Bandweaver

OPERATION, INSTALLATION AND MAINTENANCE MANUAL

DISTRIBUTED ACOUSTIC SENSING

Bandweaver Product Family: **Sentry DAS**

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1 Introduction

Sentry DAS is an intrusion alarm device based on distributed optical fiber-based vibration sensing technology. It can monitor vibrations along a continuous optical fiber placed along a security perimeter or security zone in real time. When an intrusion results in a local disturbance on the fiber, the system can quickly detect and locate the intrusion and send out alarm signals. Typical applications include short and medium-distance perimeter security for up to 10km per optical channel, with a maximum coverage of 20km with a 2 channel system.

The system uses ultra-short pulses of light as a seed that is injected into the fiber. The fiber system detects and evaluates backscattered Rayleigh signal. When the sensing fiber experiences a disturbance, the refractive index of the fiber is changed. This results in changes to the light phase at that position, which leads to variations in the scattering light intensity. Through real-time detection of the light intensity, the system compares the two signals before and after the scattering, and when an event is identified, a real-time alarm signal is given. The location of the disturbance that causes the light intensity changes is determined by calculating the time difference between the injected light pulse and the reflected light.

Optical fiber sensing technology has the following fundamental advantages over electrical and other conventional technologies:

- The optical fiber is the sensing element. It is passive, and therefore immune to electromagnetic interference, water, lightning etc.;
- No power is required in the field, only the control equipment needs power.
- The system performs in conditions with fog, precipitation, smoke which might impair the performance of technologies that rely on visual data;
- The sensing cable requires a standard single mode optical cable, with a construction suitable for the installation environment. No specialist cable or sensors are required in the field.
- Its distributed nature can achieve large-scale long-distance monitoring and accurate positioning;
- The cable has a long working life and is very low maintenance.

In addition, the Sentry DAS has some further benefits:

- It realizes fully distributed high frequency detection with high sensitivity and meter-level positioning accuracy, while intelligent algorithms can greatly reduce the nuisance alarm rate;
- Fiber optic sensor has high sensitivity with adjustable alarm thresholds that can be configured according to the complex environment and site topography.
- The sensing cable is simple to install and can be mounted on a fence structure or buried.
- It has real-time online monitoring capabilities and can provide early warning of potentially destructive events.
- It can be integrated with other security equipment to offer a variety of alarm modes to form a safe and reliable monitoring area.

2 Safety

Please read the following safety information and warnings before connecting or operating this product.

2.1 Safety Warning Information and Symbols

General Warning Symbol

DO NOT ATTEMPT TO OPEN THE UNIT.
The product does not contain any user serviceable parts.

If smoke or any burning smell is emitted from the product, or in the event of any other emergency, immediately cut the power supply to the product and inform Bandweaver or its authorised agents.

This symbol is used throughout the user manual whenever there is a mandatory requirement or a risk of personal injury or probability of damaging the product.

Laser Radiation Warning Symbol

DO NOT EXAMINE OR LOOK DIRECTLY INTO THE EXPOSED FIBER OR CONNECTOR DURING MEASUREMENT.
DO NOT UNDERTAKE FUSION SPLICING OR SIMILAR FIBER JOINING WHEN THE PRODUCT IS IN OPERATION AND CONNECTED TO THE FIBER.

This product incorporates a pulsed laser device whose invisible output radiation is potentially hazardous if viewed directly by eye.

Always turn off the product, and if possible disconnect the fiber/connector, before any examination of the fiber.

High Voltage warning Symbol

DO NOT ATTEMPT TO OPEN THE UNIT.
This product has High Voltage (HV) components inside and voltages within the equipment are high enough to endanger life.
Only manufacturer trained and approved service personnel are authorised to remove the covers.

DO NOT GET THE PRODUCT WET, OR EXPOSE TO EXCESSIVE MOISTURE.
In the event of water (or other liquid) ingress, disconnect the power and inform Bandweaver or its authorised agents. Do not touch the case during a lightning storm.

2.2 Laser Safety

This is a Class 1 laser product.

The system incorporates a pulsed laser device whose invisible output radiation is potentially hazardous if viewed directly by eye. The laser radiation emission from the laser within the system is permanently coupled into a 9µm/125µm single mode optical fiber whose end is terminated with an FC/APC angled optical fiber connector.

Sentry DAS should be interfaced to the sensing fiber, using a patch cord or pigtail assembly. It is recommended that the Sentry unit is connected to a sensing fiber or use the FC/APC connector cap to prevent the light emitting to free space, and the far end of the sensing fiber should be optically cut off.

