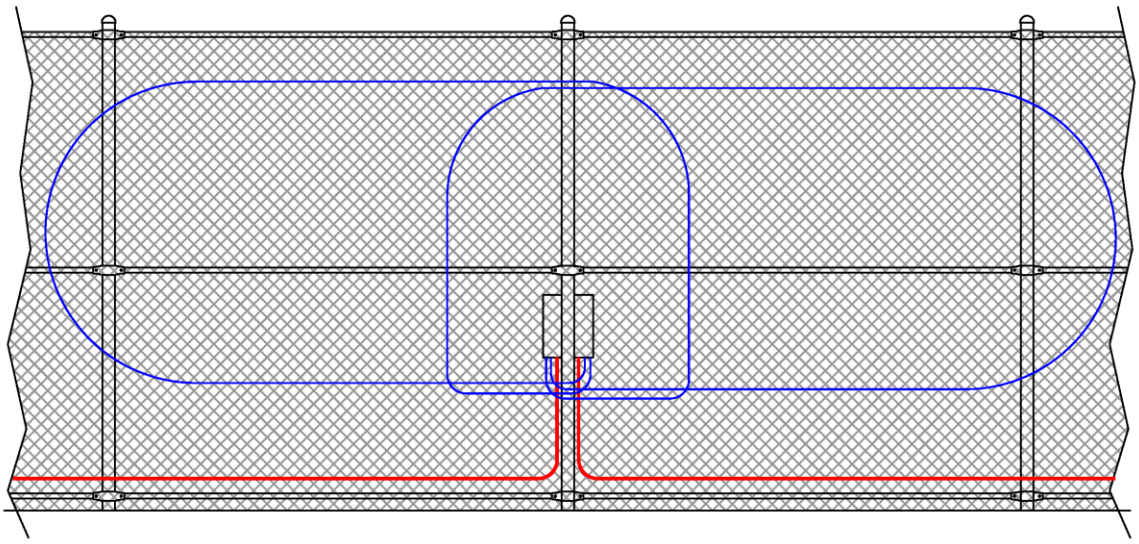
BEI SECURITY
DETECTIONS AT THE SPEED OF LIGHT

FiberSensor
Fiber Optic Intrusion Detection System (IDS)

OPERATION & INSTALLATION MANUAL

Dec 2009, Issue 3



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1.0 PRECAUTIONS

BEFORE USING THIS SYSTEM,
PLEASE READ THE FOLLOWING LIST OF PRECAUTIONS

When followed, these precautions will help insure years of trouble-free operation.

- **Do not PULL the cable by its connectors**
- **Do Not USE FORCE when mating the optical connectors**

The optical connectors are similar to coaxial cable connectors. There is a guide pin for aligning the male connector and a spring loaded bayonet fitting for securing to the female receptacle. These components must be extremely clean to allow light to pass from one connector end through the next.

- **Always CLEAN connectors with alcohol or other optical grade cleaning pad or wipe before mating**
- **Always CAP unused connectors to maintain cleanliness**
- **PROTECT connector junctions in exposed applications**

All optical connections must be kept clean and dry for the system to function properly. Seal any opening to the electronic enclosure to insure that it is water resistant. When using insensitive leads or joining any two sensing cable lengths with a feed-through coupler, encapsulate the junctions with a 3M Cable Splice Encapsulation Kit or install in NEMA grade enclosure.

The Alarm Processing Unit contains a low power laser diode. When an optical cable is not attached to the unit, the output optical connector emits light from the laser. When an optical cable is attached to the laser at one end and the other end is free, the free end emits laser light. The laser light is of a relatively low power, however it should not be viewed directly with the naked eye.

CLASS 1 LASER OUTPUT

This product complies with 21 CFR 1040.10

This product complies with the laser safety regulations of FDA 21 CFR1040.10.
There is no increased exposure when enclosure is opened. Care must be taken not to look into the Laser either at the fiber connections or at the fiber optic cable connector.

2.0 GETTING STARTED

System Components

The Motherboard has four bay locations that accept a combination of break and/or vibration modules for up to four zones of detection. The Motherboard has multiple connectors for power, optics, communications, anemometer for wind speed, tamper, and relay contacts. The drawings in Figure 1 illustrate the location and function of each input and output. The Motherboard and the modules are typically installed in the field in environmentally sealed enclosures.

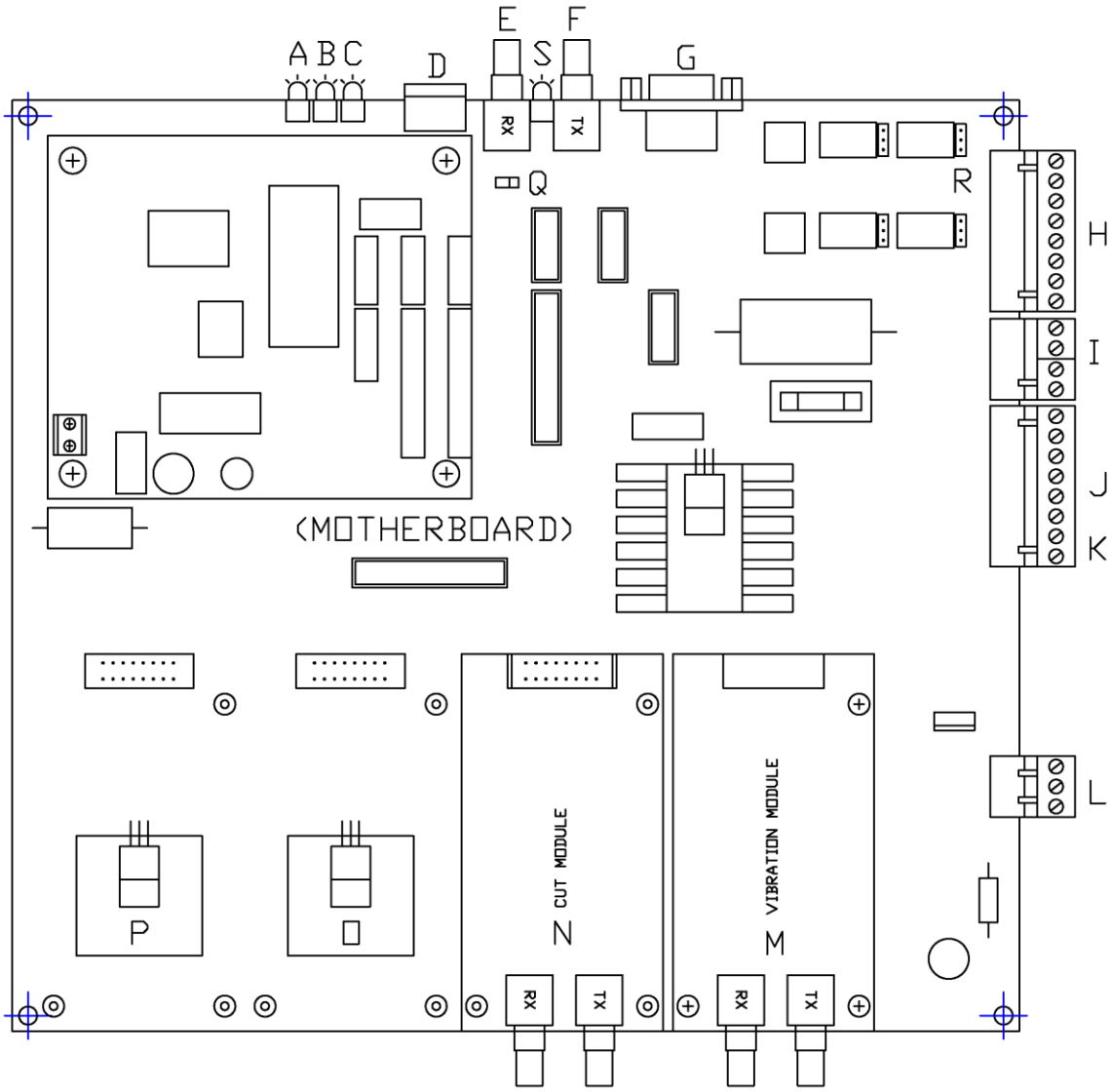


FIGURE 1

Identified in FIGURE 1 by letter are the following descriptions for all inputs and outputs from the main board.

