Bandweaver

APPLICATION NOTE

CONVEYOR BELTS – LINEAR HEAT DETECTION USING FIBER OPTIC SENSING TECHNOLOGY

The fire hazard of belt conveyors is often underestimated, but knowledge of the components and applications reveals that they can be a significant fire risk. Belt conveyors are used extensively in industry for the bulk transportation of various materials. Belts can be several meters wide and vary in length from a few to several hundred meters, with a range of associated equipment includes motors, support structures, rollers, and belting.

INTRODUCTION

Depending on the material on the conveyor belt, fire can accelerate very rapidly, resulting in extensive damage. Bearing failures can be very expensive both in terms of direct damage costs but also the downtime required to repair and replace. For example, an 8km conveyor belt for copper/molybendum mine can extract $320,000 per hour. Both combustible and non-combustible materials are transported on conveyors. Combustibles include coal, wood chips, cement, grain and sugar. Non-combustibles products include various metal ores, limestone, shale, cement and packaged materials e.g. production line goods and passenger baggage.

The main fire risks associated with belt type conveyors are as follows:

- Friction due to loss of belt traction and slipping on the drive roller
- Welding activities generating hot molten material
- Overheated materials placed on the belt
- Build up of materials that have fallen off the belt and any associated dust cloud generation
- Static electricity

Generally, there are two main types of fire that need to be detected at the earliest opportunity on belt type conveyors, static and moving fires.

1. **Static fires** can occur near the belt and or within the electrical drive equipment associated with providing energy to the belt conveyor system.
2. **Moving fires** are most often detected by infrared type technology, coupled sometimes with CO_2 detection, and located at strategic fixed-point locations along the conveyor system. This strategy alone does not provide detection coverage over the entire belt length, and so it is common to introduce a linear heat detection solution to provide detection of the static fires as well as the relatively large moving fires that can occur.

FireLaser distributed temperature sensing (DTS) technology, a fiber optic based linear heat detection system, provides a technically superior solution when compared to the other conventional technologies. Advantages include:

- Robust cable construction, where temperature measurements can be made over very long lengths of conveyor
- Minimal need to site control equipment in remote locations
- Actual temperature measurement continuously along the conveyor length and can predict imminent risk before ignition occurs
- Quality of measurement is not affected by RFI/EMI
- The system is inherently intrinsically safe (EEx ia) and is therefore suitable for use in hazardous areas

One of the additional key benefits of fiber optic LHD systems is early detection. Current conveyor belt protection systems assume the conveyor belt has reached combustion stage before raising an alarm. However, there is a stage prior to combustion which is called pyrolysis[1]. Fiber optic linear heat detection can detect the exact location of the thermal increase and measures can be taken long before the flame ignites. If action is taken during this phase, then any fire suppression or cooling measures are much more likely to be effective.