It is recommended that the unit is located where only authorised personnel have access to the optical connectors. Similarly, all personnel with such access must be made aware of the risks of working with such equipment. For unused output fiber optic connectors at the rear of the instrument, the protective caps must be utilised.

2.2.1 Additional Warnings

Avoid exposing the device to direct sunlight or other heat sources to protect sensitive components.

3 Product Specifications

Performance	
Measurement range	5km or 10km per channel
Number of channels	2
Laser Wavelength	1550 nm
Optical Pulse Width	20~100 ns
Sampling Interval	1, 2, 5 m
Positioning accuracy	≤ ±5m
Response time	≤3 seconds
Loss Budget	at 1550 nm = 5dB one way
Laser Safety	Class 1
Physical Characteristics	
Dimensions	19-inch, 3U 431mm (W) x 132mm (H) x 385mm (D)
Weight	8.4 Kg
Material	Electro-Galvanized Commercial Cold Rolled Steel (SECC)
Colour/Finish	Matt Black fine sand spray
Electrical Characteristics	
Supply Voltage	110V-220V AC +/-10% (AC), 50/60Hz
Power Consumption	<30.6W
Input	2x switch inputs
Output Relays *Integrated*	20 in total – 4 of these reserved for system status <u>Reserved relays:</u> 1. Power off indication 2. System fault indication 3. Optical Ch1 fiber break indication 4. Optical Ch2 fiber break indication
Extension	1x RS485 port relay extension driver
Data Export	20 relays, TCP/IP, RS 485
Operating Environment	
Operating temperature	-10°C to +55°C
Operating Humidity	0 to 95% RH NC
Storage temperature	-40°C to +85°C
Ingress Protection	IP40 Note: Installing the DualSentry unit inside an appropriate cabinet may significantly improve the IP rating.
Sensor Cable	
Fiber Type	ITU-T G.652/G.654 standard single-mode optical fiber
Cable installation type	Fence mounted, buried

3.1 Product Standard Packing List

No	Item description	Qty
1	Packing list	1
2	Test report	1
3	USB with software and manuals	1
4	Network cable	2
5	Chassis Keys	2
6	Screws	8
7	Chassis mounting brackets	2
8	RS232 cable	1
9	220V power cable	1
10	Connectors 2x Input connectors 4x Relay connectors 1x Expansion relay connector	7
11	Sentry Series distributed acoustic sensing unit	1
12	3mm fiber optic patch cord	1 per channel
13	Reflection Mitigation unit (RMU)	1 per channel
14	Alcohol wipe for cleaning connectors	

Table 3-1 Packing List

4 Product Start-Up and Operation

The Sentry system consists of a Detection Unit (DU) and a Processing Unit (PU). Users should familiarise themselves with this manual before using the system to ensure the system is configured correctly and to avoid unpredictable results.

4.1 Front Panel View

Figure 4-4-1 - Front Panel View

4.1.1 Front Panel Components

1. **Power On/Standby indicator:** When illuminated, this indicates the DualSentry is operating.
2. **Laser on indicator**: When illuminated, this indicates the laser is operational and is emitting light.
3. **Equipment failure indicator**: When illuminated, this indicates a system is experiencing a fault, such as a break in the sensing fiber. The indicator remains illuminated until the fault is reset or if the cause of the fault is resolved.
4. **Alarm indicator**: When illuminated, this indicates an alarm. The indicator remains illuminated until the system is reset.
5. **Power switch**: Turn this to “1” to turn on the unit and turn this to “0” to turn off the unit.
6. **Laser enable switch**: Turn this to “Off” to turn off the laser and turn this to “On” to turn on the laser. It is recommended to switch the laser off before disconnecting the sensing cable, and only switch on the laser after the sensing cable has been correctly connected.
7. **Alarm reset button**: Reset all current alarms.
8. **Mute button**: Mute all current alarm sounds.
9. **Channel 1 and channel 2 indicator lights**: These indicators are emit a steady green light when the corresponding channel signal is transmitting normally. When the signal transmission is interrupted, for example when the network cable for the corresponding channel is loose, the led emits a steady orange light.
10. **Status indicator light**: This indicator is illuminated when the system is running. Additional detail is conveyed as follows:
    a. **Normal State**: The indicator flashes at a duty cycle of 10% (100ms ON / 900ms OFF)

b. **System Abnormality**: The indicator flashes at a duty cycle of 50% (500ms ON / 500ms OFF). Detail of the abnormality can be checked in DASCM software.
c. If power is supplied, and the indicator is always on or always off, this also represents an abnormal state.