(A) THE POWER ON LED.

(B) THE EVENT DETECT LED
(C) THE RED ALARM LED INDICATING A VALID INTRUSION
(D) EIA RS232 DATA CONNECTIONS
*For Motherboards Rev D or earlier
When the jumper at(location Q JP1 pins 1-2) for wire communication the connector at (D) is enabled and the three pin data connections are TX-GND-RX.
*For Motherboards Rev E or later Use connector (G) for communications.
(E) FIBER OPTIC DATA COMMUNICATION RECEIVER
*For Motherboards Rev D or earlier
When the jumper at JP1 pins 2-3 then the fiber optic communications is selected. The fiber optic interface then communicates with a Fiber optic to RS232 interface.
*For Motherboards Rev E or later JP1 has been removed.
(F) FIBER OPTIC DATA COMMUNICATION TRANSMITTER
*For Motherboards Rev D or earlier
When the jumper at JP1 pins 2-3 then the fiber optic communications is selected. The fiber optic interface then communicates with a Fiber optic to RS232 interface.
(G) RESERVED FOR FACTORY SETUP on Motherboards Rev D or earlier.
(H) 8 PIN CONNECTOR SUPPORTING 4 DRY CONTACT RELAY CLOSURES
The connector J12 provides 4 dry contact closures paired (1-2),(3-4),(5-6), and (7-8) respectively. The contact closures can be jumper (R) either NO or NC for each relay.
(I) FOUR PIN CONNECTOR FOR AC/DC OR BATTERY BACKUP.
The power connector provides for both AC or DC operations 13-29VDC or 9-21VAC at pins 1&2 and pins 3&4 are battery backup connections.
(J) 8 PIN CONNECTOR THAT SUPPORTS FOUR INPUTS PLUS TAMPER CONNECTION.
Pins 1 thru 5 provides sense inputs for future use.
(K) THE LAST 2 PIN ON THE 8 PIN CONNECTOR IS THE TAMPER SWITCH CONNECTIONS.
This functions requires a dry contact closure to arm. When opened the Motherboard will close the first relay connection and send an alarm value via the communications interface.
(L) WIND ANEMOMETER CONNECTIONS. Connector J15 is the Anemometer connections for wind speed reject.
(M) PORT 1 Module
Either Vibration or Break module and are identified at initialization by the Motherboard. Port 1 must be present if there is only one module plugged into the main card.
(N) PORT 2 PLUGIN
Either Vibration or Break module
(O) PORT 3 PLUGIN
Either Vibration or Break module
(P) PORT 4 PLUGIN
Either Vibration or Break module
(Q) JUMPER TO SELECT EITHER THE DATA EIA RS232 WIRE INTERFACE OR THE FIBER OPTIC CONNECTION on Motherboards Rev D or earlier
(R) JUMPERS FOR THE FOUR ALARM RELAYS NO/NC. PINS 1&2,3&4,5&6,7&8
(S) COMMUNICATIONS ACTIVITY LED'S
Shows the receive and transmit activity for either the wire or fiber optic communication.

Operating Principles

Processor Electronics unit
The FiberSensor Motherboard supports up to four plugin modules comprising either a Vibration or Break modules in combination. The Motherboard controller automatically identifies the type of module and its location in the system.
When interrogated by the Software Security application it returns all Motherboard ID's and their active ports in the system.
A tamper switch is also typically installed in the enclosure for tamper detection J14.
There are four dry contact relays each linked to a specific port on the main board J12.
Activity LED'S for Events, Alarm, and Communications are available to let the user know board level activity.

Cup wheel anemometer (Optional)
The cup wheel anemometer connects directly to the FiberSensor Motherboard at J15 provides wind information to add to the processor parameters in a windy environment making dynamic adjustment in the system to minimize nuisance alarms. The Wind speed box in the software application is checked to enable or disable this function. This feature is an option and only works well in a windy environment where wind is prevailing and somewhat constant.

Vibration Module Operation
When an optical fiber is disturbed, it changes the way that it conducts light. The change is very small; but with the right light source and detection method, this change can be amplified to create a useful signal similar to the voltage generated by a microphone in contact with something that is moving or vibrating. The FIBERSENSOR exploits this principle to make an effective intrusion detector.
The system can be described on several levels. On the simplest level, a laser injects coherent light for which all of its components consistently rise and fall together into the fiber. This light transverses the fiber to a detector where it is converted to an electrical signal. The signal from the detector is processed to decide whether there is a disturbance of the right quality to generate an alarm. If the answer is yes, relays are set to signal the alarm. The signal processing depends on parameters that are set by the user to control what kind of signal will cause an alarm and what will not.

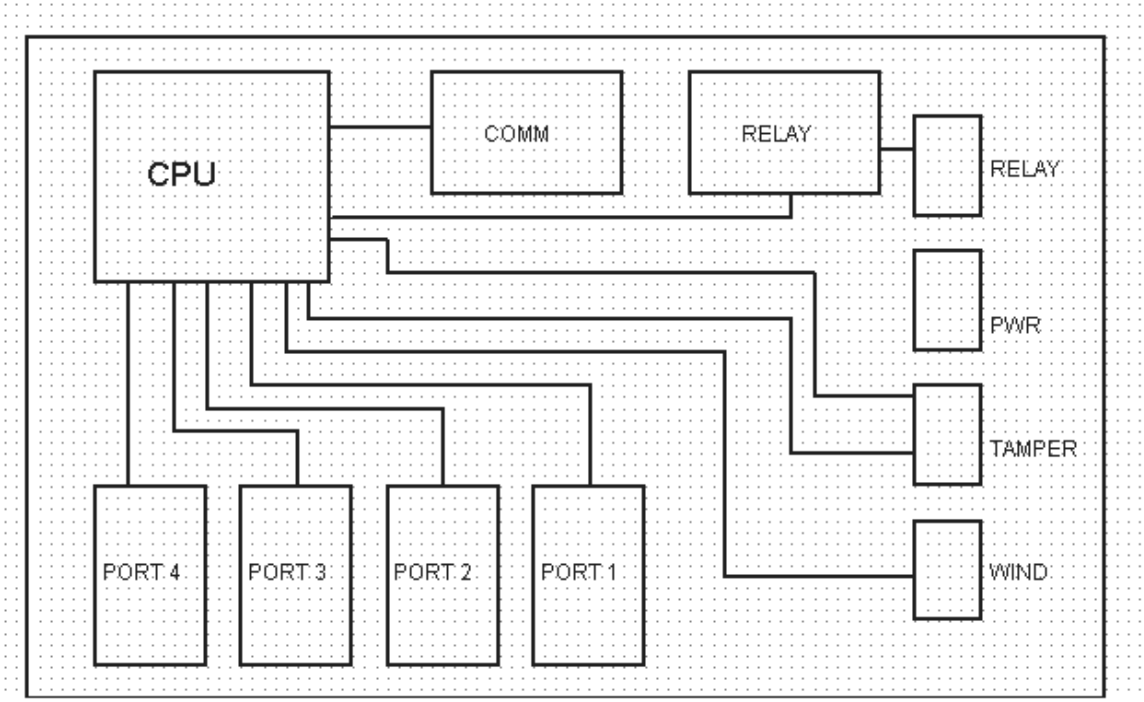
The vibration signal from the module is bandwidth defined by the user parameters.
The signal is digitized and fed to the central processor where the information is processed.
The central processor applies a variable domain negative time transform process. This helps minimize background noise, and nuisance alarms. The user parameters define the limit for each function. The NETWORK CONTROLLER INTERFACE is where these values are set and saved.

