Bandweaver

OPERATION, INSTALLATION AND MAINTENANCE MANUAL

DISTRIBUTED ACOUSTIC SENSING

Bandweaver Product Family: **Horizon DAS**

Revision 1.2, June 2020

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Revision History

Rev	Date	Reason for issue	Author	Reviewer	Reviewer
1	16-Jul-2019	First issue	E. Fernandes	R. Da Costa	
1.1	29-Oct-2019	Section 1 updated, optical budget added to specifications, Note 1 added to 4.3.3	E. Fernandes		
1.2	23-Jun-2020	Update to packing list	E. Fernandes		

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1 Introduction

Horizon is a covert intrusion detection device based on fiber optic technology. It is a distributed vibration sensing system that uses the fiber optic cable as the sensing element. It can monitor vibrations along a continuous optical fiber buried around a security perimeter or security zone in real time. The system detects and locates the intrusion cause by a local perturbation on the fiber, and raises an alarm signal. In addition, when the optical fiber is laid along pipe lines (such as petrochemical pipelines, power cables, municipal pipelines, etc.), the system can monitor external damage and pipeline failure.

The system uses ultra-short pulses of light as a seed that is injected into the fiber, and the Horizon detection unit analyses the Rayleigh backscatter. When there are disturbances in the sensing fiber, the refractive index of the fiber is changed, resulting in changes of the light phase at that position, and corresponding changes of the scattered light intensity. This in turn leads to the changes in the intensity of the backscatter. Through real-time detection of the light intensity, the system compares the signals before and after the scattering. As the light intensity changes, real-time alarm signals are triggered. The disturbance is located by calculating the time difference between the injected light pulse and the reflected light.

Fiber optic based monitoring systems have the following advantages over electrical or other conventional systems:

- Optical fiber is the sensing element, therefore, it is passive, immune to electromagnetic interference, water, acid, lightning, and the optical fiber is safe for use in intrinsically safe areas;
- Its distributed nature can achieve large-scale long-distance monitoring and accurate positioning;
- It realizes fully distributed high frequency detection with high sensitivity and meter-level positioning accuracy, while its intelligent algorithms can greatly reduce the false alarm rate;
- Fiber optic sensor has high sensitivity with independent classifiers for different types of standard intrusion events. Each of these can be according to the complex environment and site topography.
- The system is simple to install. The cable has a long working life and low maintenance requirements.
- It has real-time online monitoring capabilities and can provide early warning of potentially destructive events.
- With the optional MaxView software, 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 FIBRE OR CONNECTOR DURING MEASUREMENT.
DO NOT UNDERTAKE FUSION SPLICING OR SIMILAR FIBRE 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 fibre/connector, before any examination of the fibre.

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

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 fibre whose end is terminated with an FC/APC angled optical fibre connector.

The Horizon system should be interfaced to the test fibre, using a patch cord or pigtail assembly. In normal use, the Horizon system must be connected to the sensing fiber and the far end of the fibre should be optically cut off. For channels not in use the FC/APC connector cap must be used to prevent the light emitting to free space.

It is recommended that the unit is located where only authorised personnel have access to the front and rear connectors. Similarly, all personnel with such access must be made aware of the risks of working with such equipment, as listed in this document. 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

3.1 Horizon Detector Unit

Performance	
Measurement range	5km, 10km, 20km, 50km per channel (model dependent)
Number of channels	1 or 2
Frequency range	1Hz to 20KHz (SSOS algorithms at 2KHz range only) 1kHz / 2kHz / 4kHz available as standard. 10kHz / 20kHz by special request
Laser Wavelength	1550 nm
Spatial Resolution	±5m
Response time	≤ 3 seconds
Maximum Optical Budget	12dB @ 1550nm (50km range)
Laser Safety Classification	Class 1M
Operating Environment	
Operating Temperature	0°C to +45°C
Operating Humidity	0 to 95% RH NC
Physical Characteristics	
Dimensions	19-inch, 3U 487mm x 405mm x 132mm
Weight	14 Kg
Material	Painted Steel
Colour/Finish	Matt Black
Electrical Characteristics and Interfaces	
Supply Voltage	220V AC (110V-240V AC), 50/60 Hz
Power Consumption	25W (typical)
Communication Interface	Gigabit Ethernet port x2 (for connection to SSOS)
Fiber Optic Connector	FC/APC
Sensor Cable	
Fiber Type	G.652/ G.654 single mode optical fiber
Cable installation type	Buried (0.5m cm) ± 20cm

3.2 Product Standard Packing List

No	Item description	Qty
1	Packing list	1
2	User manual	1
3	Test report	1
4	Network cable	2
5	Keys for Laser operation	2
6	Screws for chassis mounting bracket	8
7	Chassis mounting brackets	2
8	220V power line	1
9	Horizon distributed acoustic sensing unit	1
10	3mm fiber optic patch cord	1 per channel
11	Reflection Mitigation unit (RMU)	1 per channel

Table 3-1 Packing List

4 Product Start-Up and Operation

4.1 Front Panel View

Figure 4-4-1 - Front Panel View

4.1.1 Front Panel Components

1. **Power indicator:** When illuminated, this indicates Horizon is operating.
2. **Status indicator**: A solid light indicates that system operation is normal. Blinking light indicates anomalous operation. Check the fault panel in SSOS for available details.

