Buried ported coaxial cable outdoor intrusion detection system

Purpose of document

This document is intended to provide performance specifications and operational requirements for the Perimitrax® intrusion detection system. It is written in a generic format without referring to the Perimitrax system by name or by specific identifiers. These specifications may be copied verbatim to form a generic procurement specification for a buried, ported, coaxial cable intrusion detection system.

Distribution of document

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Classification of equipment

Perimitrax is a buried ported coaxial cable electromagnetic field sensor system for outdoor perimeter intrusion detection. Perimitrax functions as a standalone system or as an integral component of a centralized control and maintenance facility.

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1.0 General performance specifications

1.1 System description

The system shall be a modular buried coaxial cable outdoor intrusion detection sensor system based on ported coaxial cable technology. The detection field shall be formed by radio-frequency (RF) signals carried by sensor cables that are buried along the perimeter. The RF signals shall form an invisible electromagnetic detection field around the sensor cables that can detect the presence of an intruder passing through the field.

A sensor module shall contain the electronics required to:

- Transmit and receive the RF signal without the use of an external antenna.
- Monitor the detection fields of two zones.
- Raise an alarm when an intruder enters the monitored zones.

Field power modules shall be available for standalone systems and network systems. Standalone power modules shall supply 12 VDC power for one sensor module. Network power modules shall supply 48 VDC power for up to nine sensor modules. The network power shall be supplied to each sensor module through the sensor cables.

As a standalone system, the primary operator interface shall be a local interface module that is connected directly to the sensor module.

As part of a network configuration, the primary operator interface shall be a PC-based central controller. The central controller shall monitor the performance of the entire buried coaxial cable outdoor intrusion detection system and any auxiliary sensors. The central controller shall have the capability of acknowledging, processing and reporting alarms. A customized color site map that is displayed on the PC monitor shall be an available option for the system.

1.2 System technology

1.2.1 Ported coaxial cable

The system shall use ported (leaky) coaxial cables as the sensing elements. A detection field shall be created using RF signals that are generated by the sensor module and carried by the coaxial cables. Each system requires a transmit cable to transmit the RF signal, and a receive cable to receive the signal and carry it back to the sensor module. Transmission and reception shall be accomplished without the use of antennae. The RF signal shall be monitored and analyzed by the sensor module for any changes in the detection field properties that would indicate the presence of an intruder. The system shall be available in two configurations that are suitable for different applications:

- a single-cable sensor system that includes both transmit and receive cables, for installation in a single narrow trench; and
- a two-cable sensor system that includes separate transmit and receive cables, for installation in two parallel trenches.
1.2.1.1 Single cable system

The single cable system shall use a single cable assembly consisting of two coaxial cables in one jacket. The outer jacket shall be made of abrasion and chemical resistant, high-density polyethylene. The cable assembly shall include a flooding compound to prevent the ingress of water if the outer jacket is nicked.

1.2.1.2 Two-cable system

The two-cable system shall use two separate cable assemblies, each consisting of a single coaxial cable in its own jacket. The outer jacket shall be made of abrasion and chemical resistant, high-density polyethylene. The cable assembly shall include a flooding compound to prevent the ingress of water if the outer jacket is nicked.

1.2.2 Electromagnetic field

Detection shall rely on an electromagnetic field that is formed completely around the buried sensor cables.

1.2.3 Sensor cable burial depth

The standard burial depth of the sensor cables shall be 23 cm (9 in.) in soil and 6 cm (2.5 in.) in hard surfaces such as asphalt or concrete.

1.3 Detection properties

1.3.1 Detection sensitivity

The system shall detect moving intruders that have a significant electromagnetic cross-section (e.g. humans, vehicles, and other large conductive objects) while rejecting other environmental stimuli (e.g. birds, small animals, weather).

1.3.2 Detection performance

1.3.2.1 Probability of detection

The probability of detecting a human intruder walking across the protected perimeter at random locations shall be 99% with a 95% confidence factor.