Break Module Operation
In its simplest form the break module detects the loss of signal thereby setting a flag to the communications interface and setting the appropriate relay based on the port number. The signaling used in this function is a serialized random number random time making is very difficult to intercept and duplicate.

Standard Values
The units are shipped from the factory with the Motherboard ID set to 001 and subsequent parameter value set accordingly.

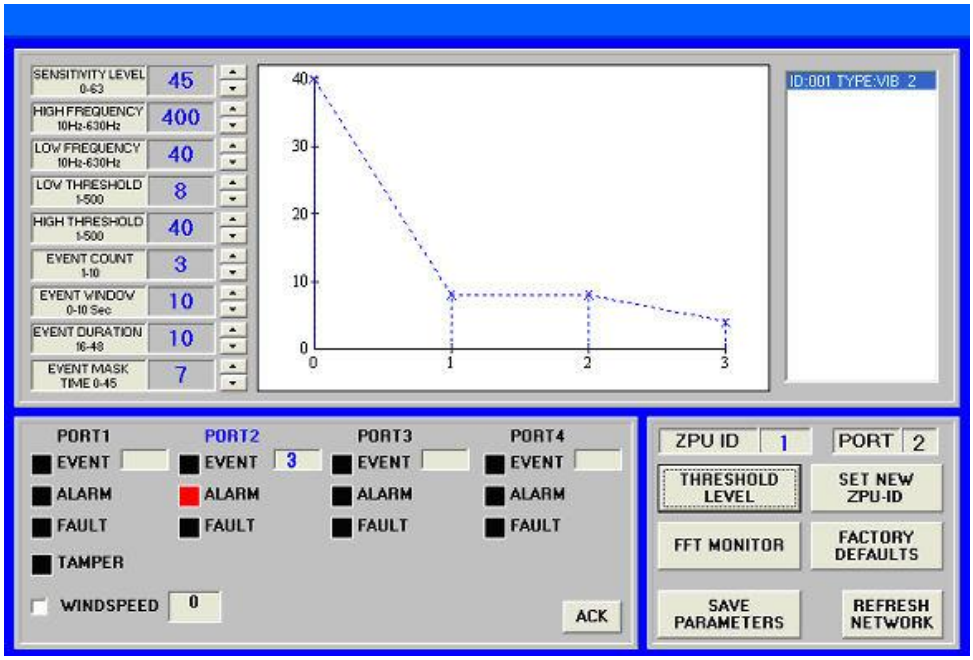
- SETTING OF Motherboard ID MUST BE DONE PRIOR TO CONNECTING THEN TO THE NETWORK.

System Block Diagram



SOFTWARE INTERFACE

MAIN SCREEN



Parameter Definitions

Db Sensitivity Value = 0-63

The sensitivity value adjustment changes the gain from unity to 63dB. Care should be taken when making this adjustment since is affects the relationship between peak and average signal levels with respect to the reference. Recommended starting value is 11.

Low Frequency Value = 10-630

This value represents the highest frequency that will be passed by the filter. The cutoff attenuates at the rate of 22dB per octave. An example is if a value of 470 is set then all frequencies up to 470Hz will be passed to the ADC for processing. Recommended starting value is 70.

High Frequency Value = 10-630

This value represents the lowest frequency that will be passed by the filter. The cutoff attenuates at the rate of 22dB per octave. An example is if a value of 230 is set then all frequencies above 230Hz will be passed to the ADC for processing. Recommended starting value is 130.

* From the example description of the low and high frequency setting a bandpass from 230Hz - 470Hz has been defined. When invoking the Spectrum Analyzer function in Windows application the system will scan from 10Hz to 630Hz in 10Hz steps resulting in a frequency analysis of the Fiber as to the predominate responses.

Low Threshold Value = 0-500

The low threshold value sets the level at which the signal energy averaged over a given time interval defined by the event duration value is exceeded. All processed signals are negative time dependent and compared to a negative time adaptive floating reference. Recommended starting value is 19.

High Threshold Value = 0-500

The high threshold value is an impulse reference that is measured during the sampling period to discriminate between noise impulses and a valid intrusion. Recommended starting value is 39.

* Both the low and high threshold values must be qualified before an EVENT is signaled and counted towards a valid ALARM condition.

No Of Events Value = 1-10

This value represents the number of events to have occurred during the EventPeriodValue in order to generate a valid ALARM condition. The Event condition must have met the High and Low threshold parameters in order to qualify. Recommended starting value is 3.

Event Period Value = 1-10

This is the window that specifies the amount of time that the No Of Events Value must qualify. If number of Events do not occur in this time period then the EventPeriodValue is reset and a new cycle of events starts. Recommended starting value is 2.

Event Duration Value = 16-48

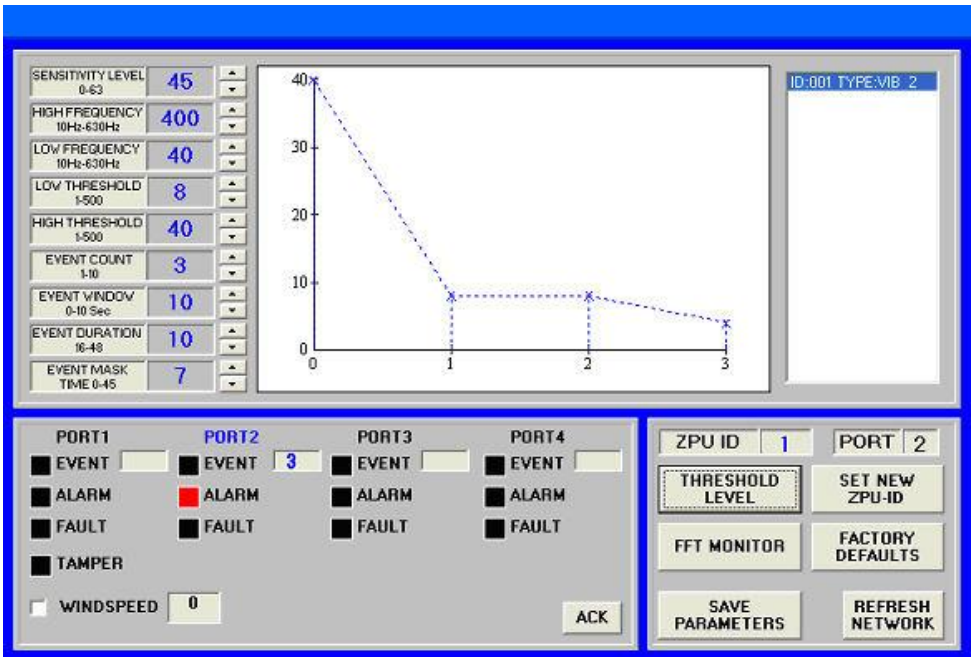
The Event Duration Value is the number of sample periods the negative time dependent transform looks at to make a determination as to impulse and average energy. The frequency domain is defined by the filter conditions and care must be taken to adjust the duration value accordingly. Recommended starting value is 17.