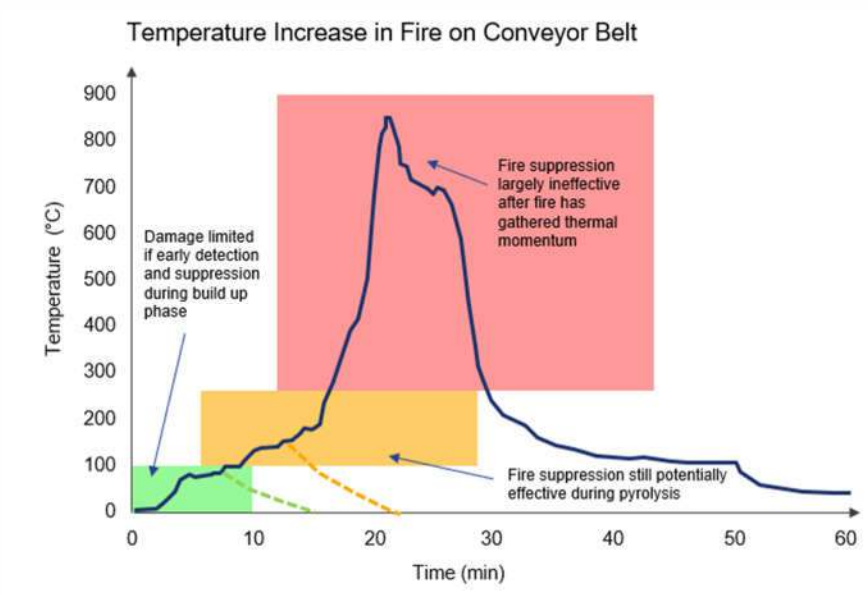


Figure 1 - Progression of fire on conveyor belt

[1] https://www.hse.gov.uk/research/crr_pdf/2002/crr02407.pdf

Therefore, it is critical in these situations for the system to detect early on to minimise damage. If action is taken early, then fire can be contained to a single location. However, if allowed to build then suppression systems (e.g. water deluge spray system) are not guaranteed to be effective at suppressing or extinguishing a flaming conveyor belt.

SMART ALARMS & FULL COVERAGE

Two of the key advantages of fiber optic linear heat detection (LHD) systems are based on the smart alarming functionality and the distributed nature of the measurements. With fiber optic LHD systems based on DTS, three different types of alarms are configurable.

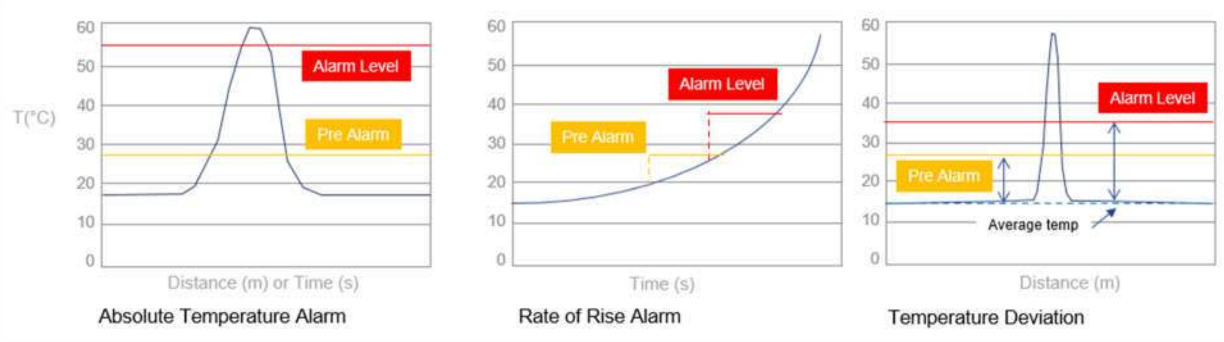


Figure 2 - Smart alarming with fiber optic linear heat detection systems

By using smart alarms, as can be seen from the figure above, fires can be detected much earlier and again significantly lowering risk.

With regards to traditional fire detection, smoke detectors are highly susceptible to false alarms due to dust and particles. Point heat detectors are used extensively, but if the seat of the fire does not happen to be immediately under a point type sensor, the fire can no longer be detected with certainty, mainly due to detector spacing. The FireLaser fire detection system takes measurement points every 0.5m along the entire length of the sensing cable and so does not have any such "gaps". Wherever the radiated heat is emitted, it is detected at all points along the continuous length of sensing cable and is recorded and displayed accordingly.

Fiber optic LHD can pinpoint the exact position and temperature of the fire and the direction in which the fire is spreading, as well as the propagation of toxic fumes and smoke.