1.3.2.2 Velocity response

The system shall be capable of detecting human intruders moving through the detection field at speeds between 2.5 cm/s (1 in./sec.) and 15 m/s (50 ft./sec.) regardless of the direction of motion. The velocity response setting shall be programmable to optimize detection at low speed while reducing site nuisance alarms.
1.3.2.3 Intruder weight

The system shall detect human intruders weighing more than 34 kg (75 lb.) at the specified probability of detection (PD) (section 1.3.2.1).

1.3.2.4 Crossing types

The system shall detect human intruders who walk, crawl, roll, jump, or run through the detection field.

1.3.3 False alarms

1.3.3.1 System-generated alarms

Alarms generated by internal electronic processes (cables excluded) shall not exceed one per zone per month. System generated alarms are averaged based on the total number of zones in the system.

1.3.3.2 Small animal alarm rejection

The probability of detecting a small animal, weighing less than 10 kg (22 lb.), crossing the perimeter shall be less than 5% with a confidence factor greater than 90%.

1.3.3.3 Environmental alarms

The system shall operate within specifications in typical outdoor environments. The system must be installed in accordance with the manufacturer’s recommendations in order to maintain the full PD for valid intruders while minimizing false alarms from the following stimuli:

• Vegetation up to 30 cm (1 ft.) high
• Rain
• Sunrise/sunset
• Wind
• Temperature changes
• Snow
• Hail
• Fog
• Sandstorms
• Seismic vibration
• Acoustic or magnetic effects
1.3.3.4 Notification of environmental concerns

After the completion of site grading, and before acceptance testing, the installer shall notify the customer in writing as to all site-specific conditions (e.g. site grade, standing water, nearby objects, etc.) which may contribute to a higher environmental alarm rate. The customer shall decide whether to remedy the situation or accept the nuisance alarm sources without further responsibility on the part of the installer or the manufacturer.

1.4 Sensor characteristics

1.4.1 Zone length

The system shall provide detection coverage to a maximum distance of 200 m (656 ft.) per zone. Sensor cables shall be available in standard lengths of 50 m (164 ft.), 100 m (328 ft.), 150 m (492 ft.), and 200 m (656 ft.). Zone length shall be adjustable to a minimum of 10 m (33 ft.) by cutting the sensor cables during installation.

1.4.2 Detection field dimensions

When the system is calibrated in accordance with the manufacturers' recommendations:

- The detection field shall be continuous and uniform over the protected site perimeter.
- The typical cross-section of the detection field, for an intruder walking upright, shall meet the following dimensions:
  - Height – 1 m (3.25 ft.) above ground
  - Width – 2 m (6.5 ft.) for single-cable systems; 3 m (9.75 ft.) for two-cable systems
  - Depth – 0.5 m (1.5 ft.) below ground

  *Note: The dimensions are typical and are dependent on threshold settings and site conditions. The dimensions shall be obtained with one cable in a single-cable system and two cables in a two-cable system.*

1.4.3 Terrain-following characteristics

The detection field shall not be limited to flat terrain or line-of-sight operation. The system shall operate within specifications over uneven terrain with a maximum grade change of 30% within 4 m (13 ft.) and around corners with a minimum bend radius of 6.5 m (22 ft.).
1.4.4 Range of containment

When system sensitivity is calibrated according to manufacturers' recommendations, the detection field shall not detect a valid target that is a minimum of 2 m (6.5 ft.) away from the nearest sensor cable.

1.4.5 Operation in frozen soil

The freezing of the burial medium during cold weather operation shall not cause degradation in the performance of the system or damage to the system’s components.

1.4.6 Operation in areas of high moisture content

The sensor cables and underground connections shall be impervious to water ingress and degradation for a minimum of 10 years. The system shall operate within specifications in water-saturated soils.

1.4.7 Burial-mediums

The system shall operate within specifications when installed in burial mediums with conductivity ranging from 10 mS/m to 175 mS/m, including, but not limited to, sand, clay, soil, asphalt and concrete.

