FiberPatrol®

Ranging Fiber Optic Fence Protection Sensor

Site Planning & Installation Guide

FP1100X/FP1400 series

FPDA0102-401, Rev F
January 8, 2019

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Compliance

The use of shielded cables is required for compliance.

Canada: This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

USA: This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including any interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Any changes or modifications to the software or equipment that are not expressly approved by Senstar Corporation void the manufacturer’s warranty, and could void the user’s authority to operate the equipment.

Europe: This device conforms to EC low voltage directive 2006/95/EC.

CE

Senstar Corporation’s Quality Management System is ISO 9001:2015 registered.

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1 System description

Principles of operation

The FiberPatrol fence-mounted perimeter intrusion detection sensor system, detects and locates intruders using fiber optic technology. FiberPatrol senses and locates minute vibrations in the fence fabric caused by climbing, cutting, lifting, or otherwise disturbing the fence fabric. A fiber optic sensor cable is attached to a perimeter fence. The controller unit transmits a laser light into two single-mode fibers in the sensor cable. The controller picks up the back-scatter reflections caused by fence motion or vibrations in the fence fabric and sends the data to the processor unit. The processor determines the magnitude and location of the disturbance, and triggers an alarm when the disturbance meets the criteria for a valid intrusion.

The sensor cable is a communication-grade single-mode fiber optic cable intended for outdoor installation. The cable includes two dedicated sensing fibers. Depending on the particular fiber optic cable used, at least 10 dark fibers are available for other perimeter applications (e.g., CCTV, data communication, etc.). The sensor cable is generally available in lengths up to 12 km (7.5 mi.) and requires professional installation using telecom industry standard practices. All fiber splices require fusion splicing, and the sensor unit fiber optic connections use FC/APC type connectors.

FiberPatrol can operate as a standalone sensor, which communicates alarm conditions via optional relay output modules. A PC-based security management system, such as the Alarm Integration Module, or StarNeT, can serve as the primary operator interface for a FiberPatrol system. FiberPatrol can also report alarms to 3rd party security management systems (SMS) via the Network Manager Service. The security management system monitors the FiberPatrol sensor, and can report alarms to an operator on a graphical site-map.

The FiberPatrol system includes Windows-based configuration software, which is used to setup and calibrate the system. The configuration software enables sensor calibration, detection parameter adjustments and system configuration settings.

FiberPatrol sensor system details

- passive, fiber optic, fence mounted outdoor perimeter intrusion detection system
- uses standard outdoor rated telecommunication grade single-mode fiber optic cables
- additional dark fibers available for auxiliary perimeter device communications
- models available for single pass coverage for fences up to 3 m (10 ft.) high
- no power required for outdoor components
- outdoor components unaffected by lightning, EMI, or electrical transients

- outdoor rated splice enclosures for fiber termination and access to fibers
- indoor components are rack-mountable in a standard EIA 19 in. equipment rack:
  - processor - locates disturbance, triggers alarms, monitors system status, includes FiberPatrol system software, configuration software and Network Manager software
  - controller - transmits laser light into two dedicated fibers and receives and isolates back-scatter signals, analyzes received signal, passes information to processor for analysis
  - start module - 1RU splice tray for connecting non-detecting lead cable to patch cables in the equipment room, separates the backscatter reflections from the transmitted laser light, and passes the backscatter to the controller unit
  - LCD keyboard/monitor/mouse combo - 1 RU user interface provides control, maintenance, calibration and configuration access to the FiberPatrol processor

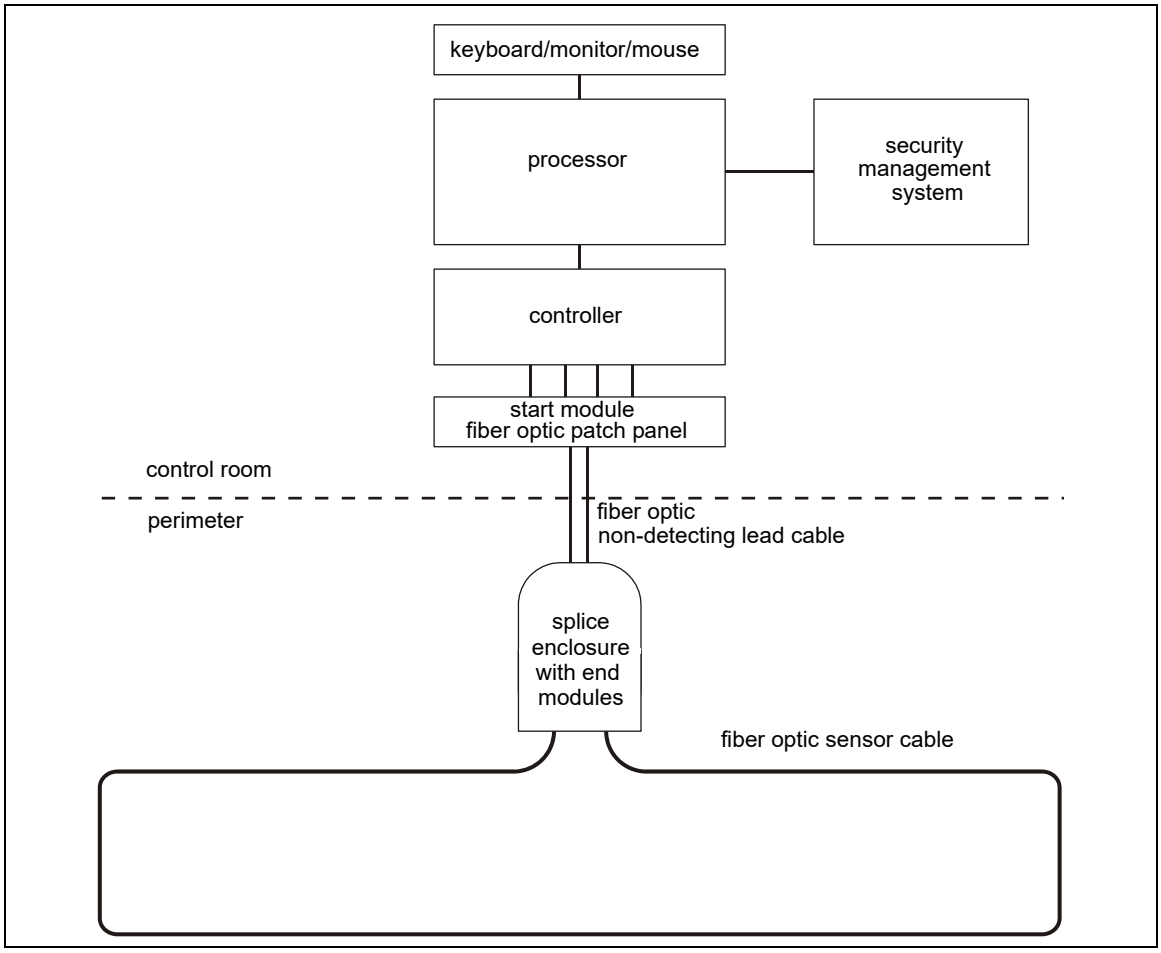


Figure 1: FiberPatrol block diagram - fully closed loop redundant configuration

FP1100X configurations

There are three distinct configurations for the FP1100X series sensor:

- Loop configurations in which the two sensors run in opposite directions in the fiber optic cable.
- Split configurations in which the two sensors run in opposite directions, in two fiber optic cables.
- Line configurations in which both sensors run in the same direction in the fiber optic cable.

The loop configuration provides single cable cut immunity whereby detection will continue over the full length of the perimeter in the event of a single cut in the sensor cable. In the split configuration,

the two sensors work independently to provide twice the linear length of protection as compared to the loop configuration. However, a cut cable ends detection beyond the point of the cut. In the line configuration, the two sensors run in the same direction in the sensor cable and work in tandem for alarm detection. With the line configuration, a cut cable ends detection beyond the point of the cut.

Alarm reporting

The FiberPatrol sensor can be incorporated into any system, which accepts contact closure alarm data. However, contact closure alarm notification does not provide precise target location. A contact closure based FP1100X Series system can be configured to report up to 262 distinct alarm zones, plus system supervision and fail alarms through the UltraLink I/O system. A contact closure based FP1400-08 system can be configured to report up to eight distinct alarm zones (up to 28 alarm zones via the optional add-on modules) plus system supervision and fail alarms through the UltraLink I/O system. The FP1400-12 system can be configured to report up to twelve distinct alarm zones (up to 44 alarm zones via the optional add-on modules) plus system supervision and fail alarms.

The FiberPatrol sensor can communicate with third party security management systems through the Network Manager Interface. In this case, the FiberPatrol security perimeter can be displayed on a graphic site map as a series of alarm zones (e.g., when a sensor alarm occurs, the zone flashes to identify the alarm's location). Key features of a FiberPatrol system include:

- user-configurable alarm zone display
- fast response time (1 second or less)
- digital recording of alarm history
- FP1100X Series - up to 1440 software defined alarm zones (software defined alarm zones enable the redistribution of alarm zones and zone lengths to accommodate changes in security equipment and requirements)
    - alarm location accuracy typically within 4 m (13 ft.) increases the overall efficiency of the entire security system
- FP1400-08 - up to 8 software defined alarm zones (software defined alarm zones enable the redistribution of alarm zones and zone lengths to accommodate changes in security equipment and requirements)
    - up to 28 software defined alarm zones via optional add-on modules
- FP1400-12 - up to 12 software defined alarm zones (software defined alarm zones enable the redistribution of alarm zones and zone lengths to accommodate changes in security equipment and requirements)
    - up to 44 software defined alarm zones via optional add-on modules

FP1100X Series Cable length requirements

Note	The distance reported by the FiberPatrol sensor unit is the optical distance of the sensor fiber within the cable. This length is similar to a measurement made by OTDR equipment. The optical distance can be up to 3% greater than the cable length due to the Helix factor of the fiber optic cable.

Note	To ensure that there is enough sensor cable to cover the fence and any installation variations, Senstar recommends ordering a 15% overage (e.g., to protect 1 km of fence, order 1.15 km of sensor cable).

The FiberPatrol FP1100X Series fence protection system is available in eight models, which are based on the required length of fiber optic cable. Careful site planning is essential to ensure the components that are ordered, are the correct components for the application. The following table includes the FP1100X Series models that are available for fence-mounted applications:

Model number	Description
FP1100X-01	• up to 1.5 km (0.93 mi.) of detection processing for cut-immune configurations • up to 3 km (1.86 mi.) of detection processing for non cut-immune configurations
FP1100X-03	• up to **3 km (1.86 mi.)** of detection processing for cut-immune configurations • up to 6 km (3.73 mi.) of detection processing for non cut-immune configurations
FP1100X-06	• up to 6 km (3.73 mi.) of detection processing for cut-immune configurations • up to 12 km (7.46 mi.) of detection processing for non cut-immune configurations
FP1100X-09	• up to 9 km (5.59 mi.) of detection processing for cut-immune configurations • up to 18 km (11.18 mi.) of detection processing for non cut-immune configurations
FP1100X-12	• up to 12 km (7.46 mi.) of detection processing for cut-immune configurations • up to 24 km (14.91 mi.) of detection processing for non cut-immune configurations
FP1100X-16	• up to 16 km (9.94 mi.) of detection processing for cut-immune configurations • up to 32 km (19.9 mi.) of detection processing for non cut-immune configurations
FP1100X-20	• up to 20 km (12.43 mi.) of detection processing for cut-immune configurations • up to 40 km (24.85 mi.) of detection processing for non cut-immune configurations
FP1100X-25	• up to 25 km (15.53 mi.) of detection processing for cut-immune configurations • up to 50 km (31.07 mi.) of detection processing for non cut-immune configurations

FP1400 sensors

The FiberPatrol FP1400 Series fence protection system is available in two models:

The FiberPatrol FP1400-08 system provides up to 2.5 km (1.55 mi.) of combined fiber optic sensor cable and non-detecting lead cable and reports alarm conditions in 8 independent alarm zones (expandable to 28 alarm zones via the optional add-on modules).

The FiberPatrol FP1400-12 system provides up to 5 km (3.1 mi.) of combined fiber optic sensor cable and non-detecting lead cable and reports alarm conditions in 12 independent alarm zones (expandable to 44 alarm zones via the optional add-on modules).

FiberPatrol components

Processor

The FiberPatrol processor supports two independent fiber optic sensors (S1, S2) and can monitor up to 1440 distinct alarm zones. The alarm zones are defined in software, and do not depend on cable length. The processor operates on 100 to 240 VAC, 50/60 Hz power and can annunicate alarm conditions with contact closure outputs or via the Network Manager software. The processor has dual redundant power supplies, which include an audible alert output that is activated in the event that one of the power supplies fails. There is a pushbutton switch located between the two power supplies that will silence the alert tone. Figure 2: illustrates front and rear views of a FiberPatrol processor and controller.

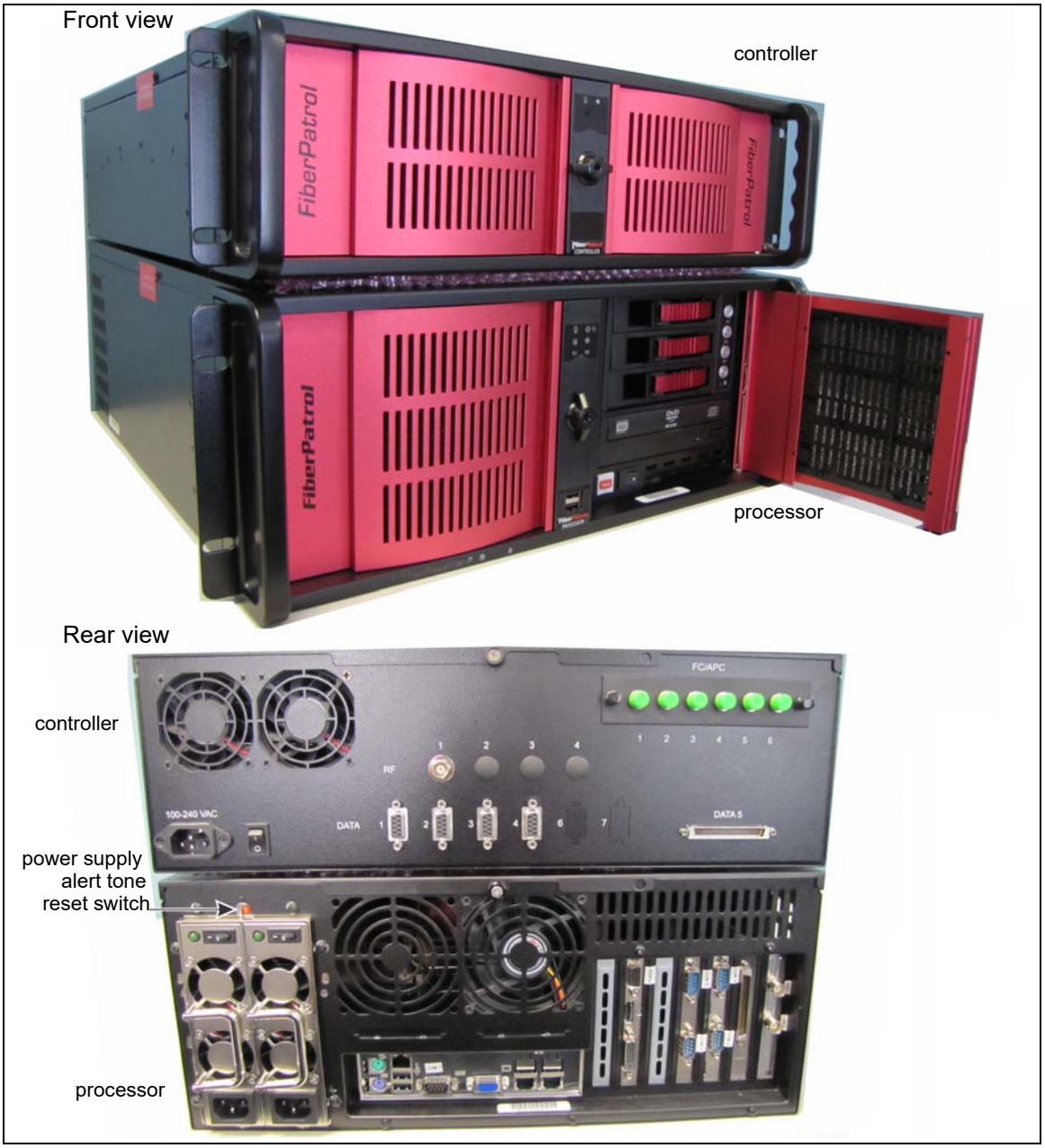


Figure 2: FiberPatrol processor

Controller

The FiberPatrol controller (see Figure 2:) generates the laser light signal that is transmitted into the fiber sensors. The controller collects the backscatter reflections created by vibrations in the protected fence, analyzes the signal, and passes the data to the processor.

Start module/fiber patch panel

The start module (see Figure 3:) connects the non-detecting lead cable to the sensor unit in the equipment room. The start module is housed in a 1 RU fiber patch panel along with a splice tray. The two sensor fibers from the lead cable must be spliced to two fibers from the start module. Four additional fibers from the start module are factory spliced to four fiber pigtails, which are attached to FC/APC connectors on the outside of the of the enclosure. Fiber patch cables then connect the four fibers to the FiberPatrol controller. The splice tray includes six unused protective sleeves, which are available to provide access to the dark fibers in the lead/sensor cable. Optionally, a second splice tray can be added to the enclosure, to make connections to any additional fibers that are being used. In some configurations, an end module is incorporated into the start module enclosure inside the rack mounted fiber patch panel. Refer to Chapter 2, Site planning for additional details.

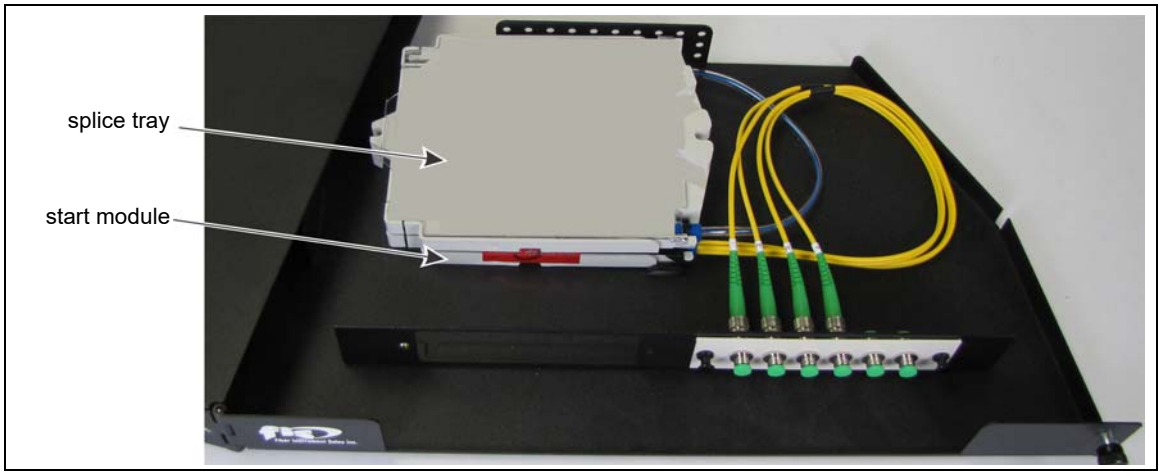


Figure 3: FiberPatrol start module/splice tray

Outdoor splice enclosure

The outdoor splice enclosure houses all field splices for the FiberPatrol system. The splice enclosure is also used to protect the FiberPatrol end module when it is installed outdoors. The splice enclosure is generally mounted on the protected fence.

Figure 4: FiberPatrol outdoor splice components

End module

The end module terminates the laser light at the end of each detecting fiber, without causing undesirable reflections. There are 3 types of end modules available, a single end module (FPMA0212) a double end module (FPMA0222) and a combined double start/end module (FPMA0223).The end module can be located outdoors in a splice enclosure or indoors with the start module, in the fiber patch panel. The location of the end module depends on the sensor cable configuration.