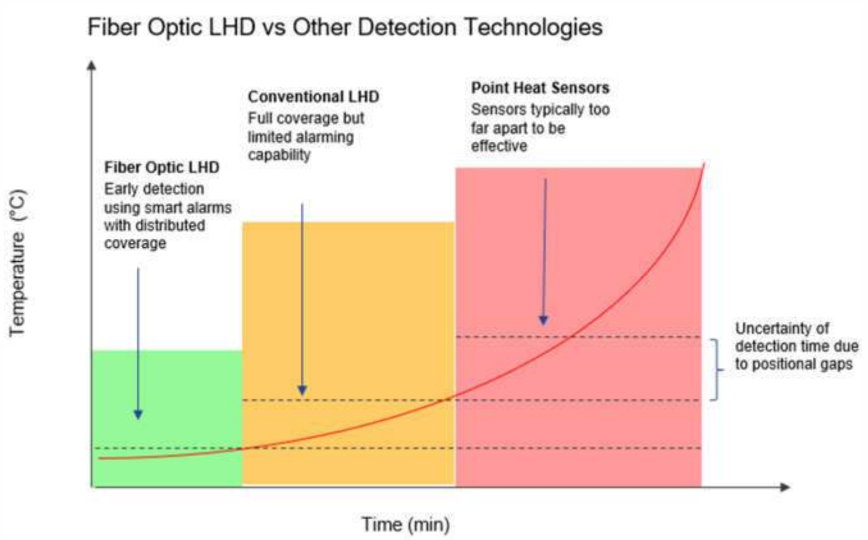


Figure 3 - Fiber Optic LHD vs Other Detector Technologies

SYSTEM INTEGRATION

A combination of detection technologies including FireLaser DTS technology can be used for the activation of sprinkler or water spray systems to help suppress or extinguish a fire event. The FireLaser DTS system interfaces directly to the Agent Release Panel (ARP) through a system of monitored zonal relay contacts. Normally each conveyor line is subdivided into fire detection zones, which shall be at least a subset of the system extinguishing zones. The system extinguishing zones are normally defined by site parameters relating to the hydraulic limitations on water delivery, quantity of water available, the type of water spray/deluge system and to some extent the cleanup activities associated with a system release.

The location of the FireLaser controllers for an application is typically near the fire control panel. The FireLaser LHD comes with its own LCD screen and so can independently display the alarm events and outputs to the fire alarm control panel.

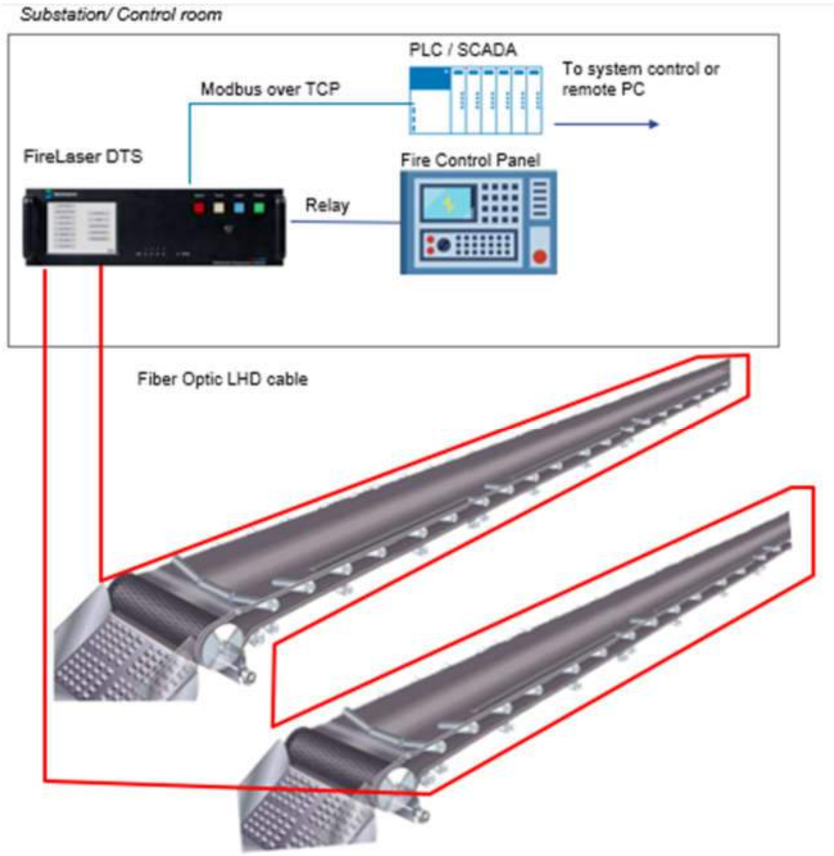


Figure 4 - Example of System Architecture

SMART ZONE CONFIGURATION

The FireLaser LHD system gives the unique capability to configure the smart alarms in conjunction with smart zones. This enables each zone to have its own precise configuration according to the specific environmental conditions or integration with other elements of the system. Examples where different zone configurations may be required include, emergency exits, ventilation zones, fire suppression.