4.2 Rear Panel View

Figure 4-4-2 - Rear Panel View

4.2.1 Rear Panel Components

1. **220V AC power supply IEC socket with fuse box**
2. **Ground terminal:** for grounding protection;
3. **In terminal:** Switch Input
4. **Relay output panel**: Terminal blocks for relay outputs
5. **RS485 connector:** RS485 connection for relay expansion modules;
6. **RJ45-1 and RJ45-2**: Gigabit Ethernet port for data transmission to the PU.
   Default IP Address for RJ45-1: 192.168.2.100
   Default IP Address for RJ45-2: 192.168.3.100
7. **Console interface**: Debugging interface – for Bandweaver use only
8. **Product Nameplate**
9. **FC/APC connector**: For connection to the fiber optic sensor cable.

4.3 Product Configuration

Sentry DAS system is composed of a Detection Unit (DU) and Processing Control Unit (PU).
The DU is the Sentry DAS host which detects vibration signals.
The PU is a standard, high-performance industrial computer which performs the data analysis, system configuration, system operation and maintenance, displays the detection results, and manages external communication. This industrial PC is used to run Bandweaver's proprietary DASCM software and MaxView platform to realize Sentry's monitoring functions.

Our MaxView platform enables the integration of devices such as security cameras, beam detectors etc. via additional optional software modules, adding additional capability to the detection solution.

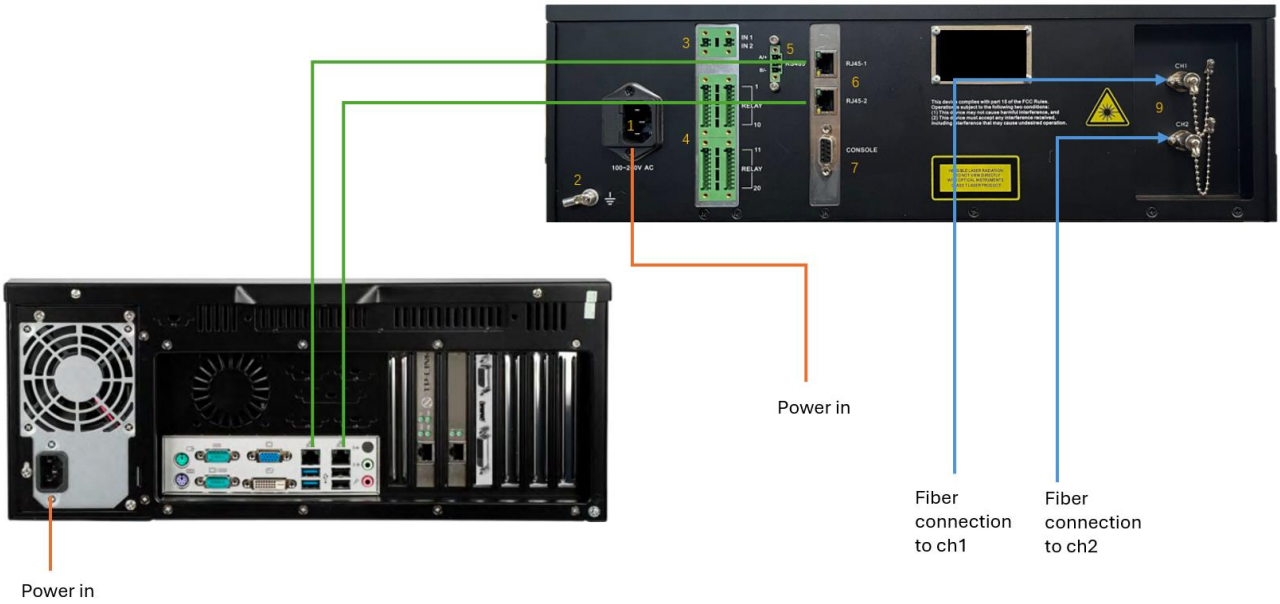

Table 4-3 General configuration

Required Equipment:

1. Sentry Distributed Acoustic Sensing unit
2. Suitable Power Supply:
   Sentry requires 220V AC power supply.
3. Sentry Processing unit (Industrial PC):
4. DASCM Software
5. Fiber Optic Sensor Cable:
   G.652/ G.654 single mode optical fiber:
   The DU end of the sensing fiber must be terminated with an FC/APC connector
   The far end of the sensing fiber must be terminated with Bandweaver's RMU
6. Optional Equipment
   Other monitoring device such as a security camera, laser beam detector etc.