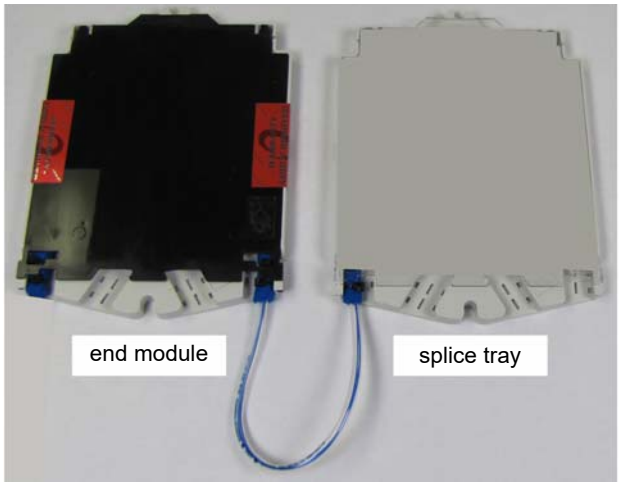
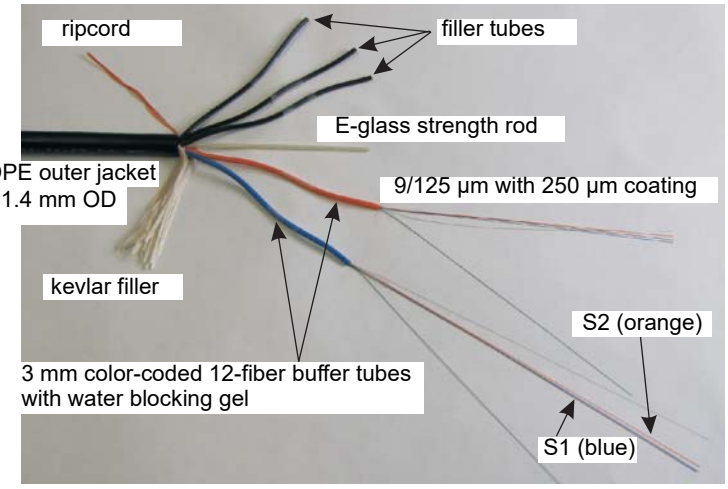


Figure 5: FiberPatrol outdoor splice components

Sensor cable/non-detecting lead cable

FiberPatrol sensor cable is telecommunication grade single-mode fiber optic cable with a medium density polyethylene outer jacket and a waterblock system. The non-armored loose tube cable is comprised of a 5 unit fiber optic core (PE filler units and 12-fiber/6-fiber buffer tubes) a central strength member and a rip cord. Sensor cable can be ordered in lengths to match application requirements. The non-detecting lead cable is identical to the sensor cable, with detection sensitivity being controlled via software.



blue tube fiber designations

fiber #	color	designation
1	blue	S1
2	orange	S2
3	green	dark
4	brown	dark
5	gray	dark
6	white	dark
7	red	dark
8	black	dark
9	yellow	dark
10	purple	dark
11	rose	dark
12	aqua	dark

Figure 6: FiberPatrol sensor cable description

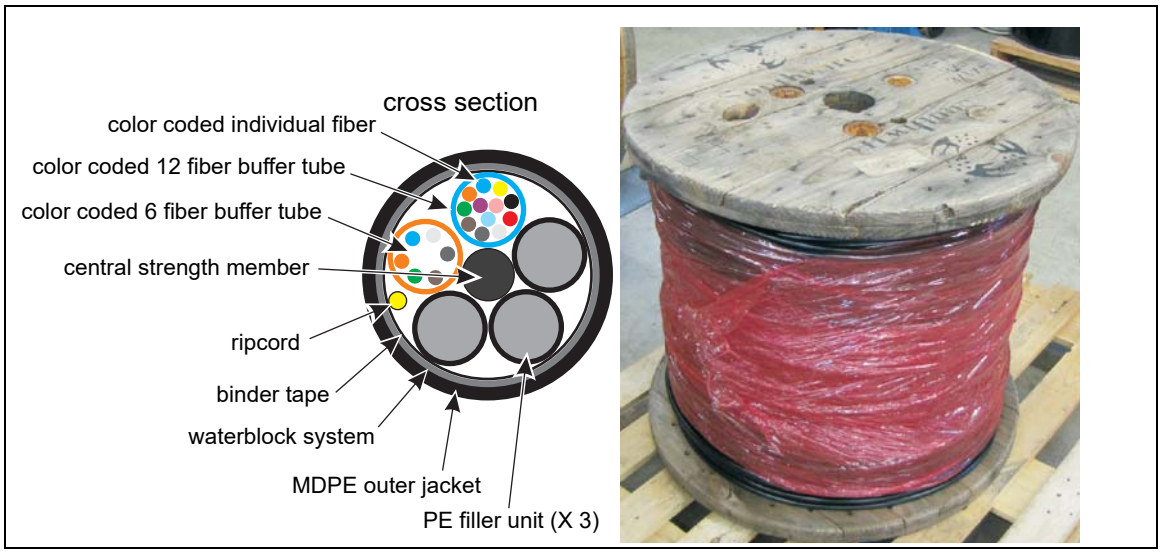


Figure 7: FiberPatrol sensor cable/non-detecting lead cable

Cable ties

FiberPatrol sensor cable is attached to the fence with stainless steel cable ties. The stainless steel cable ties provide long life and a high level of security. A cable tie tool is required to attach the stainless steel ties to the fence. The stainless steel cable ties are available with bare metal or vinyl coated in lengths of 8, 14, and 20 inches. For situations in which the FiberPatrol cable will be installed on a temporary fence and will be redeployed later, UV resistant polyethylene cable ties are recommended.

Sensitivity loops

Corner posts, terminal posts and heavy gauge tension posts generally have a dampening effect on nearby fence vibrations. To compensate for this, use sensitivity loops at all corner posts, terminal posts and heavy gauge tension posts on the fence. The sensitivity loops provide additional sensor cable for areas that typically produce lower levels of fence noise (see Figure 32).

Service loops

Service loops provide extra sensor cable for making future repairs, and for making fusion splices. A 10 m (33 ft.) service loop is recommended for every 300 m (984 ft.) of installed sensor cable. A 10 m service loop is also recommended on the hinged side of each gate that is protected by sensor cable. In addition, a 10 m (33 ft.) splice point service loop is required for each section of sensor cable at all splice enclosure locations. A 10 m service loop is typically comprised of 5 circular loops of cable with a 60 cm (2 ft.) diameter (see Figure 34).

Isolation loops

Isolation loops are optional, but are recommended for situations where a zone needs to be isolated from adjacent zones (e.g., gate isolation). Isolation loops are also recommended as a buffer between detecting sensor cable and software defined non-detecting cable. Fence-mounted isolation loops use 14 in. steel cable ties to secure 7 loops of sensor cable to the fence. The 7 loops have a 60 cm (2 ft.) diameter, which requires approximately 13 m of sensor cable.

Buried vault

Another method for zone to zone isolation is to move the sensor cable off the fence through conduit and then form a 13 m (43 ft.) isolation loop inside a buried vault. The cable is then run through another section of conduit and back onto the fence where it continues as another zone. Figure 8: provides the dimensions for the FiberPatrol buried vault.

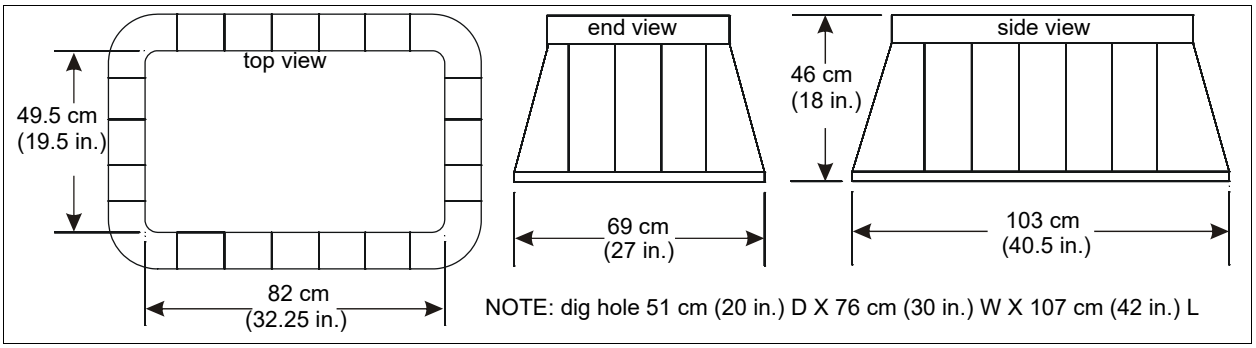


Figure 8: Buried vault dimensions

2 Site planning

FiberPatrol configurations

The recommended method for installing FiberPatrol sensor cable is to use the minimum number of splices possible; i.e., run a single length of cable from the equipment room to the fence, and continue for as far as site conditions will allow you to go. Use splices for the start module, the end module, and at any site features where a continuous run of cable is impractical or impossible.

Loop configurations

The loop configuration provides single cable cut redundancy for a closed perimeter. The sensor unit is located anywhere along the perimeter length with the start and end points of the detecting sensor cables co-located in a splice enclosure. Non-detecting lead cable carries the signal from the sensor unit to the start point of the detecting cable. The two sensing fibers S1 and S2 run in different directions around the perimeter. In the event of a cut or severely damaged sensor cable, detection will continue around the perimeter in both directions to the location of the damage. There are two types of redundant loop configurations, fully closed and partially closed. Figure 9 provides a comparison of the two.

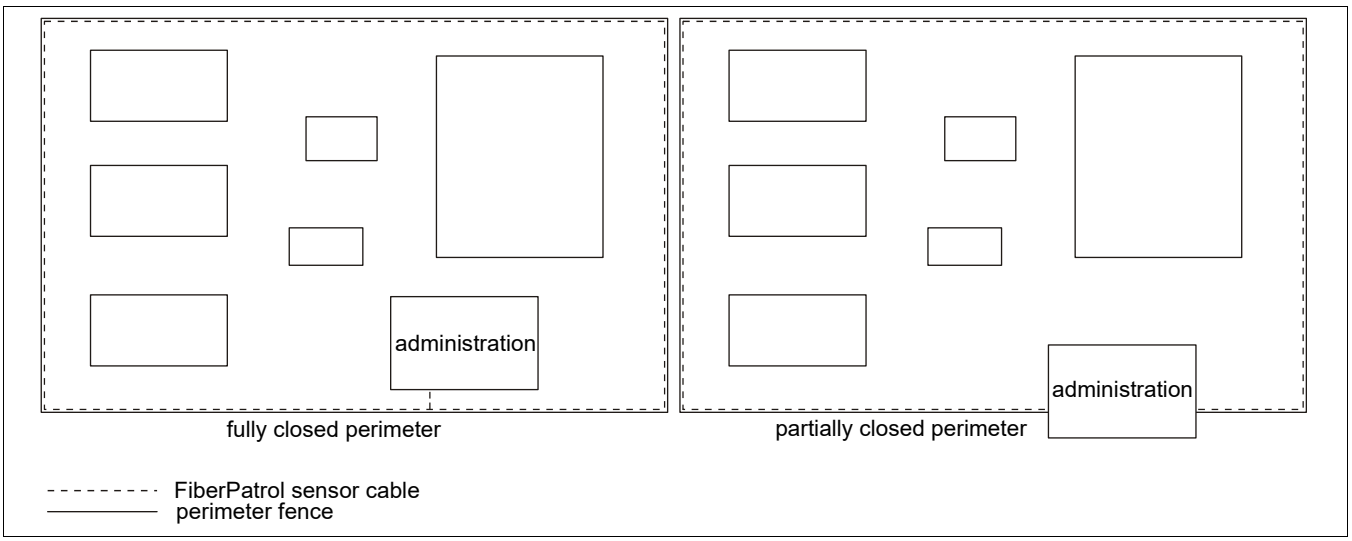


Figure 9 FiberPatrol example fully closed & partially closed configuration comparison

In some instances it is desirable to have a single length of cable running between the equipment room and the start of the perimeter. This is most common in installations where the sensor unit equipment is located at a distance from the perimeter. In this case, a dual start/dual end module is located in the equipment room, and a single lead cable runs to the perimeter fence. Fusion splices are used to join S1 (blue) in the lead cable to S1 (blue) in the detecting cable. S1 blue runs around the perimeter and is spliced to S1 (green) in the lead cable going back to the end module in the equipment room. S2 (orange) in the lead cable is spliced to S2 (orange) in the detecting cable. S2 orange runs around the perimeter and is spliced to S2 (brown) in the lead cable going back to the end module in the equipment room (see Figure 10).

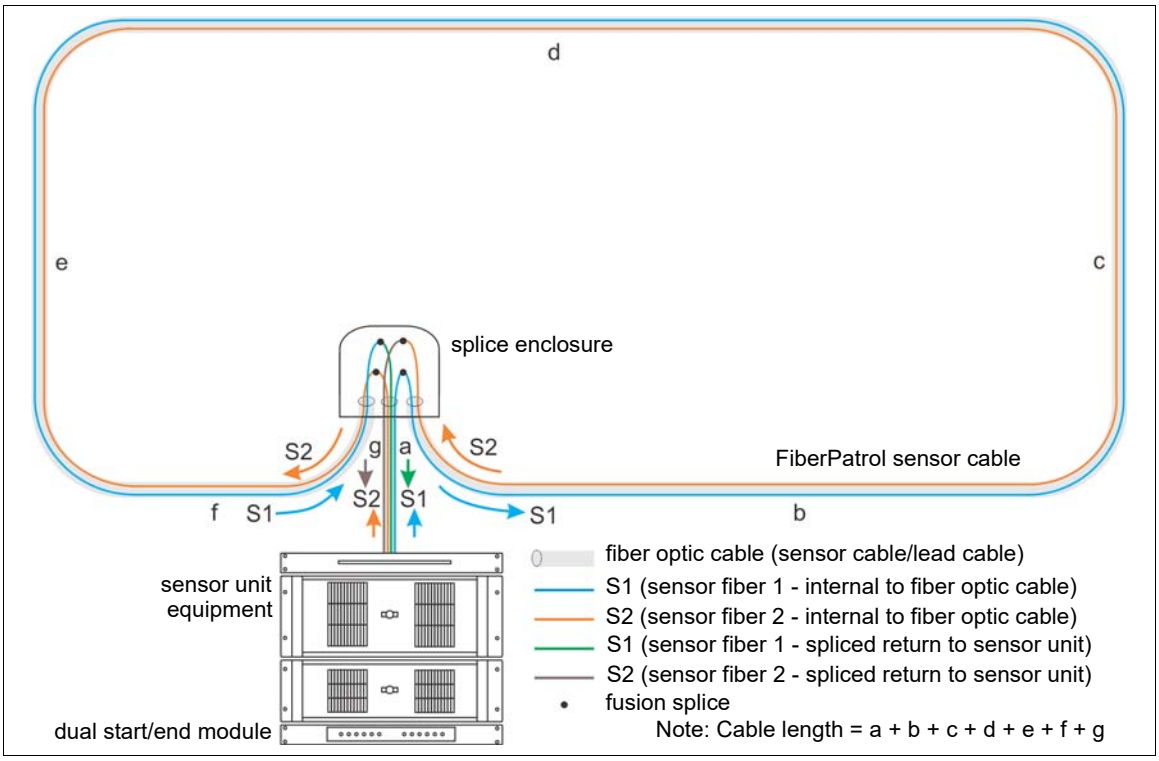


Figure 10 FiberPatrol fully closed redundant loop configuration

A fully closed perimeter can also be obtained by using a dual start module in the equipment room and a dual end module located inside a splice enclosure at the start of the perimeter. A single lead cable runs from the equipment room to the perimeter and S1 and S2 run in opposite directions around the perimeter with both terminated in the start point splice enclosure (see Figure 11).

The partially closed loop configuration uses a dual start/end module in the equipment room and has two lead cables. This configuration also provides single cut redundancy for a partially closed perimeter. The two sensing fibers S1 and S2 run in different directions around the perimeter. In the event of a cut or severely damaged sensor cable, detection will continue around the perimeter in both directions to the point of the damage.

Open-ended loop configuration

The open-ended loop configuration provides single fiber break redundancy for an open-ended perimeter. The sensor unit can be located anywhere along the perimeter length with the start and end points of the detecting sensor cables located at opposite ends. The two sensing fibers S1 and S2 run in different directions for the length of the cable. Two additional fibers are used to bring the lead fibers to the opposite ends of the perimeter, where they are spliced to the detecting fibers. The two detecting fibers run from one end of the perimeter to the other in opposite directions (see Figure 13).

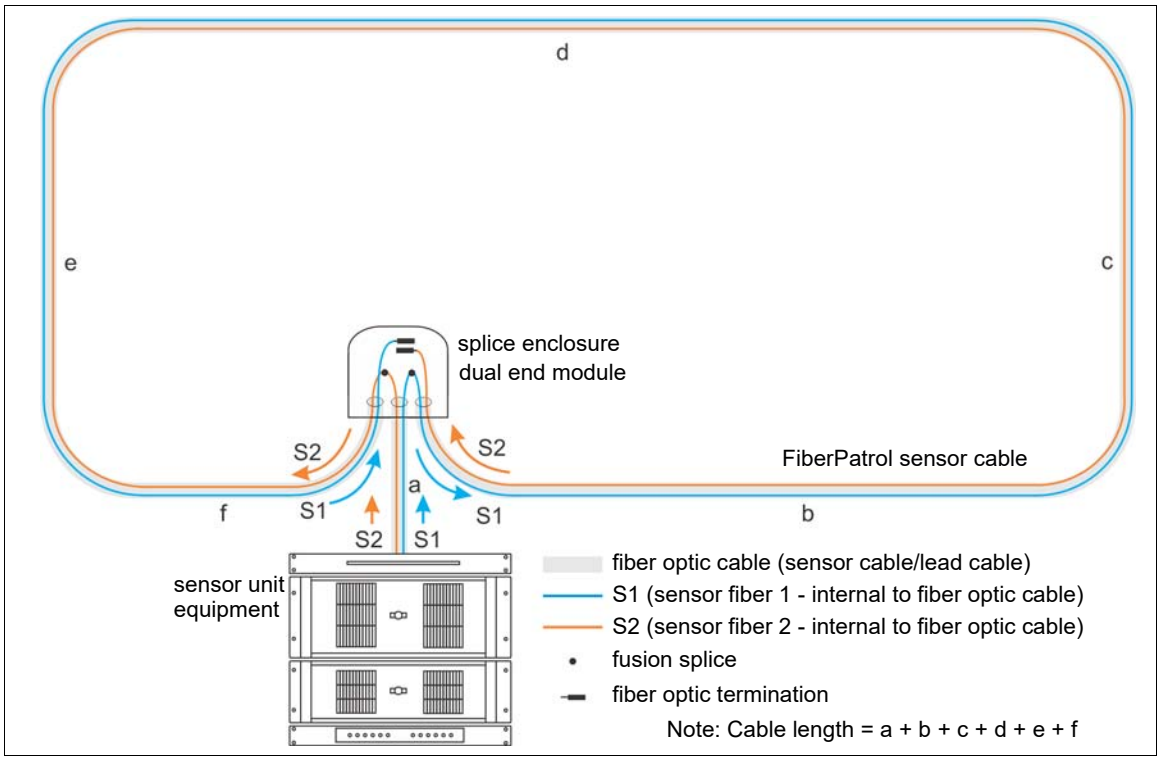


Figure 11 FiberPatrol fully closed redundant loop configuration

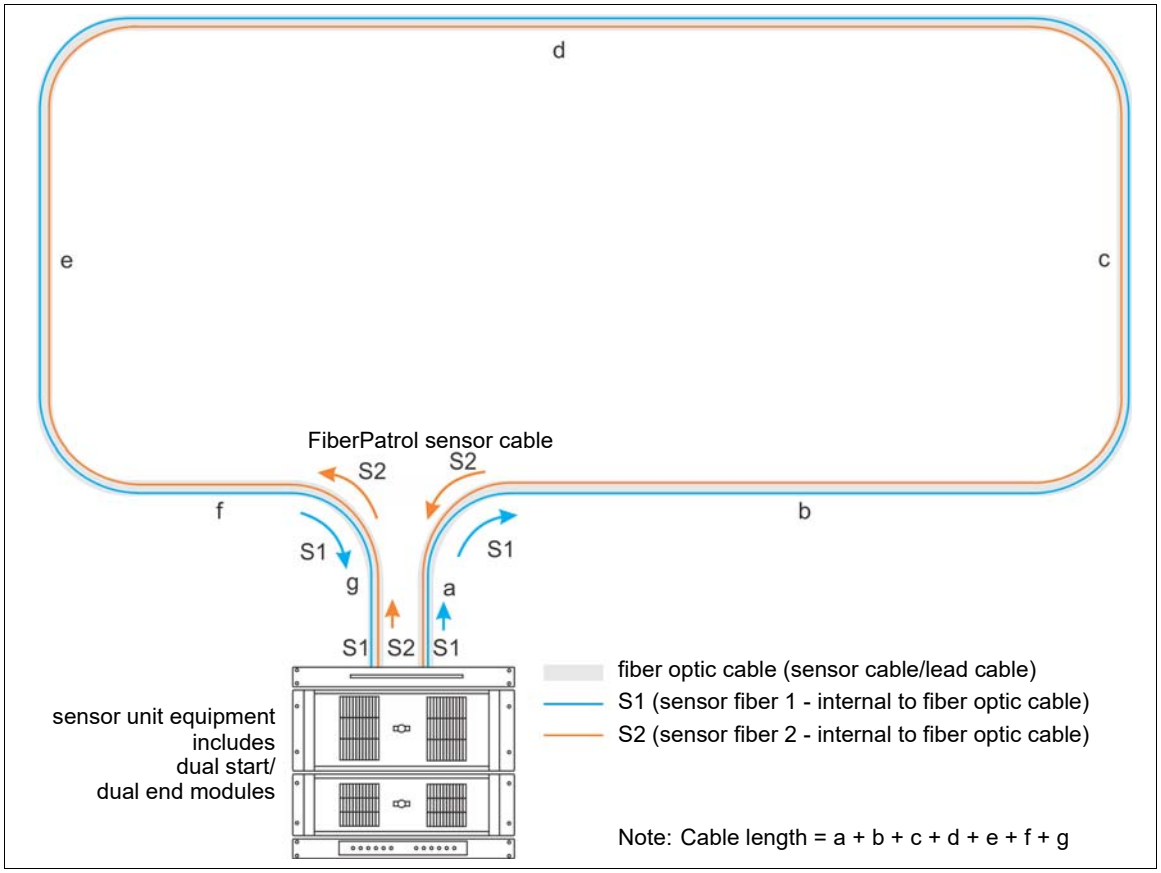


Figure 12 FiberPatrol partially closed redundant loop configuration

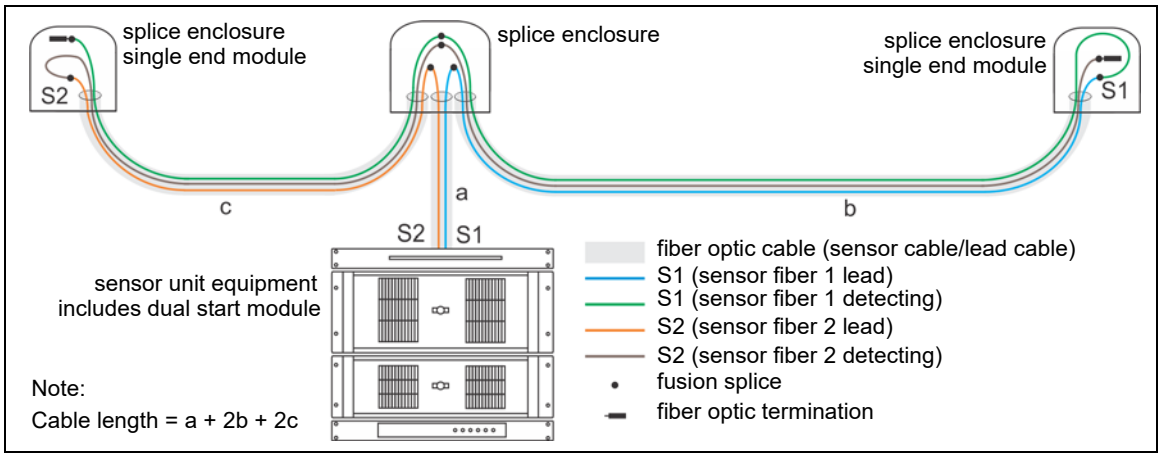


Figure 13 FiberPatrol open-ended loop configuration

Split configuration

The split configuration provides extended length coverage for an open-ended perimeter. To get the maximum length coverage the sensor unit is located near the mid-point of the protected section of fence. The sensor cable runs in opposite directions along the fence with each end module located up to 25 km away from the sensor unit. One sensor fiber provides detection in each direction with S1 running in one direction and S2 running the opposite way. A splice enclosure is required at the start point on the fence to use one lead cable from the sensor unit to the perimeter (see Figure 14). Using two lead cables eliminates the need to have the start point splice (see Figure 15).

