WAVE Siren™ SEQUENCER

The WAVE Sequencer employs state-of-the-art wireless technology to shut down and isolate vulnerable electrical components during local thunderstorms. The Sequencer receives digitally encoded signals from the WAVE Transmitter to initiate the automatic orderly protection of critical industrial systems (irrigation and computer systems) or to initiate remote sequenced events (data back-up, generator start, and other industrial control functions).

The WAVE Transmitter accepts contact-closure signals from the Strike Guard Lightning Data Receiver and sends disable and/or enable signals via radio to the Sequencer based on detection of local lightning by Strike Guard. The Sequencer has manual override capability and is programmable to initiate full automatic control or automatic shutdown with manual re-enabling.

Each Sequencer allows three separate relays or contactors to be switched automatically to power off, isolate, and/or ground any number of electrical circuits or cables. The time delays between the Sequencer outputs may be used to facilitate an orderly irrigation pump shut-down/start-up sequence. The 12 VDC outputs of the Sequencer are designed to control relays appropriate for managing the loads represented by pumps, irrigation systems and other critical equipment. Contact Wxline or your distributor for a list of recommended relays and typical wiring diagrams.

The WAVE Sequencer provides front panel manual Sequence Off and Sequence On switches and a key-switch that enables or disables the automatic restore function.

WAVE SEQUENCER DELIVERS:

- Three mile wireless communication link distance
- Secure encoded communications
- Front-panel status indicators for communication, battery and output condition
- Battery back-up for uninterrupted operation in a lightning environment
- Low-voltage outputs for controlling relays
- Extensive system self-tests, including communication, battery and output status
- Stainless steel enclosure, optional NEMA 4X enclosure

The WAVE Sequencer complements the WAVE Transmitter and Strike Guard Lightning Warning System to provide automatic remote shut-down and isolation of vulnerable electrical irrigation equipment during local thunderstorms. The Sequencer is the critical control element in modern, intelligent, active lightning protection schemes for central irrigation control computers, irrigation satellites and pump station equipment.

TRANSMITTER SPECIFICATIONS:

INSTALLATION: Wall-mountable.
ENCLOSURE: Type 304 stainless steel for indoor environment.
BATTERY: User-replaceable lead-acid batteries. Low-battery indicator.
COMMUNICATION: 10 W, 27.255 MHz, DIP switch address programming.
SETTINGS: Hours of operation for external control input are programmable via soft keys and front panel LCD.
DISPLAY: System status, power and transmit indicator, manual selection knob, key-activated manual transmission.
CONTROL INPUT: Contact-closure signaling. CAT 5 interface cable.
EXTERNAL POWER: In-line switching power supply. Input 100-240 VAC, 50/60 Hz. UL, VDE, FCC, CSA, CE.
RANGE: Three mile radius, longer range with available high-gain antenna.
ANTENNA: Standard 3 ft monopole antenna, 50 ft coaxial cable.

SEQUENCER SPECIFICATIONS:

INSTALLATION: Wall-mountable.
ENCLOSURE: Type 304 stainless steel for indoor environment.
ENCLOSURE OPTION: ABS NEMA 4X enclosure for outdoor environment.
CONTROL OUTPUT: 12 VDC (600 mA per output or 1.8 A total).
OUTPUT DELAY RANGE: 0-320 seconds per output on Sequence On and Sequence Off command.
COMMUNICATION: Superheterodyne. Complete RF supervision.
BATTERY: User-replaceable lead-acid batteries. Low-battery indicator.
ANTENNA: Standard 3 ft monopole antenna, 25 ft coaxial cable.
EXTERNAL POWER: In-line switching power supply. Input 100-240 VAC, 50/60 Hz. UL, VDE, FCC, CSA, CE.

WAVE Transmitter sends signal to Sequencers.

Strike Guard Lightning Warning System components

The WAVE Transmitter sends secure codes to activate an unlimited number of Siren Stations and Sequencers within a three mile radius.

The WAVE Transmitter offers:

1. Easy programming through front panel switches and LCD
2. Comprehensive, automatic system status monitoring
3. Manual control or automated activation from external relay input
4. Manual selection of desired transmission via front panel quick-select knob
5. Test-mode transmissions for communication tests

The WAVE Sequencer offers:

1. Three 12 VDC outputs to control up to three sequenced relays
2. Sequenced disable and enable
3. Remote automatic control via WAVE Transmitter, or local manual control of Sequence On and Sequence Off command
4. External indicators of system status, integrated self-test features

WAVE Siren is exclusively distributed by:

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WAVE Siren™

Evaluation of the "StrikeGuard" Lightning Alarm Sensor Using Lightning Location System (LLS) Lightning Data

Fukumune Suzuki, Yoshihiro Serikawa, Yuichi Onozuka

(SANKOSHA Corporation)

Abstract

StrikeGuard detects the magnetic field signal and the optical signal generated by a lightning discharge and generates lightning alarms indicating three levels of the danger. It is said that StrikeGuard can detect thunderstorm danger more accurately and output fewer false alarms when compared with conventional lightning alarm sensors. We installed a StrikeGuard sensor at Sankosha Corporation's Sagami Techno Center and compared its lightning alarm information with LLS data from the Japan Lightning Detection Network (JLDN). During an evaluation this summer, we confirmed that StrikeGuard output appropriate alarms 30 to 60 minutes before lightning occurred near the Sagami TC. We also confirmed that StrikeGuard generated alarms for 100% of the lightning detected by the JLDN at a distance of 10km or less from the sensor. Therefore, we have concluded that StrikeGuard is a practical sensor that provides sufficient performance as a lightning alarm sensor.
Keyword: LLS, Thunderstorm, Lightning alarm, Magnetic field signal