1.4.8 Snow cover

The sensor system shall operate within specifications when covered by snow up to 30 cm (1 ft.) deep. Note: Extremely deep snow cover, or deep snow cover with a solid crust, can potentially be used to bridge the detection field.

1.5 Performance history

1.5.1 Previous installations

The sensor system shall have been installed and operating in at least ten similar configurations for a period of at least one year. References shall be provided for a minimum of three operational sites.

1.5.2 Customer references

The vendor shall submit, as references, the names and telephone numbers of at least four users having a minimum of one year performance experience with the equipment.
2.0 Sensor module specifications

2.1 Sensor module description

Each sensor module shall contain the electronics required to handle the signal processing for two detection zones. The sensor module shall operate as either a standalone unit, or in a network configuration in conjunction with a central controller. The sensor module shall be mounted in a weatherproof enclosure when installed outdoors.

2.2 Sensor module operation

2.2.1 Distributed processing

Each sensor module shall transmit, receive and process the electromagnetic detection fields for two zones, independently from other sensor modules. Failure of one sensor module shall not affect the remainder of the perimeter. Each sensor module shall provide coverage for up to 400 m (1,312 ft.) of perimeter.

2.2.2 Adaptive filter

The sensor module shall use an adaptive filter to analyze the detection signal for trends which indicate environmental factors that could lead to nuisance alarms. The adaptive filter shall adjust the signal processing to reduce nuisance alarms caused by environmental factors such as rainfall or slow-running water.

2.2.3 Total perimeter length

The total perimeter shall be expandable to an unlimited length by using multiple sensor modules. There shall be no gap in the detection field between the individual zones.

2.2.4 Alarm outputs

The sensor module shall identify, by type, sensor, tamper, and fail alarms either locally at the sensor module, or centrally at a central controller. The sensor cables shall provide the data paths between the sensor modules, for the transmission, reception and display of alarm conditions. The data path between the sensor modules and the network controller shall be an RS-485 twisted pair cable. The system shall support dual redundant data paths.

2.2.4.1 Sensor alarm

Intrusion into either of the two zones that are supervised by a sensor module shall be identified by alarm type (sensor) and location (zone ID).

2.2.4.2 Tamper alarm

A tamper alarm, caused by opening the sensor module enclosure, shall be identified by alarm type (tamper) and location (sensor module).
2.2.4.3 Fail alarm

An alarm caused by power failure, cable fault, or internal electronic fault shall be identified by alarm type (fail) and location (sensor module).

2.2.4.4 Self-test

The sensor module shall be capable of performing a diagnostic self-test by either local or remote activation. The self-test feature shall cause a complete internal test of the sensor module.

2.3 Auxiliary sensor interface

Each sensor module shall include an internal interface for the collection of auxiliary sensor data. Each sensor module shall be capable of transmitting up to 8 contact-closure signals to the network controller via the sensor cables. The sensor module shall supply 12 VDC at 150 mA max. to power external sensors. The sensor module shall include four relay drive points to initiate self-test of the auxiliary sensors or to activate other external devices.

2.4 Environmental operating range

2.4.1 Temperature

The sensor module shall operate within specifications at temperatures between –40º and 70º C (–40º and 158º F).

2.4.2 Humidity

The sensor module shall operate within specifications at humidity levels ranging from 0 to 95% relative humidity, non-condensing.

2.5 Powering Requirements

2.5.1 Sensor module power

Sensor modules shall receive power from either a 12 VDC standalone field power module, or from a 48 VDC network field power module. In a network configuration, the sensor cables shall carry the 48 VDC power signal.

2.5.1.1 Single sensor module powering

It shall be possible to supply power directly to each unit for applications that require either a single sensor module or multiple sensor modules with independent power sources. Each sensor module shall require a maximum current of 500 mA at 12 VDC or 175 mA at 48 VDC.

2.5.1.2 Network power capability

The network field power module shall be capable of supplying power to a minimum of 9 sensor modules over a maximum distance of 2,800 m
(3,062 yds.). In a system block, the maximum distance between a sensor module and the field power module shall be 1,400 m (1,531 yds.).