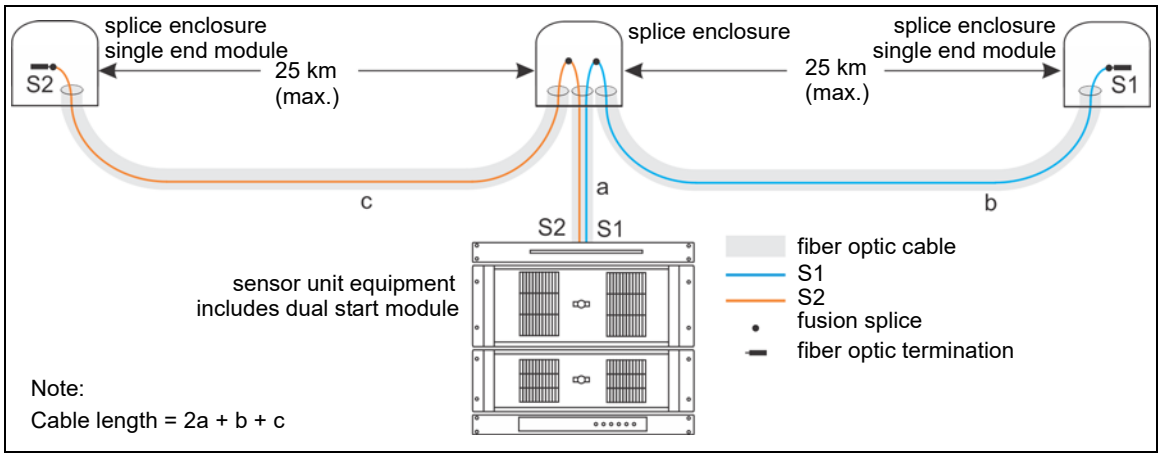


Figure 14 FiberPatrol split configuration (1 lead cable)

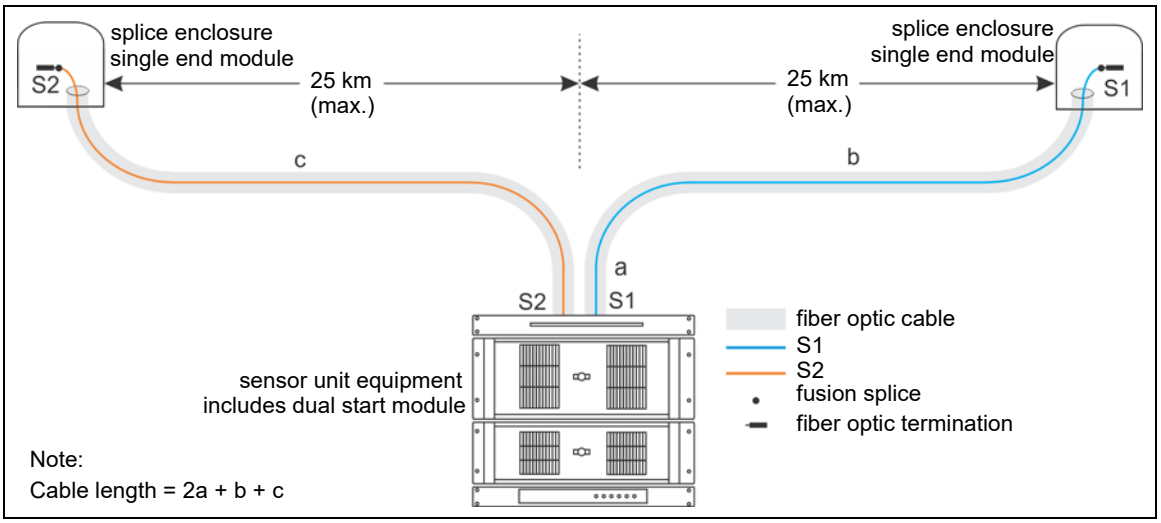


Figure 15 FiberPatrol split configuration (2 lead cables)

Line configurations

The line configuration is typically used when the sensor unit equipment is located at one end of the protected perimeter, and the perimeter extends away from the equipment room in one direction. The line configuration does not provide single cut redundancy for the full length of the sensor cable. In the event of a cut or severely damaged sensor cable, detection will continue between the start of the detecting sensor cable and the cut/damaged point in the cable. Figure 16 and Figure 17 illustrate the line configuration.

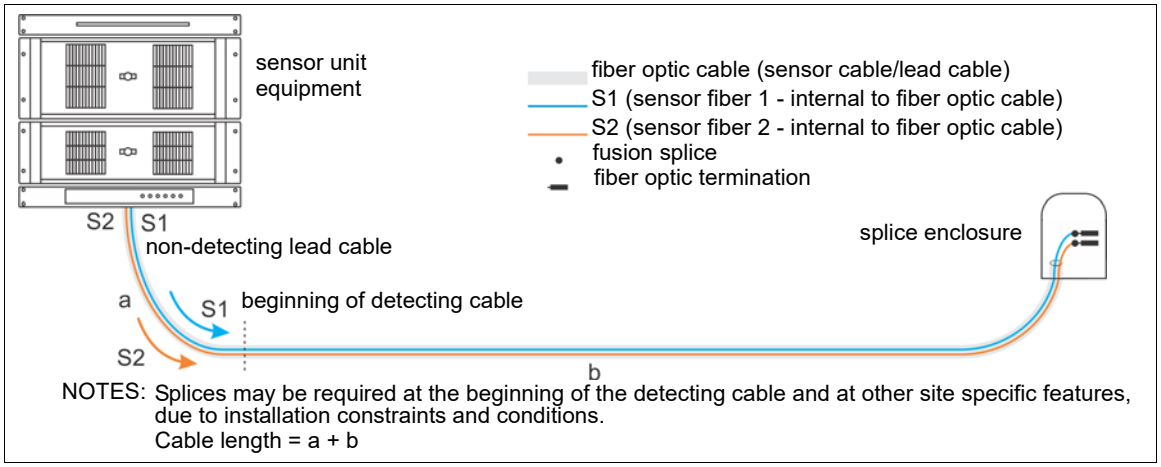


Figure 16 Recommended line configuration

If necessary, the non-detecting lead cable can be spliced to the detecting cable at the start point of the sensor cable. Splices may also be required for other site specific features.

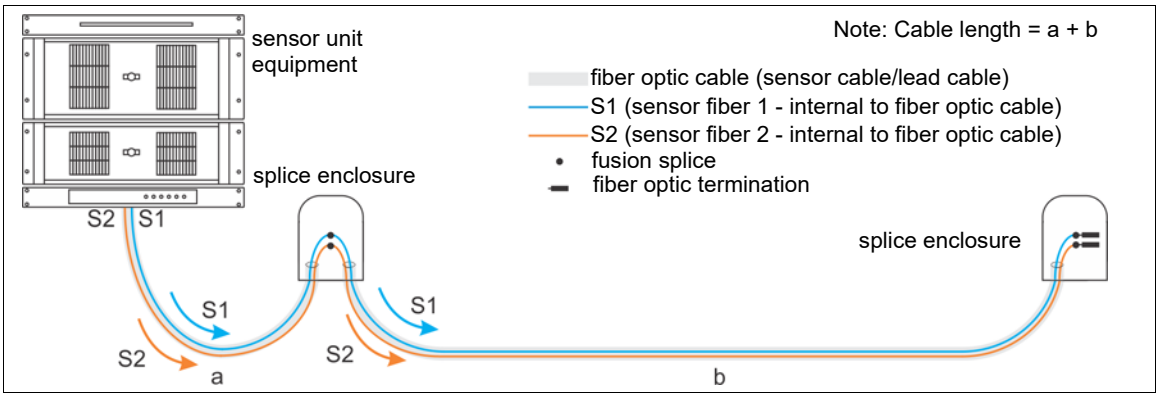


Figure 17 line configuration with start point splice

Extended lead configuration

The extended lead configuration is a variation of the line configuration in which lead cable runs from the sensor unit to one end of the perimeter. The detecting fibers S1 and S2 run the full length of the perimeter from one end to the other. The extended lead configuration does not provide single cut redundancy for the full length of the sensor cable. In the event of a cut or severely damaged sensor cable, detection will continue between the start of the sensor zone, and the cut/damaged point in the cable.

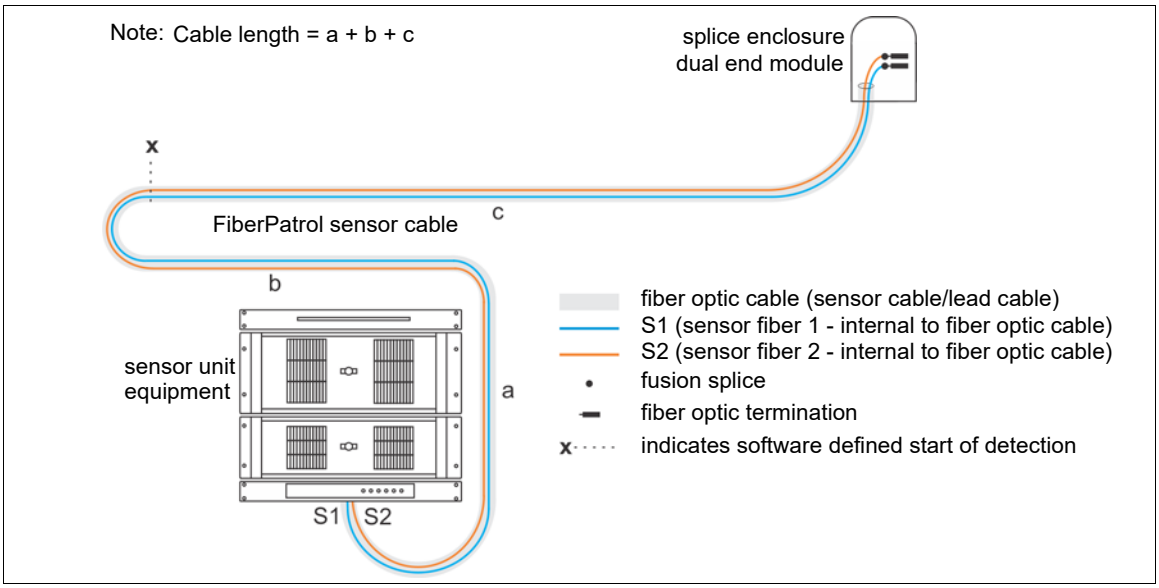


Figure 18 FiberPatrol extended lead configuration

Site survey

The first step in installing a FiberPatrol fence protection system is to conduct a detailed site survey. The survey assesses the site conditions to determine the specific installation requirements including the fence type, fence condition, fence length, zone layouts, sensor cable route, non-detecting lead cable length, length of sensor cable required to cover the perimeter, and the location for the electronic components.

Create a scale drawing of the site (e.g., CAD drawings), which indicates the locations of:

- fences (include type and condition)
- gates (include type and size)
- buildings and other structures
- roads, driveways, sidewalks, paths, parking areas
- trees, bushes, dense vegetation (near perimeter)
- location of sensor cable
- other existing or planned security devices (e.g., CCTV cameras, security lighting, etc.)

Fences

The fence must be properly installed, maintained, and tensioned, to provide effective intrusion detection with FiberPatrol. The fence should be uniform in height and quality, and should be high enough to present an effective barrier against climb-over intrusions. It is also recommended that a climb-over barrier, such as barbed wire or concertina, be installed along the top of the fence. The condition of the fence is critical to the efficient operation of the FiberPatrol sensor system. Breaks in the fence structure, or slack portions of the fence fabric, will inhibit the transmission of the fence vibrations to the sensor cable. Poor fence conditions can also cause metal on metal contact noise that will result in nuisance alarms.

Note	Fences used in conjunction with the FiberPatrol sensor must meet industry standards for security fences.

Chain-link fences

The chain-link fence fabric should meet the following specifications:

- maximum range of deflection 10 cm (4 in.) when a 22.5 kg (50 lb) force is applied perpendicular to the center of a panel (pushing and pulling) (based on 3 m, 10 ft. post spacing)
- minimum height of 2.4 m (8 ft.) with climb-over deterrent hardware securely mounted on top

Note	Any fence movement which can cause metal-to-metal contact is a potential source of nuisance alarms.

Weld-mesh fences

A typical weld-mesh fence section consists of 3 mm (0.1 in.) diameter steel wire welded into a grid configuration, with horizontal spacing differing from the vertical spacing. These fence sections are secured to fence posts and to the adjacent fence panel sections. The sections of weld-mesh fence are either welded together or connected using clips, bolts or rivets. The minimum recommended

height for a weld mesh fence is 2.4 m (8 ft.) and climb-over deterrent hardware should be securely mounted on top. All components must be securely connected to prevent any metal on metal contact which can be caused by moderate to strong winds.

Fence height considerations

FiberPatrol will provide a good level of detection for fences up to 3 m (10 ft.) high with a single pass of cable. The single cable pass is installed at one-half the fence height unless the fence includes a middle rail. For fences with a middle rail, the sensor cable should be installed 30 cm (1 ft.) below the middle rail.

Note	Contact FiberPatrol for information about using the FiberPatrol sensor on fences that are greater than 3 m (10 ft.) high.

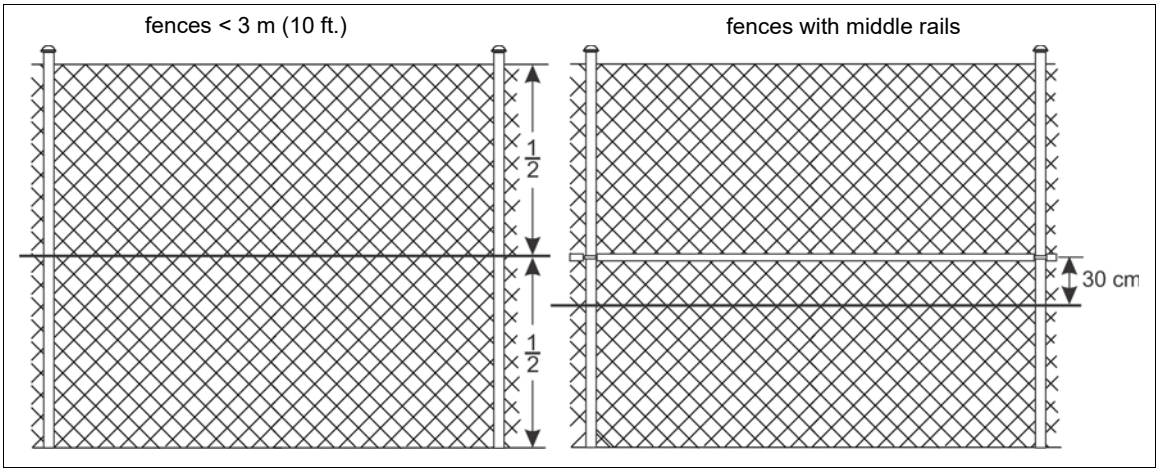


Figure 19 Recommended fence height/cable pass configurations

Note	For instances in which a portion of the fence is covered by a climb-over deterrent (i.e., razor ribbon/concertina) the fence height should be based on the uncovered portion of the fence. For example, a 3.7 m (12 ft.) fence with a 90 cm (3 ft.) coil of concertina wire covering the top section of the fence should be considered a 2.75 m (9 ft.) fence. The concertina wire must be securely attached to the fence to prevent any metal on metal contact resulting from environmental conditions.

Climb-over deterrent hardware

Barbed wire

Climb-over deterrent hardware is strongly recommended on perimeter fences under the following conditions. Barbed wire outriggers must be secure to prevent movement due to environmental conditions. Install bracing wires between the outrigger supports to prevent the barbed wires from spreading apart. Each barbed wire strand should be taut and tightly secured at each support. Any extension arms or outriggers attached to post tops should have a tight press-fit/set-screw or be spot-welded. Remove or fasten any loose or rattling material.

It is possible to install FiberPatrol sensor cable on barbed wire, but extra precautions must be taken to avoid damage to the sensor cable. Run the sensor cable along the fence and loop the cable up beside the fence posts. Secure the sensor cable to the barbed wire so that the cable

avoids contact with the barbs. Secure the cable where it crosses each outrigger. Run the cable past the outrigger and then back down to the half way height of the fence. Figure 20 shows the recommended method for installing sensor cable on barbed wire.

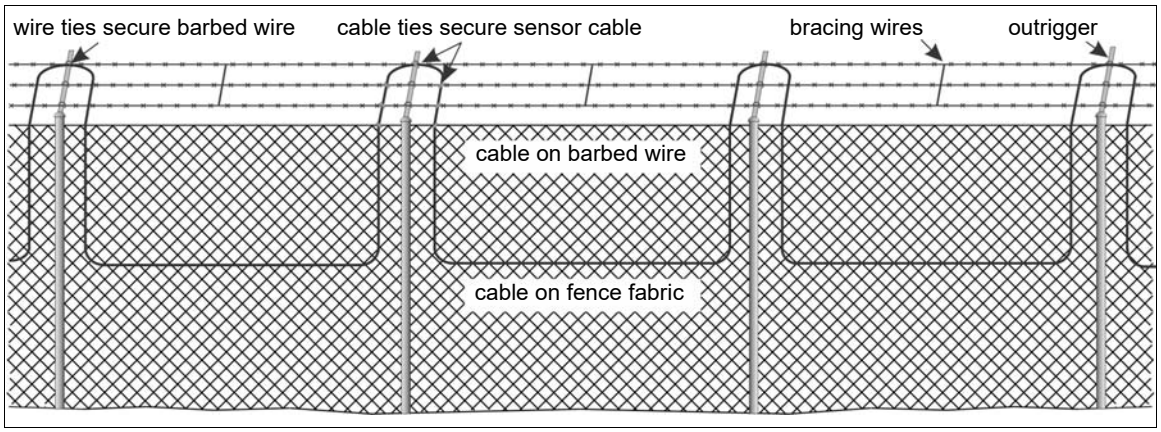


Figure 20 Sensor cable installation on barbed wire fence

Razor ribbon/concertina

FiberPatrol sensor cable can be installed on a fence that is protected with razor ribbon, providing the razor ribbon is secured so that it cannot move due to the wind, or other environmental factors. Use tensioning wires to secure the coil and to prevent the razor ribbon from separating if it is cut. Due to the nature of razor ribbon, FiberPatrol does not recommend installing sensor cable directly on the razor ribbon. Contact Senstar Customer Service if your application requires that sensor cable be installed on razor ribbon.

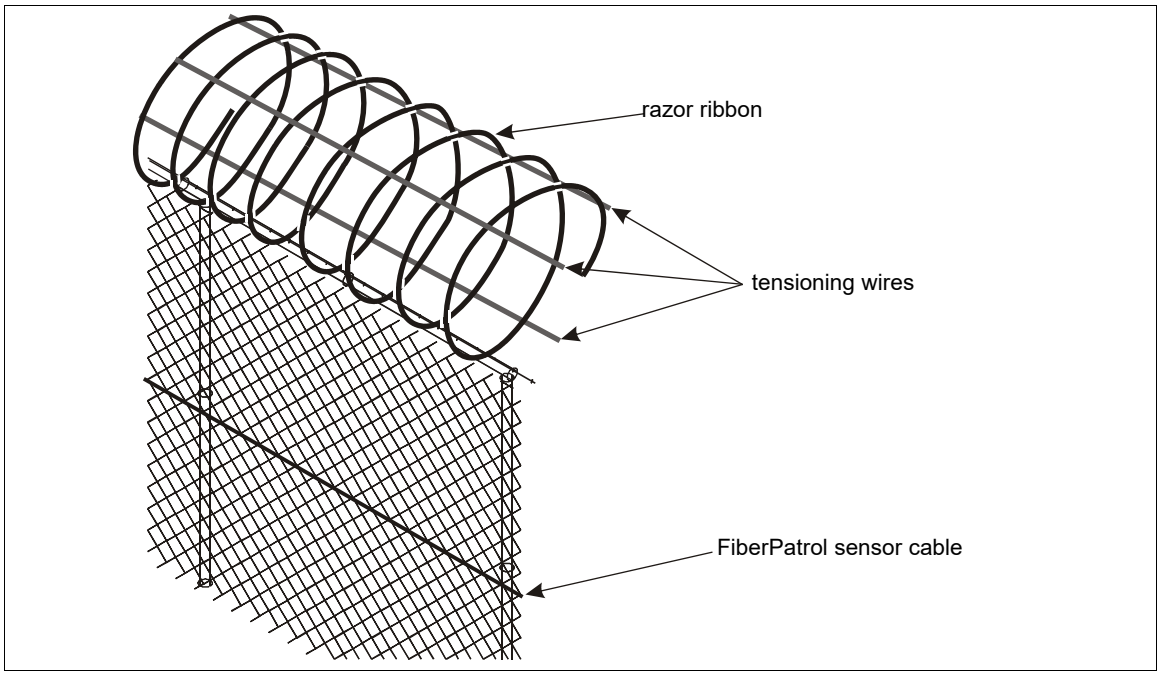


Figure 21 Razor ribbon

Gates

There are generally two types of gates used with fences, swinging gates and sliding gates. Sliding gates must be bypassed, and should be protected by another type of sensor (e.g., a microphonic non-fiber fence sensor, a microwave sensor, an IR beam). Swinging gates can be protected by FiberPatrol sensor cable. Protected gates should consist of fence fabric attached to a rigid frame that includes horizontal and vertical bracing. There are a number of factors that must be considered when planning for gates, including whether it's a single panel or double panel gate and the type of ground beneath the gate (for cable bypass). Other gate requirements and concerns include:

- firmly attach all gate hardware accessories (minimum free-play)
- make sure that double gates have travel stops (rigid anchors)
- prevent locking hardware from moving in the wind
- prevent sliding gate track hardware, supports, guides, etc., from rattling in the wind
- the direction that the protected gate opens (to the inside of the perimeter OR both directions)
- the frequency of gate use
- gate use when the sensor is active (does the gate need to be accessed while the rest of the fence is being protected)

Gate bypasses

Note	Bypassed gates should be protected with another sensor technology.

To get the sensor cable from one side of a gate to the other, the sensor cable is buried below ground inside conduit. The sensor cable continues the fence coverage beyond the gate. If site conditions make it impossible to dig underground to continue the coverage on the other side of a gate, install the cable above ground, over the gate, inside protective conduit.