1. Introduction

We installed the new "StrikeGuard" lightning alarm sensor at our company's Sagami Techno Center (Sagami TC), and we continue to operate it now in order to evaluate the sensor's performance. StrikeGuard detects the magnetic field signal and the optical signal generated by a lightning discharge, and outputs an alarm to inform people of the approach of a thunderstorm. Also, it outputs fewer incorrect alarms when compared with other conventional lightning alarm sensors and can detect the danger of thunderstorms more accurately. We analyzed the lightning alarm information from StrikeGuard using the lightning data from the Lightning Location System (LLS), evaluated its performance, and report the results of our investigation here.

2. StrikeGuard Description

StrikeGuard consists of a Sensor that is installed outdoors and Receiver that is installed indoors (Fig. 1). The Sensor is powered by a lithium battery so it doesn't require an external power supply. The Receiver is powered by an AC power supply. However, the Receiver is equipped with an inner backup battery that allows it to operate continually at the time of an AC power failure. The Sensor is connected to the receiver through a fiber optic cable so it is completely isolated electrically from the indoor equipment. The StrikeGuard specification is shown in Table 1.

Table 1: StrikeGuard Specification

Item		Specification
Sensor	Size	660mm (W) x 770mm (H) x 660mm (D)
	Weight	1.35 kg
	Battery	Lithium battery
Receiver	Size	340mm (W) x 137mm (H) x 41mm (D)
	Weight	1.7 Kg
	Battery	1.5VDC x 4 (CK14 or LR14) for backup
	Power supply	100VAC

The Sensor detects the magnetic field change and the optical pulse of a lightning discharge and outputs this information to the Receiver. The latest signal processing lightning discrimination technology prevents Sensor false alarms. The Receiver receives the data from the Sensor and outputs three levels of lightning danger alarms (Table 2). In order to inform people, the Receiver causes an LED to flash, outputs an audible alarm, and can operate external relays.

Furthermore, by connecting a PC to the Receiver, lightning alarm information can be displayed in real time enabling the viewer to visually understand the movement of the thunderstorm. It is also possible to archive and analyze lightning information in detail.

Table 2: Lightning alarm danger levels

State	Meaning
CAUTION	Thunderstorm approaches less than about 32 km
WARNING	Thunderstorm approaches less than about 16 km
ALERT	Thunderstorm approaches less than about 8 km

StrikeGuard is a new lightning alarm sensor developed in the U.S.A. Currently, 150 or more systems are used effectively around the world at golf courses, amusement parks, stadiums, factories, energy plants and other facilities.

3. StrikeGuard Evaluation

3-1. StrikeGuard Installation

We installed StrikeGuard at the Sagami TC, and we have been collecting real thunderstorm lightning alarm information for evaluation since November 2004. Sagami TC is located in Kanagawa Prefecture on the Kanto Plain (Fig. 2).

Because StrikeGuard detects the magnetic field signal and the optical signal generated by lightning discharges, it is necessary to install it in a suitable place where interference with those signals is not a problem. However, StrikeGuard uses the magnetic field signal so the installation location requirements are much more flexible than for lightning sensors that use the electric field signal. This is one of the strong advantages unique to StrikeGuard. We installed StrikeGuard on a fence on the roof of a two-story building at the Sagami TC.

3-2. LLS data for evaluation

To evaluate the lightning alarm information from StrikeGuard, we used LLS data from the JLDN (Japan Lightning Detection Network). The JLDN is the only system that offers lightning location data for all of Japan. It is owned and operated by Franklin Japan Corporation, a private weather company. The JLDN observes thunderstorms in Japan and the surrounding area in real time using a network of 29 sensors (Fig. 3).

3-3. Lightning alarm information analysis

Many thunderstorms passed through the Sagami TC area this summer, and StrikeGuard always output lightning alarms correctly in each case. We analyzed the lightning alarm information on July 7th and report the results below.

Two thunderstorms approached the Sagami TC from the northwest on July 7th. The location of each lightning discharge in the area surrounding the Sagami TC from 13:00 to 19:00 is shown in Figure 4. StrikeGuard generated 268 alarms during this period. The number of StrikeGuard alarms in each fifteen minute interval during those six hours is shown in Figure 5. As the first thunderstorm approached, StrikeGuard output "WARNING" and "CAUTION" alarms at around 13:00. Approximately 30 minutes later, lightning occurred near the Sagami TC. When the second thunderstorm approached, StrikeGuard output a "CAUTION" alarm at around 15:30. Sixty minutes later, lightning occurred again near the Sagami TC.

Next, we compared StrikeGuard lightning alarm information with data from the LLS. We selected discharge locations reported by the LLS from 13:00 to 19:00 that were less than 50km away from the Sagami TC. We plotted those discharges in Figure 6 and used the following symbols to show the corresponding StrikeGuard output. ◊ means NO alarm, ■ means CAUTION, ▲ means WARNING, and ● means ALERT in this figure. Our analysis showed that StrikeGuard generated alarms correctly as the thunderstorms approached the Sagami TC.