4.3.1 Network connection

Connection to the PU is via two the RJ-45 network connectors.

Default IP Address for RJ45-1: 192.168.2.100
Default IP Address for RJ45-2: 192.168.3.100

As a safety precaution before inserting the connector into the optical connectors on the back of the Sentry unit **please turn off the laser** or **turn off the machine.**

4.3.2 Sensing Fiber

The optical cable used should be standard single-mode communication optical cable ITU-T G.652 / ITU-T G.654, 1550nm, average loss not greater than 0.25dB/km.

It is recommended to us an OTDR to check the sensing fiber, to ensure there are no points of large loss or strong reflected signals. Generally, the loss of a single splice point should not exceed 0.3dB, and the number of splice points in the entire optical cable should be as few as possible.

The maximum optical loss must not exceed 5 dB/10km (based on OTDR measurement).

The near-side sensing fiber coming out of the machine should be vibration-free, quiet, and not freely-suspended in the air. This helps prevent the vibration of the machine or the swing of the fiber itself from affecting the signal and system performance.

4.3.3 Terminating the far end of the sensing fiber ⚠

To prevent end reflections and inadvertent viewing of the laser light, at the far end of the fiber, the fiber must be terminated with Bandweaver's RMU (Reflection Mitigation Unit). The RMU provides a reliable and repeatable way to protect against the receiver saturating from the strong signals that can be produced from an incorrectly terminated sensing fiber. These end reflections can damage the optical receiver if left unchecked.

For the purpose of ease of field use and reliability, the RMU can be spliced to the fiber end and well protected in suitable enclosures. These are all standard procedures in field applications and no special equipment or technology is required.

4.3.4 Connecting to the DU ⚠

When the optical fiber is ready, the FC/APC connector can be connected to the Sentry for vibration measurement.
Insert the FC/APC connector into the back of the Sentry unit.
The key on the connector must be aligned with the mating connector before screwing them together.

Figure 4-5 – FC/APC Connector

NOTE:

1. Turn the laser off before plugging or unplugging the optical connector;
2. Do not look directly at the connector when the laser is on.
3. Use alcohol and absorbent cotton to clean the connector before connecting it into the DU;
4. When plugging into DU, be sure to match the alignment key on the edge of the connector to the slot of its counterpart.
5. Do not force the connectors. This can deviate the optical fiber from its original position and affect communication.
6. Do not over bend or wind the patch cord too tightly as this can increase the attenuation.
7. Do not continue to use a connector if it has been damaged. Replace it as soon as possible.
8. After use, ensure the connectors are well protected against dust or grease contamination with a suitable cap.

4.4 Start Measurement

Once the optical fiber and communication cable have been connected, the Sentry system is ready for use. Before operating the Sentry DAS, ensure all users have read and fully understood the safety sections of this user manual.

Correctly apply power to the rear panel connector turn on the Sentry system.
Switch the laser switch to ON.
When the supporting PU is used, DASCM will start automatically when the PC is switched on.

For details on how to configure and operate DASCM, please refer to the DASCM User Manual.

5 Alarms

The system must be configured for each site before the required events can be detected and alarms triggered.

Refer to the DASCM User manual for instructions on configuring the detectors and managing the alarms.

5.1 Relays

The DualSentry Detection unit has 20 onboard relays for alarm outputs. The external connections to these relays are via the connectors on the rear panel of the unit.

The first 4 of relays are reserved for system alarms. The first user addressable relay starts at relay 5.

Figure 5-1 Relay Outputs

Each ??? port has 10 pins, numbered 1~10 and 11~20. Relay #5 -#20 are user-programmable relays. Please refer to the DASCM manual for more information.

Relay number	System alarm type
Relay 1	Power
Relay 2	System Fault
Relay 3	Fiber break Channel 1
Relay 4	Fiber break Channel 2