2.5.1.3 Power cable redundancy

In a network configuration where power is supplied redundantly via the sensor cables, the sensor modules shall operate within specifications when power is removed from either of the two sensor cables.

2.6 Reliability/maintainability

The sensor module shall have demonstrated a Mean Time Between Failure (MTBF) of greater than 40,000 hours in actual operation. The Mean Time to Replace (MTTR) a sensor module shall be less than 15 minutes.

2.7 Physical installation criteria

2.7.1 Sensor module enclosures

The sensor module shall be housed in an enclosure that can withstand temperatures between -40º and 70º C (-40º and 158º F) and relative humidity between 0 and 95%. Sensor modules that are located outdoors shall be installed in weatherproof enclosures. The enclosure shall be grounded in accordance with local safety regulations and manufacturer’s recommendations.

2.7.2 Covert installation

The sensor module shall be capable of fully covert installation underground, within a suitable enclosure.

2.7.3 Determination of zone length

Individual zone length, to a maximum of 200 m (656 ft.) per zone, shall be determined by the physical boundaries of the site. The sensor cables shall be capable of being cut during installation to match the boundaries of the site.

2.7.4 Location of sensor module

A non-sensing section of cable shall be included as an integral part of the cable set to allow the sensor module to be located away from the detection field. The standard length of non-sensing cable shall be 20 m (66 ft.) which shall not reduce the 200 m (656 ft.) maximum length of the active detection zone. The maximum length of the combined non-sensing and sensing cable sections shall be 220 m (722 ft.). Bulk rolls of non-sensing cable shall be available in standard lengths.
2.7.5 Lead-in/sensing cable junction

The junction between the non-sensing section of lead-in cable and the sensor cable shall be integral to the cable assembly and shall require no connectors or breaks in the outer jacket of the cable. The lead-in section of the sensor cable shall be 20 m (66 ft.) in length and shall be adjustable by either cutting out or splicing in additional sections of cable.

2.7.6 Lightning protection

The sensor module shall include internal components to protect circuitry from electrostatic discharge (ESD) and lightning. Optional external protection devices shall be available for use in areas with a high incidence of lightning.

2.8 Sensor calibration

Each cable zone shall be capable of being calibrated either locally at the sensor module, or remotely from a central controller. Additional signal processing parameters, including high speed and low speed response, shall be capable of being set from a central controller.

2.8.1 Sensitivity adjustment

Detection sensitivity for each zone shall be adjusted either locally at the sensor module with a local interface module, or from a central controller. Access to the local calibration controls shall require the removal of the enclosure’s cover and shall cause a tamper alarm to be generated.

2.8.2 Local sensitivity measurement

The sensor module's response shall be demonstrated by an analog output signal that can be displayed on a voltmeter or on an analog voltage-recording device. The output signal shall be encoded to indicate the alarm trip-point, thereby showing the sensor module’s degree of detection above or below the level required to cause an alarm.

3.0 Centralized control & maintenance

The sensor shall be capable of being integrated into a centralized control and maintenance facility. The controller shall be PC-based with separate operator, supervisor and maintenance interfaces provided via embedded software. The controller shall provide or perform the following functions:

- Monitor and control the entire security system from a central location.
- Simple, menu driven alarm response functions.
- Display all sensor alarm conditions within 0.5 sec. of the event.
- A default database that includes two site maps.
• An optional custom database that includes customized site maps, secondary language and unique site-specific features.
• The remote calibration of thresholds for individual electronic components.
• The display of sensor system diagnostic test results.
• A graphical plot mode display for walk test calibration of sensor zones.
• Relay contacts for alarm outputs.
• Upgradable software for new version releases.
• System expansion and the addition of components.
• The control of a video switcher via optional hardware and software.
• The creation and display of site maps and site databases.

3.1 Central controller

The central controller shall be based on a real-time multitasking operating system using a PC platform. The operating system shall have deterministic performance whereby the system shall respond to events within a guaranteed time period (0.5 sec.). The system shall utilize a fault-tolerant design that allows it to recover from minor hardware and software errors to provide continuous operation. The system shall be compatible with hardware systems up to Pentium® processors.