4. Conclusion

In this paper, we described our analysis of StrikeGuard performance using LLS lightning data from July 7th and showed that StrikeGuard detected approaching thunderstorms and issued alarms accurately 30 or 60 minutes before lightning occurred close to the Sagami TC. We have also confirmed the sensor's accurate performance using LLS lightning data from other dates.

During the period of our analysis, StrikeGuard output alarms for 100% of the lightning discharges reported by the LLS that were located less than 10km from the Sagami TC. In addition, StrikeGuard did not generate any false alarms during any of our tests. Therefore, we have concluded that StrikeGuard is a practical lightning sensor that is sufficient to provide prompt warning of lightning danger.

Reference

[1] M. Matsui, A. Sugita "The comparison between the IKL map and the thunderstorm day map by JLDN", The 2nd Asian Lightning Protection Forum, pp.10-14, 2004

Fig. 1: StrikeGuard Sensor (left) and Receiver (right)

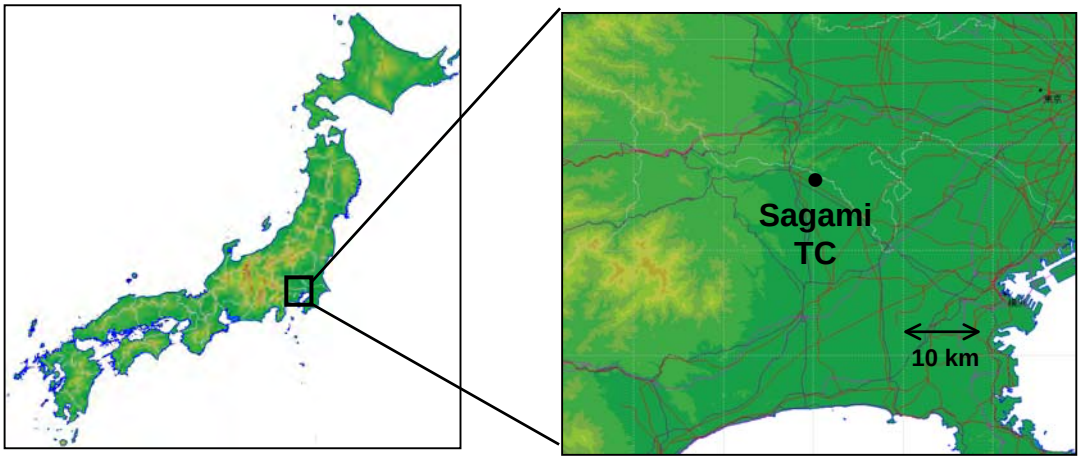


Fig. 2: The Location of the Sagami TC (left: Japan, right: Sagami TC area)

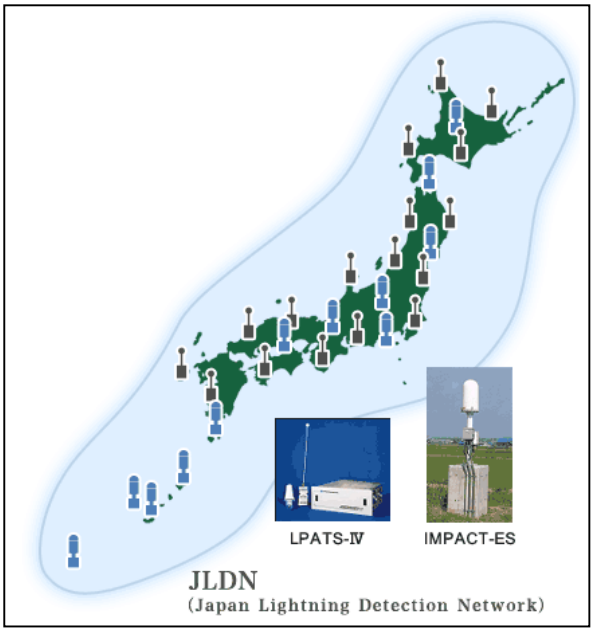


Fig. 3: JLDN (Japan Lightning Detection Network) [1]

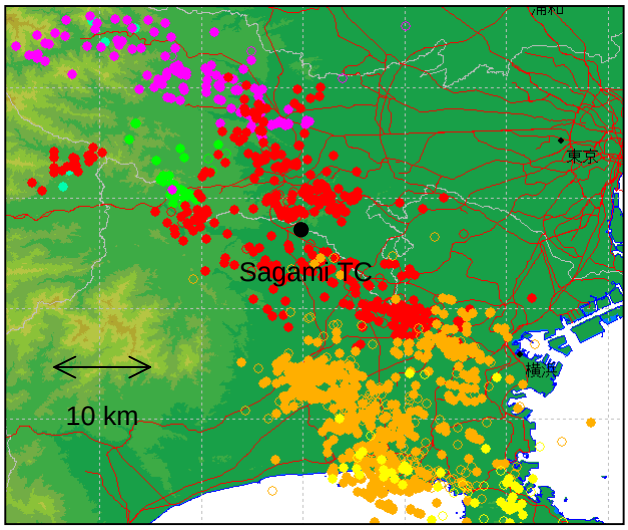


Fig. 4: Lightning locations near the Sagami TC from 13:00 to 19:00 on July 7th
(●:13~, ●:14~, ●:15~, ●:16~, ●:17~, ●:18~)