4.2 Rear Panel View

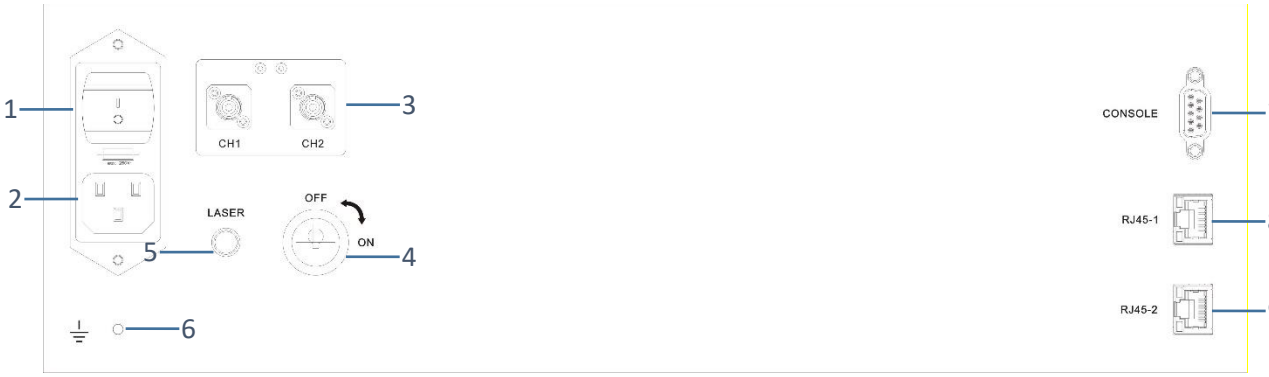

Figure 4-4-2 - Rear Panel View

4.2.1 Rear Panel Components

1. **Power** On/Off switch
2. **220V AC power supply terminals:** power supply input for Horizon DAS
3. **CH1, CH2:** FC/APC connector x2 for connection to the fiber optic sensor cable.
4. **Laser On/Off switch:** Switch to turn the laser on/off;
5. **Laser On/Off indicator**: Indicates on/off status of the laser;
6. **Ground terminal:** For grounding protection;
7. **Console:** Debugging port for Bandweaver use only;
8. **RJ45-1**: Required for connection to SSOS software – data and command;
9. **RJ45-2**: Required for connection to SSOS software – data link;

4.3 Product Configuration

The Horizon system is composed of a Detection Unit (DU) and Processing Control Unit (PCU).
The DU is the Horizon host which detects vibration signals.
The PCU is an 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 SSOS software and (optional) MaxView platform to realize Horizon'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.

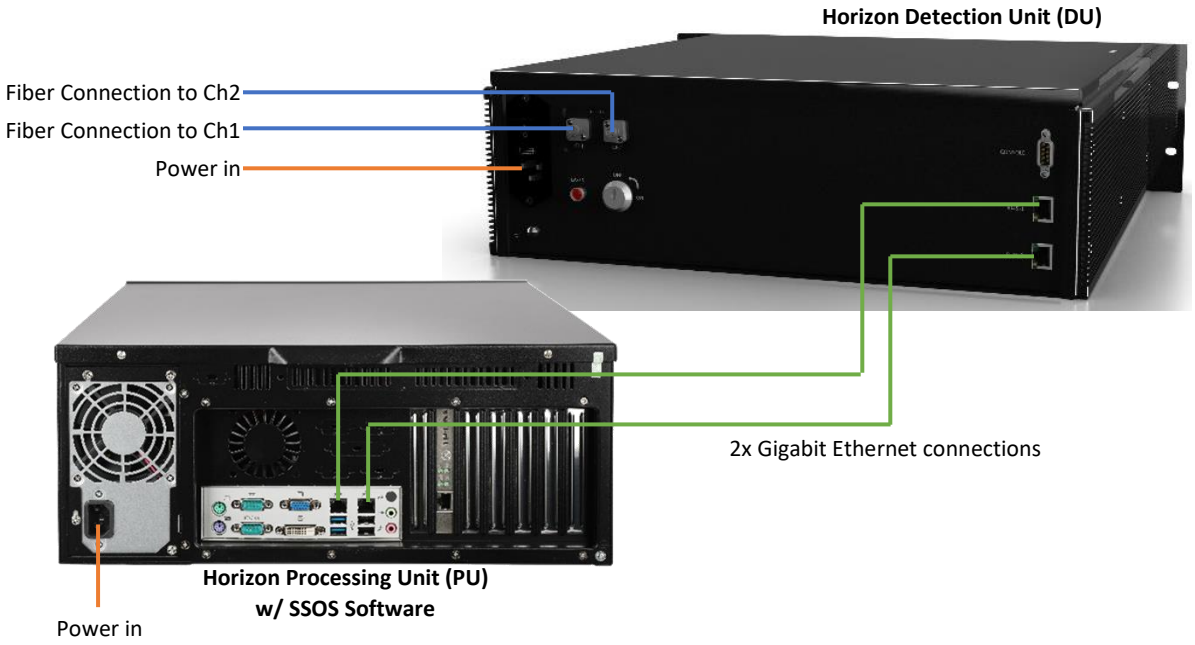

Figure 4-3 General Configuration

Required Equipment:

1. Horizon Distributed Acoustic Sensing unit
2. Suitable Power Supply:
   Horizon requires 220V AC power supply.
3. Horizon Processing unit (Industrial PC):
4. SSOS 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 Processing Unit is via two RJ-45 network connectors (Figure 4-3).

Horizon V2 default IP addresses:

RJ45-1 (Data & Command Link – IP0 & IP1): **192.168.3.100**
RJ45-2 (Data Link – IP2): **192.168.2.100**

As a safety precaution before connecting to the optical connectors on the back of the Horizon **please turn off the laser** (item 4 in Figure 4-4-2) **or turn off the machine** (item 1 in Figure 4-4-2).

4.3.2 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 fibre, the fibre 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 fibre end and well protected in suitable enclosures. These are all standard procedures in field applications and no special equipment or is technology required.

Note:
Once the cable is installed and terminated, check the OTDR curve of optical cable for abnormal points including high reflection points.

4.3.3 Connecting to the DU ⚠

When the optical fibre is ready, the FC/APC connector can be connected to the Horizon system for vibration measurement.

Insert the FC/APC connector into the back of the Horizon unit (item 3 in Figure 4-4-2).
The key on the connector must be aligned with the notch in the mating connector before screwing them together.

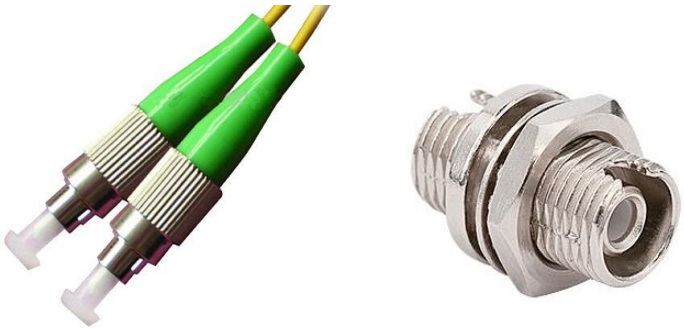

Figure 4-5 – FC/APC Connector

NOTE:

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

4.4 Start Measurement

Once the optical fibre and communication cable have been connected, the Horizon system is ready to use. Before operating the Horizon DU, ensure all users have read and fully understood the safety sections of this user manual.

After correctly applying power to the rear panel connector turn on the Horizon system and switch on the laser. The Horizon system will load the current configuration from internal memory and run in **auto measurement mode** regardless of the state of the PC and **SSOS** software.

5 Alarms

Refer to the SSOS manual DAS-HZ-02-MAN-002 for instructions to configure intrusion alarms.

6 Troubleshooting

Problem	Common causes	Recommended solution
Fiber is connected and laser is on, but no data is received from the Horizon unit	- Network cable is loose or not inserted - IP settings incorrect	- Check the network cable - Try to Ping the system Start → run → cmd ping each IP address - Make sure network connection is enabled
Raw data signal is all zero	- Laser disabled, or the fiber optic cable is not inserted	- Check the optical fiber connector - Turn on the laser
Unstable connection	- Incorrect parameters	- For repeated connection and disconnection, check whether the configuration such as heartbeat interval and health interval are correct.

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;

7 Care and Maintenance

The Horizon system 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 Horizon:

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 Horizon 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 Horizon system. 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 fibres. ⚠
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. *If the connector has been exposed to grease, lint free tissues wetted with alcohol or pre-soaked wet wipes should be used. When using pre-soaked wet wipes, excess residue should be removed using dry lint free tissues. When cleaning the connector, please wipe gently several times following the same direction.*

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 fibre loss can then be taken and compared to a baseline. This will help track any aging of the optical fibre.

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 95% capacity.

7.5 Annual Service

- Bandweaver recommends an annual service by a qualified Bandweaver engineer or authorized distributor.

  Please contact an authorised Bandweaver representative for further information.

7.6 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 Horizon 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.

7.6.1 Functional Test

Bandweaver recommend that at least one detection zone should be tested per quarterly visit. The functional test is to be done by tapping at a point of the optical cable within a detection zone. The alarm event should be verified on an IPC or laptop connected to the Horizon.

7.6.2 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.

7.7 Annual Inspection

Visual Inspection: same as per quarterly inspection.

7.7.1 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: support@bandweaver.com