3.2 Operator interface

The standard operator interfaces shall be a monitor, mouse and keyboard. A touch screen monitor shall be available as an optional interface.

3.3 Central controller capacity

The central controller shall be capable of supporting a minimum of 62 sensor modules and other network compatible devices.

3.3.1 Input point capacity

The central controller shall be capable of collecting a minimum of 620 input points (62 sensor modules with 2 sensor cable inputs and 8 auxiliary inputs per module). The actual number of input points shall be determined by the capacity of the input devices used in the system and the number of states for each device. Each input point shall be capable of supporting supervised inputs with 3 states (alarm, tamper, fail).

3.3.2 Output point capacity

The central controller shall be capable of distributing a minimum of 248 output points. The actual number of output points shall be determined by the capacity of the output devices used in the system.
3.3.3 Optional I/O components

Optional network compatible devices shall be available to utilize the I/O capacity of the central controller. These devices shall be available in the following formats: 16 inputs/8 outputs, 64 inputs/32 outputs, 64 inputs/64 outputs expandable to 256 inputs/256 outputs in groups of 64.

3.4 Display capability

The central controller shall be capable of displaying alarms either on two default system maps, or on optional site specific maps. Each map shall display the sensor modules, the sensor zones, the auxiliary sensors and the status of the sensors. The two default maps shall be capable of displaying a minimum of 384 points.

3.5 Central controller operating description

The central controller shall be capable of annunciating alarm conditions using four distinct methods: local audible indication, visual indication, relay contact closure and through a serial communications port (requires optional hardware and software components).

3.5.1 Audible alarm indication

The central controller shall be capable of generating a pulsating audible signal to annunciate an alarm condition in any zone. The signal shall continue until an operator acknowledges the alarm.

3.5.2 Visual alarm indication

The central controller’s VGA monitor shall be capable of displaying a visual indication of alarms on a graphical representation of the system or site. The display shall indicate the location and type of each alarm. Each zone of the system shall appear on the display as either a physical line or a symbol. The current state of each zone shall be indicated by the zone’s color on the monitor: access (yellow), secure (cyan), alarm (red), and fail (magenta). The alarm display shall remain until an operator acknowledges the alarm.

3.5.3 Operator prompting

Operator response to system alarm activity shall be facilitated by alarm prompt messages.

3.5.3.1 Alarm prompt

During alarm conditions, user defined zone specific information shall be displayed on a text line at the bottom of the monitor. The text line shall be a minimum of 70 characters.
3.5.3.2 Location prompt

During alarm conditions, an alarm location message shall be displayed for each zone that is in alarm state. This message shall be field programmable and shall remain intact during power-out conditions.

3.5.3.3 Response prompt

During alarm conditions, individual operator response messages shall be displayed for each zone that is in alarm state. The messages shall be field programmable and shall remain intact during power-out conditions.

3.5.4 Contact-closure output (optional)

The central controller shall be capable of providing voltage-free, contact-closure outputs for each zone in the system. The contact-closure output function shall be capable of operating in an automatic mode whereby alarm conditions shall be reset upon the removal of the alarm stimulus, without operator intervention.

3.5.4.1 Optional output type

The central controller shall be capable of providing normally open or normally closed contacts for other integrated systems through the use of transponder units.

3.5.4.2 Optional relay output cards

The central controller shall be capable of supporting two optional relay output cards to control or drive auxiliary devices. The central controller shall include vacant slots for the installation of the two optional cards. Each relay output card shall provide either 16 or 32 contact closure outputs to the system.

3.5.5 System menus

The central controller shall display user-selectable menus on the screen. The menus shall provide access to specific functions through keyboard, mouse or optional touch-screen controls. A separate set of menu screens shall be provided for system operators, supervisors and maintenance personnel. The menus shall provide a graphical user interface to simplify the performance of each system task.