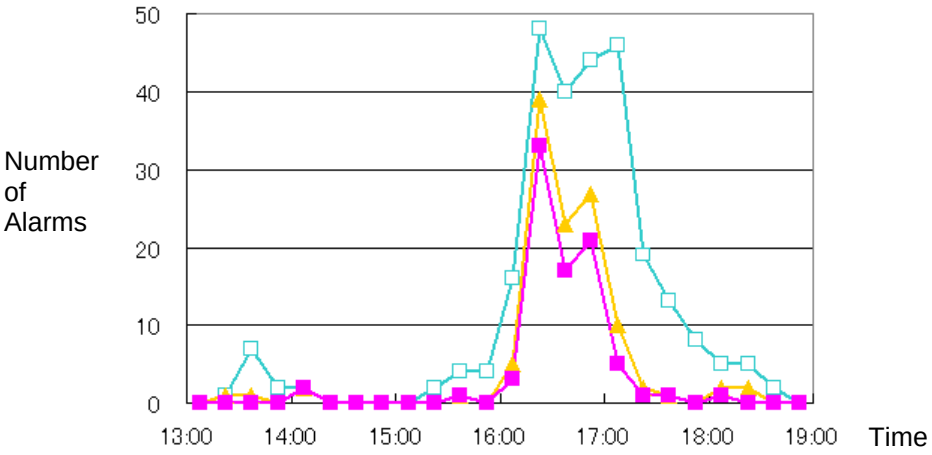


Fig. 5: The number of StrikeGuard alarms in 15 minute intervals
(- □ - : CAUTION, –▲–: WARNING, –■–: ALERT)

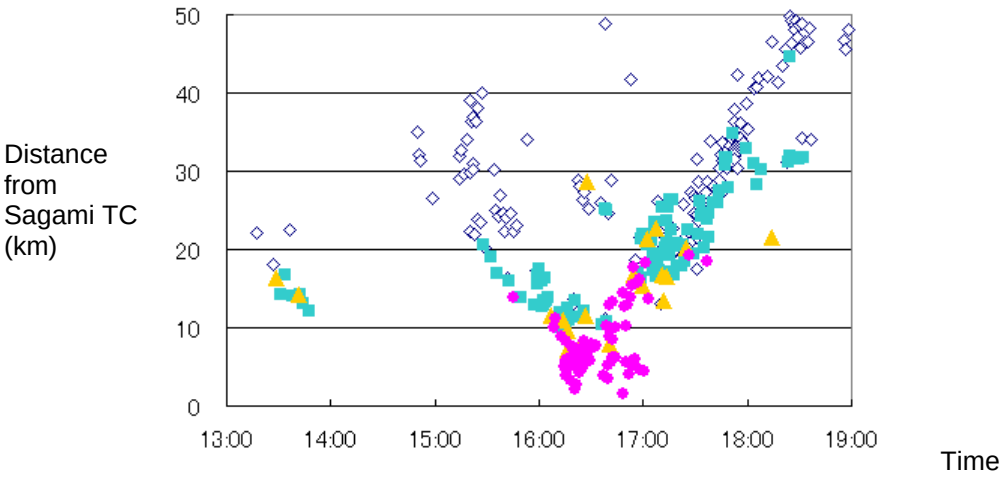
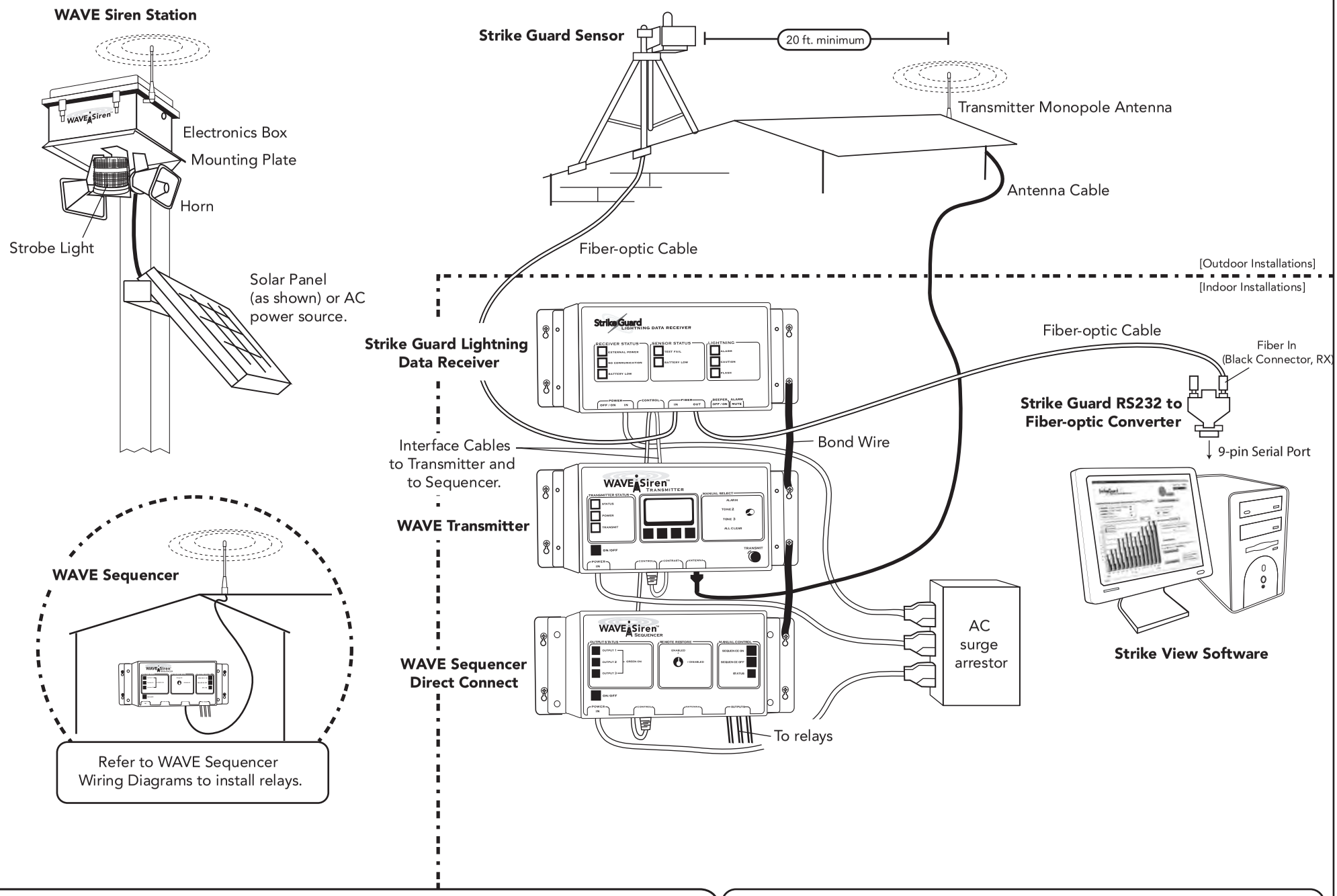