Event Mask Value = 0-45

The Event Mask Value is the period between valid Events that the system ignores in order to allow the transform to be deterministic. This value is in increments of 55 milliseconds and should be adjusted accordingly. Recommended starting value is 7.

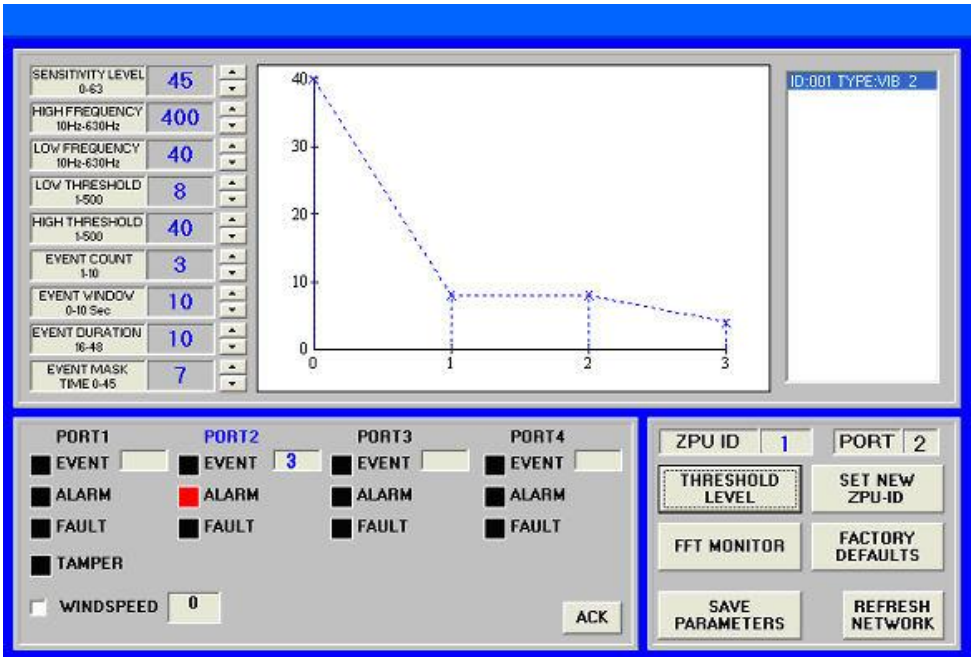
- ONCE YOU HAVE SELECTED YOUR SETTINGS AND YOUR COMFORTABLE WITH THESE VALUES SELECTING THE SAVE PARAMETERS FUNCTIONS WILL SAVE THEM IN FLASH MEMORY! IF YOU NEED TO MAKE ADJUSTMENTS TO YOUR SETTINGS IT IS RECOMMENDED THAT YOU DO A (SAVE PARAMETERS).

To change the Motherboard ID you first select a valid motherboard ID from the List Box on the right of the screen. Next select the SET NEW Motherboard-ID this will invoke a new ID select screen where the user can change select and change the ID. Once the selection is made answer either OK or CANCEL to proceed. If you select OK then it will prompt you to answer ARE YOU SURE! And if the answer is affirmative then the system will update the module with the new ID. This change will not take place until the unit is power cycled.



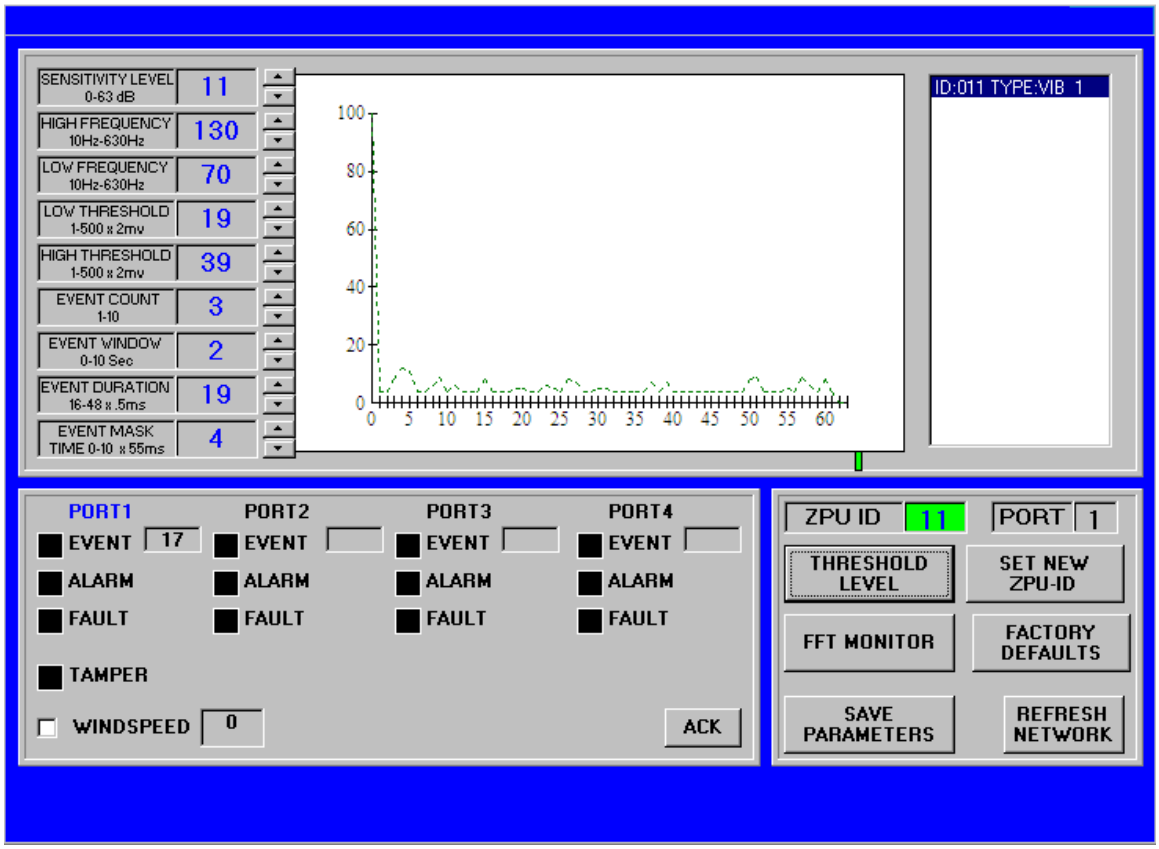
- IT IS NOT RECOMMENDED THAT THE ID BE CHANGED ONCE CONNECTED TO THE NETWORK.

The graph shows the peak and average energy of the selected port based on the parameters that are presently set. These values can be changed while observing the activity on the graph. This graph represents only the port that has been selected when the THRESHOLD LEVEL button has been selected. To stop this functions you only to reselect the THRESHOLD LEVEL button.