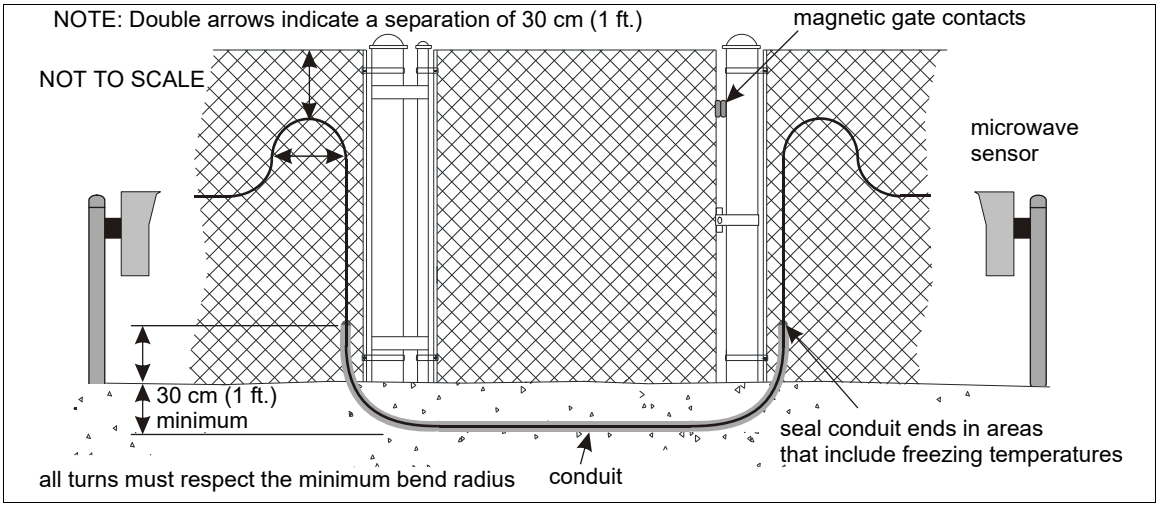


Figure 22 Gate bypass

Protecting swinging gates with FiberPatrol

To protect a swinging gate with FiberPatrol sensor cable, the sensor cable is passed through a section of split conduit that is attached to the fence post that also supports the gate's hinges. The sensor cable passes around the outside of the gate panel, 30 cm in from the edge of the gate, then passes through the split conduit a second time. The sensor cable is routed below ground through conduit, to the other side of the fence, where the fence protection continues. All hardware on the gate must be well secured to prevent any metal on metal contact while the gate is not in use. Excess sensor cable at a gate location is coiled into a service loop on the hinged side of the gate.

Note	FiberPatrol recommends creating a service loop on the hinged side of all protected gates.

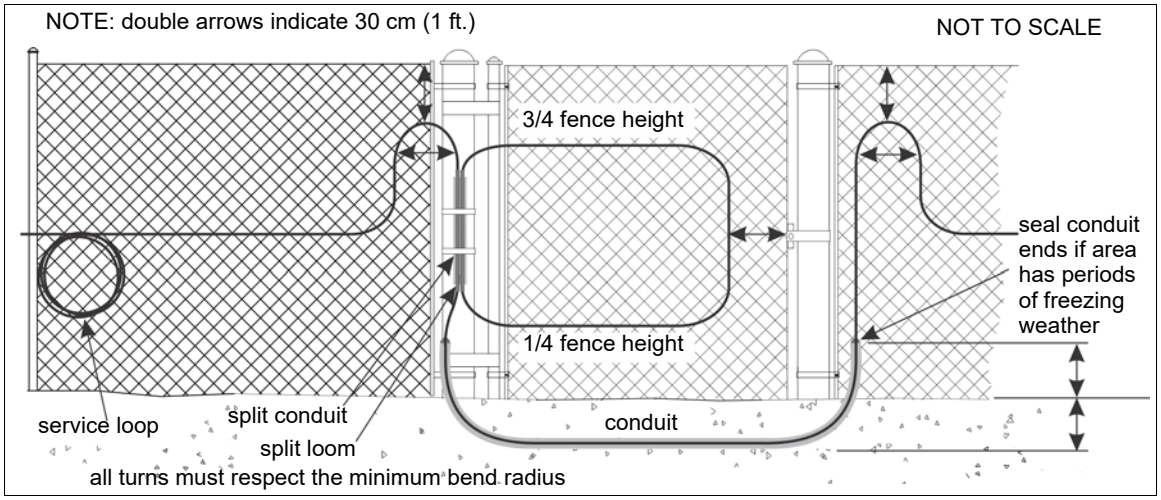


Figure 23 Cable layout on a single panel swinging gate

For a double swinging gate, both gate panels are protected by sensor cable.

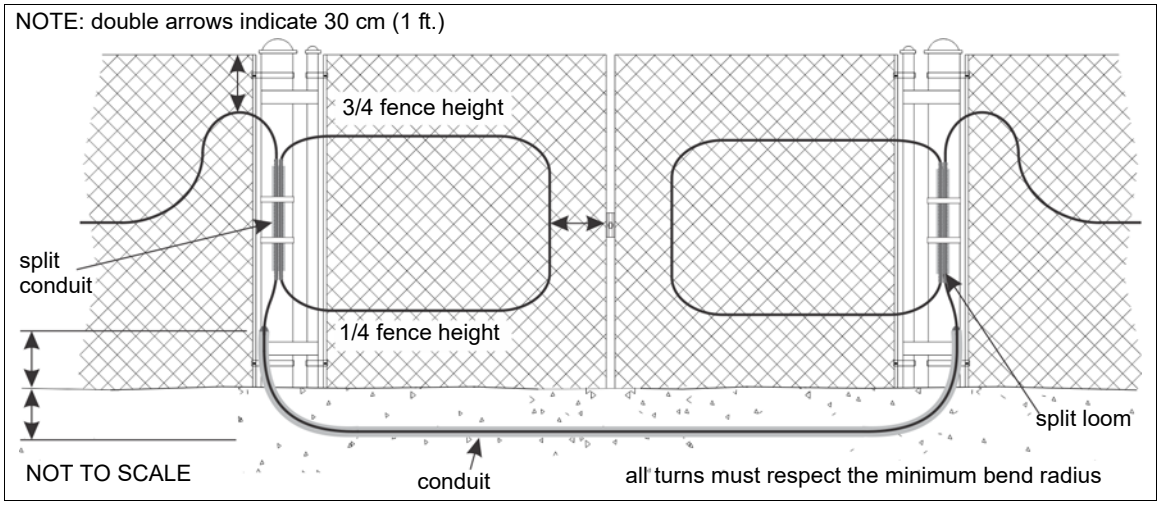


Figure 24 Double panel swinging gate

Gate protection for periodically bypassed gates (independent zones)

For a gate that will be used while the system is operational, it is recommended that the gate be made into an independent zone. The gate zone includes the sensor cable on the gate, below the gate, and the two adjacent fence panels (one panel on each side). In addition, each side of the gate should have a 13 m isolation loop to provide a buffer between the adjacent zones. The hinged side of each gate should also have a 10 m service loop. The isolation loops should be far enough away from the gate to prevent the transmission of vibrations into the adjacent zones when the gate is in use. The SMS software should be configured to ignore alarms from the gate zone when the gate is in use (zone accessed/bypassed).

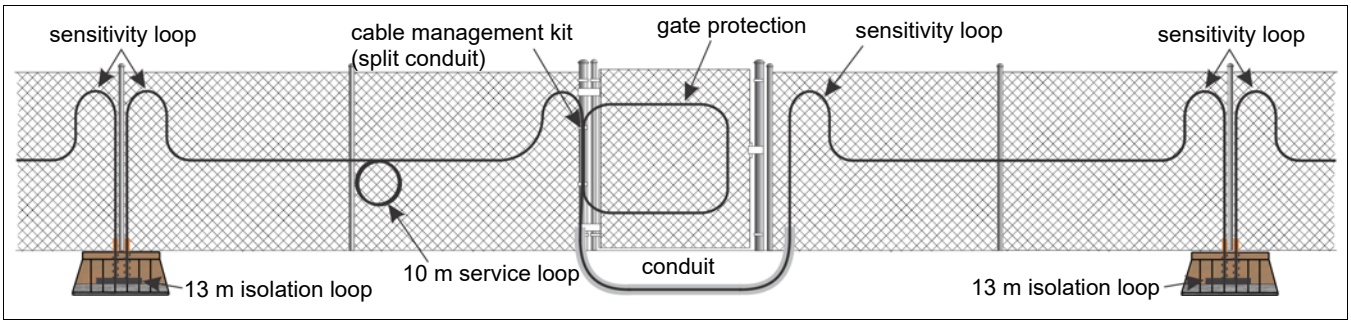


Figure 25 Independent gate zone (with buried isolation loops)

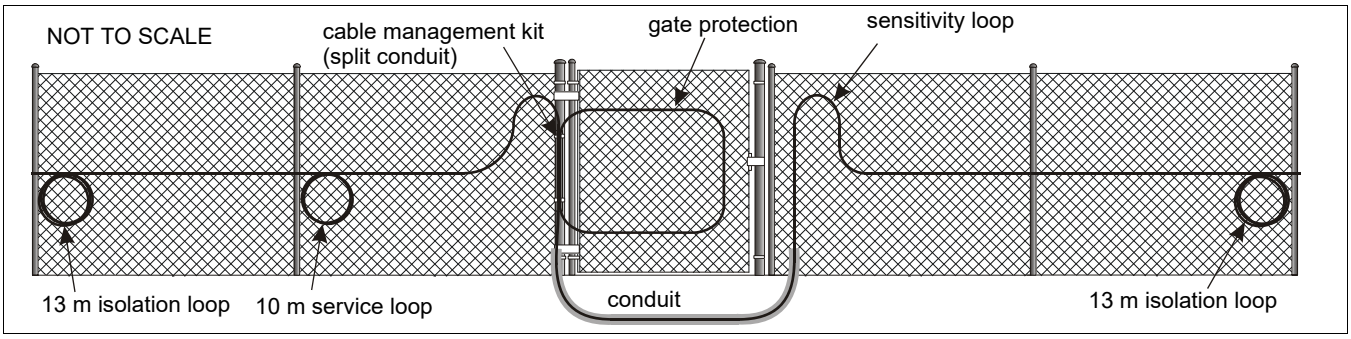


Figure 26 Independent gate zone

Determining cable length requirements for gates

1. For each gate panel:
   - The sensor cable passes around the circumference of each gate panel at ¼ the gate height, 30 cm in from the outside edge, and ¾ the gate height.
     length of cable to protect a gate = 2 X (gate length - 30 cm) + gate height + 2 X (distance from inside edge of gate to fence post) + (fence height - 60 cm, for sensitivity loop) + 10 m service loop (per gate)
2. To reach the other side of a gate:
   - Create a sensitivity loop beside the fence post adjacent to the gate. Run the sensitivity loop up to 30 cm from the top of the fence and back down the post to pass through the split conduit. Loop the cable around the gate as described in step 1. Pull the cable through the conduit to the other side of the gate. The conduit should be buried at a depth of 30 cm, and the ends should extend at least 30 cm above ground level. Seal both ends of the conduit (water tight) for areas which experience periods of freezing temperatures.
3. To isolate the gate zone for access/secure operation:
   - Add the length of the cable required to cover the two adjacent fence panels (one on each side of the gate) plus two 13 m (43 ft.) isolation loops plus length of cable to reach the buried vaults (if used).

Using the cable management kit at the hinged side of protected swinging gates

A section of split conduit is used at swinging gate locations to protect the sensor cable from being caught or pinched by the gate while allowing the cable to rotate freely within the conduit when the gate is opening and closing. FiberPatrol offers a cable management kit (p/n FPKT0500) which includes a 1 m length of split conduit, two 1.15 m pieces of split loom and two gear clamps. The split conduit is fitted against the fence post on the hinged side of the gate, the split loom prevents the cable from rubbing against the edges of the conduit and the gear clamps are used to secure the conduit to the fence post. The conduit must have notches cut at any points where gate hardware is attached to the post, so the conduit can fit snugly against the fence post.

1. Hold the conduit against the fence post and on the conduit, mark the positions of any hardware on the fence that will require notches in the conduit.
2. Make any required notches in the conduit.
3. Attach the sensor cable to the gate.
4. Hold the notched half of the conduit under the cable and against the fence post.
5. Press-fit the sensor cable into the split loom so the split loom extends 7.5 cm (3 in.) beyond the top and bottom of the split conduit.
6. Fit the other half of the conduit over the cable and secure the conduit to the fence post with the supplied gear clamps. Ensure the split loom covers the sensor cable, and protects it from chafing against the top and bottom edges of the conduit.

Protecting masonry walls and buildings

If some, or all, of the perimeter is comprised of masonry walls or buildings, FiberPatrol sensor cable can be installed along the outside edge, and if necessary, the inside edge of the structure to protect against climb over intrusions. In this case, custom P-brackets are used to fasten the sensor cable to the structure so it extends slightly outside and above the structure. A P-bracket is installed every 60 cm (2 ft.) along the structure to hold the sensor cable in place.

Note	FiberPatrol functions as a contact sensor when it is installed on masonry walls and buildings.

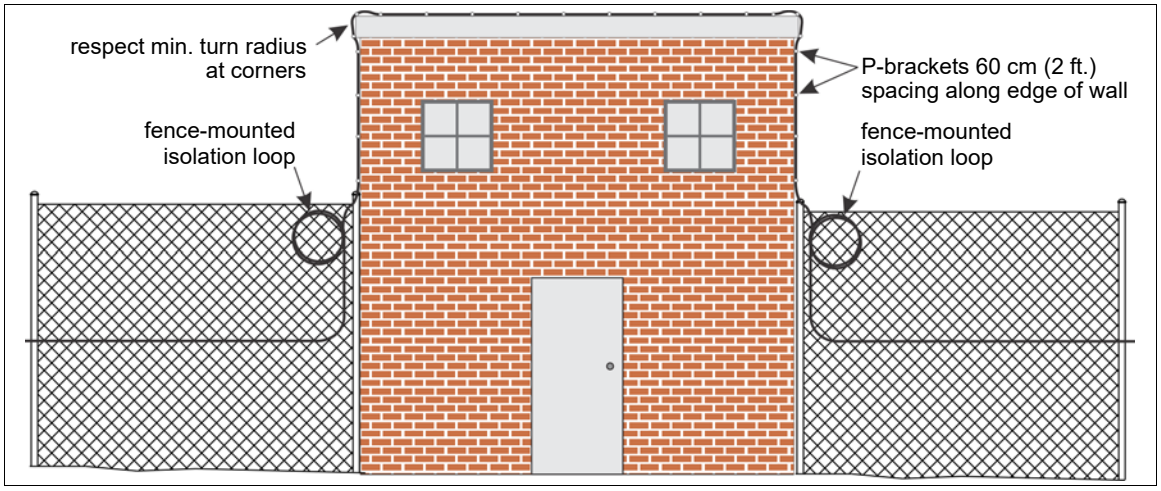


Figure 27 Protecting a masonry structure along the perimeter

For a masonry wall, the recommended sensor cable configuration uses 2 cables. One along the outside edge and one along the inside edge.

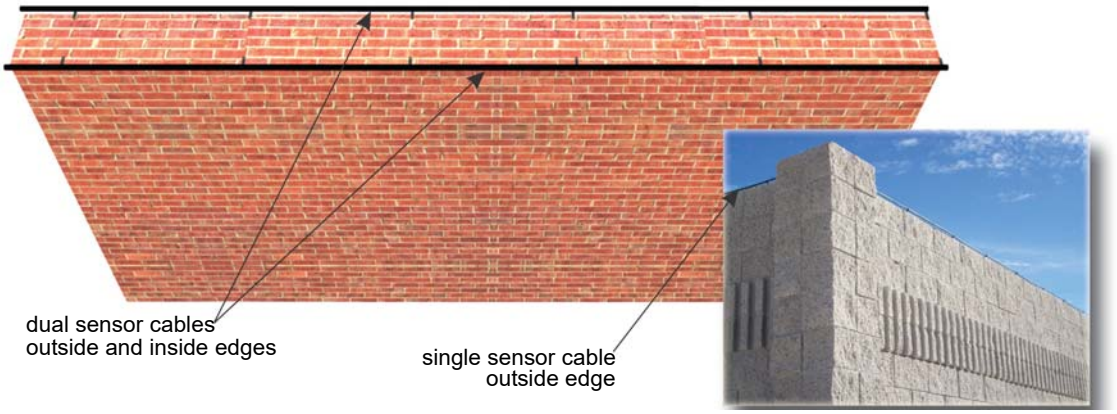


Figure 28 Protecting a masonry structure along the perimeter

Selecting conduit for below ground bypasses

When the sensor cable must go below ground to reach the other side of a gate, or go through or below a building or object, the cable must be protected by using conduit. For sites that include periods of freezing weather, solid wall conduit is required. For sites in temperate climates that do not experience freezing weather, split conduit can be used.

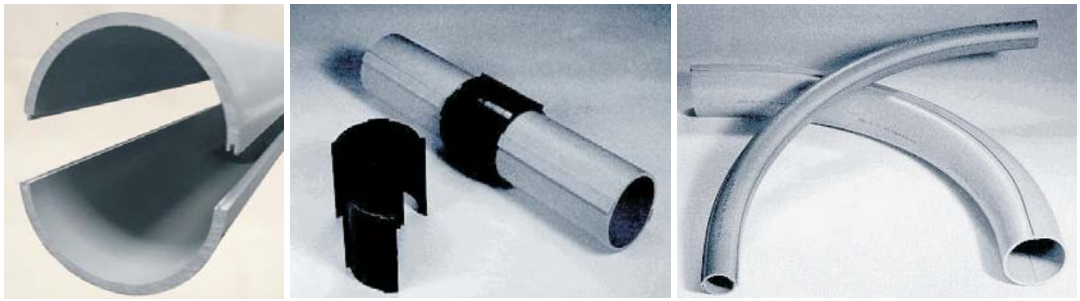


Figure 29 Split wall conduit

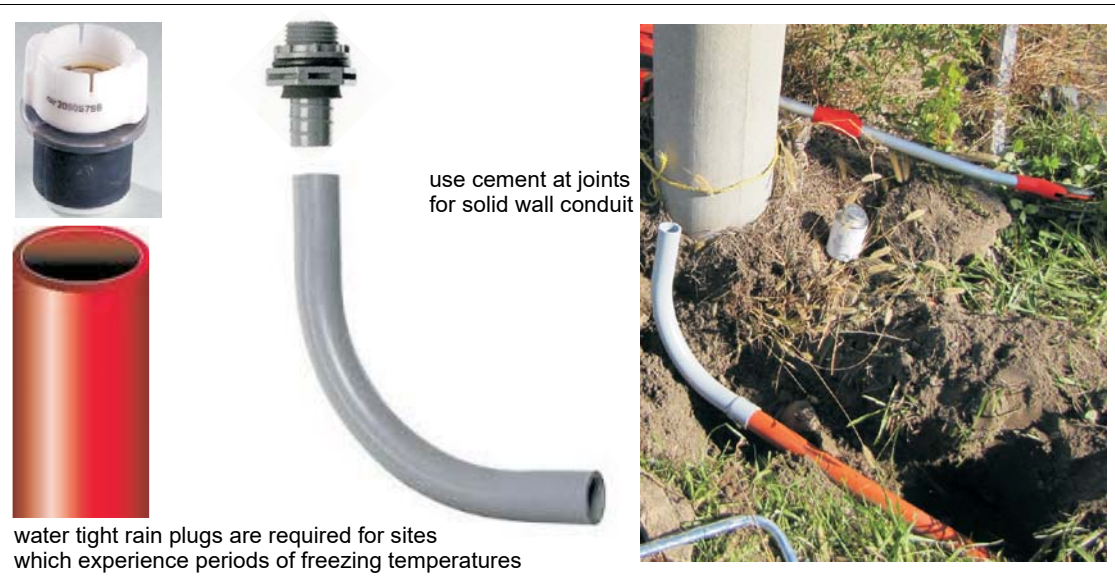


Figure 30 Conduit fittings

flexible solid wall conduit is required for areas with freezing temperatures

Figure 31 Solid wall conduit

Solid wall conduit

- Both ends of the conduit must be sealed to prevent water from entering the conduit and freezing.
- Flexible conduit can be bent and formed into the required shape for a cable bypass.
- The minimum bend radius for flexible solid wall conduit is 46 cm (18 in.). (If the conduit is kinked during bending it must be replaced.)
- If conduit sections are used, the sections must be glued together (water tight).
- Use conduit sweeps. Do not use 90º elbows. (Cable bend radius rules must be followed.)
- Bury the conduit at least 30 cm (1 ft.) below ground.

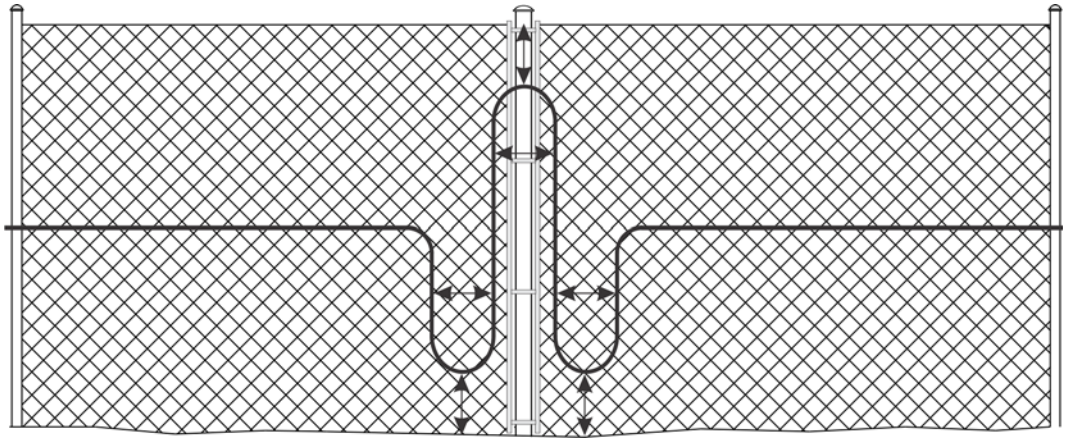
Split wall conduit

- Use conduit sweeps. Do not use 90º elbows.
- Bury the conduit at least 30 cm (1 ft.) below ground.