Fig. 6: LLS data and StrikeGuard Alarms
(: No alarm, ■: CAUTION, ▲: WARNING, ●: ALERT)



Strike Guard® Lightning Warning System with WAVE Siren® Station and WAVE Sequencer

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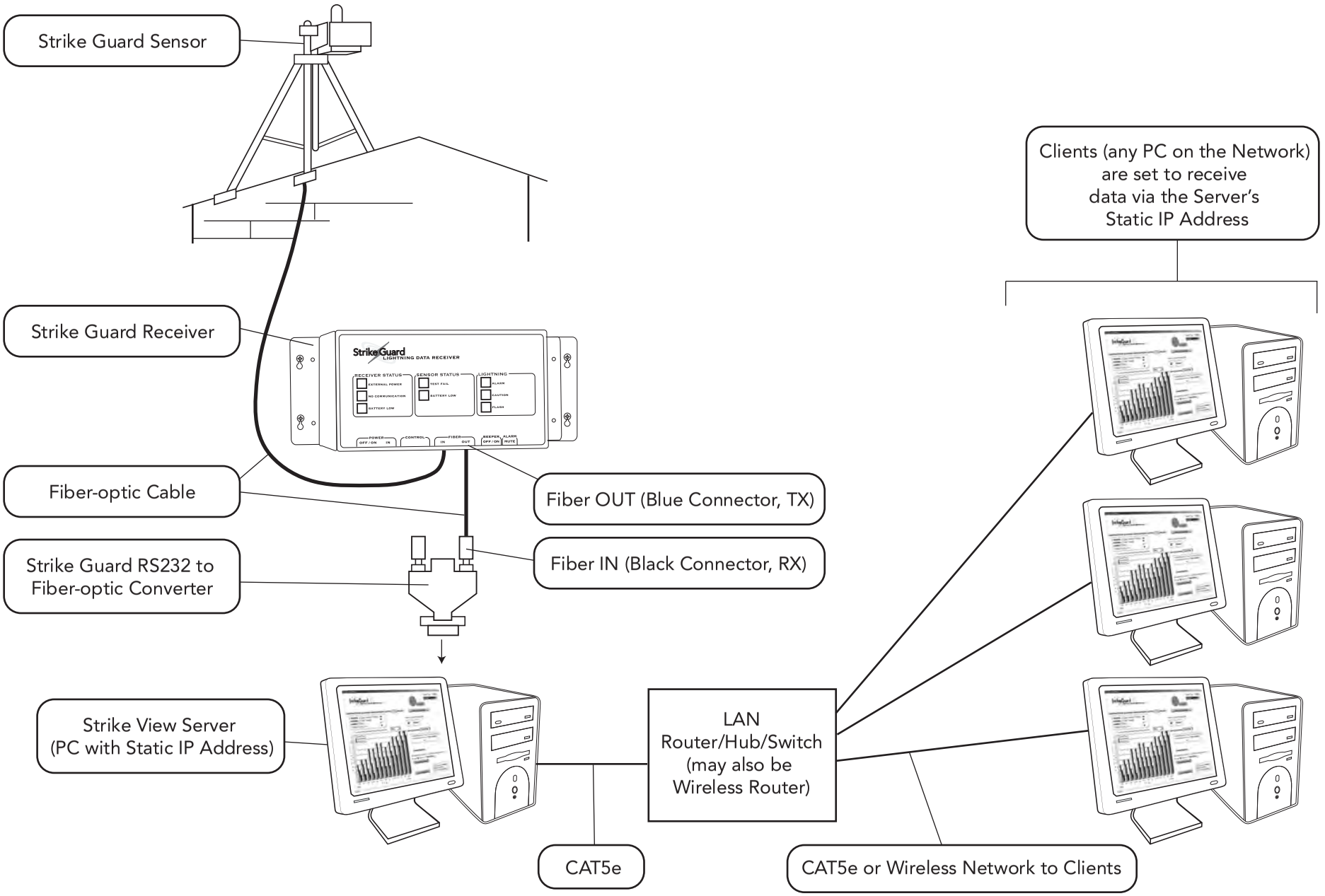

Strike View Software on a Local Area Network (LAN)

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Strike Guard™
Lightning Warning System

Strike Guard employs state-of-the-art technology to address the most demanding lightning safety and equipment protection applications.