The following table gives an example of how the smart zones integrate with the rest of the system. Because the fiber optic LHD system gives you the precise location and temperature of each event you can decide how the system will respond. In some cases, an entire zone may communicate through a relay switch (e.g. direct contact to the fire panel) and activate the fire suppression for that zone. In other cases, the actual data can be transmitted via Modbus (or other protocol) to the system where it can decide what actions to take. The diagram below details how this may work with integration of the other sub systems.

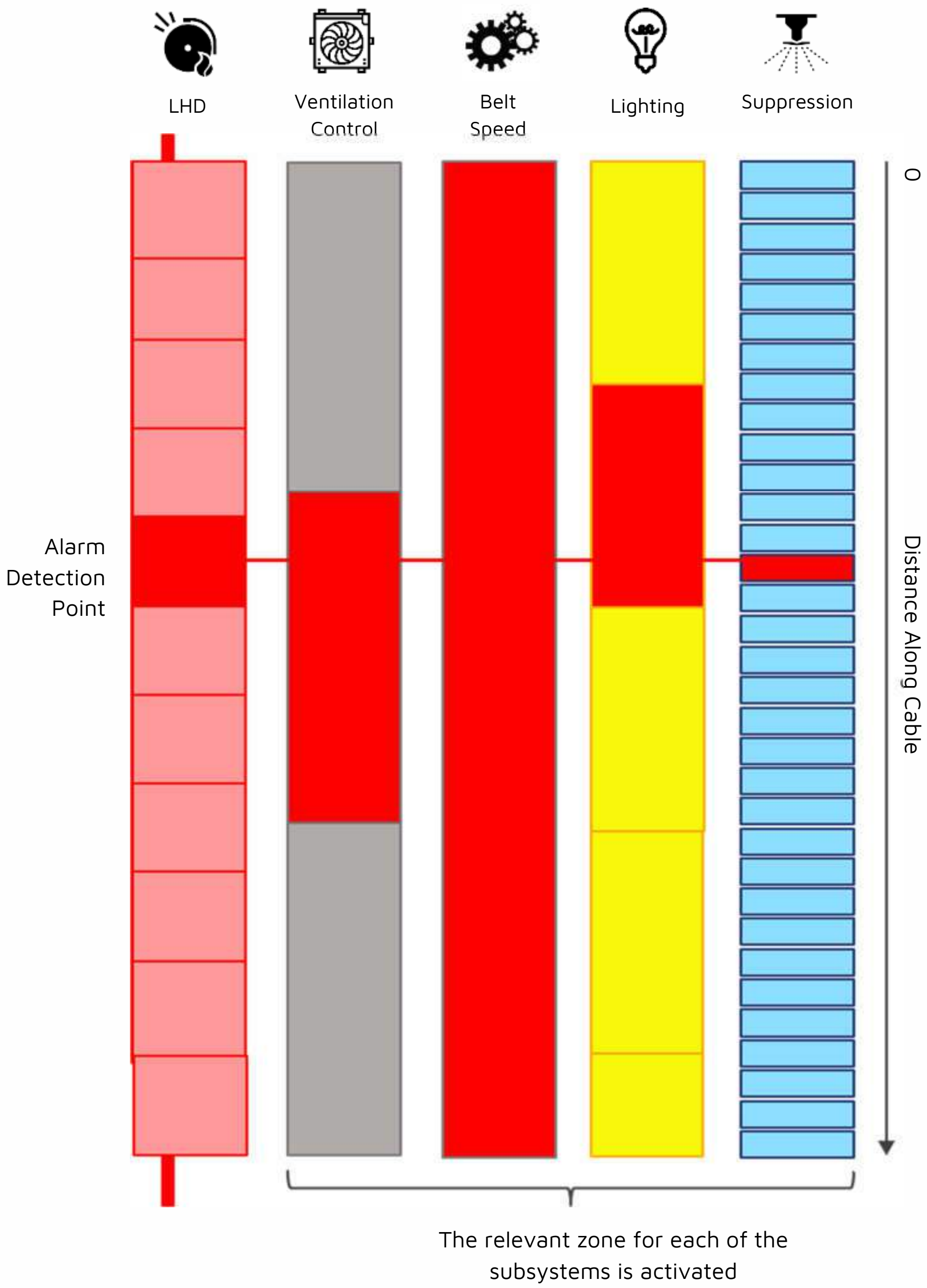


Figure 5 - Example of smart zone configuration

Sensing Cable

The sensing cable is a completely passive element and is based on standard fiber optic telecommunications fiber. For the fire industry, the standard fiber configuration has been using a 62.5/125 fiber optic due to its superior performance at distances up to 10km.

As the sensing cable is made from fiber optic and is completely passive, it has the following benefits:

- **Continuous coverage:** No discrete sensors but continuous spatial measurements. FireLaser provides measurement points every 50cm
- **Immune to electromagnetic interference:** Can be used in areas of high electromagnetic activity without fear of affecting or being affected by other electrical equipment