Sensitivity loops for heavy gauge posts and corner posts

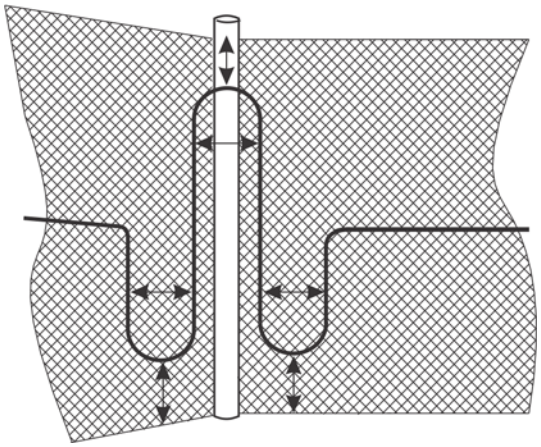
Corner posts, terminal posts and tension posts are usually made of heavier gauge steel and can have a dampening effect on nearby fence vibrations. To compensate for this, FiberPatrol recommends using sensitivity loops at all corner posts, terminal posts and tension posts on the fence. The sensitivity loops provide additional sensor cable for areas that typically produce lower levels of fence noise. The length of cable required for a sensitivity loop can be calculated using this formula:

3 X (fence height - 60 cm) + 90 cm = sensitivity loop cable length requirement.
For example, on a 2.4 m (8 ft.) fence, the service loop would go down 90 cm, then up 1.8 m, then down 1.8 m, and up down 90 cm over a horizontal length of 90 cm.



NOTE: All double arrows indicate 30 cm (1 ft.) separation.
All turns must respect the minimum bend radius.

Figure 32 Sensitivity loop (heavy gauge post)



NOTE: All double arrows indicate 30 cm (1 ft.) separation.
All turns must respect the minimum bend radius.

Figure 33 Sensitivity loop (corner post)

Service loops

Service loops provide extra sensor cable for making future repairs, and for making fusion splices to access the dark fibers in the sensor cable. A 10 m (33 ft.) service loop is recommended for every 300 m (984 ft.) of installed sensor cable. A 10 m service loop is also recommended on the hinged side of each gate that is protected by sensor cable. A 10 m service loop is typically comprised of 5 loops of cable with a 60 cm (2 ft.) diameter. In addition, a 10 m (33 ft.) splice point service loop is required for each section of sensor cable at all splice enclosure locations. Service loops must be securely attached to the lower section of the fence beside a fence post. Attach service loops directly to the fence fabric using one cable tie at each 45º point of the loop (8 cable ties).

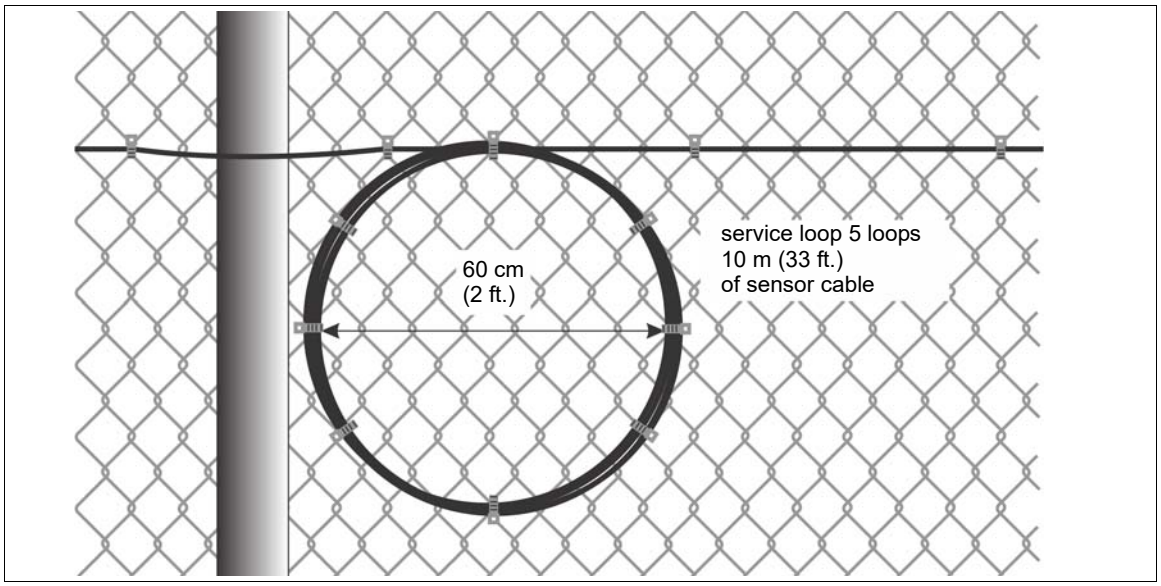


Figure 34 Service loop

Isolation loops

Isolation loops are recommended at the start point of the detecting cable, on both sides of gates that will be setup as independent zones, and at cable bypasses. Isolation loops require approximately 13 m (43 ft.) of sensor cable coiled into a 60 cm (2 ft.) diameter loop (7 loops) to provide a distinct zone demarcation point. Isolation loops can be buried in cable vaults, which will provide the greatest level of isolation between two zones. However, if using a buried vault is impractical, isolation loops can be attached directly to the fence fabric with 14 in. steel cable ties. Figure 35 shows a cross section of a fence-mounted isolation loop attachment and Figure 25 shows the buried vault installation method for isolation loops. Isolation loops are attached to the fence in the same manner as service loops (see Figure 34).

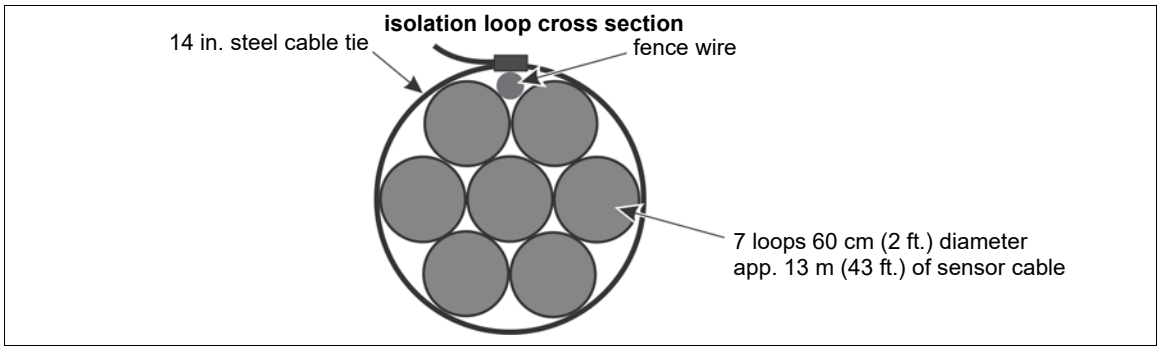


Figure 35 Zone boundary isolation loop (fence-mounted)

Cable bypasses for buildings and structures

If there is building or other structure along the perimeter, it can be bypassed in the same manner as a sliding gate. In some instances, it may be possible to pull the cable through conduit that has been embedded in the structure. Otherwise, use the below ground cable bypass method. To ensure the bypass cable will not cause alarms, use a 13 m (43 ft.) isolation loop at each end of the bypass. The isolation loops can be buried in FiberPatrol vaults (see Figure 37). If this method is impractical, the isolation loops can be attached to the fence (see Figure 36 and Figure 38).

Note	Bypassed sections of perimeters should be protected by another sensor technology (e.g., a microwave sensor).

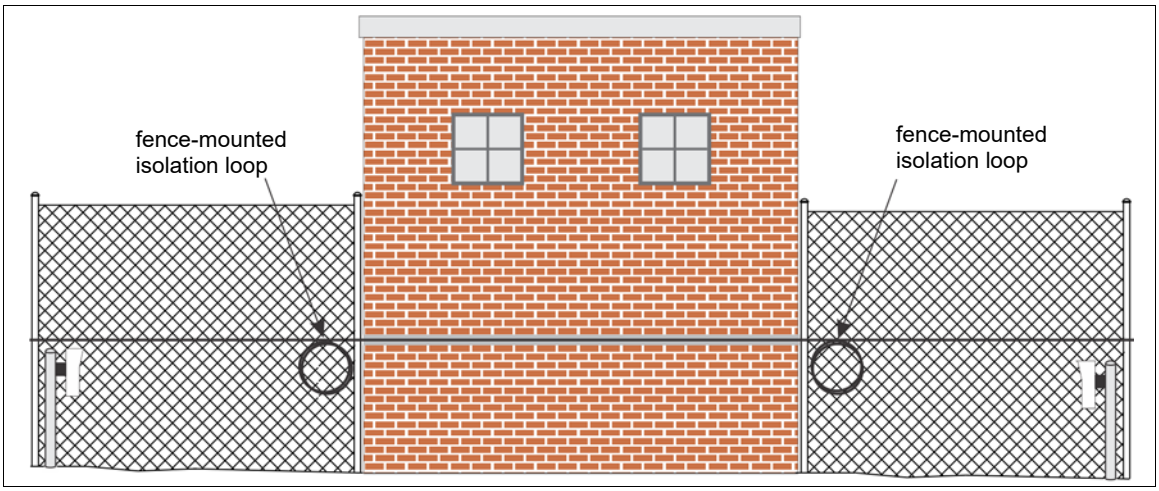


Figure 36 Perimeter structure bypass (through structure)

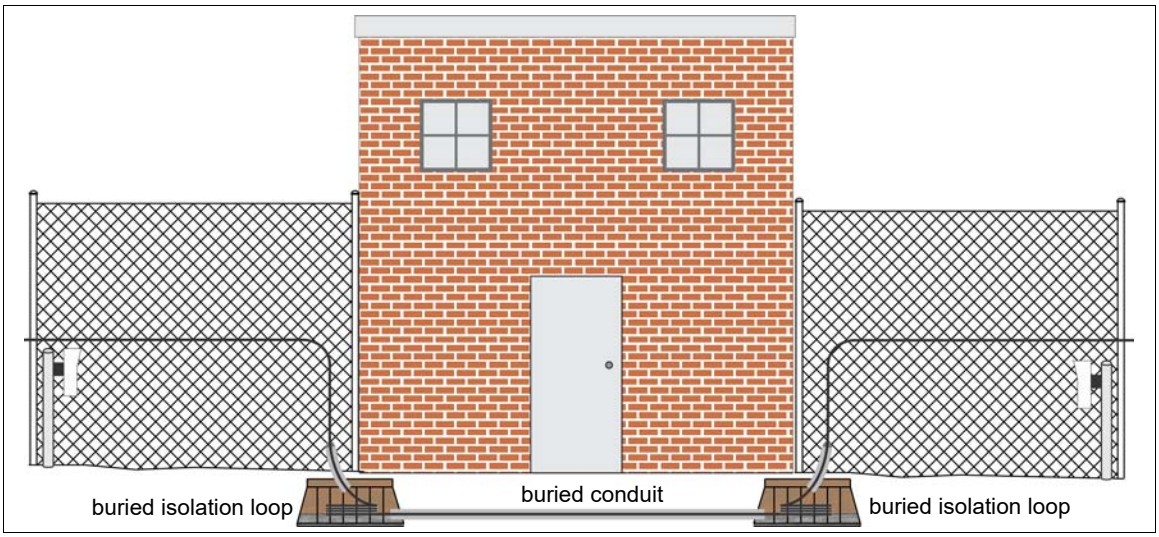


Figure 37 Perimeter structure bypass (below ground with buried vaults)

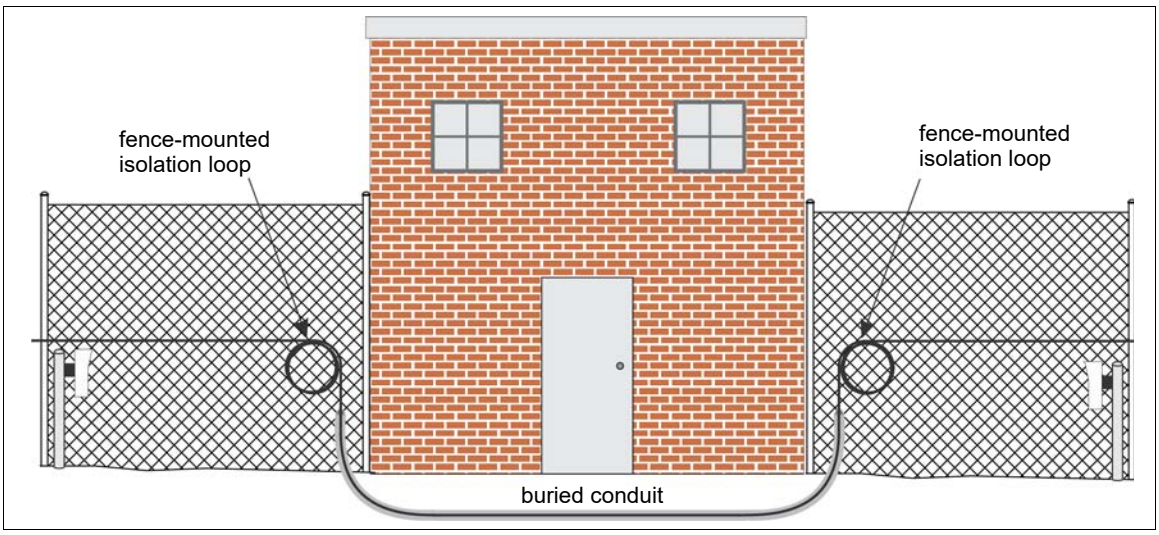


Figure 38 Perimeter structure bypass (below ground)

Deploying the sensor cable

Note	Install FiberPatrol sensor cable on the side of the fence that is opposite the threat (the secure side of the fence).

There are two standard methods of deploying FiberPatrol sensor cable.

1. The cable drum can be mounted on a cable stand and then pulled around the perimeter.
2. The cable drum can be mounted on a reel trailer or a truck, which lays out the cable on the ground as it moves around the perimeter.

Refer to the site plan and pull back and lay out sufficient sensor cable to cover the site specific features (gates, bypasses, service loops, sensitivity loops, isolation loops, fiber access points).

The following factors must be considered when deploying FiberPatrol sensor cable along the inside of the perimeter fence:

- The length of the section of sensor cable being deployed.
- Clearance and access along side the fence.
- Service loops, sensitivity loops, isolation loops, splice loops, gate coverage.
- Site-specific features such as cable bypasses for gates and other structures on the perimeter.
- The location of splices.

Sensor cable splices

At all designated splice points, each section of sensor cable requires a 10 m (33 ft.) service loop. The service loops at splice points allows the sensor cable and splice enclosure to be attached/ removed from the fence fabric for splicing. Inside the splice tray, sensor fibers S1 and S2 and any dark fibers that are designated for use must be fusion spliced. When dressing the bare fibers, ensure that the turn radius is kept above a minimum bend radius of 32 mm (1.25 in.). Any tighter bend radius may lead to optical fiber damage and an increased loss at the splice location. Once the field splices are complete, and the sensor cable is installed, the loss must be measured from both ends of the cable to ensure the quality of each splice. The average loss for the full length of sensor cable must be 0.3 dB per km or less, and the maximum event loss is 0.1 dB. The fusion splices at the start module and the end module are made once the field splices have passed the OTDR measurement test.

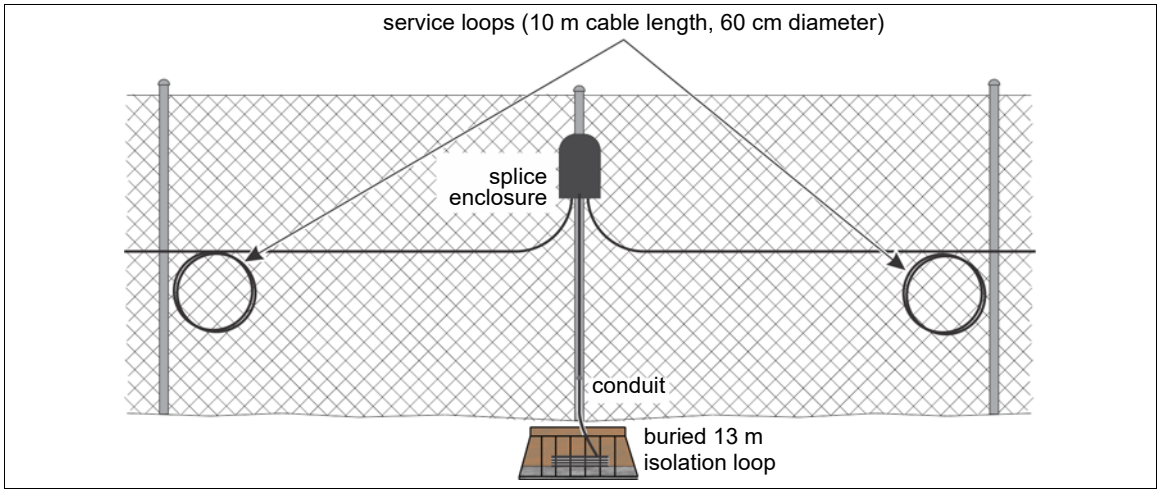


Figure 39 Cable splice service loops and buried isolation loop at fully closed perimeter start/end point

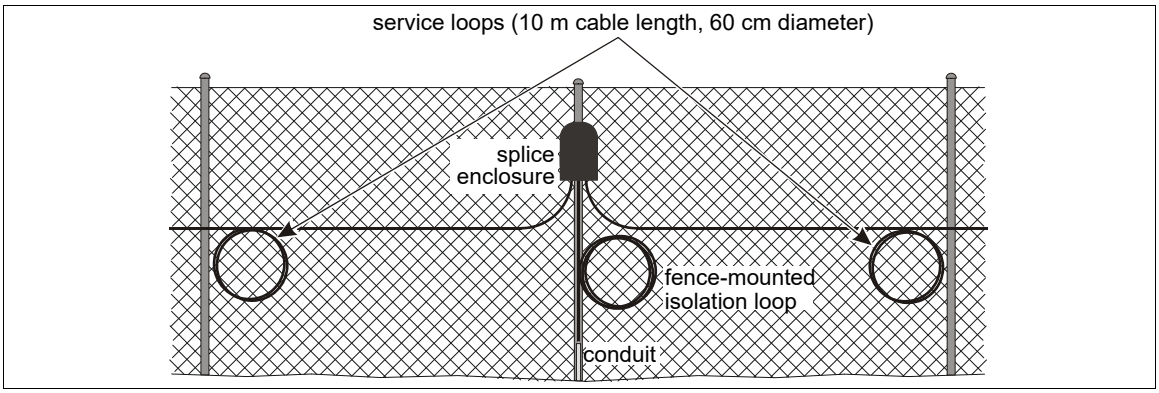


Figure 40 Cable splice service loops and fence-mounted isolation loop at fully closed perimeter start/end point

Site analysis checklist

✓	Description
	create a site plan
	accurate CAD drawings with precise measurements and/or GPS coordinates
	detailed description of fences (type, condition, height, fence rails, climb over deterrent hardware, other cables, conduit, or signs attached to fence)
	detailed description of gates (type, condition, location, size)
	locate all obstacles on site survey
	spur fences or fences abutting the perimeter fence
	sidewalks, paths, roads, driveways
	buildings, walls and other structures
	utilities (sewers, pipes, conduits and electrical cables, etc.)

Cable requirements

Calculating the total length of fiber optic cable is one of the most critical phases of site planning. Other equipment requirements, including the necessary software license, are determined by the length of cable. The following table provides guidelines on how to determine how much cable is required. An alternate method uses the following formula to calculate sensor cable requirements:

(fence length + lead cable length) + (fence length + lead cable length) X 0.15 = cable requirement

Feature	**Description** (length unit = meters, single pass coverage)	**Cable length**
lead cable	distance from equipment room to start of perimeter	
perimeter length	length of protected fence including gates and bypasses	
gate coverage	length of cable required to cover all protected gates	
building/wall coverage	length of cable required to cover all protected buildings and walls	
service loops	(protected fence length divided by 300 m + number of service loops for gates + number of cable sections going into splice enclosures + equipment room service loop) X 10 m	
isolation loops	number of isolation loops X 13 m	
sensitivity loops (1)	number of corner posts, terminal posts and tension posts X 3(fence height - 60 cm)	
sensitivity loops (2)	(number of heavy posts at gate/obstacle locations) X 2(fence height - 60 cm)	
cable overage	calculated length of cable (above 7 features) X 1.05 (for 5% overage)	
cable requirement	sum of the above 9 features = total cable requirement	

Equipment requirements

For the FP1100X Series, the total length of fiber optic cable (sensor cable + lead cable) determines the required model of the processor, controller and the software license for the FiberPatrol system. Specific FP1100X Series equipment and software licenses are available for cable lengths of 1.5 km, 3 km, 6 km, 9 km, 12 km, 16 km, 20 km, and 25 km.

The FP1400-08 system provides up to 2.5 km (1.55 mi.) of combined non-detecting lead cable and sensor cable, and the FP1400-12 provides up to 5 km (3.1 mi.).

Other required equipment includes:

- dual start module
- one dual or two single end modules

Note	For fully closed loop perimeter configurations there is a dual start/end module assembly, which can be rack mounted in the fiber patch panel.

- 1RU rack mount fiber patch panel (for start module and control equipment fiber splices)
- outdoor splice enclosure (1 required for each out door cable splice, or termination)
- splice consumables kit (1 required for each cable splice indoor/outdoor)
- cable management kit (1 required per gate panel for each protected swinging gate)

- stainless steel cable ties (1 tie per 60 cm (2 ft.) of cable, additional ties required for cable loops and outdoor splice enclosures, requires installation tool)
- FiberPatrol cable vaults (optional) for buried isolation loops
- conduit for below ground cable bypasses

3 Installing FiberPatrol

FiberPatrol installation overview

Note	The FiberPatrol sensor cable requires professional installation by qualified personnel who are trained and certified in fiber optic cable installation to telecom industry standards.

There are ten steps required to complete a FiberPatrol installation:

1. Create a detailed site plan.
2. Deploy the sensor cable along side the fence according to the site plan.
3. Attach the sensor cable to the fence.
   Pull the cable through bypass conduit, if required.
   Create service loops, isolation loops and sensitivity loops.
   Attach cable to protected gates.
4. Make the field splices (excluding the splices required for the end module and start module).
5. Use an OTDR to measure the loss in each spliced fiber from both ends of the sensor cable.
6. Install and connect the sensor unit equipment in the control room.
7. Make the fusion splices for the start and end modules.
8. Set up and configure the system software.
9. Calibrate the system.
10. Test the system to ensure it meets the site's detection requirements.
11. Put the system into operation.