Table 5-1 Reserved System Fault relays

6 Troubleshooting

Problem	Common causes	Recommended solution
DASCM cannot be started when running it for the first time.	- If IPC being used has not been supplied by Bandweaver, this problem may occur due to hardware compatibility.	- Contact Bandweaver
The waterfall data is not updating.	- The network is not configured correctly	- Click the network real-time curve icon in the lower right corner of the DASCM interface to view the connection status of connections 0, 1, and 2. Connections 0 and 1 correspond to IP 192.168.2.100, and connection 2 corresponds to IP 192.168.3.100; - If the three connection statuses are all disconnected, ping the following IP address from the Windows console window: 192.168.2.100. - If the ping fails, swap the two network cables and try again. - If the connection still fails, check the settings of the two network ports of the PU and ensure that they are in the same subnet as the DU network ports to which they are connected. Example: If the default DU configuration is used, the IP of the PU network port connected to the DU RJ45-1 network port should be set to 192.168.2.xxx (xxx cannot be set to 100 or 1), and the subnet mask is set to 255.255.255.0 - If the above operations cannot eliminate the fault, disconnect and reconnect the network cable, or replace the network cable, or restart the DU.
Waterfall is experiencing significant latency.	-	- Open the windows task manager and check whether the transmission rates of the two network ports RJ45-1 and RJ45-2 are stable and up to standard.

		In dual channel 10 km range and 1 m filtering interval, the data volume of each network port should exceed 150 Mbps. If not, try changing the connected network cable. ***Note:*** *Contact Bandweaver if the problem persists.*
The signal reflection at the front connector is strong and the signal at the end is weak	- It may be that the front-end optical fiber connector is not clean	- Use a fiber cleaning pen to clean the DU and mating pigtail fiber end faces respectively.

If any problem persists or if the user is unable to resolve it, please contact Bandweaver or an authorized distributor.

Please include the following information when requesting support:

1. Serial number of the product. This is located on the rear panel of the product;
2. Full description of the problem and any troubleshooting measures already attempted;
3. Configuration of the product when the issue is experienced;
4. Data files while the issue is experienced. The data files can be found in the **data** subdirectory located in the **DASCM** folder.

7 Care and Maintenance

The DualSentry is designed to provide a low-cost monitoring solution for many years.

There are measures that the user can take to extend the life of the product and ensure trouble free operation of the DualSentry:

7.1 Installation environment

- Ensure the instrument is positioned in a well-ventilated area, with free air flow around the unit. Do not obstruct the air intakes or vents.
- Ensure that the operating environment of the DualSentry system is within specification.

7.2 Connector Care and Maintenance

- Ensure all optical connectors are clean before mating and are tightened firmly.

The FC/APC optical connectors should be cleaned and/or inspected before attaching to the DualSentry unit. Failure to ensure connectors are clean and free of foreign matter can severely compromise the performance of the system and may possibly damage the integral system connector.

There are two methods for cleaning connectors which are approved by Bandweaver. The technique used is dependent on the type of contamination.

Ensure the laser is off before cleaning any fibers. ⚠
Use alcohol and absorbent cotton to clean the connector first before connecting it into the DU ⚠

1. *If the connector has been exposed to slight dust contamination, the preferred method is using a 'cassette style' cleaning tape. When cleaning the connector, please wipe gently several times following the same direction.*

2. *Use a fiber optic cleaning pen which is convenient and quick.*

7.3 Fiber Optic Sensor Cable

- It is good practice to take a baseline reading of the fiber loss after installation. Periodic examination of the fiber loss can then be taken and compared to a baseline. This will help track any aging of the optical fiber.

7.4 Data Storage

- If data is being collected frequently, periodic examination of the hard disk will be needed to ensure sufficient free space. Excess data should be cleared before the hard disk reaches 90% capacity.

7.5 Quarterly Inspection and Test

The purpose of the visual inspection is to ensure that there have been no significant changes to the installation site, regarding its structure or from its environment or any other factor that may affect the system performance. The cables and control unit should be visually inspected for mechanical damage, or other conditions, likely to interfere with correct operation. Visual inspections are carried out upon initial system installation and handover.

Many of the applications for Bandweaver's DualSentry are such that the systems are installed in critical areas, which are difficult to access. In such cases, it is important that the equipment servicing is carried out during periods of approved shutdown.

7.5.1 Functional Test

Bandweaver recommend that at least one detection zone should be tested per quarterly visit. The functional test is to be done by simulating an alarm event at a known location and ensuring that the system alarms correctly.

7.5.2 Optical Loss Test

Ideally every quarter some baseline raw vibration data should be recorded for reference. The optical loss of all connectors and splices should be measured and compared with the previous quarter to see if there is any degradation of the connections.

7.6 Annual Inspection

Visual Inspection: same as per quarterly inspection.

7.6.1 Functional Test

Similar to quarterly inspection, simulated intrusion tests shall be done to at least one detection zone to verify whether system responds correctly to intrusion events and provides accurate intrusion positions.

8 Contacts

Please refer to the contact page of the following webpages for details to contact Bandweaver:

English: www.bandweaver.com

Chinese: www.bandweaver.cn

Or email us on support@bandweaver.com