- **Corrosion and vibration resistant:** As the sensing element has no moving parts and immune to corrosion, the cable has an extremely long lifetime and can be more than 30 years

The FireFiber range of cables are designed to give maximum protection to the fiber optic while maintaining a thermal conduction, which can enable the system to react very quickly. The AT cable is the standard fire detection cable and uses a combination of steel tube and Kevlar protection, providing a very robust construction that is also very lightweight and flexible, making it easy to install.

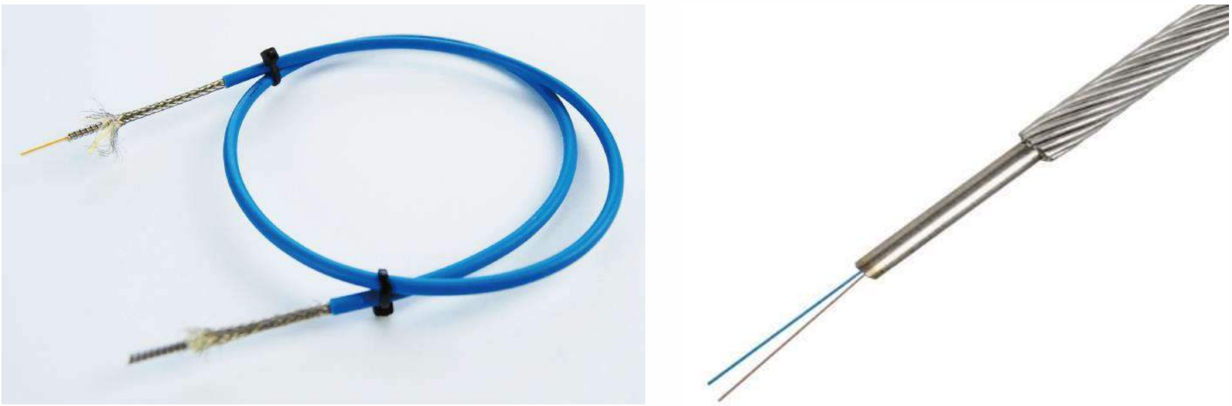


Figure 6- Examples of fiber optic sensing cables

CABLE INSTALLATION AND POSITIONING

The sensor cables are typically located on either side of the conveyor to maximize the detectors ability to detect heat increase from the main sources of static and large moving fires. Care should be taken to ensure that the sensor cable location in relation to the conveyor should not hinder access to the roller bearings, nor should it be located in an area when it may be prone to interference with system wash-down apparatus.

An example of the application of sensor cable is illustrated in the figure below. The sensing cable is in close proximity to the belt conveyor, thereby providing 'local' fire protection. This is sometimes located on the external frame and sometimes underneath the rollers.