Laser light safety

WARNING	FiberPatrol operates with Class 1 laser light levels. NEVER look directly into the end of a fiber connector. Ensure that the fiber optic light source is off, BEFORE using a scope to check a fiber optic connector.

Optical fiber safety

WARNING	Use care when working with exposed optical fibers. The bare fibers are 125 microns in diameter and can easily penetrate skin. Always wear safety glasses when working with optical fibers. Always dispose of bare fibers in a sealed and labeled container that is specifically designed to contain fiber optic waste. NEVER dispose of bare fibers in a standard waste receptacle.

Fiber optic cable handling

Note	Standard FiberPatrol cable (p/n FPSP04XX - XX = number of fibers) typically includes 12, 24, 36, or 48 optical fibers inside 1, 2, 3, or 4 gel filled buffer tubes. The number of tubes and the number of fibers inside each tube may vary, depending on the specific cable used at the site. However, the basic cable construction and specifications are fixed regardless of the number of tubes/fibers.

FiberPatrol sensor cable performance specifications

The following manufacturer's performance specifications apply to FiberPatrol sensor cable:

- Fiber count (typical) 12, 24, 36, or 48 12/6 fibers/tube
- Fiber type single-mode
- Fiber wavelength 1550 nm
- Manufacturer's maximum cable attenuation 0.25 dB/km @ 1550 nm
- Minimum allowable bend radius (dynamic) 220 mm (8.66 in.)
- Minimum allowable bend radius (static) 110 cm (4.33 in.)
- Minimum allowable bend radius (single fiber) 32 mm (1.25 in.)
- Maximum allowable tensile rating during installation 2,700 N (600 lbf)
- Crush resistance (short term) 220 N/cm (125 lbf)
- Temperature ratings (storage) -40 to 75ºC (-40 to 167º F)
- Temperature ratings (installation) -30 to 60ºC (-22 to 140º F)
- Temperature ratings (operation) -40 to 70ºC (-40 to 158º F)
- Typical outside diameter (may vary with cable type) 11.2 mm (0.44 in.)
- Cable weight 93 kg/km (may vary with cable type) (62 lb/1,000 ft.)
- Maximum available cable length 12 km (7.46 mi.)

Additional cable requirements

- central strength member
- water blocking tape
- gel filled buffer tubes
- rip cord

Cable loss limits (maximum attenuation)

Note	Test the fibers from both ends of the cable before splicing the fibers to the start module and end module.

After being fully attached to the fence, each spliced fiber must be tested using an OTDR operating at 1550 nm. Measure the loss from both ends of the cable, and use the higher of the two readings.

- Average loss over the full length of installed cable < 0.3 dB/km
- Individual event loss limit < 0.1 dB

Note	Fusion splice performance typically results in a loss of between 0.01 and 0.03 dB.

Cable handling recommendations

- Bend management systems must be used to restrict cable bend during installation so that the minimum bend radius is not exceeded. (Cable pulleys of a suitable diameter must be used at points where the cable changes directions during installation.)
- Fused swivels and tension controlled hauling winches must be used to ensure the cable is installed at a tension that does not exceed the specified limits.
- Cable spools must be positioned to limit cable bending and minimize the angle of cable pay-off during unwinding/hauling.
- Cable spools must be held firmly in the pay-off stands to ensure smooth rotation and prevent any vibration which can damage the drum and the cable.

Illustrated installation requirements

- Attach the sensor cable to the fence fabric with cable ties at the junction of 2 fence wires. Space the cable ties 60 cm (2 ft.) apart.

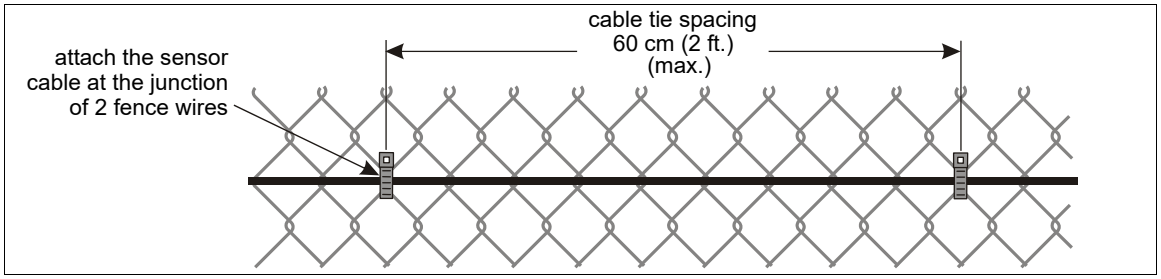


Figure 41 Cable tie spacing on fence fabric

- Attach the sensor cable at both sides of each fence post 30 cm (1 ft.) away from the post. Ensure the cable is snug against the fence post, but is not pulled tightly and stressed.

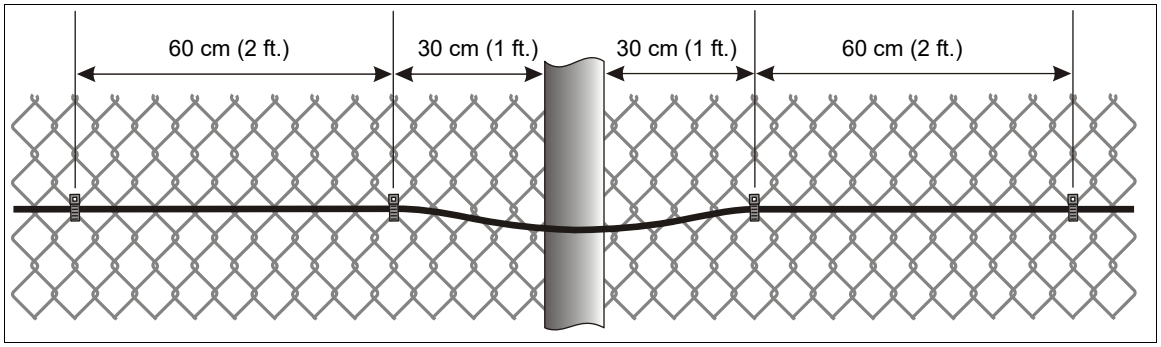


Figure 42 Cable tie spacing at fence posts

- For all cable turns attach the cable to the fence fabric at each 45º point of the curve.

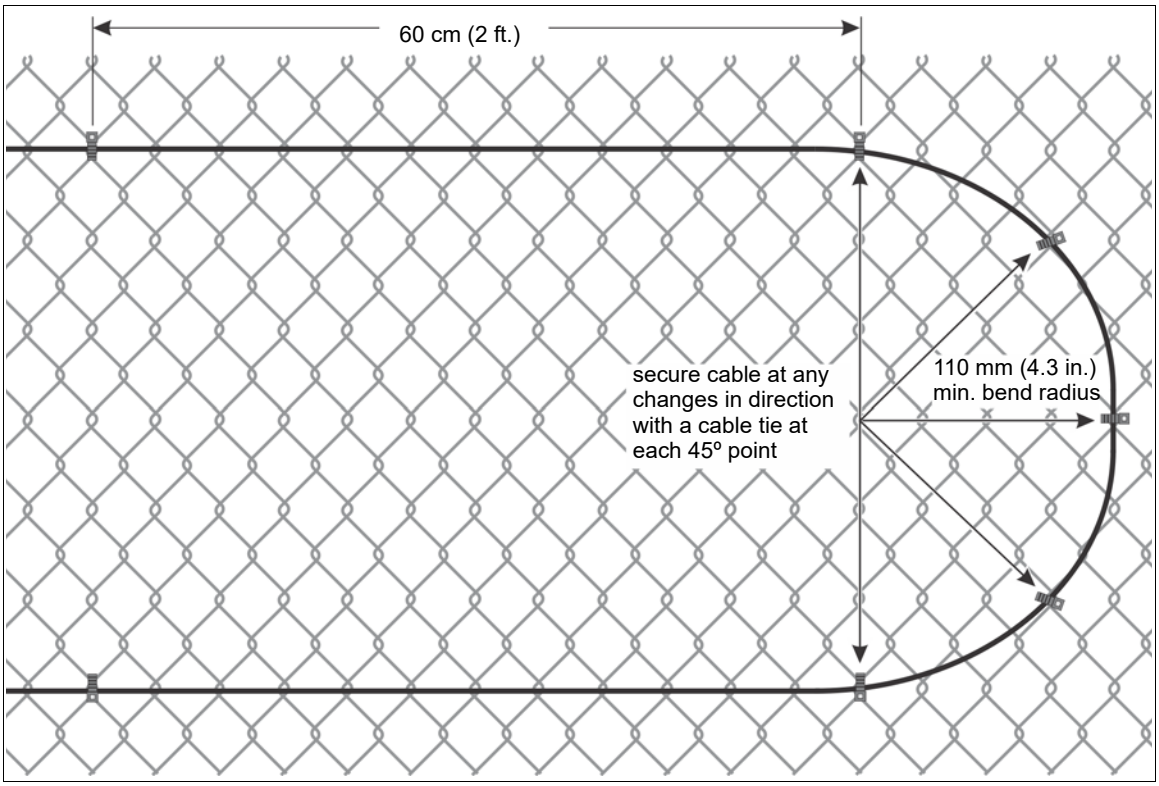


Figure 43 Cable tie spacing around corners

- Ensure that the minimum bend radius (dynamic and static) is not exceeded during or after installation.

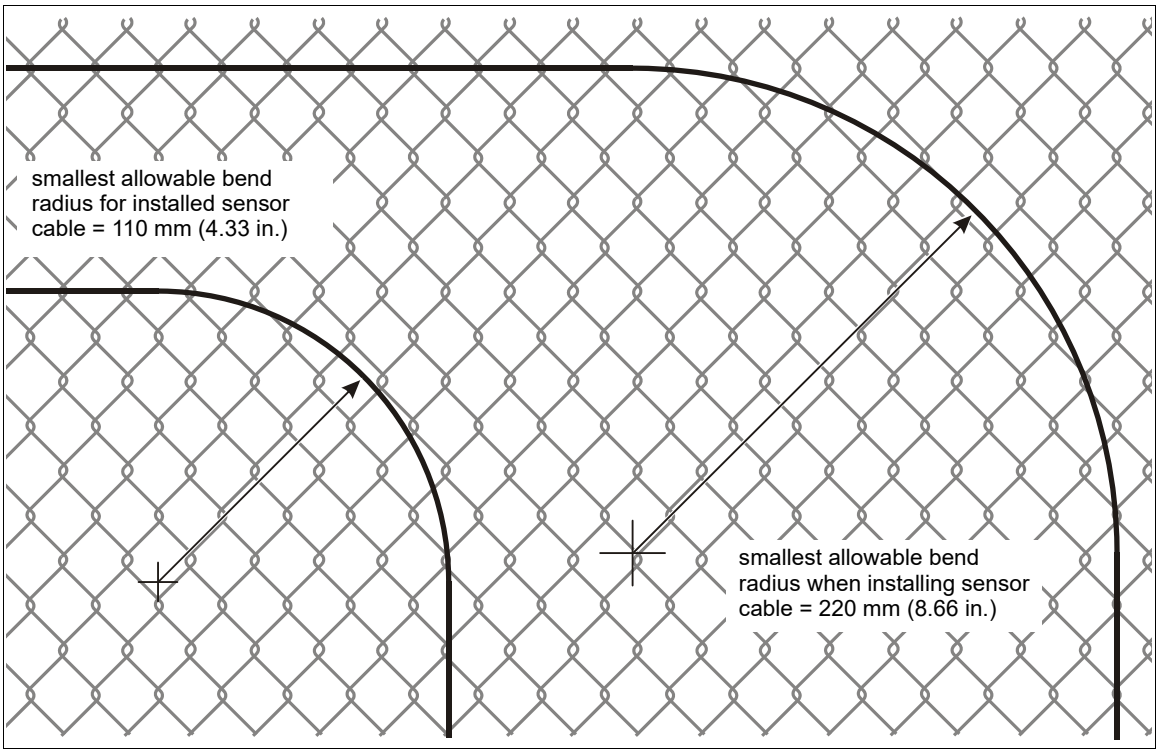


Figure 44 Static and dynamic bend radius limits

- Attach service loops beside a fence post on the lower section of the fence using cable ties at each 45º point of the loop

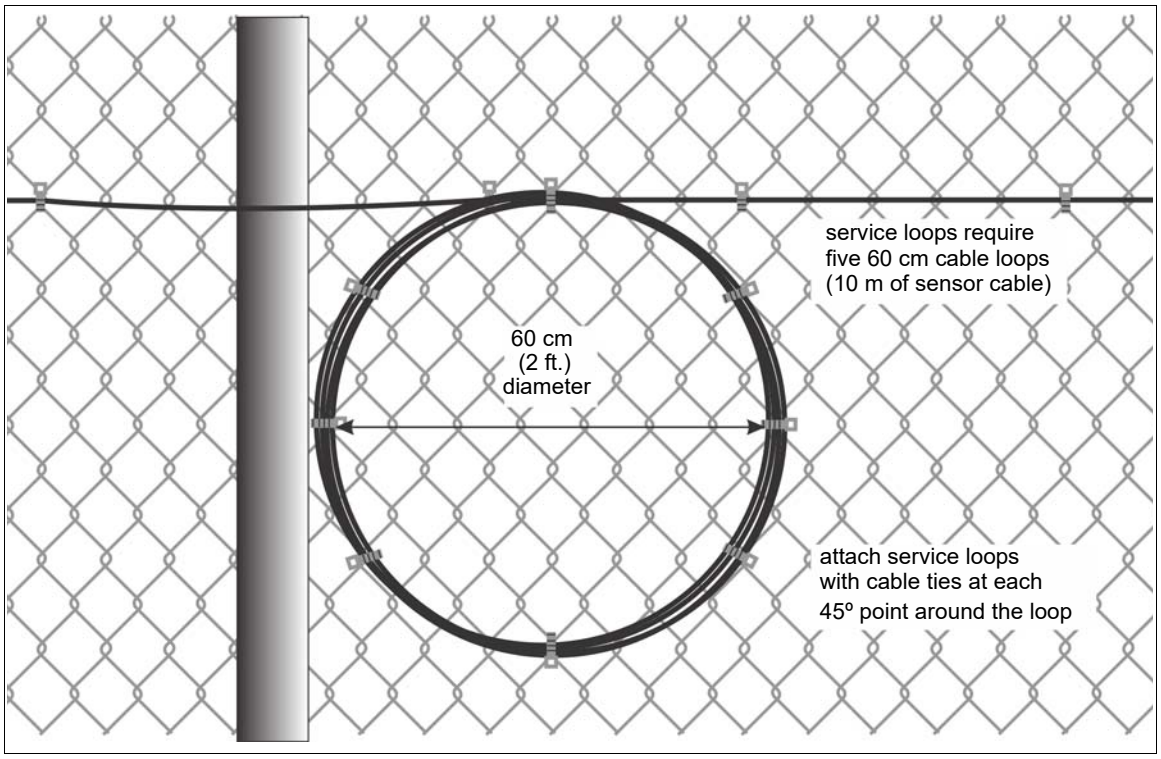


Figure 45 Service loops

- Attach isolation loops beside a fence post on the lower section of the fence using cable ties at each 45º point of the loop

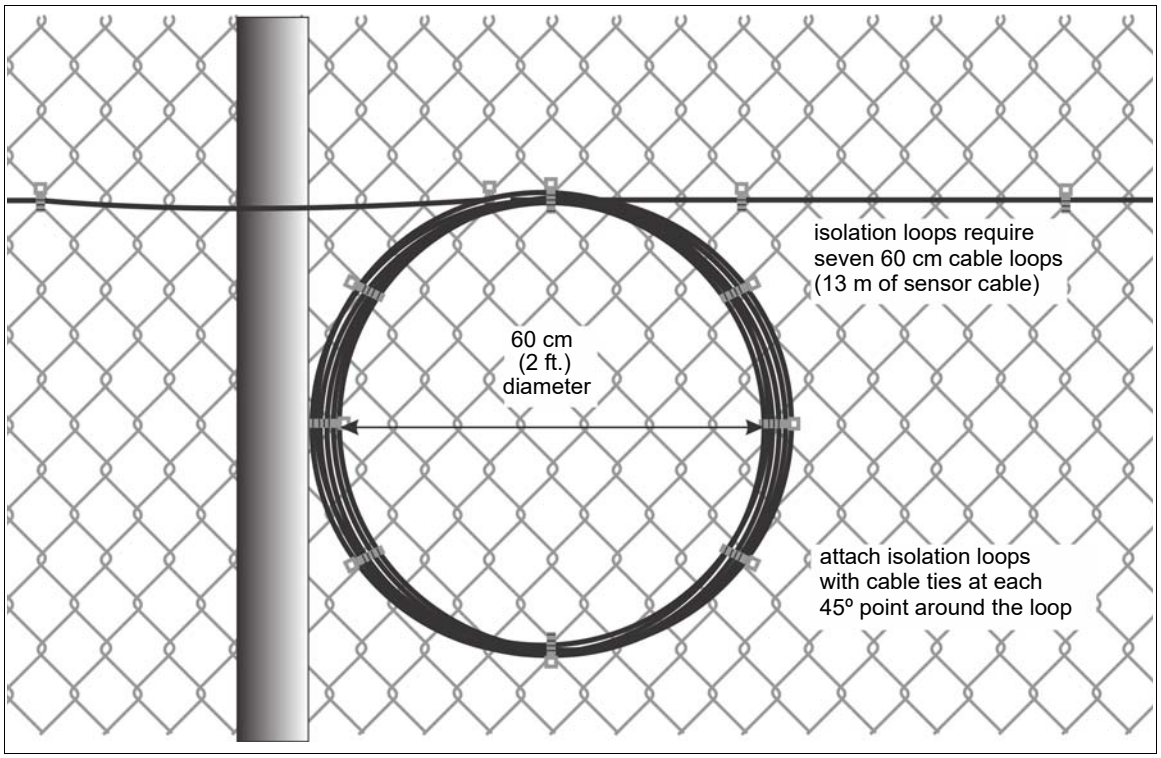


Figure 46 Isolation loops

- Buried vault installation details
  - burial depth - flush with ground surface 46 cm (18 in.) (dig a deeper pit for below ground vault)
  - pit dimensions (nominal) - 51 cm (20 in.) deep X 76 cm (30 in.) wide X 107 cm (42 in.) long
  - gravel layer - to depth of conduit entry points 13 cm (5 in.) nominal (plus 5 cm (2 in.) gravel layer on the bottom of the pit)

Note	Conduct the OTDR cable testing BEFORE filling the vault with sand.

  - sand layer - pour sand over cable, splice enclosure and gravel layer to completely fill the vault
  - conduit entry points - cut holes at cable entry points; 4.3 cm (1.7 in.) minimum hole size

Note	The conduit must be sloped at a slight downward angle (app. 15º) as it enters the vault. Otherwise, the conduit ends must be sealed to prevent water ingress.

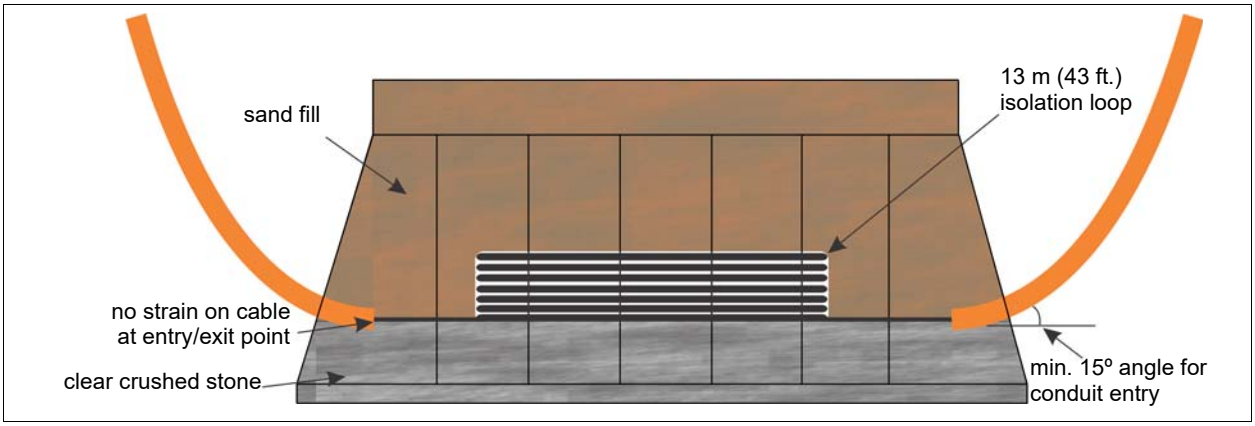


Figure 47: Buried vault isolation loop recommendations

- For instances where the cable must be unreeled and pulled back to accommodate site specific installation requirements (e.g., gates, bypasses) lay the cable on the ground in a large figure 8 pattern to prevent twisting or kinking. Never lay the cable in a circular roll.

Figure 48 Laying cable in a figure-8 pattern

FiberPatrol sensor cable and below ground bypasses

FiberPatrol sensor cable typically passes through conduit that is buried below ground to get from one side of a gate to the other. There are several techniques that can be used to pull the cable through conduit. The best method to use depends on a number of site specific factors:

- the local climate, if the site has a temperate climate and the ground never freezes, split conduit can be used to protect the sensor cable
- in areas where ground freezing occurs, solid wall conduit must be used; the solid conduit must be sealed at both ends to prevent water from entering
- if the cable is being deployed from a cable stand, the cable can be pulled through the conduit as it is dispensed
- if the cable is being deployed from a trailer or truck, it will have to be pulled back to pass through the conduit
- a sufficient amount of cable must be pulled back for isolation loops, service loops, and gate coverage, as required

Figure 49 Solid wall conduit

FiberPatrol installation

1. Ensure that there is enough sensor cable in the equipment room to reach the controller in the equipment rack and to create a 10 m service loop.
2. Run the sensor cable to the designated start point of the detecting cable.
3. If the site plan calls for a splice at the designated start point, ensure that there is enough cable to reach the splice enclosure on the fence and to create 10 m service loop, and if required, a 13 m isolation loop (optional) then cut the cable.