Designed for critical industrial applications, Strike Guard monitors cloud and cloud-to-ground lightning within a user-set radius and provides contact-closure signaling at user-set lightning activity thresholds. Patented optical signal processing and proprietary optical-coincidence technology prevent false alarms.

Strike Guard Sensor data are communicated via lightning-proof fiber-optic cable to an independent Lightning Data Receiver with system status, caution and alarm indicators, relays, and PC compatible output.

STRIKE GUARD DELIVERS:

- Fully automatic alarm triggering with user-set range categories
- 20 mile detection radius
- No false alarms! Patented technology
- Sensor and communication self-test
- Sensor is battery powered for easy installation
- Durable fiber-optic communication with connector-less technology
- Lightning-proof data communication
- NEMA 4X Sensor enclosure
- Lightning Data Receiver with battery-back up
- Optional, Strike View, Windows® -based display software
- Strike Guard Simulation Software for training and testing

The proven and patented technology in Strike Guard provides significant improvement over first-generation lightning sensors. Strike Guard enables automated initiation of lightning evacuation plans, data back-up, generator activation, and equipment shutdown procedures with utmost confidence.

LIGHTNING DATA RECEIVER SPECIFICATIONS:

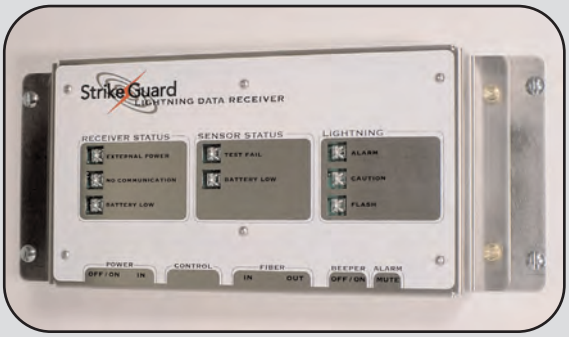
INSTALLATION: Wall-mountable with size 10 screws.
ENCLOSURE: Type 304 stainless steel.
BATTERY: User-replaceable alkaline C-cells. Low battery indicator.
COMMUNICATION: Connector-less fiber-optic link for Sensor input and output to PC. Integral Sensor data repeater.
EXTERNAL CONTROL: 2 relays, single pole, double throw. 1 A at 120 VAC, UL, CSA approved.
LIGHTNING ALARM RANGE SETTINGS: <5 miles, <10 miles or <20 miles.
SETTINGS: Lightning alarm range, alarm timeout, and lightning counts for contact-closure signaling.
AUDIBLE NOTIFICATION: Alarm Mode, Lightning Flash.
EXTERNAL POWER: In-line switching power supply. Input 100-240 VAC, 50/60 Hz. UL, VDE, FCC, CSA, CE.

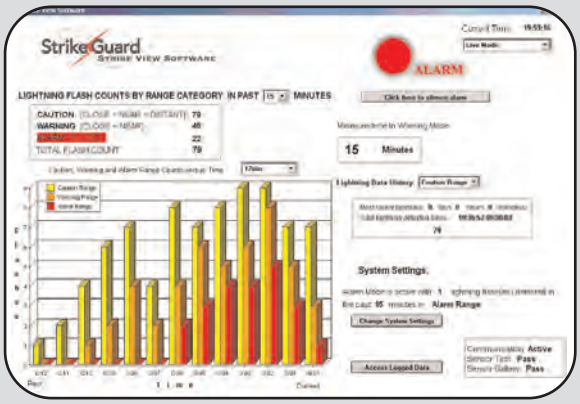
SENSOR SPECIFICATIONS:

INSTALLATION: Materials and hardware included for roof-mount.
SITE REQUIREMENTS: Minimal siting restrictions.
ENCLOSURE: NEMA 4X
COMMUNICATION: PMMA fiber-optic, 100 ft cable included.
BATTERY: Lithium primary cells, 4-year life minimum.

STRIKE VIEW SOFTWARE SPECIFICATIONS:

COMPUTER REQUIREMENTS: 64 MB; Pentium I or higher recommended.
PLATFORM: Windows® 95/98 ME/2000/XP
PC INPUT: Strike Guard RS-232 to Fiber-optic Converter provided with 9 socket serial interface. USB adapter cable available.
CABLE: PMMA fiber-optic cable.
INSTALLATION: CD-ROM.





Strike Guard Sensor interfaces to a Lightning Data Receiver and optional Windows®-based Strike View Software.

The Lightning Data Receiver offers:

1. Audible and visual alarm and system status indicators
2. Full battery back-up (200 hr typical)
3. Relays to interface with sirens and remote-controlled equipment
4. Output for PC to run Strike View Software

Strike View Software offers:

1. Lightning Data Receiver-to-PC fiber-optic communication link for RS-232 or USB port
2. Data logging
3. Exclusive countdown timer from last lightning detected
4. Lightning histograms to monitor storm progression

Each lightning detection and notification problem presents unique challenges. Let us consult with you to configure a custom solution that meets your needs.