By adjusting the sensitivity, frequency, and thresholds the graph gives the user a representation of the fiber activity in quiescent or an intrusion state.
The 0 locations is the high threshold followed by 1 which the peak energy for a given instant. The value 2 is the low threshold and average energy setting for the event duration value followed by location 3 which is the changing average energy. The normal setting of peak to average should be about a 2 to 1 ratio.

The graph shows the frequency spectrum of the fiber between 10 and 630 Hz providing the user with setup information as to the best frequency fit to the fiber. The graph represents only the port that has been selected when the FFT MONITOR button has been activated. To stop this function you need only to reselect the FFT MONITOR button.



It is recommended that you let the FFT run for a short period of time while observing the FFT pattern in normal state (not in alarm condition) and setting the frequency bandwidth to exclude this value. If you observe that the response line is close to 0 then increase the sensitivity slowly but do not exceed 40 and continue to monitor. Once you exit the FFT restore the sensitivity to its previous value.
While FFT is active no Events or Alarms are being processed.

The REFRESH NETWORK clears the List box and scans the network for Motherboard ID'S and logs them in the list.

The FACTORY DEFAULT button restores the factory default values to the selected port. Once this selection is done you will need to reselect the Motherboard ID and the new values will be displayed on the parameters list.

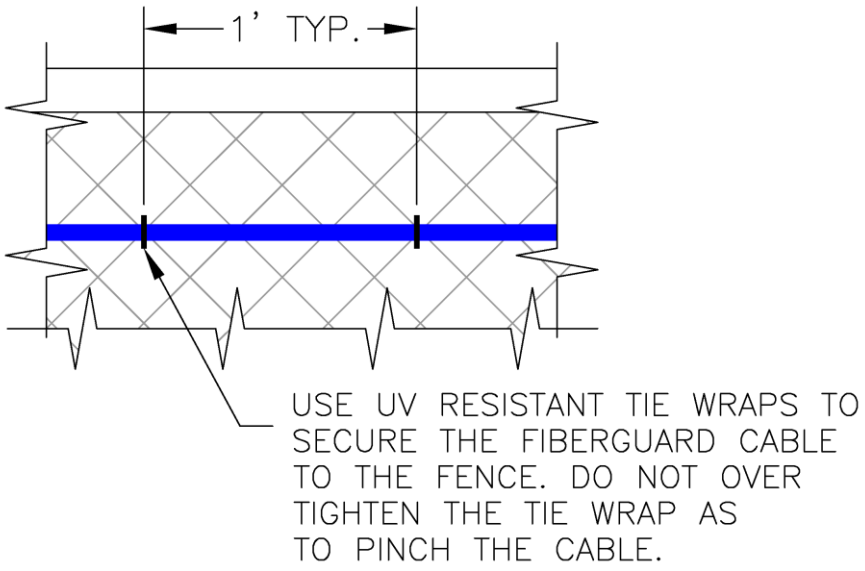
The ACK button is used to clear the RED ALARM display on the screen. The EVENT display will appear briefly in YELLOW and then return to BLACK. The EVENT count is a cumulative number of events and can be clear to zero by clicking on the counter box. This is true for all four ports.

When the WINDSPEED box is checked then the system will register the wind speed when the ANEMOMETER is attached.

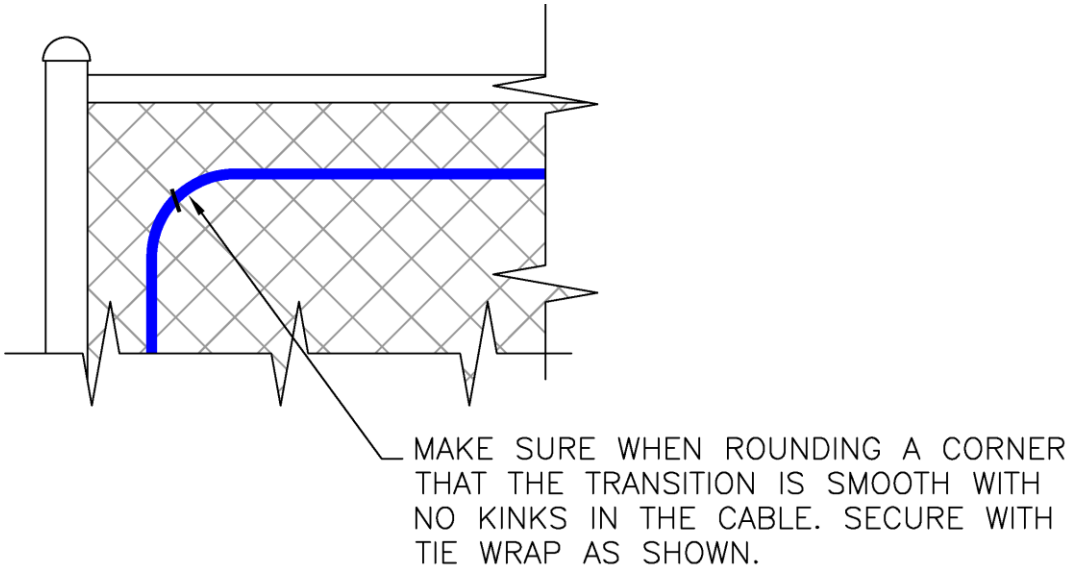
3.0 Fiber Optic Cable and Motherboard installation.

The following describes the installation of the Fiber Optic Cable to a chain link fence and the connections to the controller.

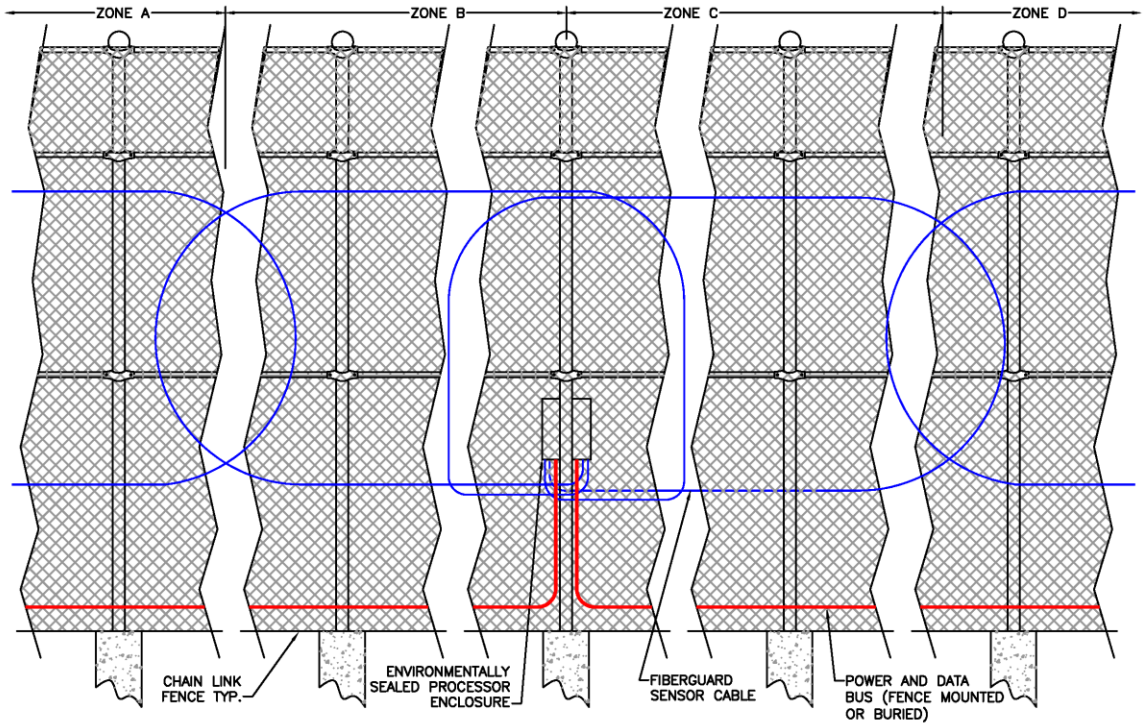
1. Attaching the fiber optic cable with tie's should be a done at approximately one foot intervals down the perimeter of the fence. When securing the fiber to the fence at the corners see the following illustrations.