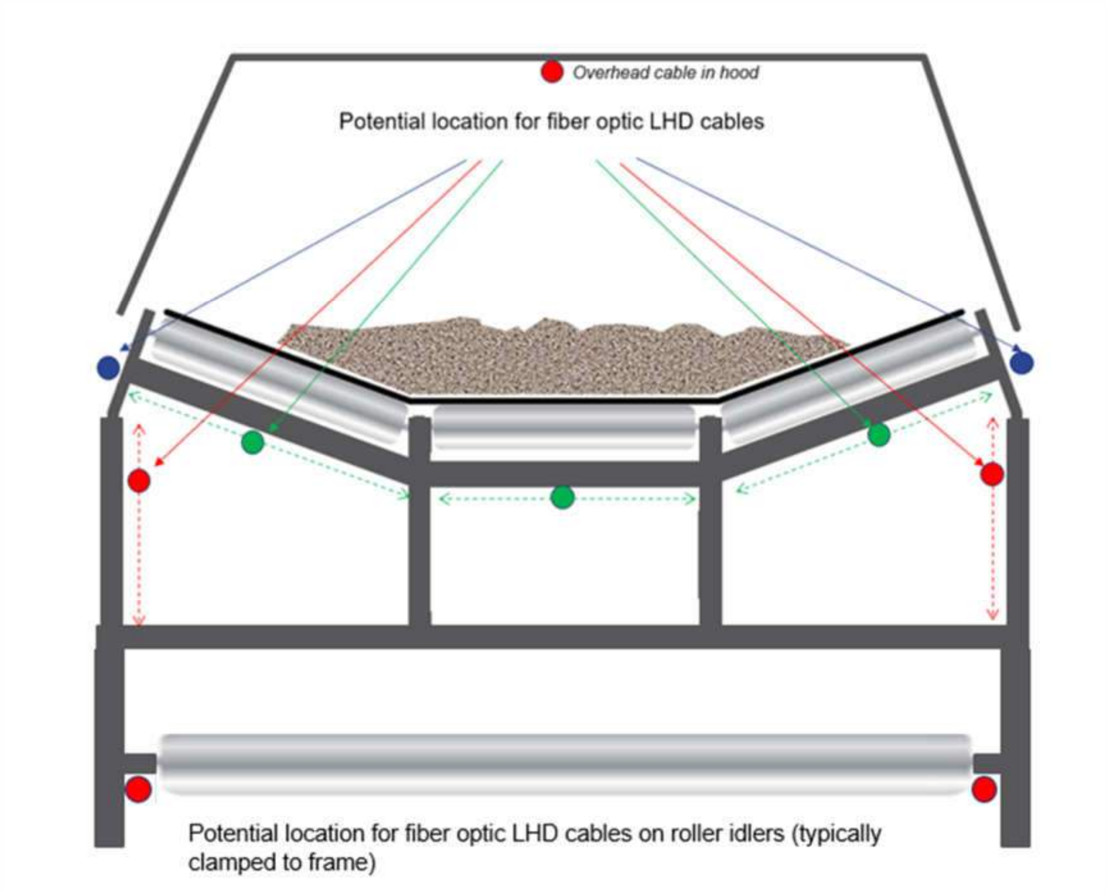


Figure 7 - Example of installation locations

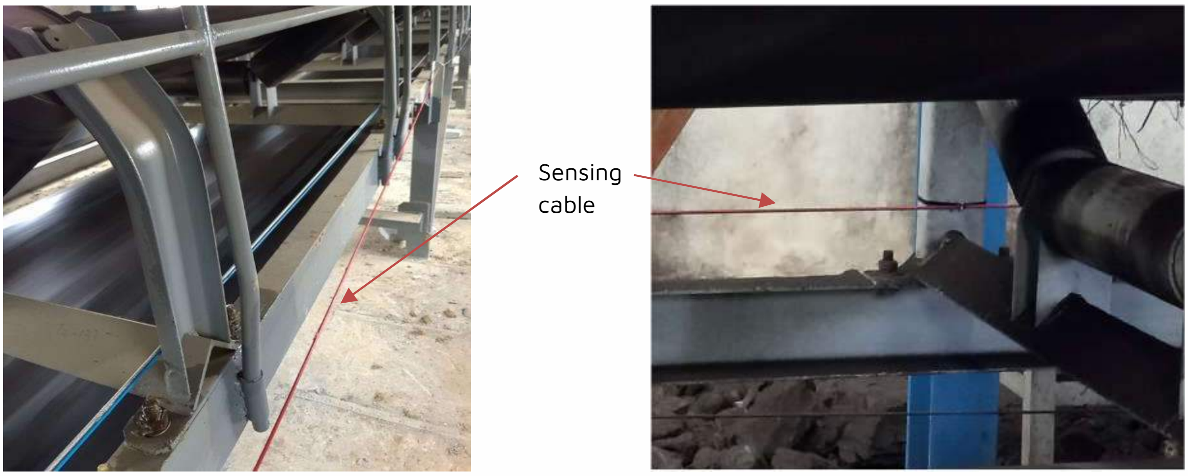
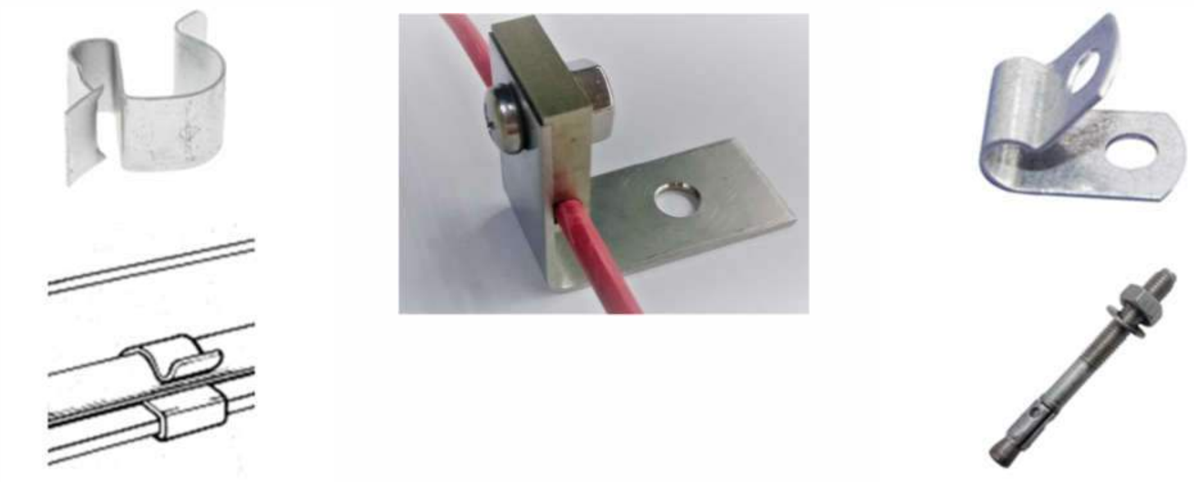


Figure 8 - Photos of cables in Bandweaver installations

The sensing cable is attached to the conveyor belt by use of various fixing methods. This can be using clamps directly to the frame or via tension wire. In some cases, banding has been used to attach the cable to the frame, but this is not as substantial as clamps. Whichever method is used, an assessment should be made to ensure that the chosen technique is robust enough for the specific installation and can withstand the vibrations of the environment.

For spacing, typically an interval of 1m is preferred. However, in the case of conveyor belt installations, typically the interval between clamps is defined by the spacing of the rollers. Below are some samples of different cable clamp types.



Cable clip for attachment to frame | Standoff cable clamp: L-Shape | Steel P-Clip and anchor bolt

Figure 9 - Examples of cable fixtures

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SYSTEM REDUNDANCY

Depending on the customer requirements, different levels of redundancy can be implemented. Essentially there are two key types of redundancy:

- **Cable Redundancy:** In the event of a cut to the cable, the system can continue to function (although a system alarm will be generated so that action for repair, analysis can be taken)
- **Controller Redundancy:** In the event of failure of one of the fiber optic LHD controllers, the system will continue to function

The example below shows the principle of a loop configuration with cut redundancy and with controller and cable redundancy:

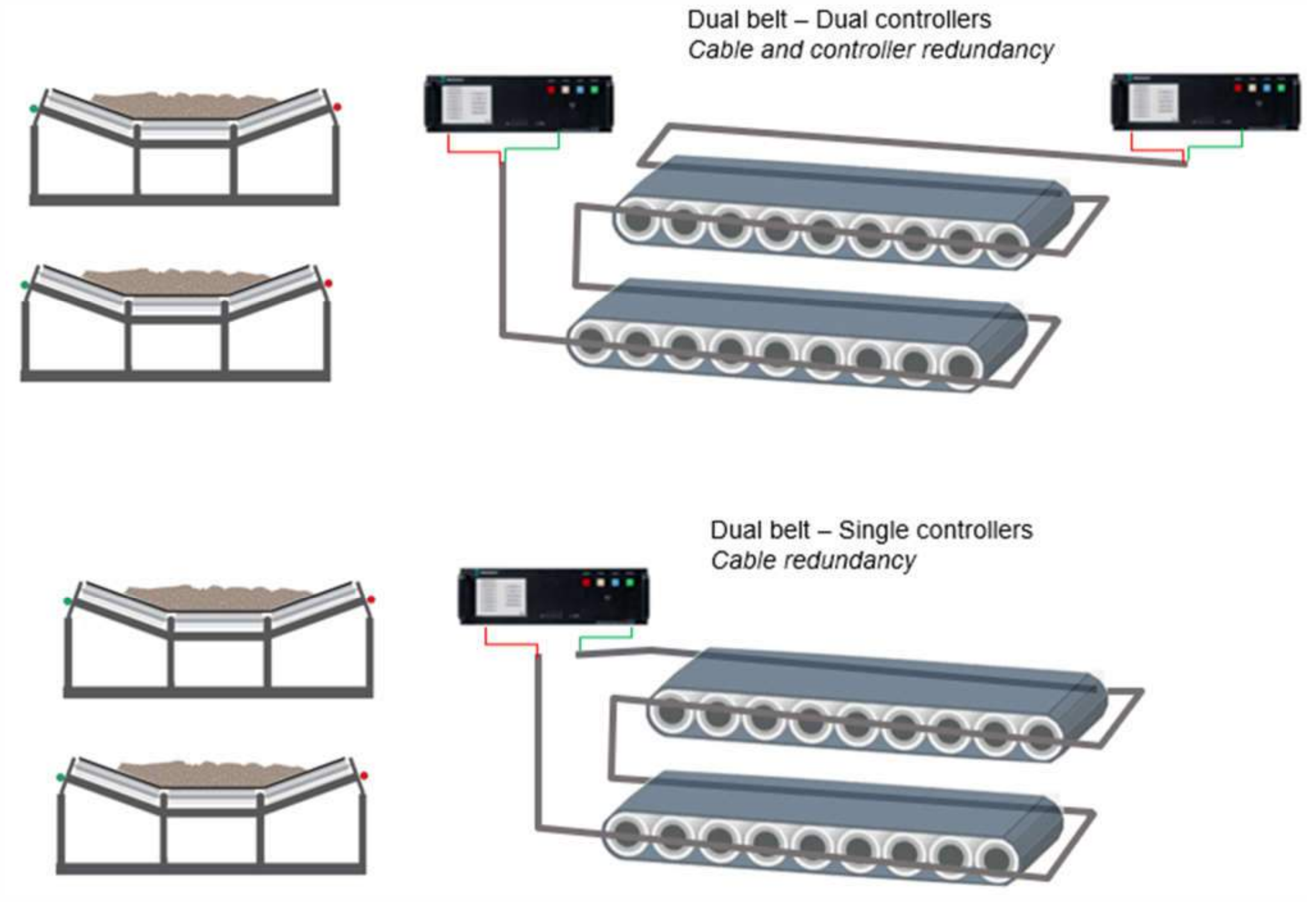

Figure 10 - Cable and controller redundancy example

ABOUT BANDWEAVER TECHNOLOGIES

Bandweaver has been providing advanced fiber optic monitoring sensors and integrated technologies since 2002. With an installed base of over 60,000km and 8,000 systems installed, our knowledge regarding the application of distributed temperature sensing technology and linear heat detection within the fire industry is second to none. We focus on the safe integration of FireLaser DTS technologies into clients' proprietary systems and Bandweaver and our partners provide exceptional systems design support, product support during installation and provide long term maintenance packages.

For further information please contact our global team at info@bandweaver.com