Ask us about networked sensors to cover larger areas and multiple locations.

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Specifications are subject to change.

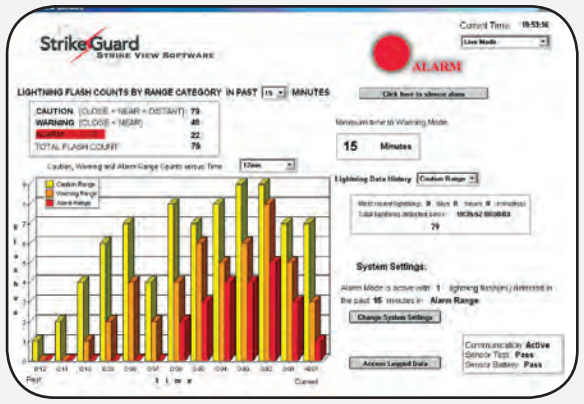
StrikeGuard™

Strike Guard®

Strike View Software with E-mail Notification

Strike View Software with E-mail Notification runs on a personal computer which connects to the Strike Guard Lightning Data Receiver to provide PC-based lightning data displays, audible and visual lightning alarms, and lightning data logging.

Strike View Software helps the user to categorize lightning data, analyze storm progression, and estimate the time to resume operations. Strike View expands upon the information presented by the Lightning Data Receiver.



STRIKE VIEW DELIVERS:

- Lightning counts in three range categories: Caution (<20 miles), Warning (<10 miles) and Alarm (<5 miles)
- User-defined e-mail notification for lightning and all-clear conditions
- User-set audible and visual alarms
- System state indicators
- Lightning data logging
- Lightning data histogram
- Countdown to "No Lightning Detected"
- Lightning-proof fiber-optic link between Lightning Data Receiver and PC
- Network (LAN) option available

SOFTWARE SPECIFICATIONS:

COMPUTER REQUIREMENTS: 64MB; Pentium I or higher recommended
PLATFORM: Windows® 98/ME/2000/XP
INTERFACE: Strike Guard RS-232 to Fiber-optic Converter to PC's 9-pin serial port or USB Port
CABLE: Rugged, connector-less PCS PMMA fiber-optic cable
FORMAT: Installation CD

Contact us today to receive a Strike View Demonstration CD.

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WAVE Siren™

Wireless Audible Visual Enunciator

WAVE employs state-of-the-art wireless technology to address the most demanding audible and visual event notification and hazard warning applications over areas of less than an acre to hundreds of acres.

Designed for critical safety applications, the WAVE Transmitter broadcasts digitally encrypted messages to activate WAVE Siren Stations within a three mile radius. The Transmitter accepts contact-closure signaling for automated triggering during programmable hours of operation. WAVE relies on low-frequency RF communication to operate in noisy environments and over challenging terrain.

WAVE Siren Station horns are modular in design to provide audible notification specific to the desired coverage area and application. Based on coverage area and sound pressure level requirements, Siren Stations can be ordered with up to four 100 W re-entrant horn, high-efficiency compression-drivers.

WAVE SIREN DELIVERS:

- Automatic or manual wireless siren actuation within a three mile radius
- Secure encoded communications
- Comprehensive, automatic self-test of RF communication and system status
- High intensity strobe light option for visual notification
- Siren Station NEMA 4X enclosure
- RF transmission test signal for Siren Station site selection
- Manual key operation or automated operation with contact-closure signal
- Programmable hours of operation to restrict automated external control
- Solar- or AC-powered Siren Station available
- High capacity, battery back-up for uninterrupted operation in a lightning environment
- Exclusive quick-connect technology for horns and solar panel

WAVE Siren and the Strike Guard Lightning Warning System combine to provide a fully automated lightning warning system. Strike Guard easily connects to the WAVE Transmitter to trigger the WAVE Siren Stations and WAVE Sequencers for audible lightning hazard notification and equipment protection at multiple locations.

TRANSMITTER SPECIFICATIONS:

INSTALLATION: Wall-mountable.
ENCLOSURE: Type 304 stainless steel for indoor environment.
BATTERY: User-replaceable lead-acid batteries. Low-battery indicator.
COMMUNICATION: 10 W, 27.255 MHz, DIP switch address programming.
SETTINGS: Hours of operation for external control input are programmable via soft keys and front panel LCD.
DISPLAY: System status, power and transmit indicator, manual selection knob, key-activated manual transmission.
CONTROL INPUT: Contact-closure signaling. CAT 5 interface cable.
EXTERNAL POWER: In-line switching power supply. Input 100-240 VAC, 50/60 Hz. UL, VDE, FCC, CSA, CE.
RANGE: Three mile radius, longer range with available high-gain antenna.
ANTENNA: Standard 3 ft monopole antenna, 50 ft coaxial cable.