3.5.5.1 Operator normal processing menu

In the operator normal processing menus, the operator shall be able to:

- view a checklist of information
- view site maps
- perform a diagnostic test of all self-testing sensors
• change sensors status to access or secure
• process sensor, tamper, and fail alarms

In systems that include the video switcher option, the operator shall have menu driven access to the camera views for display on CCTV monitors.

3.5.5.2 Operator alarm processing menu

The system shall automatically switch to the operator alarm-processing menu when an alarm is generated regardless of other system activity. In the alarm-processing mode, the system shall perform the following functions:

• notify the operator that an alarm has occurred by sounding an audible alarm that requires operator acknowledgment
• display on the monitor, the type and location of the alarm
• display on the monitor, instructions on how to process the alarm
• return to the pre-alarm state after the alarm has been processed

3.5.5.3 Supervisor menu

In the supervisor-processing menus, the system supervisor shall be able to:

• assign passwords and menu access to individual users
• schedule automatic access for sensor groups and zones
• create a checklist of information
• create location and alarm prompts for display on the monitor
• create a list of alarm causes that shall be used by the operators during alarm processing
• review system activities
• generate statistical reports for equipment and sensors
• create and perform alarm simulation sequences

3.5.5.4 Maintenance menu

In the maintenance processing menus, the system maintenance technician shall be able to:

• produce status and test reports for equipment and sensors
• examine the input/output point assignments
• adjust the sensitivity of the sensors
• generate detection signal plots for system calibration
• access the operating system
3.5.5.5 Setup menu

In the setup processing menus, the system maintenance technician shall be able to:

- verify the display color of the monitor
- align the touch screen
- set the system date and time
- change the format of the date
- set the system to automatically transfer alarms that are not processed within the timeout period
- set the maximum time to acknowledge an alarm before a remote alarm is generated
- assign alarm priority levels
- set the system to automatically switch to the highest priority alarm during multiple alarm processing
- set the communication parameters for system devices
- copy site database information from a floppy disk to the system hard disk
- shut down the system

3.6 Datalogging

3.6.1 Hardcopy output capability

The central controller shall be capable of generating a hardcopy record of all system activity by connecting a printer. The record shall include the time, date, and details of the event and the operator’s response.

3.6.2 Activity log files

The central controller shall maintain an event log of all system activity in the system’s hard drive. The capacity of the event log shall be a minimum of 250,000 lines.

3.6.3 Serial communications output (optional)

The central controller shall be capable of outputting the status of all sensor zones and auxiliary systems via an RS-232 serial data link (requires optional hardware and software components). The output signal shall utilize a fail-safe communication protocol to ensure complete and accurate transmission of system messages.
4.0 System installation and commissioning

The system shall be installed and commissioned in accordance with the manufacturer's recommended procedures as defined in the product's installation and setup guides.

Prior to installation, the installer shall have completed a manufacturer's training program and be certified by the manufacturer. Alternatively, the installer shall be required to have the manufacturer, or their designate, provide qualified technical support for installation and commissioning.

Acceptance tests shall be performed in accordance with standard procedures available from the manufacturer.

5.0 System maintenance and repair

5.1 Recalibration requirements

The system shall not require recalibration after initial calibration, with the exception of systems that are installed where seasonal changes cause freezing and thawing of the burial medium. These systems may require minor seasonal recalibration to maintain ideal sensitivity levels.

5.2 Sensor cable repair

If the sensor cable is cut or damaged, it shall be capable of being repaired by splicing in connectors and additional cable, as necessary.

5.3 Product support

The supplier shall provide technical support and shall warrant that spare parts and assemblies shall be available for a minimum of 10 years after installation.

6.0 Product certifications

The system shall comply with FCC and IC regulations for the operation of a radio-frequency radiating device.

The system shall comply with CE regulations and carry the CE mark for European applications.

The product shall be manufactured in accordance with ISO 9002 standards.
7.0 System availability

A product that meets or exceeds this specification is the Perimitrax® buried ported coaxial cable outdoor intrusion detection system, available from:

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