OR

3. If the site plan calls for a continuous run of cable at the designated start point, leave enough cable to create a 13 m isolation loop (optional) and continue to deploy the sensor cable around the perimeter.
4. At each point in the installation where extra cable is required, lay out a sufficient amount of cable in a figure 8 pattern to cover the feature. If you are pulling the cable around the perimeter, you must pull back a sufficient amount of cable after the cable is dispensed to cover the cable length requirement for each feature.
5. Once you have reached the end of the cable reel, leave enough cable to create a 10 m service loop for the splice (or for fiber termination).
6. If the installation extends past the end of this cable reel, leave enough cable to create a 10 m service loop for the splice, and continue deploying the sensor cable.

Attaching the sensor cable

FiberPatrol sensor cable is attached to the fence fabric with stainless steel cable ties. Figure 50 is an overview of the recommended cable attachment procedure.

- Install the sensor cable on the secure side of the fence (the side opposite the threat).
- Keep the sensor cable straight and taut while attaching it to the fence fabric.
- Attach the cable to the fence fabric at the junction of two fence wires.
- The maximum allowable spacing between cable ties is 60 cm (2 ft.).
- Attach the sensor cable at both sides of each fence post approximately 30 cm (1 ft.) away from the post.

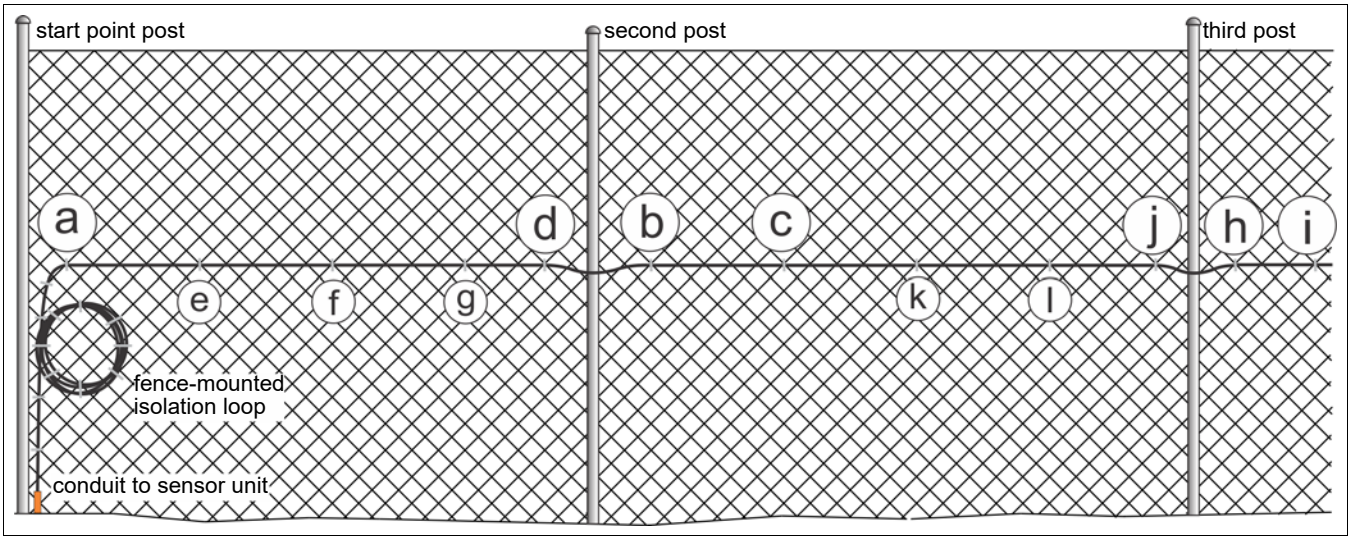


Figure 50 Cable installation procedure

1. Beginning approximately 30 cm away from the start point post, attach the sensor cable to the fence at the junction of two fence wires at the specified height above ground (point a).
2. Hold the cable straight and level just past the second post and attach it to the fence at the junction of two fence wires app. 30 cm away from the second post (point b).
3. Attach the sensor cable at the junction of two fence wires app. 60 cm past point b (point c).
4. Attach the sensor cable at the junction of two fence wires app. 30 cm before the second post (point d).
5. Attach the sensor cable at 60 cm intervals on the first fence panel (points e, f, g).
6. Hold the cable straight and level just past the third post and attach it to the fence at the junction of two fence wires app. 30 cm away from the third post (point h).
7. Attach the sensor cable at the junction of two fence wires app. 60 cm past point h (point i).
8. Attach the sensor cable at the junction of two fence wires app. 30 cm before the third post (point j).
9. Attach the sensor cable at 60 cm intervals on the second fence panel (points k, l).
10. Proceed along the perimeter, attaching the cable to the fence one panel at a time.

Attaching the sensor cable at protected swinging gates

Before attaching the sensor cable to a swinging gate, ensure that there is a sufficient amount of sensor cable laid out to:

- cover the gate

- form the sensitivity loops
- create a 10 m service loop on the hinged side(s) of gate
- create 13 m isolation loops (if required)

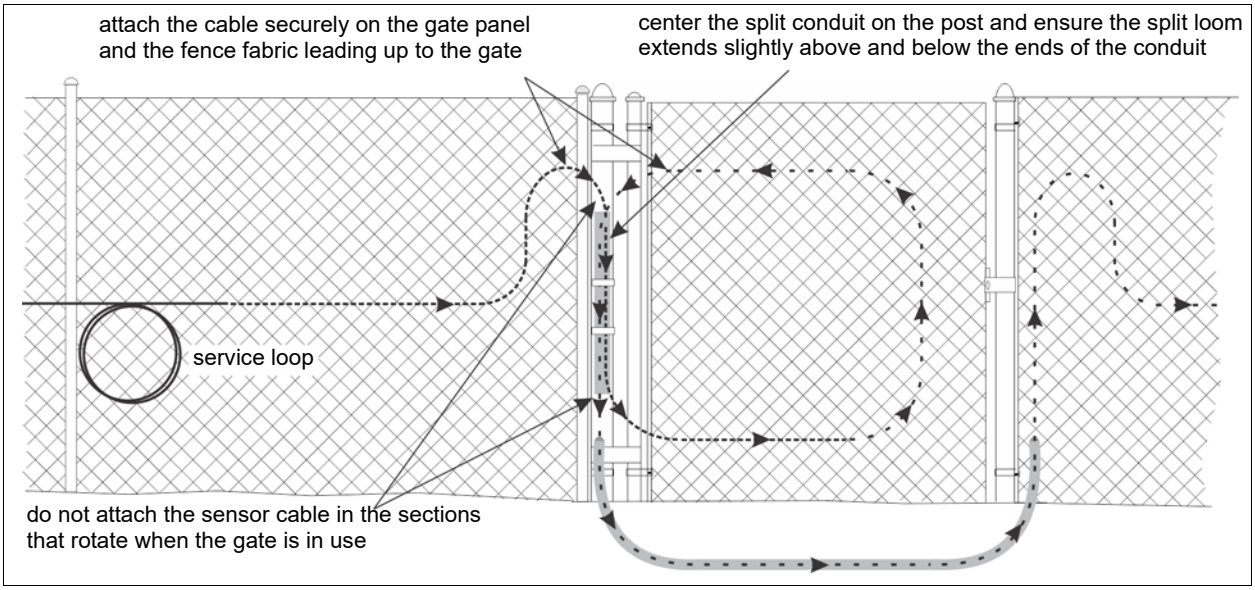


Figure 51 Cable installation on gates

1. Refer to the site plan and lay out a sufficient amount of sensor cable in a figure 8 pattern.
2. Loosely attach the sensor cable to the post on which the gate is hinged. Attach the sensor cable to the gate at ¼ the fence height, 30 cm away from the outside edge, and ¾ of the fence height.
3. Hold the conduit against the fence post and on the conduit, mark the positions of any hardware on the fence that will require notches in the conduit.
4. Make any required notches in the conduit.
5. Place the notched half of the conduit under the cable against the fence post and hold it in place.
6. Press-fit the sensor cable into the split loom so the split loom extends 7.5 cm (3 in.) beyond the top and bottom of the split conduit.
7. Fit the other half of the conduit over the split loom and cable and secure the conduit to the fence post with the supplied gear clamps. Ensure the split loom covers the sensor cable, and protects it from chafing against the top and bottom edges of the conduit.
8. Form a sensitivity loop and attach the sensor cable to the fence panel leading up to the gate.
9. Form a sensitivity loop and attach the sensor cable to the fence panel leading away from the gate.

Masonry walls and buildings

To install sensor cable on masonry, P-clamps are used to secure the cable so it extends about 5/8 in. past the edge of the wall and 5/8 in. above the height of the wall. The P-clamps are attached to the masonry surface every 60 cm (2 ft.). Adjust the spacing of the P-clamps at any changes in direction (horizontal or vertical) to ensure the minimum bend radius of the sensor cable is not violated. Follow standard masonry fastening procedures approved for light to medium duty applications.

The P-clamps are 2.5 in. galvanized steel, and are designed to be anchored with a single screw.

Self-tapping 3/16 in. by 1-1/4 in. concrete screws, such as Tapcon® screws with slotted hex washer heads are recommended. The required mounting holes are 5/32 in. diameter and 1 1/2 in. deep and are centered 1.5 in. from the edge of the surface. The cable loop in the P-clamp is vinyl-coated and sized to grip a standard sensor cable snugly once the clamp is closed.

Begin by drilling 5/32 in. mounting holes that are centered 1.5 in. from the edge of the surface. Each hole should be 1 1/2 in. deep. 3/16 in. X 1 1/4 in. Tapcon hex washer anchors are recommended for fastening the P-clamps to the surface.

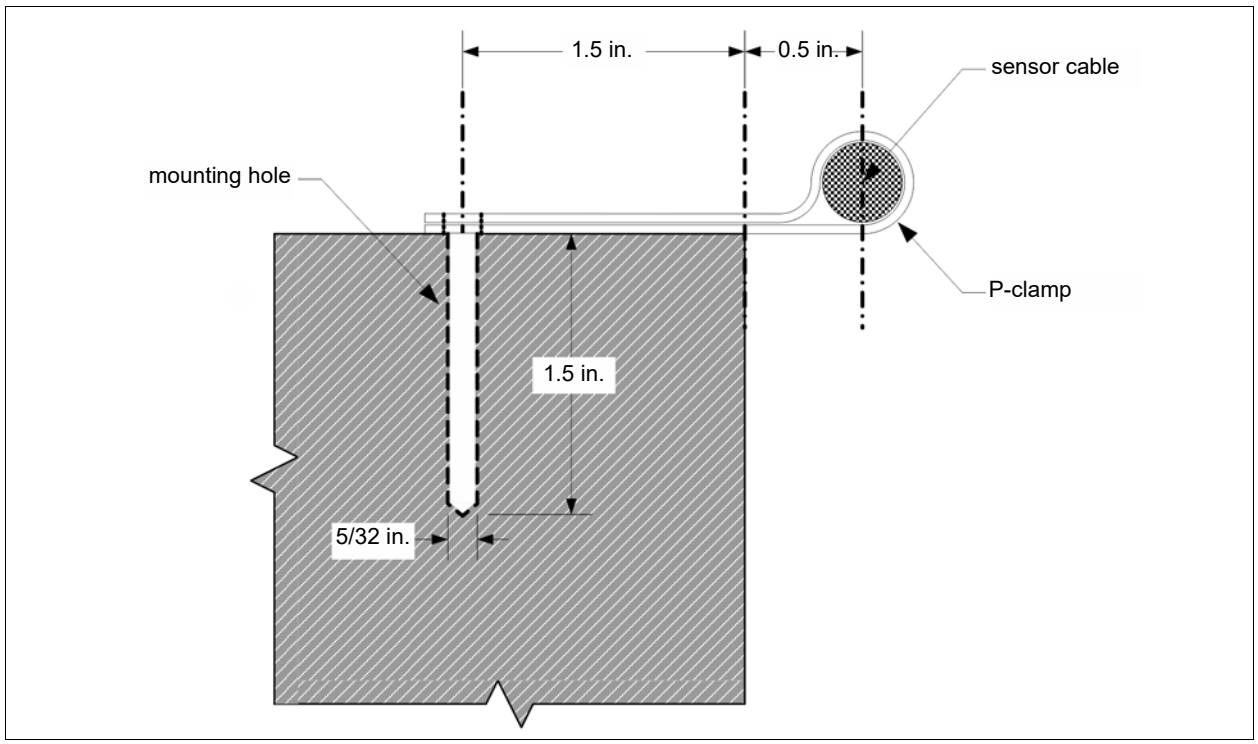


Figure 52 Masonry surface mounting hole dimensions

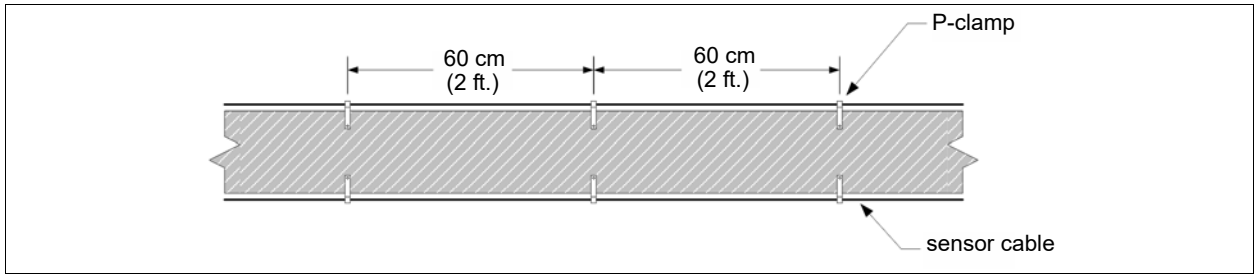


Figure 53 Masonry surface P-clamp spacing

1. Measure and mark the mounting hole locations on the surface.
2. Using a 5/32 carbide-tipped bit, drill the mounting holes 1 1/2 in. deep.

Note	Mark the desired hole depth on the bit with a piece of colored tape.

3. Once the holes are drilled, use compressed air to blow out any residue.
4. Fit a P-clamp over the sensor cable and pinch the ends together with your fingers so the 2 holes line up.
5. Use lineman pliers to squeeze the bracket together at the sensor cable end of the clamp.
6. Fit a 3/16 in. X 1 1/4 in. Tapcon screw through the 2 holes and fasten the P-clamp to the mounting surface with a 1/4 in. power driver.

Do not over-tighten to avoid stripping or shearing the screws. The sensor cable should be manually tensioned as it is being clamped and fastened to keep it straight and taut. Installed sensor cable must not sag or touch the surface.

Sensor cable verification and test

Before making the splices in the equipment room and to the end modules, do a continuity check of all spliced fibers and OTDR test the two sensor fibers (S1 and S2).

Continuity test

Use a visual fault locater (VFL) to verify continuity in S1 an S2, as well as any dark fibers that were field spliced during the cable installation.

OTDR test

Before splicing the sensor fibers to the start and end modules, test the two sensor fibers from both ends of the cable with an OTDR at the following settings:

wave length = 1550 nm
pulse width = 100 ns
average time = 2 min.
splice loss $\leq$ 0.05 dB (typical)
range $\geq$ cable length

Calculate the average loss per km from each end of the sensor cable and use the higher reading. The maximum cable loss must be 0.3 dB per km or less.

CAUTION	Critical losses in the sensor cable discovered by OTDR testing must be investigated and rectified before making the connection module and end module splices.

Control equipment installation

The FiberPatrol electronic control components are designed to be installed in an EIA 19 in. equipment rack. The rack requires a mounting depth of 20 in. (51 cm) plus a minimum 2 in. (5 cm) of front space between the equipment and the rack doors and at least 6 in. (15 cm) of rear space for cables and ventilation. The overall depth of the rack must be a minimum of 28 in. (71 cm). Both the front and back of the equipment rack must be accessible for a technician to make the cable connections and to access power switches and reset buttons. The FiberPatrol electronic control components require 9 contiguous RU beginning at least 12 in. (30 cm) above the floor. The processor occupies 4 RU, the controller 3 RU, the patch panel/splice enclosure 1 RU, and the optional rack-mount keyboard/monitor/mouse 1 RU.

The FiberPatrol sensor unit (processor and controller) operates on 100 to 240 VAC 50/60 Hz and consumes 250 W maximum. The processor unit requires 2 independent AC receptacles and the controller requires 1. An additional AC receptacle is required if the optional rack-mount keyboard/monitor/mouse is being used at the site. FiberPatrol recommends that the FiberPatrol components be powered through a UPS system.

Figure 54 FiberPatrol sensor unit (rear view)

Cable ID	Cable type	Connector	Connector	Included
D1 - D4	EIA-232	DB9-F	DB9-M	Yes
D5	custom mixed signal	68-pin SCSI-M	68-pin SCSI-M	Yes
RF1	50 Ohm coax	BNC	BNC	Yes
FO1 - FO4	fiber optic patch cable	FC/APC	FC/APC	Yes

Cable identification details

CAUTION The FiberPatrol Controller and patch cables include protective dust caps on the connectors. Leave the dust caps on until you make the connections. Do not touch the ends of the fiber connectors or allow the ends of the fiber connectors to touch anything. To make the connection, remove the dust cap, clean the connector ends, and then gently insert the ST connector and tighten only until finger-tight.

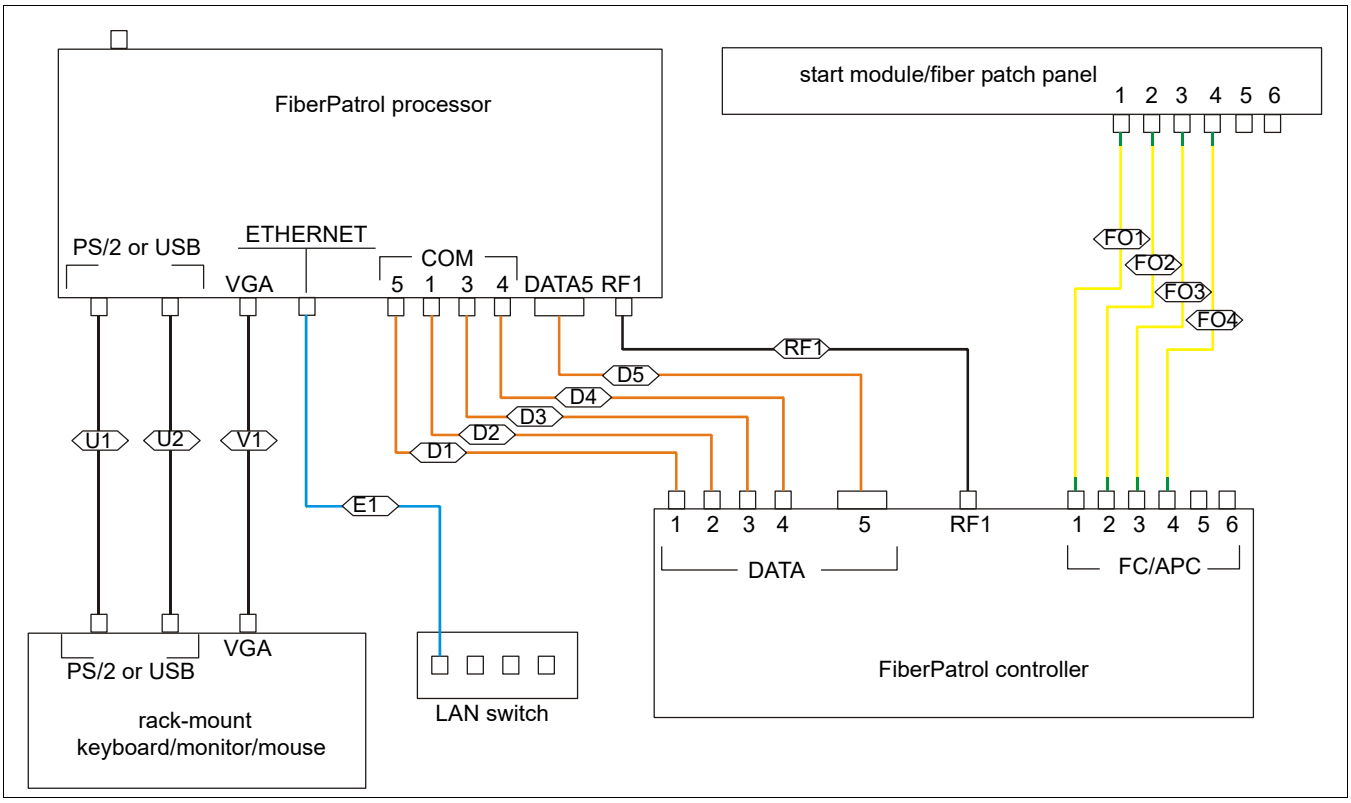


Figure 55 FiberPatrol interconnect diagram

FiberPatrol Processor	Cable	FiberPatrol Controller
COM 5	D1	DATA 1
COM 1	D2	DATA 2
COM 3	D3	DATA 3
COM 4	D4	DATA 4
DATA 5	D5	DATA 5
RF1	RF1	RF1

FiberPatrol Processor	Cable	Rack-mount KVM
USB	U1	USB
USB	U2	USB
VGA	V1	VGA

FiberPatrol Processor	Cable	LAN SWITCH
ETHERNET	E1	ETHERNET

FiberPatrol Controller	Cable	FiberPatrol Start Module
FC/APC 1	FO1	1
FC/APC 2	FO2	2
FC/APC 3	FO3	3
FC/APC 4	FO4	4

Cable interconnection details

FiberPatrol splices

Note	Use an OTDR to test the fibers from both ends of the cable before splicing the fibers to the start module and end module.

FiberPatrol sensor cable requires high quality fusion splices in the equipment room, as well as at any outdoor field splice locations including fiber terminations. All splices are made in a splice tray which is installed either in the 1 RU fiber patch panel for equipment room splices, or in an outdoor rated splice enclosure for outdoor splices. All fiber splices must be tested and verified with an

OTDR (typical results range from 0.01 to 0.03 dB loss per splice; maximum allowable loss per event is 0.1 dB). Figure 56 shows a splice tray and a dual start/end module. The equipment room fiber splices are identified in the following table.

Note	The loss at splices must not cause the average loss of the sensor cable to exceed 0.3 dB/km, as measured by the OTDR. The maximum allowable loss for any cable event is 0.1 dB.

splice tray

dual start/end module

Figure 56 FiberPatrol dual start/end module and splice tray

Sensor cable fiber	Start module fiber (label)	End module (label)
S1 - blue (cable beginning)	5	- - -
S2 - orange (cable beginning)	6	- - -
S1 - blue (cable end)	- - -	7 or 8
S2 - orange (cable end)	- - -	7 or 8
Refer to the site plan for details on dark fibers which may require splicing.		

