status or perform a functional diagnostic of the system.
- 4) The acquired photos can be managed as follows:
 - Option 1): The photos remain available for a maximum of 24 hours
 - Option 2): The photo is replaced by the new one without the possibility of image archiving

4. Operating logic of the meteorological station

The meteorological station is mainly used to evaluate the environmental favourable conditions that can develop the fire in the forest area; it is also used, during the occurrence of the event, to evaluate the wind conditions to support the personnel in charge of extinguishing. For this purpose, the station is equipped with the following measurement sensors:

1. Wind speed and direction
2. Air temperature and humidity
3. Atmospheric pressure
4. Precipitation
5. Global solar radiation
6. Temperature and humidity of the ponderosa pine stem (optional)

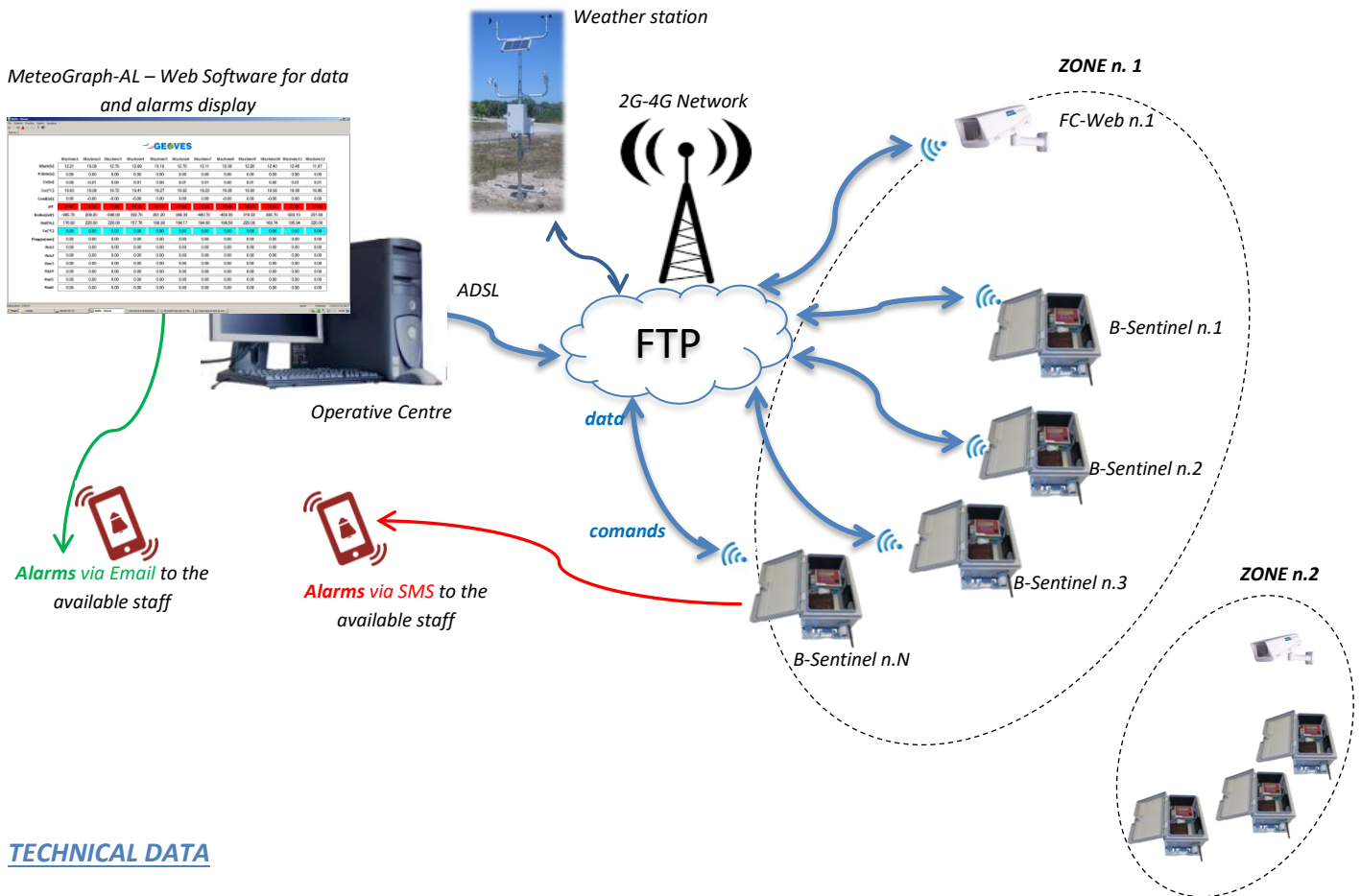


Each measurement is used to evaluate in real time the climatic conditions of the site and establish the degree of danger of possible development of the fire.

5. Operating logic of the data transmission system

The data transmission system is based on a GPRS wireless network that allows the transfer of data to a protected FTP area, while for sending alarms it uses SMS message technology. This system allows to obtain a wireless network in telemetry with **distributed intelligence** in which each Butterfly sensor and each weather station can transmit data autonomously without the need to rely on intermediate repeater points for retransmission.

Layout of the data transmission system



TECHNICAL DATA

Butterfly-Sentinel – Forest fire monitoring&alarm system

I/O Channels	3 analog inputs dedicated to the measures of T, RH and CO ₂ + 1 dedicated input for battery monitoring
Power supply	Rechargeable 12Vdc battery with 10W fotovoltaic panel, integrated recharger with intelligent battery management (11,5Vdc: battery safe threshold; 12,5Vdc: threshold of power restores to the load)
Data communication	via GPRS on FTP area
Alarms transmission	via SMS
Programming	On site: setting of text file in the SD Card memory By remote: by sending of setting file on FTP area
Settable parameters	- Alarm threshold for every measure (configurable as rising or falling overflows) - Storage rate (settable) - Transmission rate (settable) - Date and time with NTP synchronization (network time protocol)