SIREN STATION SPECIFICATIONS:

INSTALLATION: Typically affixed to a custom 12 ft (above ground) fiberglass pole available from Wxline. Also designed for tripod mount or pressure-treated wood pole mount (4x6 or 6x6).
EXTERNAL INDICATORS: Status, power and communication.
CONFIGURATION: Up to four compression drivers per Siren Station.
HORN MOUNTING: Stainless steel mounting plate with horn orientation adjustments.
HORN SPL OUTPUT: 130 dB at 3 m.
COMPRESSION DRIVER POWER RATING: 100 W continuous.
AMPLIFICATION: Internal 150 W, class AB amplifier.
ENCLOSURE: NEMA 4X, corrosion resistant.
COMMUNICATION: Superheterodyne. Complete RF supervision.
BATTERY: 7 AHr user-replaceable lead-acid battery, 12 AHr with solar unit.
ANTENNA: Eight-inch monopole antenna. High-gain antenna available for longer range.
EXTERNAL POWER: Input 100-240 VAC, 50/60 Hz. Solar-powered option available.
OPTION: High intensity strobe light.

The WAVE Transmitter sends secure coded RF messages to activate an unlimited number of Siren Stations and Sequencers within a three mile radius.

The WAVE Transmitter offers:

1. Easy programming through front panel switches and LCD
2. Comprehensive, automatic system status monitoring
3. Manual control or automated activation from external contact-closure
4. Manual selection of desired transmission via front panel quick-select knob

The WAVE Siren Station offers:

1. Simplified installation and flexibility through modular design
2. Solar or AC power input
3. Optional strobe light to provide visual indication of conditions
4. External indicators of system status
5. Super-high sound pressure level – directional or omni-directional

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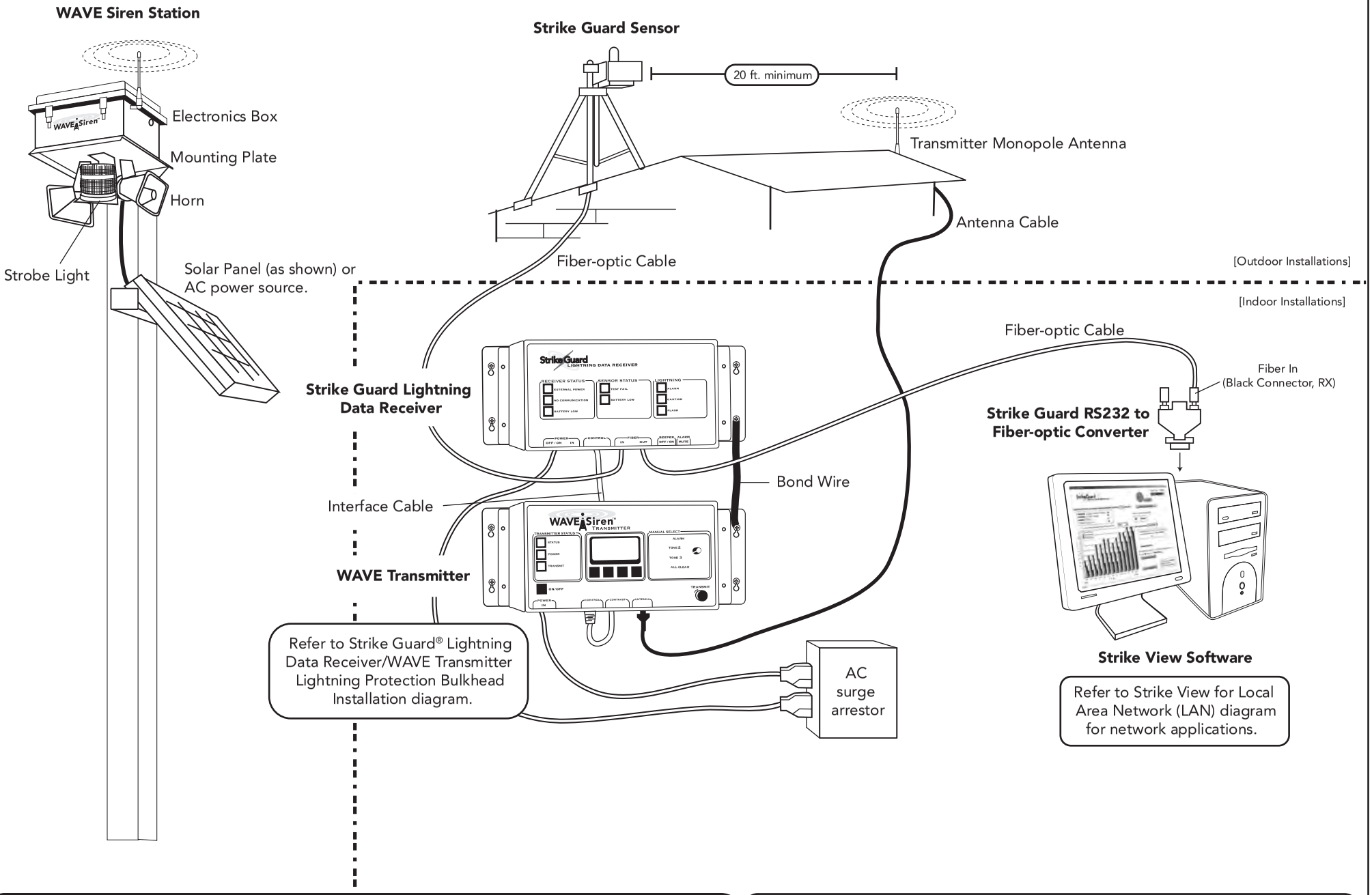
WAVE Siren™



Strike Guard® Lightning Warning System with WAVE Siren® Station

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