Standard sensor cable fiber splicing connections

For a fully closed redundant loop configuration using a single lead cable between the equipment room and the perimeter fence (see Figure 10) green and brown fibers are used for the connections to the end module in the equipment room:

Sensor cable fiber	Start module fiber (label)	End module (label)
S1 - blue (cable beginning)	5	- - -
S2 - orange (cable beginning)	6	- - -
S1 - green (cable end)	- - -	7 or 8
S2 - brown (cable end)	- - -	7 or 8
Refer to the site plan for details on dark fibers which may require splicing.		

Single lead cable closed loop fiber splicing connections

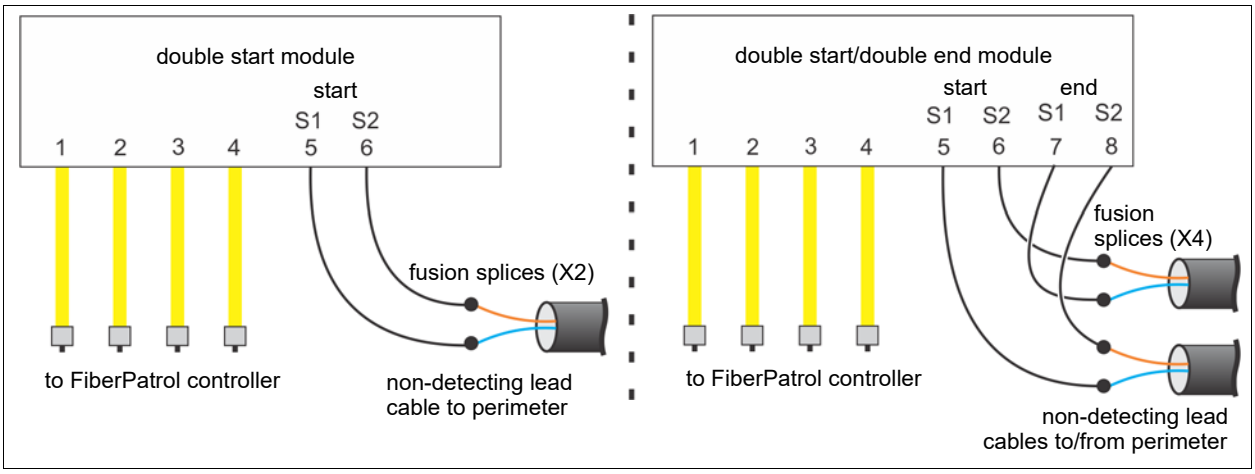


Figure 57 FiberPatrol equipment room splice requirements (2 lead cables)

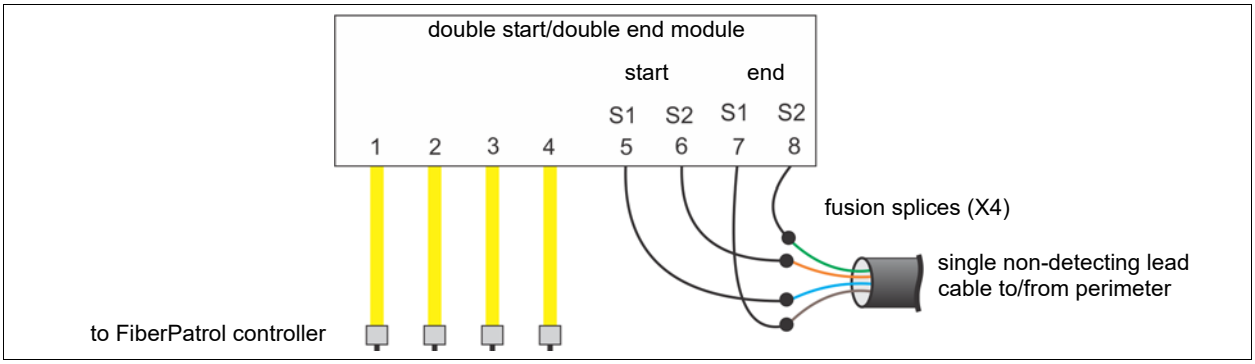


Figure 58 FiberPatrol equipment room splice requirements (1 lead cable)

Fiber terminations are often done in the field at the end of the detecting cable length. These terminations must be protected inside weatherproof splice enclosures. Figure 59 illustrates a single end module as required by a split configuration, and a double end module that could be used in a linear configuration. The following tables show the connection details. For terminations, either sensor fiber can be spliced to either end module fiber.

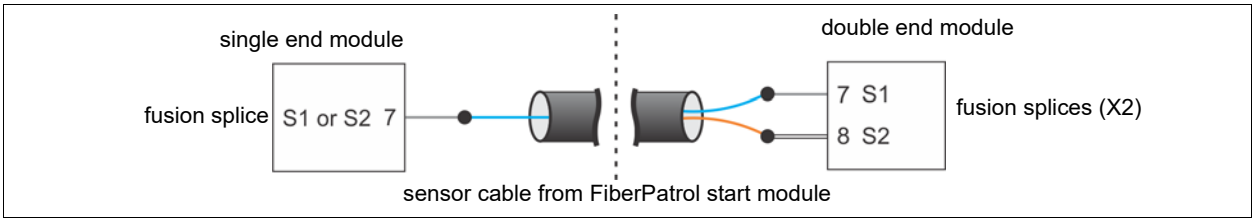


Figure 59 FiberPatrol field termination splice requirements (single and double end module)

Sensor cable fiber	Single end module	End module (label)
S1 - blue (cable end)	- - -	7
S2 - orange (cable end)	- - -	7

Single end module termination splice connection

Sensor cable fiber	Double end module	End module (label)
S1 - blue (cable end)	- - -	7 or 8
S2 - orange (cable end)	- - -	7 or 8

Double end module termination splice connections

4 Maintenance

Recommended maintenance

The FiberPatrol sensor requires minimal maintenance to ensure proper operation. However, setting up and following a maintenance schedule based on your site-specific requirements can ensure proper detection performance, prevent nuisance alarms and extend the operational lifetime of the system. The frequency at which the maintenance should be scheduled depends on your security requirements and on the installation environment. This section includes the recommended maintenance activities along with suggested intervals.

Note	FiberPatrol strongly recommends that the fence be kept clear of accumulating snow and ice. Both snow and ice have a dampening effect on the transmission of vibrations and will lead to a reduced probability of detection. Significant snow accumulation can also provide a bridging aid for defeating the sensor.

1. Perform a visual inspection of the installation (quarterly). Check for the following:
   - fence condition - ensure the fence is in good condition and that there are no loose panels, loose fittings or metal bits that can move with the wind and cause nuisance alarms (a shake test in which you grip the fence fabric in the middle of a panel and shake it back and forth with an increasing amount of force can help identify any loose pieces)
   - gates - ensure that all gate hardware is tight and secure and cannot move in the wind
   - there are no washouts or depressions under the fence
   - vegetation beside and above the fence is cut back and cannot make contact with the fence (the frequency at which vegetation must be cut back depends on the local growing conditions)
   - the sensor cable is fastened firmly against the fence fabric and the cable ties are holding the cable securely in place
   - there is no loose sensor cable
   - service loops and isolation loops are securely attached to the fence fabric
   - splice enclosures are properly mounted and secured according to the installation instructions
2. Physically test the system (once per week at randomly selected locations; once per year at all locations). High security sites should increase the frequency of testing (daily at randomly selected locations; twice per year at all locations).

- use a hard, blunt tool (e.g., a screwdriver) to simulate a series of cut intrusions by tapping the fence fabric; verify that alarms are declared and accurately located each time
- climb on the fence at several locations; verify that alarms are declared and accurately located each time

3. Check the system status on the FiberPatrol Information Display System (IDS).
   - Monitor the System Status on the Status panel (daily).
     Initializing (steady) indicates the system is starting up
     Armed (steady) indicates the system is operating properly;
     Warning (flashing) system operation is compromised, but detection is operational;
     Disarmed (flashing) indicates system failure;
     Cable Cut (steady) indicates that the sensor cable is cut or damaged and some or all detection capability is lost

Note	Contact maintenance promptly if the System Status field displays Cable Cut, Warning, or Disarmed.

   The supervisor should use the **Test Alarm**, **Simulate Cut** and **Simulate Status** functions regularly, to verify the system's functionality.
   - The supervisor should review the **Log Files** on a regular basis to verify system operation.
   - The supervisor should review the **Event Processing** sub-panel on a regular basis to check the **Signal Display**.

4. Check the electronic equipment and connections (quarterly).
   Verify that all system connections are properly seated and secure. Ensure that all cables are properly organized and are not exposed to potential damage. Check the LEDs on the RAID hard drives (blue Led lit = ON). Verify that there is adequate clearance for ventilation and clean the processor's filters, if required (clean the filters in warm water and ensure that they are completely dry before replacing them in the filter trays on the front doors).
5. If a reflection is found at the start of the sensor cable you must clean both the external connectors (from start/end module) and the internal connectors (inside Controller).
   Disconnect the external connectors from the back of the Controller.
   Clean the external connectors with a lint free cloth and isopropyl alcohol and fit the dust caps onto the connectors.
   Loosen the thumb screws on the Controller's fiber optic connection panel and carefully remove the panel from the Controller.
   Disconnect the internal connectors from the Controller's fiber optic connection panel.
   Clean the internal connectors with a lint free cloth and isopropyl alcohol and reconnect the internal connectors.
   Reinstall the fiber optic connection panel and reconnect the external connectors.
   Verify that the reflection at the start of the sensor cable has been removed.

CAUTION	DO NOT disconnect the fiber optic cables after they are installed (S1/S2). Any dust or contamination will compromise system operation.

6. Battery test (once per year)
   If your FiberPatrol system includes battery back-up, disconnect the power to the components and allow the system to run on battery power until the battery runs down and the system shuts down. Note the duration of the battery run-time, and replace the battery when the run-time no longer meets the specification.

a System component list

Component	Part Number	Description
FiberPatrol processor and controller	FP1100X-01	FiberPatrol sensor unit for fence mounted applications: up to 1.5 km (0.93 mi.) of cut-immune detection processing up to 3 km (1.86 mi.) of non cut-immune detection processing
FiberPatrol processor and controller	FP1100X-03	FiberPatrol sensor unit for fence mounted applications: up to 3 km (1.86 mi.) of cut-immune detection processing up to 6 km (3.73 mi.) of non cut-immune detection processing
FiberPatrol processor and controller	FP1100X-06	FiberPatrol sensor unit for fence mounted applications: up to 6 km (3.73 mi.) of cut-immune detection processing up to 12 km (7.46 mi.) of non cut-immune detection processing
FiberPatrol processor and controller	FP1100X-09	FiberPatrol sensor unit for fence mounted applications: up to 9 km (5.6 mi.) of cut-immune detection processing up to 18 km (11.18 mi.) of non cut-immune detection processing
FiberPatrol processor and controller	FP1100X-12	FiberPatrol sensor unit for fence mounted applications: up to 12 km (7.46 mi.) of cut-immune detection processing up to 24 km (14.91 mi.) of non cut-immune detection processing
FiberPatrol processor and controller	FP1100X-16	FiberPatrol sensor unit for fence mounted applications: up to 16 km (9.94 mi.) of cut-immune detection processing up to 32 km (19.88 mi.) of non cut-immune detection processing
FiberPatrol processor and controller	FP1100X-20	FiberPatrol sensor unit for fence mounted applications: up to 20 km (12.43 mi.) of cut-immune detection processing up to 40 km (24.85 mi.) of non cut-immune detection processing
FiberPatrol processor and controller	FP1100X-25	FiberPatrol sensor unit for fence mounted applications: up to 25 km (15.53 mi.) of cut-immune detection processing up to 50 km (31.07 mi.) of non cut-immune detection processing
FiberPatrol processor and controller	FP1400-08	FiberPatrol sensor unit for up to 2.5 km (1.55 mi.) of detection processing for fence mounted applications with 8 independent alarm zones
FiberPatrol 4 zone add-on	FP1400-EXP-04	4 zone expansion module increases the number of independent alarm zones by 4 (FP1400-08 - max. 5 expansion modules for 28 alarm zones) (software license addition must be ordered at time of purchase)
FiberPatrol processor and controller	FP1400-12	FiberPatrol sensor unit for up to 5 km (3.1 mi.) of detection processing for fence mounted applications with 12 independent alarm zones
FiberPatrol 4 zone add-on	FP1400-EXP12-04	4 zone expansion module increases the number of independent alarm zones by 4 (FP1400-12 - maximum 8 expansion modules for 44 alarm zones) (software license addition must be ordered at time of purchase)

Component	Part Number	Description
rack-mount keyboard, monitor, mouse combo	GB0296-15	Rack-mount 15 in. LCD monitor with keyboard and mouse for maintenance access to FiberPatrol processor
rack-mount keyboard, monitor, mouse combo	GB0296-19	Rack-mount 19 in. LCD monitor with keyboard and mouse for maintenance access to FiberPatrol processor
rack-mount splice tray	FPEM0400	1 RU splice tray for the equipment room fiber optic connections (contains start/end modules)
End module single	FPMA0212	Single end module for terminating 1 fiber sensor
End module double	FPMA0222	Double end module for terminating 2 fiber sensors
Start module double	FPMA0221	Double start module for equipment room fiber optic connections
Start/End module double	FPMA0223	Double start/end module for equipment room fiber optic connections and terminations
outdoor splice enclosure	GM0749-24	outdoor splice enclosure for up to 24 outdoor fusion splices
outdoor splice enclosure	GM0749-48	outdoor splice enclosure for up to 48 outdoor fusion splices
splice consumables kit	FPKT0200	Components required to make up to 24 fusion splices
single-mode fiber optic cable	FPSP0412	single-mode fiber optic lead/sensor cable for fence applications (12 fibers) in multiples of 100 m (328 ft.)
single-mode fiber optic cable	FPSP0424	single-mode fiber optic lead/sensor cable for fence applications (24 fibers) in multiples of 100 m (328 ft.)
single-mode fiber optic cable	FPSP0436	single-mode fiber optic lead/sensor cable for fence applications (36 fibers) in multiples of 100 m (328 ft.)
single-mode fiber optic cable	FPSP0448	single-mode fiber optic lead/sensor cable for fence applications (48 fibers) in multiples of 100 m (328 ft.)
buried vault	GM0748	Buried vault for below ground splices and cable loops 100 x 75 x 45 cm (39 x 30 x 18 in.)
cable ties, polypropylene	GH0916	Bag of 1000 UV resistant cable ties (for temporary usage)
cable ties, stainless steel	GH1080-08	Bag of 100 stainless steel cable ties 20 cm (8 in.) (requires installation tool)
cable ties, stainless steel	GH1080-08C	Bag of 100 coated stainless steel cable ties 20 cm (8 in.) (requires installation tool)
cable ties, stainless steel	GH1080-14	Bag of 100 stainless steel cable ties 26 cm (14 in.) (requires installation tool)
cable ties, stainless steel	GH1080-14C	Bag of 100 coated stainless steel cable ties 26 cm (14 in.) (requires installation tool)
cable ties, stainless steel	GH1080-20	Bag of 100 stainless steel cable ties 51 cm (20 in.) (requires installation tool)
cable ties, stainless steel	GH1080-20C	Bag of 100 coated stainless steel cable ties 51 cm (20 in.) (requires installation tool)
cable tie tool	GX0310	cable tie installation tool for stainless steel cable ties
cable tie tool	GX0311	deluxe cable tie installation tool for stainless steel cable ties
gate protection split conduit	FPKT0500	Split conduit 1 m (3.3 ft.) section and two gear clamps for sensor cable installation at protected swinging gates
FiberPatrol connector cleaning tool kit	GX0313	fiber technician connector cleaning kit for FiberPatrol applications
FiberPatrol installation tool kit	GX0314	fiber technician tool kit customized for FiberPatrol applications
Contact FiberPatrol for information on ordering FiberPatrol sub-assemblies.		

b Specifications

FiberPatrol control room equipment	**Sensor unit part number (Sensor unit includes FiberPatrol processor & controller)**	• FP1100X-01 - up to 1.5 km (0.93 mi.) of cut-immune fence detection - up to 3 km (1.86 mi.) of non cut-immune fence detection • FP1100X-03 - up to 3 km (1.86 mi.) of cut-immune fence detection - up to 6 km (3.73 mi.) of non cut-immune fence detection • FP1100X-06 - up to 6 km (3.73 mi.) of cut-immune fence detection - up to 12 km (7.46 mi.) of non cut-immune fence detection • FP1100X-09 - up to 9 km (5.6 mi.) of cut-immune fence detection - up to 18 km (11.18 mi.) of non cut-immune fence detection • FP1100X-12 - up to 12 km (7.46 mi.) of cut-immune fence detection - up to 24 km (14.91 mi.) of non cut-immune fence detection • FP1100X-16 - up to 16 km (9.94 mi.) of cut-immune fence detection - up to 32 km (19.88 mi.) of non cut-immune fence detection • FP1100X-20 - up to 20 km (12.43 mi.) of cut-immune fence detection - up to 40 km (24.85 mi.) of non cut-immune fence detection • FP1100X-25 - up to 25 km (14.91 mi.) of cut-immune fence detection - up to 50 km (31.07 mi.) of non cut-immune fence detection • FP1400-08 - up to 2.5 km (1.55 mi.) of fence detection • FP1400-12 - up to 5 km (3.1 mi.) of fence detection
	Power	• 3 separate AC circuits, 100 - 240 V, 50/60 Hz 4th circuit required for keyboard/monitor/mouse (if applicable) • 250 W max. (not including optional keyboard/monitor/mouse)
	Mounting	• EIA-19 in equipment rack with 51 cm (20 in.) mount depth, 5 cm (2 in.) front space and 15 cm (6 in.) rear space • 9 RU contiguous rack space, min. 30 cm (12 in.) above floor 4 RU - processor 17.8 cm (7 in.) 3 RU - controller 13.4 cm (5.25 in.) 1 RU - fiber patch panel 4.5 cm (1.75 in.) 1 RU - keyboard/monitor/mouse 4.5 cm (1.75 in.)
	Environmental	• temperature: 10 to 35º C (50 to 95º F) • humidity: 20 to 80% non-condensing
	Weight	• processor: 22.25 kg (49 lb) • controller: 12.25 kg (27 lb) • rack-mount enclosure: 5 kg (11 lb) • keyboard/monitor/mouse: 10.5 kg (23 lb)
Alarm reporting FP1100X	**Target resolution**	• 45 m (150 ft.) for simultaneous alarms - simultaneous alarms within 45 m will be reported as one alarm; simultaneous alarms separated by more than 45 m will be reported as individual alarms
	location accuracy	• 4 m (13 ft.) in a quiet environment
	Virtual alarm zones	• maximum 1440 software defined alarm zones per sensor
	Cable cut	• reported and located to within 30 m (100 ft.)

Alarm reporting FP1400	**Target resolution**	• 1 target per zone for simultaneous alarms
	Virtual alarm zones (software configured)	• 1400-08 - 8 zones per system (expandable to 28 zones via FP1400-EXP-04 expansion modules) • 1400-12 - 12 zones per system (expandable to 44 zones via FP1400-EXP120-04 expansion modules) • minimum zone length - 15 m (50 ft.)
	Cable cut	• reported and located to specific alarm zone
FiberPatrol sensor cable	**Sensor cable part number**	• FPSP04XX (XX = no. of fibers: 12, 24, 36, 48)
	Max. length per reel	• FP1100X Series 12 km (7.5 mi) typical • FP1400-08 2.5 km (1.55 mi.) • FP1400-12 5 km (3.1 mi.)
	Fiber count	• optional number of fibers: 12, 24, 36, 48 (2 required as sensor fibers, remaining dark fibers available for perimeter applications)
	Fiber type/wavelength	• single-mode; 1550 nm
	Bend radius (smallest allowable)	• dynamic (during installation) - 220 mm (8.66 in.) • static (during operation) - 110 mm (4.33 in.)
	Tensile rating	• during installation - 2700 N (600 lbf)
	Outside diameter/weight	• 11.5 mm (0.45 in.) maximum; 93 kg/km (62 lb/kft)
	Optical power loss	• max. allowable loss 0.3 dB/km (averaged over length of cable; OTDR measured form both ends of cable) • max. cable attenuation - 0.25 dB/km @ 1550 nm • max. loss per event (e.g., fusion splice) 0.1 dB
Conduit	**Material/size/weight/length/ bend radius**	• flexible innerduct - high density polyethylene • OD 42.2 mm (1.66 in.); ID 35.3 mm (1.39 in.) • wall thickness 3.12 mm (0.12 in.) • 394 kg/km 265 (lb/kft) • maximum continuous length 1829 m (6000 ft.) • min. bend radius 46 cm (18 in.)

Adjustable detection parameters	**Disturbance Threshold**	• the minimum level that a localized disturbance must reach to be accumulated and counted towards alarm generation, default = 5
	Alarm Threshold	• the minimum disturbance count that must accumulate in a location range and a time range in order to generate an alarm, default = 10
	Duration Threshold	• the minimum event duration (in seconds) required in order to declare an alarm, default = 0 (disabled)
	Disturbance Life	• the length of time, in seconds, for which any localized disturbance is retained, default = 15 s
	Disturbance Mask	• used to prevent a single disturbance event from being recorded as additional disturbances due to continuing reverberations caused by the initial disturbance, default = 0.3 s
	Disturbance Range	• defines the length of cable (or fence) over which a current disturbance event can be added to by additional disturbances in the same general area default = 6 m
	Event Life	• the length of time, in seconds, after which an event is complete, provided that no additional disturbance has occurred within the localized area of the event, default = 60 s
	Environment Compensation	• used to help screen out environmental factors like strong wind gusts and heavy precipitation that can cause nuisance alarms • Spatial Environment Compensation monitors disturbance signals over a longer length of the sensing cable and removes common-mode disturbance signals caused by environmental factors • Temporal Environment Compensation works at a localized point of the sensor and removes background signals based on the point's history over a time period
	Parallel motion rejection	• used to prevent nuisance alarms caused by nearby vehicles or trains moving alongside the sensor cable, and by planes taking off and landing alongside fences at airports
	Perpendicular motion rejection	• used to prevent nuisance alarms caused by vehicles approaching the sensor cable directly, or passing through frequently used gates, and by planes passing over fences at airports

c Location/calibration table

tap point #	description	time/location 1	time/location 2	time/location 3	avg. location

tap point #	description	time/location 1	time/location 2	time/location 3	avg. location