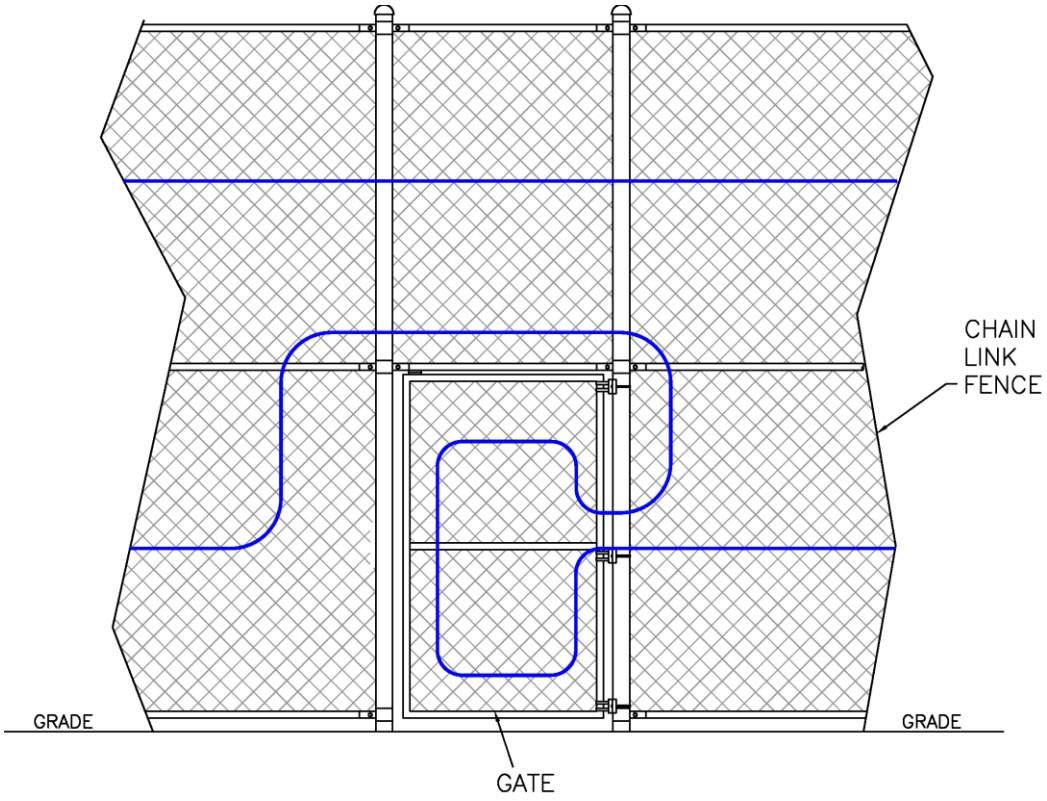
2. Attaching the fiber at the corners should be done with a gradual transition as not to exceed the bend radius of the fiber, which is about a 3 inch radius.



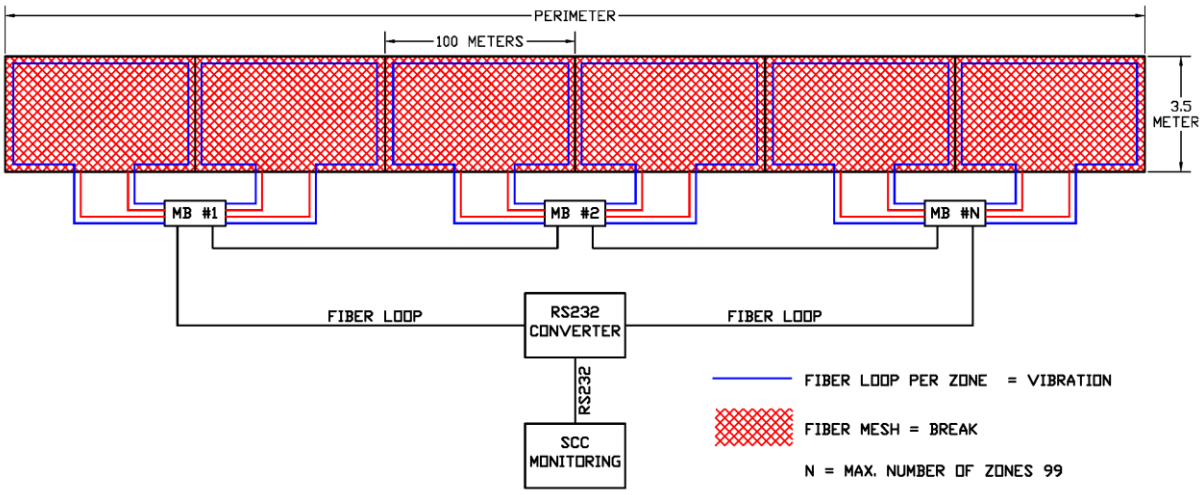
3. This example shows a typical installation of FiberSensor on a perimeter chain link fence.



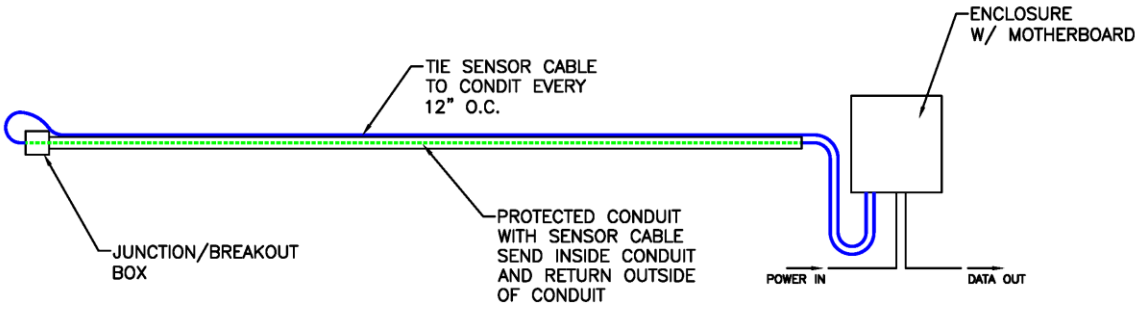
4. This example shows a typical fiber loop configuration on a Gate. A small amount of slack is provided to allow opening and closing the gate.