Measuring	Elaborated data in the data storage period		
Data storage	Backup of 500 days data with circular storage on SD Card		
Working Temperature	-30...+70°C		
IP65 Enclosure	Plastic material Dim.(LxHxP): 300x200x150mm, screw closure and universal brackets for mounting on the pole.		
Sensors features		<u>Range</u>	<u>Accuracy</u>
	Air Temperature:	-40...+60 °C	±0.3°C
	Air Rel. Humidity:	0...100% RH	±1.5%
	Carbon Dioxide (CO ₂):	0...2000ppm	±50ppm

Construction technology

Thanks to its cutting-edge technology, B-Sentinel has **very low consumption**, which allows it to mount small batteries and small solar cells, thus obtaining a very compact device with **low environmental impact**. Wireless technology combined with an autonomous power supply allows B-Sentinel to be installed at any point of interest without the need for connections, making it an ideal instrument both as a single measurement station and to create a multi-point monitoring network spread across the territory.

The data collected all refer to the same date and time using **NTP (network time protocol) synchronism**. Butterfly is housed in a waterproof outdoor box, therefore, it can be used in any outdoor environment. The power supply system does not use lithium batteries, which present the risk of flammability and explosiveness at temperatures that can easily be reached (>45°C).



B-Sentinel – Example of mounting on a pole inside forest area

General technical data of the WEB Camera (FC-Web)

The FC-Web is powered by an independent 20Watt photovoltaic unit with a 12Vdc 18AH battery. The battery and the charge regulator are housed inside an IP66 container with a 300x200x150 lock in reinforced polyester.



The camera is installed near the top of the 4.5m pole and oriented horizontally to capture, when required, the tops of the plants to identify any columns of smoke that appear on the horizon. The FC-Web has an image aperture of approximately 80° and a maximum depth of a hundred meters, greater distances can be covered at the expense of image resolution.

Each FC-Web is equipped with a router with a mobile SIM for transferring images with a 4G GPRS connection. The FC-Web periodically sends a diagnostic message to the server to inform that it is active, functional and connected to the monitoring network.

Each FC-Web Remote Camera is identified with a unique identification code (FCxxx)