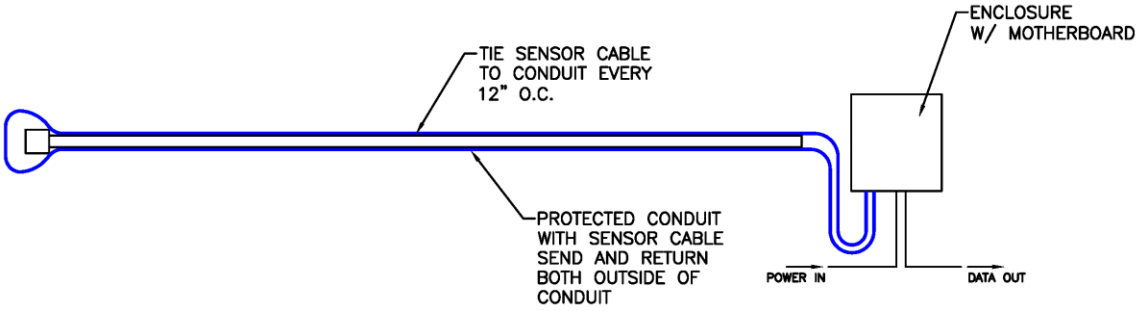
5. This example shows a typical daisy chaining of zones along a perimeter.



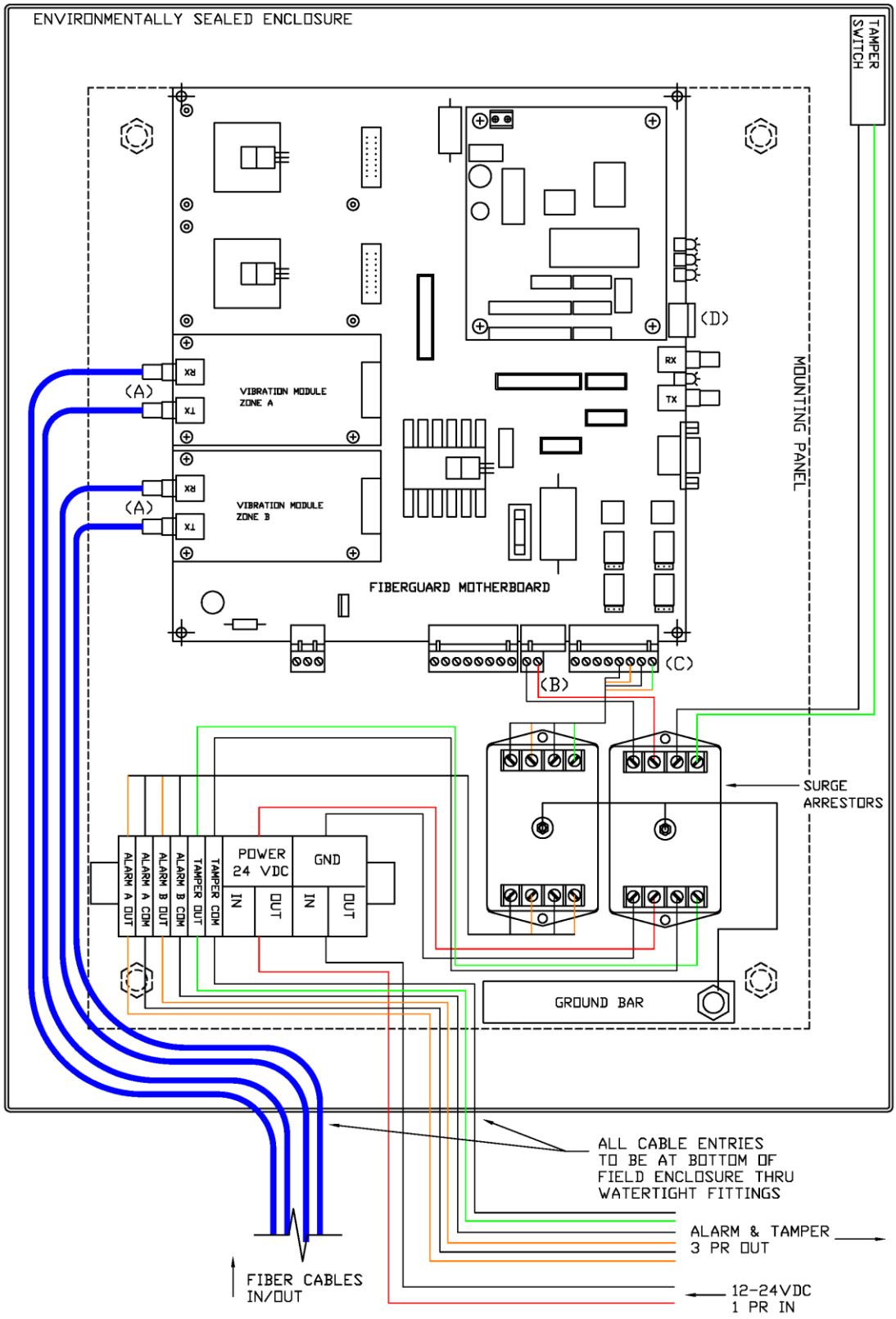
6. This example shows two typical methods of protecting conduits with sensitive data cables inside.



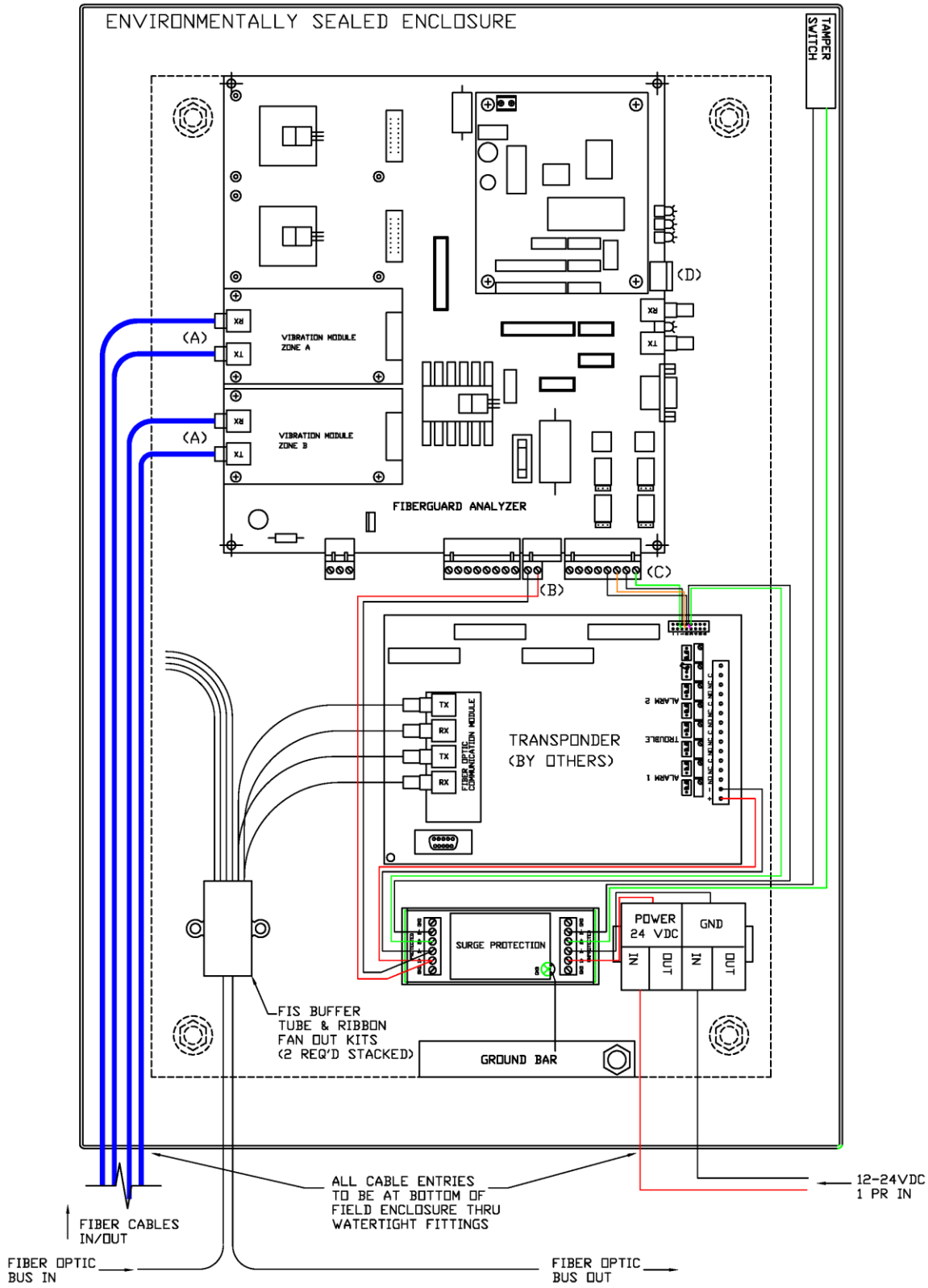
NOTE:
PROTECTED CONDUITS COULD BE MOUNTED ON A WALL OR IN A RACEWAY



7. This example shows typical Motherboard connections in an environmentally sealed enclosure without a transponder.



8. This example shows typical Motherboard connections in an environmentally sealed enclosure with a transponder.



The following letter designations correspond to previous examples 7 and 8 Motherboard Connections.

(A) denotes a zone fiber loop connections. The fiber in and out comes through the same opening/.conduit. BE VERY CAREFUL WHEN THREADING THE FIBER OPTIC CONNECTORS THROUGH THE CONDUIT. DO NOT PULL THE CABLE BY THE

FIBER OPTIC CONNECTOR.

(B) is the power connection to the Motherboard.

(C) is the relay contact strip for port1-port 4. All active ports are energized to insure relay operation when power is lost.

(D) is the RS232 interface to the application program for control and setup. The interface communicates with the host @9600 8,N,1 when the control program is active and a port is selected.

4.0 ALARM PROCESSING

The alarm processing of the FiberSensor is presented to the user in two ways. The first is by dry contact closure per active port on the main board. This action is designed for stand alone operation with no network connected.

The second processing method is by connecting the Motherboard by either EIA RS232 cable or the dual fiber optic communication back to Central control. The processor at Central control can utilize the Security network control software to provide alarm information or module setup per Motherboard.

Alarm Relays

Either the Normally Open or Normally Closed alarm relay contacts may be selected to obtain an alarm state. The contacts are rated up to 1 ampere at 24 volts DC. Should the supply voltage fail or should the system light level drop below the **FAULT THRESHOLD**, the normally energized relay contact closures will activate. **DO NOT CONNECT** AC Voltage to these contacts. Additionally, a tamper switch contact pair is also provided to allow signaling of unauthorized entry to the environmental enclosure.

Power and Alarm Signal Wiring

The control unit requires at lease13 volts DC to operate. Power, ground, alarm, communications and wind speed monitoring connector are available on the PCB. These connectors will accommodate 24 to 16 AWG wire.
There can be a significant DC voltage drop in small gauge wiring. Be sure that the DC voltage at the processor is at least 13 VDC at the Motherboard.

5.0 Wind Anemometer

Installing and Setting the Optional Anemometer

Proper placement of the Wind Anemometer is very important. It must be located in or adjacent to the zone for which it is to be used. And, because eddies from trees, buildings, or other structures can greatly influence wind speed, it must be located in the most exposed region of the zone.

Connect the cable to the controller at the connection labeled "J15 WIND" on the Alarm Processor. If the FiberSensor Motherboard is located outdoors, be sure to seal the entry of the cable where it passes through the wall of the environmental enclosure to be sure that water cannot follow the cable into the box and damage the electronics.
Once the wind speed device is in place then the Motherboard will automatically account for the changing wind speed. It must be noted that the system cannot respond to wind impulses that occur at distances from the location of the Anemometer.

6.0 PRODUCT SPECIFICATIONS

General:

Processor Size:	8” x 6” x 1” (20.3cm x 15.2cm x 2.5cm).
Processor Weight:	11 oz. (0.3Kg).
Storage Temperature:	-67°F to 185°F (-55°C to +85°C) ambient.
Operating Temperature:	-22°F to 158°F (-30°C to +70°C) ambient.

Humidity (processor):	20% to 95% relative, condensing.
Max Zone Length	2,500' (762 M')

Electrical & Optics:

Power	Input voltage: 13 – 29 VDC, 0.5 A or 9 – 21 VAC, 0.5 A, Current 500 mA
Laser Type:	Class 1
Fiber Optic Sensor Cable:	Multi Mode (site specific) Mil Spec Tactical Cable, Kevlar Reinforced Polyutherane Jacket
FM 750 Address Selection:	Factory or field set.
Indicators:	One (1) LED for Power One (1) LED each for Alarm & Events. One (1) LED each for Tx Indication & Rx Indication
Outputs:	Four (4) Alarm relays (dry contacts)
Inputs:	Four FiberSensor Zones (2 Vibration Zones &/or 2 Cut Zones)
Maintenance Port:	RS-232, DB-3 pin.
Fiber Optic Bus:	Dual Port (Repeaters).
Wavelength:	820nm.
Bus Cable:	Multimode Fiber

Range:

Fiber Optic:	Multimode (6000'), (2Km).
Jumper selectable:	Four (4) Zone Control.

Connectors:

Communication Ports:	Phoenix Connector
Power:	Phoenix Connector
Relay Outputs:	Phoenix Connector
TTL's Inputs:	Phoenix Connector
Fiber Optic Sensor Cable:	Phoenix Connector
FAR:	Less than one per zone per year
POD:	95% w/ 95% Confidence Factor
Mean Time to Repair:	Less than 30 Min. (PCB replacement).
Mean Time Between Failure:	100,000 Hours.
Warranty:	12 Months from date of approved Installation

7.0 TROUBLESHOOTING REMINDER

The **OPTICAL FIBER** within the cable **CAN BE BROKEN** by hitting it with a sharp object.
KEEP the **CONNECTORS CLEAN** - light cannot be transmitted through dirt.
The **OUTPUT** (light from the laser diode) of the Zone Processing Unit may cause **EYE DAMAGE** if viewed directly.

Wind

In almost all installations, the sensor will be free from nuisance alarms in winds up to 20 MPH. For nuisance alarm free operation in winds over 20 MPH, care must be taken

with the application of the fiber cable on the fabric and in the condition of the fence. Loose fence fabric, signs, and tree or shrub limbs can create nuisance alarms.

Animals

Some animals will climb a fence or dig beneath the fabric so that they may crawl under it. Animals such as cats, dogs, raccoons, and coyotes can sometimes cause this type of alarm. Larger animals such as cattle, horses, deer, elk, etc., are more likely sources of alarm when they live near or adjacent to an installation.

Birds

Large groups of birds are an occasional source of nuisance alarms when they land on the sensor cable itself..

Loose Cable Ties

Even UV resistant wire ties will loosen over months/years of service. When they do, the frequency of nuisance alarms can increase due primarily to wind.